6th International Forum of Design as a Process

SYSTEMS & DESIGN

BEYOND PROCESSES AND THINKING

2016

Electronic book

PROCEEDINGS

June 22nd – 24th, 2016

EDITORIAL UNIVERTITAT POLITÈCNICA DE VALÈNCIA

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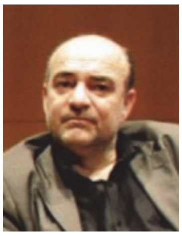

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INTRODUCTION

“Systems and Design” aims to provide a global view from the perspective of systems in general, and how they have contributed to a new vision of design. Since ancient times we can observe how systems have participated in thought, customs and development of civilizations, and how this symbiosis (systems-design), has influenced the existence of those goods and products that currently surround us. The construction of our world and its future evolution is with no doubt largely influenced by systems and how they contribute to its formation and development.

In the last decades, the design is subject to a permanent renewal result of the multidisciplinary influence and the systems. The design of the intangible is an inexorably part that will be subsequently processed by transformation functions resulting products or services properly optimized.

Therefore, analyzing how the design is affected by the systems, and measuring their degree of participation and influence today, it has been one of the objectives of this Congress.

They have brought different perspectives, from the contribution of researchers from different universities and continents. And with this vision and in this context, we have tried to cover the different considerations about Systems and Design provided by SD2016 participants.

Bernabé Hernandis

POSITIONING PAPER

Systems and Design: Beyond Processes and Thinking

Celaschi, Flaviano; Celi, Manuela; Formia, Elena; Franzato, Carlo; Imbesi, Lorenzo; Peruccio, Pier Paolo & Hernandis, Bernabé.

Scientific committee

Abstract

A contemporary vision of design needs to be encompassed in the actual mutation of the productive and cultural contexts facing different systems of change. Conceived as a collective work, this introductory paper looks at these changes in the design field by identifying six possible perspectives that, albeit laying on parallel dimensions, present many interrelated aspects: productive, professional, creative, cultural, sustainable, prospective. The conclusive paragraph brings forwards an in depth analisys that offers an engineering vision of design cultures.

***Keywords**: Industry 4.0, productive, knowledge, creative, cultural, sustainable, prospective systems*

1. Productive system. Awaiting the "digital tsunami" of the revolution in production processes[1]

When we are in the middle of some phenomena, very close to them, indeed, when the phenomena are right on top of us, it is always very difficult to describe them. As described by Massimo Bergami (2016, 13), "Up until now we have witnessed the appearance of gradual innovations that have added new tools and means of communication to our everyday life. In reality, the impact of the new technologies on processes is greater than what is immediately visible. It is also likely that this trend will suddenly accelerate due to the conjunction of enabling factors that are rapidly converging. Among these we could

[1] Flaviano Celaschi, PhD, Full Professor at Alma Mater Studiorum, University of Bologna (Italy), Director of the First and Second cycle Design Degree Programmes at UNIBO, Founder and coordinator of the Latin Network for the Development of Design Processes, Founder of the Advanced Design Network at the University of Bologna.

mention the diffusion of networks and ultrafast connectivity services, new abilities to rapidly manage large volumes of variable and diverse data, breeding grounds of revolution in industrial systems due to manufacturing computerization, the immersion of simulation systems that flip planning logic, the diffusion of cognitive computing, the effects of virtual/augmented reality, and the democratization of innovation potential, all obviously in addition to the 4.9 billion connected things in 2015, destined to become 6.3 in 2016, and 20.7 in 2020 according to estimates by Gartner."

With disarming clarity, nations at the forefront of production systems like Germany and the USA call it "Industry 4.0," intending with this slogan to establish that what is about to engage, and in part has already engaged the global production system is a revolution comparable in scale to the previous revolution in industrial automation that was led by Japan in the 1980s (Celaschi, 1992), recognized as a "revolution" comparable to the industrial upheaval linked to Ford and Taylor in the early 1900s, both analogous to the industrial revolution associated with steam in England in the late 1700s.

Personally I agree with this vision that underlines the moment, defining it as "revolutionary". As with the production revolutions that preceded us I am convinced that we can clearly use such a strong adjective because that which happened already in the first of these great revolutions is happening again now: the systemic set of innovations regarding the production system (what we would call B2B in professional jargon) and the set of innovations that regard our personal lives and communities every day (the rooms, the homes, the cities, where we live, in other words B2C) will be integrated into a single system that is more complex than in the past.

The processes that govern our everyday lives: food shopping, fueling and urban movement, fun and entertainment, education, sport training, emotional or sexual encounters, medical treatments, financial wagers, preparation of food, buying and selling houses, performing religious ceremonies, etc. will be strongly influenced, for the first time in real time and in digital form, by what can happen in the other half of the world (B2B), up until now characterized by being separated, closed, secret, and intended only for authorized personnel.

Production processes are at the center of this fourth revolution, due to two different drivers:

- Because the manufacturing dimension of making products and providing services is heavily influenced by the digital revolution that permeates it, redefining the relationships between operator and machine (control interface), but also the relations among suppliers, information management, geographical localization of factories, and their own productive nature.
- Because all this rethinking of the B2B dimension of production systems opens up to and can/must cross over into the other half of the world represented by people's lives (singly and collectively), heavily influencing their effects, but also being themselves heavily influenced in real time by the changes that will be triggered in the consumer and life part of the world.

Bergami, summarizing an intense contemporary bibliography, briefly suggested some of these drivers, which we will try to list: additive production, power of computer networks, cloud computing, sensors and Internet of objects, internet of behaviours, neurosciences applied to cognitive behaviours and decisions, big data, open sources, continuous innovation, futures studies, extreme design, automation and artificial intelligence, augmented and immersive reality, digital modeling, rapid prototyping, cyber security, photonics, traceability of production, use, and decommissioning processes.

Manufacturing passes from being producer of objects to being producer of production services, industry mixes with the lives of people and follows and influences each choice, quickly and continuously drawing from them useful indications of how to redefine the production itself (Frison, 2016), transforming us, as an integrated system of ubiquitous actors and consumers in real time, from factors of linear growth into factors of exponential growth. Just in the EU the directorate general of production activity estimates a need for 800,000 professionals by 2020 capable of operating in this new system of production and consumption, in a market that is estimated to be 27% of the global market, so 3 million new actors in the world[2].

From our point of view we must observe that even now we educate designers that in recent years are trained to work in a context in which the production system and the consumption system dialog amongst themselves. Since the first Maldonado (1972), the definition of designer has placed the accent on the need to mediate between production system and consumption system (Celaschi, 2008). However, the mediation that we find ourselves managing is no longer a soft action between two hard systems, but now has become the queen of the tableaux. The mediation system has taken over the scene, and herein lies the true transforming force of the production system of industry 4.0.

The framework that I suggest as matrix for reflecting on this document is therefore a system divided into four quadrants influenced by two worlds, one digital and one manufacturing, that come together, and by two systems, one production and the other consumption, that mix. Each of the four quadrants identified interacts continuously and in real time with the other, breaking down every door and resistance, systematically pervading the globe, without creating immediate dystopias but structurally modifying the model of life and production of billions of people.

Every aspect of the digital tsunami that awaits us is therefore soaked with design cultures, within the factory in the rethinking of production processes and products, outside of them in the rethinking of use processes and consumer and life models.

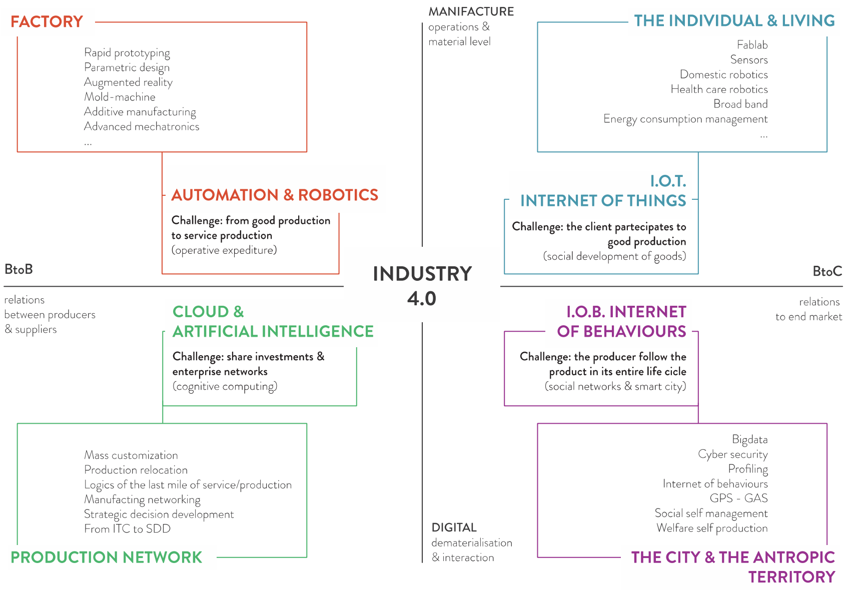

Fig. 1 Industry 4.0

[2] From the introduction speech by Khalil Rouhana, DG Connect, European Commission Component and System, conference Industry 4.0, Parma, 18/03/2016.

2. Knowledge system. Personal Factory, Design Cognitariat and Post-industrial Society: the design profession along with the transformation of the creative labour[3]

Along the crisis of industry, knowledge and the creative labour come to be the primary workforce capable of generating value and innovation. Industry is living an historical shift of its role within society and production through the admittance of the new technologies and the service sector.

The process of digitalization is leading to a transformation of the nature of the enterprises, while opening to new forms of micro-factories and "personal capitalism", in order to share locally and globally skills and knowledge, as well as resources and tools, to the accomplishment of projects and products.

The new generations of designers have come to terms with deindustrialization and, while their predecessors had a role in the assembly line with manufacturing processes, today's designers are aware of their service and strategic role concerning innovation.

Then, the young designer is experiencing a special space for self-organization, while incorporating all the productive aspects in his own office and even experimenting with self-branding, thereby revealing a spontaneous and alternative space to the official production.

Can we still speak of industrial design, while production seems to assume a completely new shape and organization, while delivering new outcomes? What are the characters of the post-industrial production in order to address design education and the role of the creative practitioner?

2.1 The Knowledge Cognitariat of Design

If the physical 'objects' are in the background of the creative activity of the project, design itself becomes a service in a collaborative network of players, where every segment is helping to finalise the end result. As property and goods were at the heart of the industrial capitalism and could be used for measuring the degree of innovation of production, the post-industrial era is investing in the immaterial assets of knowledge. The labour of the mind comes to be considered the primary workforce for generating value and design is an activity that can be located in-between 'doing' and 'knowing', material and immaterial.

In the knowledge society, the digitalisation process permeates every trait of the professional activity; it determines times and resources, and thereby reduces the entire design process to producing and processing data that has been re-elaborated by the knowledge and creativity that are put into play. The computer becomes the ultimate tool (Gorz, 2003), and unlike instruments requiring innate specialised skills and abilities, today's user-friendly software opens up the field to a vast, totally new group of young people, who would not have had access to design earlier.

In this way, the rate at which software is updated measures how quickly innovations are made to products, and design training becomes lifelong education and learning how to use updated technologies, thereby constantly redefining the rules of the game. In order to increase the value of their own cognitive 'fixed assets', the creative class needs to continually update and reinvest its knowledge through a constant training, in its daily grind producing and managing ideas, knowledge and techniques (Gorz, 2003). Even when off the job, they form and transform their knowledge and abilities: as a consequence, the continuous mobilisation of this live workforce through a constant creative effort occupies every moment of their life, so blurring the border between the time devoted to work and the time for leisure.

Everything in designers' daily lives - relationships, affective and emotional aspects, language and the ability to co-operate - is used as an investment to produce value. Thus, the anthropology of young

[3] Lorenzo Imbesi: Arch PhD, Associate Professor, Cumulus Executive Board, EAD Executive Committee, Design Unit Coordinator, Department of Planning, Design, Technology, Sapienza University of Rome.

designers is creating a ‘creative proletariat’ class, or to use a neologism, a ‘creative *cognitariat*’ (namely a cognitive proletariat of creativity) primarily through the imposition of new technologies (Imbesi, 2008).

In satisfying a broad demand of aesthetics, the ‘creative *cognitariat*’ is pushed to reinvent its own role every day, generating new products and services, as well as new markets and consumption models. The emergence of this new character with a bent for mobility and innovation, is spreading in our global cities, a bit as our 19th-century ancestors on the assembly lines created the *cité industrielle*.

2.2 Self-Capitalism

While observing the transformation of the nature of labour and enterprises in Italy, Bonomi and Rullani state the emergence of a new form of “personal capitalism”, where people may organize autonomously smaller entrepreneurships, while sharing locally and globally skills and knowledge, as well as resources and tools, to the accomplishment of projects and products. If the big Fordist corporation was self-sufficient with a pyramidal structure of organization, the model highlighted by the Italian industrial districts is made of a number of little and medium enterprises, networking each other horizontally and geographically positioned (Bonomi, Rullani, 2005).

At this end, the crisis of the big multinational companies seems to re-evaluate the experience and the organization of such ‘personal capitalists’, then leaving a special space for the self-organization of the individuals, with their unique trait and special contexts. Knowledge and creativity raise to be important levers with the support of the new technologies, to create innovation and value and to develop new autonomous experiences of production. At the same time, this is affecting also the way the young designers operate and manage their work. In a world where the number of designers are increasing and then the competition is more difficult - and without mentioning, at the same time the crisis of industry is restricting the spaces and the chances for them to work - the younger generations are trying to explore alternative professional approaches, also becoming themselves “personal capitalists”.

In the knowledge society, if it is true that the computer has become the tool of production *par excellence*, also its liberated accessibility is bringing closer the worker and his product, then opening up to new economies and new design experiences. This *'homo flexibilis'* of project often becomes an entrepreneur himself, building new biographical and production scenarios by experimenting with new forms of self-production that develops new critical keys beyond the immediate marketability (Imbesi, 2008).

With the help of information technology and the advancement of rapid prototyping and its related accessibility, for the first time the designer is in the position to close the circle of production, playing on his own every segment, ranging from design, to production, distribution, communication and even sales. The young designer - who has now learned to exploit his abilities to individually connect to a collaborative network of peers - can integrate every productive segment in his office, as a real entrepreneur, and even his name appears be used as a real brand.

The design studio happens to be renewed in a design office management; the prototyping workshop becomes a factory that produces small series of products; the tasks of the agent for distribution can be executed through Internet portals and e-commerce, just as every aspect connected with communication, such as designing the packaging, processing the corporate identity and all strategic aspects of product marketing may be handled by the same design office. The work of the designer may be extended even to curating the exhibition design of the points of sale and the selling itself, as it often happens in many international design fairs, where young designer are often self-promoting them.

Thus, the creative “cognitariat” of design discovers new capabilities for experimenting new experiences of self-organization and self-brand, while releasing a spontaneous and alternative space beside the official production, which may still be intertwined with, and then disseminating power for design.

3. Creative systems. Facing the tension between Authorial Creativity and Creative ecosystems[4]

In the prologue to his *The rise of the network society,* Manuel Castells affirms: "our societies are increasingly structured around a bipolar opposition between the Net and the self" (2012, 3). Very effective global networks are connecting individuals, groups, regions or even countries towards the fulfillment of the multiple goals that they search for achieving, with the same ease they could switch off them the next day. The ever-changing scenario gives multiple, temporary and weak opportunities to discuss, criticize, elaborate ethical positions and reasons for action. Individuals, grouped into several and frequently contradictory movements, go back to comforting primary identities, such as religious, ethnic or national ones, as today European vicissitudes demonstrate. While networks are shaping the world, we search for our identity to signify our social position and role.

Professionals, including design ones, are living this bipolar opposition. Designers design within powerful networks, frequently without being the protagonists of the design process. Many other actors, already involved in the design process (such as specialists of other area or the same entrepreneurs) or recently summed up (such as stakeholders or final users), could become equally or even more important for designing.

Adrian Forty (1992) already challenged the myth of the designer's omnipotence, stressing that, even if the literature have represented design as an act of pure creativity of the individual, society is a fundamental factor for inspiring the design process and creatively interpreting its results: thus, they are essential for the design success. However, today networks are taking on specific design potentials, becoming designing networks.

New information and communication technologies let many actors collaboratively interact in design processes, even if they are not designers, and web-platforms of design crowdsourcing, with commercial purposes or social ones, are making it even easier. Large design processes are being developed in real time, by actors distributed all over the world, without need of pivotal actors. Even the last winner of the Pritzker Architecture Prize, Alejandro Aravena, is well known for the development of wide participatory design processes, besides for his masterpieces.

Moreover, the design process continues within the use of the resulting devices. As foreseen by Pierre Lévy in 1990, in the knowledge ecology of the cyber culture, there are not clear limits that separate technical development and use: "no technical advance is determinate a priori, before to be tested by the heterogeneous collective, by the complex network in which it has to circulate and that eventually it should be able to reorganize someday" (1992, 204, authors' translation). As it was explained at the beginning of our positioning paper, industry 4.0 fades away the boundaries between production and consumption systems.

Instead, we should consider the ecosystems of creation as a whole. As other types of cultural ecosystems, creative ecosystems host countless, diverse, articulated connections that incubate creative processes aimed at interpreting, criticizing, rethinking and transforming the world, including design processes.

[4] Doctorate in Design from Politecnico di Milano (2008) and Bachelor in Industrial Design from the same University (2004), he is Professor in Design and Dean of the Shool of Creative Industries at Unisinos University (Porto Alegre, Brazil). His research focuses on complex collaborative design networks developed by designers, other professionals, organizations and institutions, users and citizens.

From an ecosystemic point of view, the design process is considered within those creative relations that it contribute to weave. Thus, the design focus shifts from the development of products, services, product-service systems or any other type of artifacts, to the practice of the creative relations. This way, the designer could aspire to be one of the most important actors of the designing networks, since his or her technical skills could serve as a platform for the cross-disciplinary convergence of the various actors of the creative ecosystem.

This way, the design process results in a method for the creation, the practice and the evolution of the strategies that organize the various actors for collaboratively designing. Through the design action, it becomes possible to lead with the instability of the ecosystem. In this direction, the designer's aptitude of reading the signals emitted by the ecosystem, allied to scenario-based design methodologies, come to be the core of design process, since they permit to consider the regular and the evident, the possible and even the deviation and the unpredictable, the chance and the error.

In the described context, even if design emerges as a very important process among the processes of the creative ecosystems, even if the designer – as we affirmed – remains immanently an important actor, which is the role of a most authorial design? We can highlight at least three possibilities of this form of expression that is so important for the design history:

- Critical design. Designers can use the design process to criticize our relationships with the natural and social environment, and, through their artefacts, propose alternative scenarios that discuss contemporary lifestyles and open to the democratic discussion of our future (see Dunne, 2008);
- Adversarial design. In this direction, designers can go on using the design process with political purposes, defying the status quo, the network society as well (see Disalvo, 2012);
- Advanced design. The previous possibilities are related to our present, but looking to a next future that we can socially construct. Anyway, designers can use evolved design processes to imagine a faraway future and design towards it (see Celi, 2010).

Interestingly, these possibilities for authorial design match the previous processes of designing within creative ecosystem in the metadesign level, in which it is possible to critically reflect upon the design process, in order to evolve it. In fact, as presented in the 5th international forum of design as process (Franzato, 2014), metadesign allows the speculative design processes that support critical, adversarial and advanced design, besides to allow the opening of design processes to designing networks. In this sense, metadesign is a crux for contemporary design processes.

4. Cultural systems. The role of design in the new system of cultures[5]

The infra-ordinariness of design is a distinctive feature. In the model of Design as Mediation Between Areas of Knowledge, Flaviano Celaschi affirms that "The design that we study appears to us today as a form of knowledge that creates relationships between other forms of knowledge. A discipline that would appear to take shape around the sensitivity of not producing an independent knowledge of its own (or at least one that has not yet succeeded in doing so) in competition with the capacity for analysis and with the levels of knowledge gained by other, historic lines of study in modern science. If anything, it is precisely by respecting the rules and the sets of analytical knowledge used up by other disciplines that it takes hold

[5] Elena Formia, PhD, is a Fixed-term Senior Assistant Professor at the Alma Mater Studiorum, University of Bologna, where she is member of the Advanced Design Network. Since 2008 she has been Scientific Secretary of the Latin Network for the Development of Design Processes, taking part in the organization, promotion and spreading of its various initiatives. Her research interests cover the concept of design cultures and the relationships between humanistic knowledge and design sciences.

of them as input and as a basis for bringing about an organised transformation of the world of goods that surrounds us." (Celaschi, 2008, 21)

The systemic model proposed by Celaschi was on some level a continuation of a previous thread of debate that first saw the light more than 40 years ago, when it then became apparent that design had to be recognized as a subject in its own right - a necessity based on objectivity and rationality. An example of this is the historical definition given by Tomàs Maldonado (1972), who spoke about design as the process of coordinating, directing and guiding different factors belonging to different spheres of knowledge that interact within a complex system: the functional factors, alongside those concerned with production and with socio-cultural and economic aspects, are the four elements that influence design. A few years later, John Haskett (1980) coined the non-definition of design, seen as an expansive and confusing discipline, full of incongruities, with many manifestations and whose boundaries are uncertain and polarized by different driving forces ("Design is to design a design to produce a design"). More recently, with the idea of "multi-faceted design", Ezio Manzini (2007) highlighted the fact that design can interact with and connect different spheres and fields of knowledge. Together, these all contribute towards expressing a new kind of innovation which is, at the same time, technical, social, cultural and esthetical. According to Alessandro Deserti (2009), if we place design on a hypothetical map, its development can be described in terms of a progressive expansion from a "solid centre" – which can be described as the link to the traditional interest in giving shape to new products – to much softer peripheral areas, that overlaps extensively with other disciplines. From here comes the idea of a "product-system", as a complex combination of material and immaterial factors and qualities, all of which have to be addressed with a new strategic mind-set.

These definitions have maintained a certain continuity over time and are strictly tied to the essence of design as a discipline, in being a subject that, historically, has cut across culture and science, art and technology, culture and technology (Mumford, 1952; Maldonado, 1979). The philosopher Vilem Flusser (2003) spoke about design as a "bridge" between the two forms of knowledge (scientific and artistic) or between what is termed the "two cultures". The direct reference to Charles P. Snow is evident and can be taken as granted. Between 1959 and 1963, the British scientist and novelist set out his theory whereby it is possible to create connections between disciplinary boundaries, between sciences and humanities, and between scientists and intellectuals, optimistically to introduce a mediating "third culture", defined by John Brockman in *The Third Culture: Beyond the Scientific Revolution*, published in 1995. While the purpose of this rapid overview is not to bring up the theory proposed by Snow more than 50 years ago, it is clear that scientific literature on design has progressively recognized and rationalized its capacity to be commonplace, disruptive, dynamic, open and relational; that it can work in a complex and not linear way; and that it can use an abductive model of reasoning when being generated.

The system of knowledge around design has progressively grown, consolidating its relationships with other subjects. British professor Guy Julier introduced the idea of a *Culture of Design* (1st ed. 2000, 2nd ed. 2007, 3rd ed. 2014) as a possible lens through which to analyse the ubiquitous role of design in contemporary society (both as an object of study and as an academic subject). The idea of a "cultural turn" has penetrated many humanistic disciplines since the early 2000s - from history, to anthropology, human geography and sociology (Nash, 2001; Barnett, 2002) - posing interesting questions about how to interpret the world around us or, in other words, our material culture. This change has progressively influenced the fields of design. In recent studies, the definition of culture itself has been closely examined, i.e. "which culture(s) should we refer to as scholars in the field of design?" (Penati, 2013). One of the most solid models remains the concept of production-consumption-mediation as a form of interpreting and studying design artefacts, processes and activities (Lees Maffei, 2009). The culture of the designer (education, ideological factors, historical influences, professional status and market perception), together with that of production (materials and technology, manufacturing systems, marketing, advertising, product positioning and distribution channels) and consumption (demography, social relations, taste, cultural geography, ethnography and psychological response) are the domains in which to study the culture of design. They inform each other in an endless cycle of exchange and can be nurtured through the integration of many disciplinary skills. The emphasis on mediation has, naturally, acquired more significance, and mediating channels are now increasingly the focus of attention.

This discourse is highly complex and has been interpreted from many perspectives. Within the concept of the Industry 4.0 introduced at the beginning of the paper by Celaschi, we can examine whether this interpretative model still remain central and valid. Facing the challenges of the "new industrial revolution", we are asking further questions: Is it the network/system of knowledge already in place sufficient? Are there any other forms of culture that we should take into consideration when approaching and interpreting these new frontiers?

The French scholar Yves Citton has recently come up with an interesting proposition. In bringing up the importance of interpretation, he notes that the interpretative gesture offers a privileged condition for the encounter and synthesis between intuition (aesthetics) and order (scientific), between the immediate evidence of the textual data and the critical autonomy of the subject (Citton, 2012). Faced with the challenge posed by the new 4.0 Industry, the value of the designer, in a hermeneutic perspective, could, once again, play a key role in mediation.

5. Ecosystems. Against a throwaway culture[6]

Time has passed since "industrial design has put murder on a mass-production basis" as in the words of Victor Papanek (Papanek, 1970). Quite apart from any ethical judgements about this kind of behavior, it is nevertheless obvious that the designer is still an "accelerator" of events, a force he shares with the consumer. Even more today in the 4.0 Industry era: together they are capable of influencing market dynamics and therefore the production of goods and services. In one way or another, the choices a designer makes have a global fallout. His destiny is to play a crucial role in society.

In a 4.0 Industry scenario, sustainable design paradigms have to change. As production processes, logistics and resources modify their roles and even new players (e.g. Internet of Things, Big Data, Augmented Reality, etc.) enter the system, a product-centered environmental process to design seems to be ineffective in tackling contemporary issues.

An ecodesign approach, based on reducing, reusing, recycling, dematerializing, using renewable energy, disassembly and other strategic efforts to minimize the impact of products and services, only partially faces urgent sustainable challenges. It is necessary a shift in design methods and even more important, a behavior change. Rapid prototyping, sensing, clouding computing, IoT, Artificial Intelligence and other drivers of 4.0 Industry are powerful means by which we can modify our culture and, by extension, our Planet. "We have to accept that technological products are not neutral - Pope Francis clearly says -, for they create a framework which ends up conditioning lifestyles and shaping social possibilities along the lines dictated by the interests of certain powerful groups. Decisions which may seem purely instrumental are in reality decisions about the kind of society we want to build" (Francis, 2015).

As "industry mixes to life" (Celaschi, infra) we cannot ignore anymore the complex relationship between action and reaction in natural and artificial systems. From the smallest units to the largest entities, we are

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all part of a complex system as described in the milestone documentary film “The Power of Ten” (1968) by Charles and Ray Eames.

Designers and architects were already aware of this in the 1950s when they realized how complex and difficult design actually was. Too many variables became involved and an interdisciplinary approach was needed with inputs by experts from more than one field of knowledge. The process that gradually developed and grew during that period helped to break down disciplinary barriers and moved in the opposite direction to the monodisciplinary and specialist approach of the first half of the nineteenth century. In particular, architectural projects and design met with the culture of complexity at the Ulm School with the introduction of new “design” disciplines such as cybernetics, theory of systems, information theory, semiotics, and ergonomics. Nonetheless system is not a real object: it is a simulacrum, a tool used to simulate reality and “exists only as we thought it. It is an arbitrary concept and also its limits are fixed arbitrarily by the observer in relation to cognitive ends he pursues it” (Bologna, 2008).

Sustainability is not a private issue. It is a common value shared by the entire community.

In a 4.0 Industry era, designers are asked to design open industrial systems to avoid production waste, and create ecologically sustainable communities. The focus moves on the design of an entire system located in a precise social, political, economic, and cultural context. Designers establish relationships with the natural world and even replicate some of its more virtuous processes, rather than entering into conflict with it. “After 3.8 billion years of evolution – Janine Benyus writes in Biomimicry - nature has learned: what works, what is appropriate, what lasts”.

This confirms a shift in the idea of industry, away from linear models in which waste is considered the norm, to integrated systems where both digital techologies and traditional manufacturing play an important role, in which everything has a use because it is converted into value-added input for other processes.

In such a cultural scenario we can recognize a strong interest on the organization of autonomous forms of enterprise. It means self-production in a design context: from do it yourself to digital manufacturing. Some of these activies are part of the so-called informal economy: "if we call formal economy the processes of production and exchange of goods and services regulated by the market and typically carried out by industrial and commercial profit-oriented enterprises, operating under the rules of business law, tax, labor - Arnaldo Bagnasco recently explains - than we could call informal economy all those processes of production and exchange that tend to escape one or more aspects of these distinctive characteristics (Bagnasco, 1999).

In an interesting pamphlet of 1978, Ivan Illich investigates the keen issue of unemployment and flanks the word creative, highlighting the potential of vernacular activities - for instance, the assistance offered to children and the elderly, bricolage or other household chores - as a historic opportunity to break the dominance of conceptual pair capital-labor which, from the time of Adam Smith onwards, makes up the corner stone of Western economy.

The informal economy makes way in the interstices of economic processes by enabling new projects from the bottom. If the traditional literature describes the two economies as in opposition to each other, nowadays it is necessary to think of a unique production system consisting of at least two souls. The definition of this model requires the presence of an official economy, formal, recognized, which is accompanied by an informal economy - also called submerged, underground, hidden, shadow or gray – unregulated, because it is outer of accounting of GDP per capita of a nation.

The interdependence of ecological and social issues as well as the re-growing phenomena such as informal economy and social capital (network of relations) are the basis of the concept of “integral ecology” (or “systemic approach” by Fritjof Capra[7]) outlined in chapter four of Pope’s Encyclical (Francis, 2015). From this point of view also new technologies, on one side, and designers, on the other, could play active roles in fighting the throwaway culture, which is the result of the irrational belief in infinite growth. Not more production but better production in which the waste products of a production cycle become a resource for another production process. This is one of the most interesting challenges we need to face in order to activate virtuous growth processes in a territory.

6. Prospective Systems. Strategic Design & Anticipatory Design: different approaches to systemic change[8]

Design, as a driver of innovation and change, is a complex discipline characterized by unique ways of learning, abductive thinking and often untranslatable processes. Since Design discipline has grown its borders from material products and artifacts to the immaterial side of the project, many adjective have been used to define the design ability to shape, influence and determine the pathway to change.

Strategic and anticipatory nature represents different ways of facing future perspective in design activity.

Both of them aspire to a wider aim of design, not only connected with the solidity of the products world and the connected markets, but with the immaterial side of goods (meaning, ethics, social aims), both of them have the aim of planning and designing not only for the immediate tomorrow and nevertheless they show different attitude.

6.1 Strategy: the art of planning

The term Strategic design and its culture were born around a strong emphasis on the “company” as the main subject of the strategic design culture. Since Peter Beherens, whose first works for AEG have been defined a first contribution to design management (Burdek, 2005), emerged the first tendencies to valorise the design competences in the wider context of the entire company. Michael Farr, in particular, was the first one to intertwine knowledge from system theory, design and management defining a design path inside companies: “Design management is the function of defining a design problem, finding the most suitable designer, and making it possible for him to solve it on time and within a budget. This is a consciously managed exercise which can apply to all the areas where designers work.” (Farr, 1965)

Further reasoning in the seventies focalized two main issues dealing with design management: the necessity to foster corporate strategy and the need of develop methodology for information processing. The influence of the operation area was at that moment justified by the necessity of growing a continuous practice of product development and of the companies’ inadequacies in including design practice into the process of product development. In the eighties the design management had a great impulse thanks to the acknowledgment of its capability of increasing the product value on the market: companies have soon learned that the product, when bringing a semantic value, can be better or differently placed in the market

[7] The systems view of life, integrating life’s biological, cognitive, social, and ecological dimensions, is implicit in the conceptual framework of Laudato Si’. The Pope states explicitly that that solving our global problems requires a new way of thinking, and he makes clear that what he has in mind is thinking in terms of connectedness and relationships — in other words, systemic thinking” (Capra, 2015).

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acquiring new customer's segment. But it is in the nineties that the idea of a Strategic Design takes place: a more holistic approach, the central role assumed by many designer in the product development process and the grow of a corporate culture and image were calling for a designer profile with mixed competences between project, economy and culture. In particular there has been a strong emphasis on a systemic interpretation of the project connected to the so called Product Service System (PSSD) dimension: emerges an orientation toward different kinds of social and market actors, a clear intention to produce innovation, and an emphasis on a systemic interpretation of sustainable development (Meroni, 2008). Francesco Zurlo in his definition of the term Strategic Design describes the strategic adjective as a hat that covers more approaches (operations, tools and knowledge building models) and is involved in theoretical and practical aspects (design leadership, design thinking, design direction, business design, research, etc.). In a wider sense when design is involved in the decision making process its role becomes strategic. Strategic Design is the activity able to plan or design to impact favourably the key factors on which the desired outcome of an organization depends. Another definition of strategy refers to methods or plan to bring about a desired future, such as achievement of a goal or solution to a problem. This openness toward future is connected to the design ability to foster change inside organization but, dew to the origin of such practice –as we have seen- and to the context primarily limited to enterprise (commercial or social) this change is normally connected to a predetermined objective. An horizon toward which the designer look designing scenarios, producing visions and then prototypes and artefacts able to catalyse and exploit the present resources to produce a certain range of results.

If we consider the literature coming from the Future Studies area and the contribution of Voros (2003) in particular it is soon clear that this perspective encompass only a limited vision of the futures. To foster a process toward what we "want to" happen, means to consider only the perspective of the preferable futures. In other words futures that are more emotional than cognitive, futures that derive from value judgments and for this reason are more subjective depending on who is doing the preferring.

6.2 Anticipation: the art of reacting

Paradoxically the only time in which we can act is the future and Design is an activity heavily projected in to the future. Even if the consciousness of the centrality of the futures study within our discipline is slow to grow the actual strength of the international scientific debate about the study of the future - and Anticipation Studies in particular - allows us to meet this important area of concern together with other human and social science (sociology, psychology, anthropology, technology, economy, art) involved in the dimension of time yet to come. The future awareness or better what Miller (2007) calls future literacy, is crucial in the design profession for many reason: its huge responsibility in shaping goods, its ability in planning products longevity or life cycle, its contribution to service design and social design, but most of all for its unique capacity of imagining, shaping and communicating new values and perspective.

According to Poli, Miller and Rossel (2013) "all efforts to "know the future" in the sense of thinking about and using the future are forms of anticipation. Equally the future is incorporated into all phenomena, conscious or unconscious, physical or ideational, as anticipation".

One important motivation the conscious use of the future is the statement that perfect anticipation of change is both practically and theoretically not achievable in our universe.

Our incapability of predicting - but also determining the future - is connected from one side to the lack or unavailability of both the data and models but, most of all, the consciousness that our universe is "creative" in the sense that novelty happens – provided that suitable enabling pre-conditions are given (Poli, Miller & Rossel, 2013). The certainty that characterises scientific disciplines and underpins the repeatability of scientific experiments does not belong to those of the project; this is precluded also to the disciplines of anticipation. Starting from this assumption the pretention of designing the future is an oxymoron nevertheless we can recognize that design, constantly dealing with uncertainty is a discipline able to deal with the future dimension. The world of design is constantly subject to a state of continuous emergency; the product is increasingly temporary and precarious and takes on increasingly ephemeral connotations. In this condition of accelerated obsolescence that causes distress, some high-value technology products are promoted through the "future-proof" expression to emphasise their permanence in time and their adaptability to subsequent developments. When establishing new ways of future-oriented projects, there are no future-proof methods, however, as this means being able to predict today what will happen tomorrow with certainty, while the project of the future requires the unconditional acceptance of uncertainty (Celi & Celaschi, 2015). The capacity to understand context constraints, strong and polymorphous reframing capabilities and mediation skills are the knowledge areas that Design, and Advanced Design field in particular, can offer to anticipation. Zamenopoulos and Alexiou (2007), who already explore the possibility of an anticipatory view of design, also suggest another capability: "More importantly, design also involves the capacity to anticipate the correspondence between theories and models, which can only be verified by experimentation or the actual realisation of the design artefact" (Zamenopoulos & Alexiou, 2007, 431).

The design of the future must move on the ground of the possibility and its many never unique expressions. This approach, this ability can be recognized as an anticipatory attitude of design able to leave the orizon open to different possibilities, able to interact with several different actors and to produce multiple scenarios and solutions.

7. What is Systemic Design?[9]

Systems, existing from the beginning of creation, have evolved since ancient times generating a scientific and academic discipline through which the complexity of living beings, nature and even the evolution itself of current science is explained to a large extent.

The study of systems through modeling and subsequent simulation has enabled us to gain new knowledge and thus explain the behavior of countless phenomena. Their Identification and later classification, according to their origin, type or intangibility, have allowed us to represent, understand and study their past, present and future development, on the basis their expected behaviors.

Open, closed, adaptive, emergent, and other systems are defined according to their structure, behavior and evolution. In the field of design, taking the existing knowledge about system into account inevitably generates new approaches inherent in current design processes, suggesting new strategies that allow us to improve the management of the intangible in order to optimize the design of the tangible.

The social and business environments, the territory and the products are common areas, where knowledge management optimization is sought as to observe the largest possible number of factors affecting the decisions underlying the design of new products or services.

The challenges posed by the complexity of our times requires observation and study to be carried out with different approaches and research lines able of interpreting many complex relationships, considering their behavior and involvement in the design process from a multidisciplinary point of view.

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Therefore, systems deserve our greatest attention, in the light of their permanent existence as a constitutive element of our reality able to represent, in any discipline, the complexity of our world.

Furthermore, within the design field, it will be necessary to study, consider and analyze how systems are part of the academic and scientific domains to which we, as researchers, devote most our time.

Perhaps, as they evoke our not too distant past, today systems constitute an indivisible whole underpinning the behavior of many of the processes we base our work on both in the field of education and in that of research. And, probably, in a not so distant future, they will be studied for their structural uniqueness. We must not forget that since ancient times there has existed a continued interest in analyzing the tangible and intangible aspects that constitute reality.

However, the synergy process stems from a complexity which requires the existence of added elements to justify its balance. Perhaps systems are indispensable elements constituting the necessary blocks to stabilize continuous change.

What can we learn from the study of systems in order to optimize the design process? This will be a key issue to deal with in the next decade. Perhaps, System Design is currently able to provide a way to address the issue of what approach we should use to tackle the complexity of design without losing its inherent creativity power. This complexity should investigate the social and economic aspects of the territory, the companies and the products, considering both the tangible and the intangible, so as to provide sustainable solutions that envisage a future beyond processes(HERNANDIS, 2015).

The conference “SYSTEMS and DESIGN: Beyond Processes and Thinking” aims to present some of these new approaches leveraging this forum to pool new thoughts, voices and insights that pursue any of the objectives described above. Although it may seem that everything has been invented and designed already, multiple inspiring visions still arise that suggest new approaches in the traditional disciplines. Mankind continually reinvents itself, coming up with new ways of working and turning new methods into future proposals. Studying systems from a design perspective with a view to improving the reality as much as possible, as well as bringing a new distinguishing visions to design, might pose a challenge worth solving.

Through knowledge management we are able to transform the intangible aspects associated with different sociocultural, business, territorial and technological dimensions by using design as a transforming function capable of converting intangible knowledge into tangible solutions (i.e. products and services demanded by society).

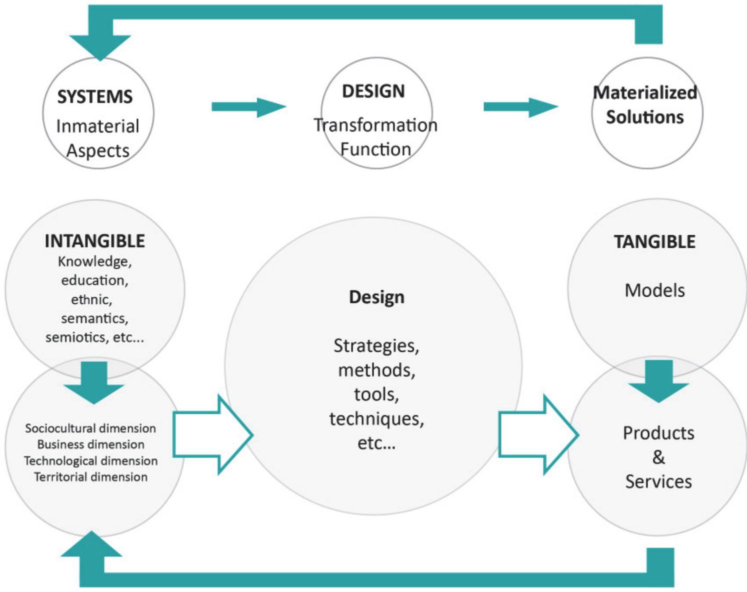

Fig.2 Management of the intangible in order to optimize the design of the tangible. Hernandis, B. (2015)

This stands for a conceptual model expressing that the function of the intangible is susceptible of being transformed into tangible through the intervention of the transformative role of Design. The design of intangibility, i.e. the knowledge necessary to represent systems, generates tangible subsystems, namely products or services, through the design transformative function (1).

$$[D(I)_k] \text{ x } \Phi(D) \equiv [D(T)_{p/s}] \qquad (1)$$

One may say that the designer uses knowledge management consciously or unconsciously as a starting point for the ideation of the product. The handling of the intangible becomes more and more relevant over time as different methods emerge for knowledge extraction and subsequent organization. This calls upon the designer to have a broad knowledge about the possibilities offered by new methods based on innovation and creativity.

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INTANGIBLE ASPECTS

Smart specialization strategy: model innovation systems

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Abstract

We are in the knowledge and network society which are the factors generating growth of society. But the combination of these two factors does not make other factors essential to achieve that growth? In this global world where we are increasingly more often companies, institutions, cities and territories establish their development strategies to achieve leadership. Strategies, as it can't be otherwise, must be intelligent and because of that we speak of smart cities and territories. Every intelligent design requires the establishment of adequate representation of this in order to, with the influence of the past, imagine scenarios of future success. This representation must be systemic by the number of agents, relationships and committed knowledge, but the practical management of these systems need to devise models that simplify reality but take into account the main features of the system they represent. In the case of innovation I will show you how the complexity of the system need to innovate can be modeled in order to understand the initial situation and to establish, with relevant information, smart specialization strategy system.

***Keywords**: Knowledge, systemics, strategy, smart specialization.*

Design after Design: Creating a wisdom economy through Generative and Collaborative Design practice.

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Keynote Speaker

Abstract

In this information age what becomes most critical is our capacity to sift through data, recognize patterns and synthesize knowledge into actions that will improve the quality of life on our planet for all citizens and species. The capacity to make wise choices and to foster wisdom at the broadest level in society will be critical to addressing the global challenges we are facing all the way from income inequity to climate change. Industrial Design has had a critical role in advancing our standard of living and at the same time exacerbating our current environmental malaise by enabling hyper-productivity. Can we re-imagine a Design after Design that will power a new paradigm for creation and sharing in this next century characterized by balance and moderation? By examining new generative models for design and new inter-disciplinary ways of collaborating we can begin to imagine a new systems design philosophy that fosters co-creation returning to people the fundamental act of creativity enriching their lives with continuous learning.

***Keywords**: Knowledge, prospective systems, industrial design,*

The Series Lies within the Object

Bihanic, David
University of Paris I Pantheon-Sorbonne, France.
Keynote Speaker

Abstract

The new industrial and digital craft objects shall not be considered as finished products, so in other words 'ready-to-use' and closed in on themselves. They are not the ultimate outcome of expert anticipatory (or predictive) studies (i.e. future sensing), and even less the material support of prescribed/predefined uses. In fact, these new objects are inherently unfinished, and therefore spur both designers and users into action (in favor of manifold design and development proposals). As their shape and function (amongst others) continuously change, the object acquires a new status, a new nature: it becomes a genuine system that provides an infinite number of possible object. The series3 would thus be lying within the object — the first occurrence of the object-system allows establishing the foundations of his ad hoc combinational logic (leading to countless generations of object states). In my speech, I will strive to highlight the main challenges and opportunities brought by what appears to be a new systemic revolution of product design. To do so, I will focus on two key strategic axes: (1) from the object improvement to his 'parametric mutation'; (2) from the customization4/adaptation5 of object to a new type of innovative use (towards an innovation through practice).

Keywords: *Object systems, series, parametric, custom.*

Learning systems within the design praxis

Íñiguez-Flores, Roberto.
Tecnológico de Monterrey. Mexico.
Keynote Speaker

Abstract

During the second half of the last century the General Systems Theory (GST) received much attention, not just because of its promise regards offering a "unified science" as Checkland mentioned, but also because in its becoming it demonstrates to the world a completely different way to observe the reality. In a third stage (after theoretical and bio-systemic) the GST demonstrate a capability of application, particularly in the management and engineering field that have had a huge impact.

Nowadays, the systemic thinking offers an alternative to complexity management, precisely in application fields where design is getting present more and more, complexity brings more uncertainty so that the meeting points between systemics and design are required: from methods to visualization (or modelization) design has been nurtured from applied systemics. An important key to understand the overlap phenomenon between systems and design (mainly inside organizations) is learning; at the systemic tradition, methods suggest "learning" as the element that connects the real world problematic situations with change and the improvement that and organization may want to perform. ¿How to deal with learning inside complex processes?, ¿which are the characteristics of the convergence at the design processes? ¿how the organizations face or lead the learning processes to cope with change?

Keywords: *Design. systemic thinking. innovation management*

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Diseño inmaterial - Hacia la desmaterialización y digitalización de productos y servicios como herramienta de sostenibilidad

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Resumen

La crisis ambiental es también un problema de comportamiento, y no está limitado sólamente a tecnología, producción y volumen. Por lo tanto, con la evolución y los avances en la tecnología, los procesos y métodos de producción para desarrar nuevos productos y servicios, es necesario analizar el nuevo papel del diseño en la sociedad actual. El objetivo propuesto de este estudio es el de describir la relación entre dinámicas de desmaterialización y digitalización (o informacionalización) de productos y servicios y la sostenibilidad.

La investigación se lleva a cabo a partir de un estudio de caso con un enfoque cualitativo y un énfasis analítico-descriptivo, sobre la manera en que factores tales como los avances tecnológicos, junto con los comportamientos y las emociones de los usuarios influyen en la configuración de productos y servicios y su relación con la sostenibilidad. Es importante resaltar hasta qué punto se puede sentir amenazado el "know how" del diseñador con la aparición, cada vez más frecuente, de productos y servicios desmaterializados y/o digitalizados. En este sentido, se plantea que, más que una amenaza, puede ser una oportunidad para evolucionar, considerando enfoques sistémicos desde una perspectiva multi-objetivo, multidimensional y multidisciplinaria. El presente análisis podría proporcionar pistas en el campo del diseño, teniendo en cuenta el contexto inmaterial para desarrollar productos y servicios desmaterializados y digitalizados, comprometidos con una sociedad más sostenible.

Palabras clave: *Diseño, inmaterial, desmaterialización, digitalización, sostenibilidad.*

Abstract

The environmental crisis is also a behavioral issue, and not one simply of technology, production, and volume. Thus, with the evolution and advances in technology, processes and production methods for development of new products, it is necessary to analyze the new role of design in today´s society. The proposed aim of this paper is to describe the relationship between dematerialization and digitalization (or informationalization) of products and services into sustainability.

The research is carried out from a case study with a qualitative approach and an analytical-descriptive emphasis, how factors such as technological advances along with behavior and emotions of users influence the configuration of products and services and its relationship to sustainability. It is important to stress to what extent the "know how" from the Designer can feel threatened with the appearance of increasingly frequent dematerialized and/or digitalized products and services. And in this sense, it might be stated that rather than a threat, it could be an opportunity to evolve, considering systemic approaches from a multi-objective, multidimensional and multidisciplinary perspective. This analysis could provide clues to field of knowledge taking into account the immaterial context, to develop dematerialized and/or digitalized products and services committed with a more sustainable society.

Keywords: *Design, immaterial, dematerialization, digitalization, sustainability.*

1. Introducción

La actividad del Diseño tiene una gran responsabilidad del actual estado del medio ambiente, además de un papel fundamental en la búsqueda de la sostenibilidad. En el contexto actual, enfocado hacia una sociedad sostenible, es conveniente reflexionar sobre la influencia que tiene el diseño sobre productos y servicios, a modo de lograr un planteamiento, desarrollo y puesta en funcionamiento -o uso- de los mismos de manera sostenible. Del mismo modo, es necesario reflexionar sobre la forma de abordar los problemas de la sostenibilidad, pues se considera que aunque ya se han logrado algunos avances, es un campo aún por explorar. De hecho, hasta hace poco, las metodologías de diseño sostenible raramente estaban comprometidas con las cuestiones más fundamentales como el sentido y el lugar de los productos y servicios en nuestras vidas, y la contribución de los bienes materiales a lo que podría ser definido ampliamente como el esfuerzo humano (Chapman, 2009). Aunque las cuatro décadas y media de actividades del diseño sostenible, según y cómo lo afirma Chapman, *"han hecho este desperdicio e ineficiencia ligeramente menos derrochadora e ineficiente"* (2009, pág. 30), es una perspectiva de sostenibilidad limitada e insuficiente desde un punto de vista evolutivo y de proyección en el tiempo, por lo que se hace indispensable un abordaje desde otras perspectivas, en términos de proponer alternativas y medios que permitan alcanzar una sociedad sostenible en todos los niveles.

La sostenibilidad está evolucionando, actualmente su naturaleza va más allá de los tres pilares básicos con que era concebida (ecológico, económico y social), por lo que es conveniente analizar si hay una nueva visión de la sostenibilidad, en la cual a través de una perspectiva holística y sistémica de las alteraciones ambientales, sea posible encontrar soluciones que incluyan elementos *materiales* e *inmateriales* relacionados con el comportamiento humano y las dimensiones culturales. Planteamientos propuestos por autores como Walker (2006), Wahl & Baxter (2008), González (2013) o Wigum (2004), destacan la importancia de las motivaciones esenciales de los individuos, como una la fuerza dinámica que permita un cambio en productos y servicios, a través de las demandas y aspiraciones reales, que no pueden llevarse a cabo y definirse sólo a través de hechos físicos.

Autores como Mugge, Schoormans, & Schifferstein (2007) se cuestionan sobre el porqué las personas desarrollan relaciones sólidas hacia determinados productos y cómo los diseñadores pueden influir en el grado de apego a través del diseño de productos. Aunque lo anterior se refiere a productos tangibles, se plantea que también se puede presentar en productos y servicios intangibles. Lo cual es una gran oportunidad para que, diseñadores y desarrolladores de productos y servicios, lo enfoquen hacia su área de estudio, y en éste caso en especial hacia "la sostenibilidad".

Por otro lado, también es importante tener en cuenta al usuario o consumidor y su percepción sobre la sostenibilidad, a modo de identificar cuales son los rasgos, aspectos o atributos que deben poseer productos y servicios sostenibles, según sus criterios. Esto puede servir para identificar, cómo se le puede dar un nuevo enfoque a la sostenibilidad -en caso de ser necesario- o comprobar si el modelo actual es el adecuado; con el fin de ratificar o replantear el concepto que la sociedad tiene de la sostenibilidad. Para ello se debe ir más allá de la caracterización del fenómeno. Es decir, saber si el fenómeno de la sostenibilidad hoy en día se caracteriza por reparación, reuso, uso secundario, mínimo consumo de recursos, recuperación, reciclaje, compostaje, etc., o si se está caracterizando por otros aspectos basados en actualización, cambio de formato (producto a servicio), desmaterialización, sustitución, virtualización, multifuncionalidad, optimización de la vida útil, uso compartido, creación de experiencias, vinculo emocional y otros elementos que podrían hacer parte de ese *contexto inmaterial*, relacionado con las emociones y los valores, y que posiblemente no sean considerados en la actualidad como impulsores de la sostenibilidad.

El propósito del actual estudio es, desde una perspectiva sistémica, reflexionar sobre unas dimensiones material (*contexto material*) e inmaterial (*contexto inmaterial*), que se creen presentes en el planteamiento, desarrollo y puesta en funcionamiento -o uso- de productos y servicios, a modo de identificar un *diseño inmaterial* que relacione las actuales dinámicas de *desmaterialización y digitalización -o informacionalización-* de productos y servicios con la sostenibilidad. Con base en lo mencionado, se plantea el análisis de un estudio de caso en el que se consideren enfoques y estudios basados en las necesidades de los seres humanos, así como las emociones y sistemas de valores, que permitan reconocer puntos clave pertenecientes a esa *dimensión inmaterial*, los cuales a menudo se pasan por alto en la configuración de un producto o servicio y que se cree son relevantes al momento de generar una solución de diseño sostenible.

2. Marco conceptual

2.1. El modelo de diseño concurrente

El presente estudio se basa en el *Modelo de Diseño Concurrente* (MDC) de Hernandis, B. (2003). El modelo consta principalmente de un *sistema exterior* y de un *sistema de referencia* o sistema en estudio. En el *sistema exterior* se consideran tanto los aspectos relacionados con la *dimensión más tangible* del diseño del producto/servicio (materias primas, procesos, tecnologías, funcionalidad, distribución, proveedores, infraestructuras, entre otros), así como los aspectos más próximos a una *dimensión intangible* (cultura, sociedad, emociones y valores de los usuarios, percepción y motivaciones de las personas, entre otros) y demás aspectos que aportan consideraciones y restricciones que influyen sobre el problema de diseño.

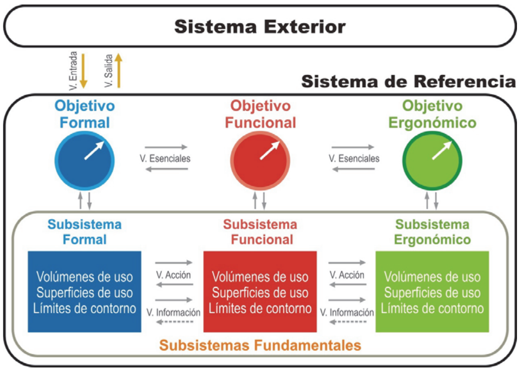

Fig. 1 Modelado teórico. Fuente: adaptado de Hernandis (2003)

Se parte de la idea de que en el *sistema exterior* se encuentran los *suprasistemas* (o subsistemas del *sistema exterior*), que abarcan la realidad que nos rodea y pueden definir las variables que permiten la configuración de un producto, sistema o proceso; y es en ésta fase del diseño conceptual en la que se deben aplicar los criterios para generar una respuesta sostenible a un problema planteado. Desde esta perspectiva, Vezzoli & Manzini (2008, pág. 238) afirman que, "mejorar el impacto de productos es más probable durante las primeras fases de desarrollo, cuando la innovación tiene una mayor magnitud".

2.2. Derivación del sistema exterior

Cualquier problema de diseño, abordado desde la sistémica, se debe asumir como un sistema que se compone de subsistemas en donde la respuesta, acertada o no, depende de las interacciones y relaciones de estos subsistemas o componentes, en donde, según Wahl & Baxter (2008), es pertinente abarcar otra dimensión, además de la física, para obtener respuestas acertadas. En este sentido, existen dos extremos específicos: el primero, a partir de artefactos culturales, instituciones, patrones de producción y consumo, que expresan la *intencionalidad material*; y el segundo, en la *dimensión inmaterial*, el “metadiseño” de nuestro conocimiento consciente, sistemas de valores, cosmovisiones y aspiraciones que definen la intencionalidad detrás del diseño materializado.

Se propone una perspectiva de sostenibilidad apoyada en una vision holistica y sistémica, que abarque varias disciplinas, panoramas y enfoques, que permitan y faciliten una acertada toma de decisiones. Para ello Rivera et al (2013), plantean dos contextos como componentes del *sistema exterior*, el *contexto material* y el *contexto inmaterial,* a manera de reconocer criterios que validen los supuestos o conocimientos sobre los conceptos identificados de la realidad percibida.

Fig. 2 Esquema de derivación del Sistema Exterior. Fuente: adaptado de Rivera et al (2013)

Resultado de estos análisis se ha identificado, que además de las variables de entrada, relacionadas con el *contexto material* de un problema de diseño, hay otras asociadas con un *contexto inmaterial* en el que se consideran aspectos emocionales y valores, como factores psicológicos y psicosociales, que satisfacen necesidades no materiales de los usuarios/consumidores.

2.2.1. Contexto material

En el *contexto material*, se suponen aspectos ligados a los conceptos físicos de productos y servicios, en donde son analizadas las características, materiales, producción, energía, etc., además de las relaciones e interacciones de elementos ya desarrollados y el medio en que se utilizan. A este respecto, Wahl & Baxter (2008), indican que la intencionalidad que hay materialmente detrás del diseño, "se expresa a través de las interacciones y relaciones formadas por productos de consumo, sistemas de transporte, economías, sistemas de gobierno, patrones de asentamiento, y los recursos y la energía utilizados, con la complejidad de los procesos sociales y ecológicos (pág. 74). Bajo esta perspectiva, se propone que durante el planteamiento y desarrollo de una solución a un problema de diseño se debe realizar un *"análisis físico"* en el que se consideren aspectos relacionados con el componente tangible o *contexto material* del proyecto.

2.2.2. Contexto inmaterial

En este contexto, se formulan analisis relacionados con conceptos psicológicos y sociológicos que estén ligados a las diversas cosmovisiones, ideas, sistemas de valores y aspiraciones de la sociedad. Wahl & Baxter (2008), señalan que, inmaterialmente nuestras ideas de organización, cosmovisiones y sistemas de valores, expresan cómo damos sentido a nuestra experiencia de la realidad a través del metadiseño (pág. 74). Aquí esta formación del sentido por medio del metadiseño, va más allá de los aspectos tangibles del *contexto material*, para lograr una relación con conceptos y supuestos psicológicos y sociológicos. En esa dirección, Stegall (2006) afirma, que el nuevo objetivo es diseñar productos que sean más que simplemente no tóxicos o reciclables, en realidad sirvan como herramientas para formar personas, vidas y valores, para lo cual es necesario examinar los rasgos, valores y comportamientos que las personas deben tener en una sociedad sostenible (pág. 58). Para ello, es necesario un enfoque holístico en el que se incluyan diversas disciplinas académicas y profesionales, visiones y enfoques diferentes.

Lo que se pretende con la derivación del *sistema exterior*, es observar en el *contexto inmaterial*, si algunos de sus componentes -necesidades, emociones y valores-, que a menudo son ignorados en la configuración de un producto o servicio, pueden ser relevantes al generar soluciones de diseño sostenible. A partir de este planteamiento, se analizan los anteriores contextos, para identificar elementos que estén en línea con la sostenibilidad, considerando teorías relacionadas con las necesidades humanas, las emociones y los valores, desde lo que se ha denominado *diseño inmaterial*, mediante dinámicas sostenibles emergentes de *desmaterialización* y *digitalización* de productos y servicios.

2.3. Dinámicas sostenibles emergentes

El diseño sostenible está madurando, se cree que hay un cambio hacia una nueva dimensión, en donde una serie de motivaciones (necesidades, emociones y valores) traen consigo una nueva visión de la sostenibilidad que pasa por la *desmaterialización* y *digitalización* de productos y servicios. En el *Atlas del Diseñador de Sostenibilidad*, Thorpe (2010) se refiere a esta mayoría de edad como la segunda etapa en un debate en el cual el rol del diseño en aspectos económicos y sociales de la sostenibilidad está más plenamente explorado, además de la atención ya establecidos en materia de energía y materiales (Thorpe, 2010, pág. 5). Para Chapman (2009), la crisis de la sostenibilidad es un problema de conducta, y no simplemente de tecnología, producción y volumen. Las condiciones de comportamiento que ambos manejan y los patrones de la influencia del consumo de materiales son complejos, pero fundamentales para un compromiso efectivo con una agenda contemporánea de diseño sostenible.

Afirmaciones como las anteriores hacen que emerjan interrogantes sobre las perspectivas de la sostenibilidad y los roles de cada uno de los actores involucrados en alcanzarla, así como del surgimiento de dinámicas sostenibles emergentes como la *desmaterialización y la digitalización* de productos y servicios que consoliden una nueva dimensión de sostenibilidad, en donde, y siguiendo a Robèrt et al (2002), se genere una transformación cultural que cambie el foco en los productos y servicios, a fin de encontrar completamente nuevas formas de satisfacer las mismas necesidades en los usuarios/consumidores, sean estas necesidades básicas o de autorealización.

2.3.1. Desmaterialización

En primer lugar, se harán algunas aclaraciones sobre el concepto de *"desmaterialización"* utilizado en el presente estudio, debido a que este término tiene varias interpretaciones. En este caso en particular, el termino *desmaterialización* es tomado como una estratégia que apoya a la sostenibilidad, con antecedentes asociados desde la *Rueda de LiDs* (Lifecycle Design Strategies) de Brezet & van Hemel (1997) hasta enfoques más conteporaneos que podrían estar asociados al bienestar humano; tal como sugieren Beuren, Ferreira, & Miguel (2013), quienes citando a *Baines et al.,* (2007), indican que la desmaterialización de productos, además de haber sido discutida en la literatura por autores como Mont (2001), Ehrenfeld (2001), Manzini & Vezzoli (2003), Wong (2004) y Tomiyama (2001), también ha sido utilizada como un objetivo para los *sistemas producto-servicio* (PSS en inglés product service-systems).

Li, Zhang, Li, & Tong (2010), afirman que la *desmaterialización* se ha convertido en un concepto importante en la ecología industrial, el cual ha penetrado en todas las fases del ciclo de vida del producto. A lo que Beuren et al (2013) interpretan, que consecuencia de ello, un producto puede ser desmaterializado mediante la inclusión de servicios que reducen la cantidad de materiales consumidos en el ciclo de vida de un producto, no sólo en su creación sino también en su uso, reutilización y reciclaje; en ese sentido Kestemont & Kerkhove (2010) aseveran, que la idea es tender hacia un desarrollo más sostenible y eficiente para "producir más bienestar humano utilizando menos recursos naturales", es decir, desvinculando el crecimiento económico del uso de material, mediante la utilización de menos "cosas", o en su defecto de productos y servicios más eficientes, proyectados y desarrollados desde la *desmaterialización*. En este caso, no se trataría solamente de la *desmaterialización* a través de la cantidad de material consumido, sino y como afirma Cleary (2010), con posibles escenarios de gestión de residuos, incluyendo la prevención de residuos, mediante la ampliación de los límites del sistema. Lo cual podría ser la prevención de residuos a razón de la desmaterialización, en donde los propios usuarios/consumidores tomaran conciencia de algún tipo de bienestar humano, logrado a raíz de la utilización de menos recuros naturales o la reutilización de productos.

Para el desarrollo del presente estudio, y siguiendo a Beuren et al (2013), se toma como principal objetivo de la *desmaterialización*, el de mejorar el bienestar de la sociedad, mediante el desarrollo más eficiente y sostenible, en donde, y coincidiendo con *Baines et al.,* (2007), la *desmaterialización* sea una oportunidad para que sistemas producto-servicio, rompan el vínculo entre el valor entregado al cliente/usuario y la cantidad de material físico necesario para crear ese valor.

2.3.2. Digitalización o informacionalización (de átomos a bits)

El principio que se expone a continuación, pueden ser reconocido por otros nombres como *Transmaterialización* y *Servicing* (prestación de servicios), pero se ha considerado que los conceptos de *"digitalización"* e *"informacionalización"*, son los que se aproximan más al principio que se propone, a efectos del presente estudio, para ello se ha partido de diferentes aproximaciones teóricas.

Singh (2002) afirma, que en la era industrial, la atención estaba enfocada en los bienes tangibles, pero que en la era postindustrial, la atención se centra en la producción y el uso de bienes intangibles, relacionados con la información y el conocimiento. Del mismo modo, sostiene que en la era industrial la persona promedio estaba más preocupada por los bienes materiales, pero que en la emergente *sociedad de la información*, la persona promedio está más interesada en aspectos psicológicos y espirituales de la existencia, afirmando que de esta manera, mediante la digitalización se ha pasado *"de átomos a bits"*.

Shedroff (2009) por su parte propone, que con la informacionalización se pueda replantear un problema y su contexto, en donde por medio de la reducción de recursos se logre convertir *"algo en casi nada"*, a modo de buscar como objetivo principal el tratar de enviar mensajes, recetas, datos, etc. cuando sea y donde sea, para que ese algo en sí mismo -material o inmaterial-, pueda ser replicado en el destino.

En el contexto del diseño de productos y de acuerdo a planteamientos como los propuestos por Vezzoli & Manzini (2008), referentes a la digitalización de productos o algunos de sus componentes; Garetti, Rosa, & Terzi (2012), proponen una optimización general para alcanzar una condición más sostenible, la cual sólo puede obtenerse mediante la acumulación y la eficiente gestión de un profundo conocimiento de todo el ciclo de vida del sistema, y la implementación de herramientas avanzadas.

En esta misma dirección, Stevels (2007) afirma que mediante los avances en las tecnologías y la *digitalización,* se fortalece la entrega de más funciones por unidad de carga ambiental. Lo cual puede ser aprovechado a nivel de producto y servicio, con el fin de sustituir la *Tecnología Mecánica* (TM) por *Tecnologías de la Información* (TI) y *Tecnología Óptica* (TO) o combinar TM, TI y TO de manera inteligente. Esto ya está sucediendo con los actuales *Smartphones* y *Tablets*, así como con la transformación de productos en servicios, lo cual, además de haber generado una revolución frente al diseño clásico, disminuye notablemente las cargas ambientales, y va en línea con el aumento de satisfacción emocional del usuario/consumidor.

Desde esta perspectiva, y con base en los anteriores planteamientos, a continuación se nombrarán algunos ejemplos del principio de *digitalización -informacionalización-,* en donde algunos productos y servicios están desapareciendo y otros han cambiado su estado en bits a partir de átomos. En la música, por ejemplo, lo que anteriormente eran medios fisicos como, discos, casetes, discos compactos, han sido desplazados por la música digital, y en la misma línea se pueden nombrar:

- El video digital, como tecnología de grabacion de imágenes
- El correo electrónico, como servicio de envío y recepción de mensajes y archivos digitales (documentos, imágenes, audios, videos, etc.)
- Los libros digitales (eBooks), como versión electrónica o digital de un libro
- La fotografía digital, como reemplazo a la fotografía química
- Los documentos digitales, que ganan terreno sobre los impresos
- Las herramientas de diseño asistido por ordenador (CAD, CAE, CAM)[10], que permiten la simulación y pruebas virtuales, de productos modelados digitalmente.

Aunque en estos ejemplos, se ha cambiado el estado de los elementos de atomos a bits, para que haya una interfaz entre el usuario/consumidor y el elemento se necesita de un medio que lo permita, sea este: un ordenador, reproductor de música, teléfono móvil, tablet, televisor, etc.; tamnién es importante resaltar,

[10] Por sus siglas en Inglés, Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), Computer Aided Engineering (CAE)

que puede haber oportunidades en donde estos elementos, se conviertan en material físico por acciones como una impresión, un revelado o una grabación.

2.4. Relación de las necesidades complementarias y las emociones con la sostenibilidad

Debido al enfoque del presente estudio, se reconocen otro tipo de necesidades complementarias de las personas como usuarios/ consumidores de productos y servicios, para indagar cómo diversas motivaciones y aspiraciones, que no son sólo necesidades básicas -como el beber alguna marca en especial de bebida en lugar de solamente agua-, son aspiraciones o motivaciones que se pueden dar en función de la sostenibilidad. Para analizarlo se recurre a los planteamientos de Maslow (1966), Max-Neef (1992) y Jackson & Marks (1999) sobre las necesidades, las formas de satisfacerlas y sus escalas o jerarquías.

Wigum (2004), basada en las nueve necesidades humanas fundamentales propuestas por Max-Neef (1992), afirma que estas se pueden dividir en *materiales* (subsistencia y protección) y *no materiales* (afecto, entendimiento, participación, ocio, creación, identidad y libertad), y que al menos en parte, pueden estar satisfechas por tanto satisfactores[11] materiales como no materiales.

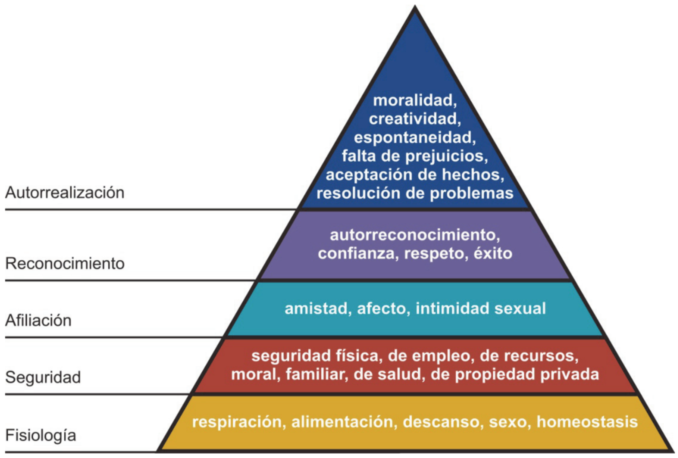

Fig. 3 Pirámide de Maslow – jerarquía de necesidades. Fuente: adaptado de Bartiaux et al (2011)

Por otro lado, se ha tomado como referencia la clasificación de necesidades de Maslow (1943), derivando que, gran parte de los componentes del *contexto inmaterial* que se relacionan con la sostenibilidad, se encontrarían en la parte superior de la jerarquía de necesidades. Estas necesidades de reconocimiento, pertenencia y autorrealización pueden estar relacionadas con aspectos emocionales, afectivos, espirituales y valores pertenecientes a la *dimensión inmaterial* en búsqueda de la sostenibilidad.

Para analizar la dimensión emocional, se toma el concepto de *"la experiencia del producto"* de Desmet & Hekkert (2007), el cual emplean para referirse a todas las posibles experiencias afectivas involucradas en la interacción producto-humano. Ellos afirman que la interacción producto-humano no sólo se refiere a la interacción instrumental, sino también a la no instrumental, e incluso la interacción no-física. En ese mismo sentido, Nagamachi (1995) afirma, que los consumidores son exigentes en la elección de los productos en términos de su demanda y preferencias. En la actualidad los consumidores son más sofisticados y desean que los productos se ajusten a sus propios sentimientos de diseño, funcionalidad y precio. Un ejemplo de ello ocurre en Japón, donde basados en el *"Valor KANSEI"* (2007), se pregunta a

[11] Los *satisfactores,* son formas de ser, tener, hacer y estar, de carácter individual y colectivo, conducentes a la actualización de necesidades.

usuarios/consumidores comunes, sobre sus necesidades y recomendaciones para desarrollar productos o servicios que despierten emociones, empatía o resonancia simpática. En este sentido, Vezzoli & Manzini (2008) afirman, que al tener en cuenta la demanda de satisfacción en nuevos sistemas producto-servicio, se ofrecen diferentes -y más sostenibles- formas de obtener resultados, que podrían convertirse en socialmente apreciados y al mismo tiempo radicalmente favorables para el medio ambiente.

Planteamientos como los anteriores, sobre la relación de algunas necesidades humanas y emociones con la sostenibilidad, apoyan el enfoque que se propone sobre aspectos pertenecientes a un *contexto inmaterial*, del *sistema exterior* del MDC, abordados desde una perspectiva sistémica.

3. Metodología – Planteamiento metodológico

El presente estudio es realizado de forma descriptiva para analizar, si dinámicas de *desmaterialización y digitalización* o *informacionalización* de productos y servicios están relacionadas con la satisfacción de las actuales motivaciones (necesidades, emociones y valores) en los usuarios/consumidores. Con base en un trabajo anterior de los autores, y desde una perspectiva sistémica en la que se establecieron un *contexto material* y un *contexto inmaterial*, como derivaciones del *sistema exterior* del MDC; se pretende establecer si hay una conexión de estas dinámicas y las actuales motivaciones de los usuarios/consumidores con la sostenibilidad.

La investigación es descriptiva correlacional, para lo cual, basándose en investigaciones y teorías sobre actuales dinámicas de *desmaterialización y digitalización* de productos y servicios, así como en estudios sobre las necesidades del ser humano (Maslow 1966, Max-Neef 1992, Jackson & Marks 1999), las emociones y la relación usuario-producto (Desmet & Hekkert 2007, Mugge et al, 2007, Vezzoli & Manzini 2008), por medio del análisis de un estudio de caso, se logre establecer si estos factores pueden estar relacionados con la sostenibilidad, desde un *contexto inmaterial*, en el cual se busque llegar a productos cada vez más desmaterializados y digitalizados que afecten menos el medio ambiente.

4. Estudio de caso

En la actualidad, algunos productos han desaparecido (VHS, Betamax, casetes de música, máquinas de escribir, etc.), mientras que otros han sido reemplazados por un solo dispositivo (teléfonos, videograbadoras, reproductores de música, calculadoras, GPS, grabadoras, etc.). Aunque actualmente se siguen fabricando muchos de estos productos, se debe resaltar que algo ha cambiado en algunos de ellos; han evolucionado de cómo eran anteriormente en términos de volumen y peso. Los libros se siguen fabricando, a pesar de los ebooks o la enciclopedia británica, después de haber sido reconocida como algo icónico durante más de dos siglos, desaparece como -hecho- *medio material* y evoluciona hacia un *medio virtual e inmaterial*, disponible en la red como una nueva vía de acceder al conocimiento.

Con base en las anteriores teorías y planteamientos, como estudio de caso, se establece que el *contexto inmaterial* puede estar presente en la cotidianidad, sin ser percibido. Para ello, como ejemplo práctico se plantea el siguiente supuesto en el que:

> *Una persona puede estar retirada de la ciudad, por decir algo, a 50 kilómetros de la zona urbana en un entorno rural, y desde ahí acceder a una serie de servicios que le brindan las funciones y aplicaciones de su Smartphone.*

En tiempos pasados esto era muy difícil, por no decir imposible de lograr, debido a que en algunos dispositivos, su volumen, su peso o su conectividad eran un impedimento (teléfono, contestador, ordenador, televisor, reproductor de música, radio, etc.), donde en el mejor de los casos, se debían elegir algunos de estos objetos/elementos para llevar consigo. Hoy en día, esta situación ha cambiado, ya que en algunas ocasiones con solamente un dispositivo es posible: hacer llamadas, tomar fotos, grabar videos, escuchar música, jugar, ver películas y programas de Tv, así como conocer las condiciones atmosféricas y la geolocalización del lugar en el que se está; todo esto sin contar, que con el desarrollo de nuevas aplicaciones se amplía el espectro de funciones de este tipo de dispositivos.

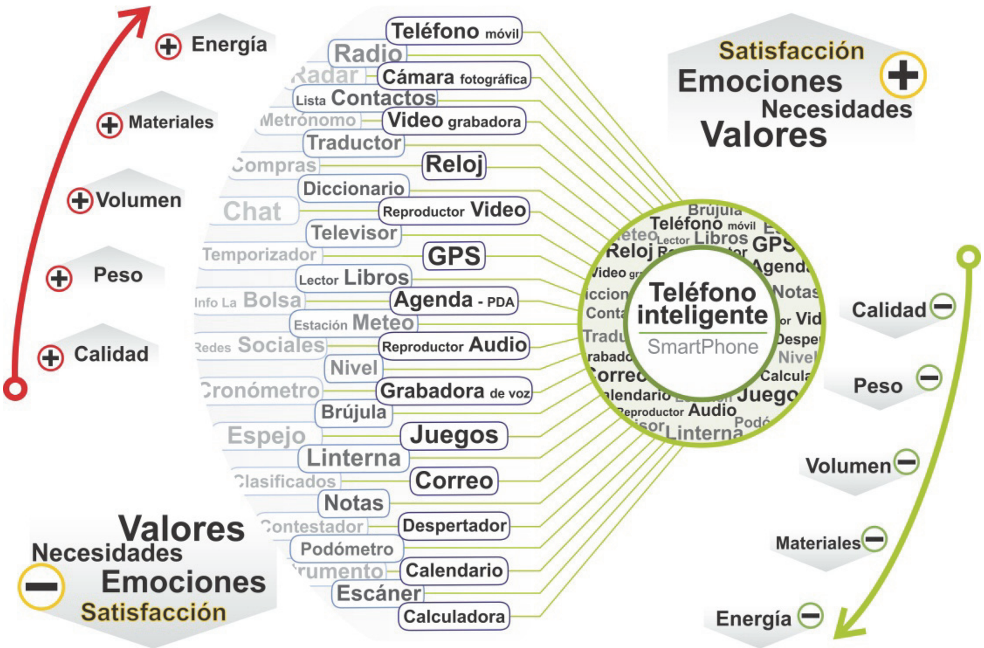

Fig. 4 Desmaterialización y digitalización de productos y servicios. Fuente: elaboración propia

Lo que se pretende con el anterior supuesto, es reafirmar que hay una *contexto inmaterial* que está presente y tiene una relación directa con la plenitud, las necesidades y las motivaciones reales de la gente, en donde la *desmaterialización* y la *digitalización o informacionalización* de productos y servicios contibuyen al desarrollo de todo este fenómeno. Esto se refuerza con el planteameinto de otro caso hipotético en el cual:

La misma persona, que se retira a 50 kilometros del entorno urbano, pero suponiendo que disponga del dinero y los medios de desplazarse con esos equipos físicos e independientes enrtre sí (teléfono, contestador, televisor, reproductor de música, reproductor de video, radio, calendario, etc.), podría generar aspectos negativos en relación con la plenitud de la experiencia y sus motivaciones, además del impacto negativo que causaría en el medioambiente.

Es importante en este punto, hablar de experiencia, satisfacción y bienestar, pues si se evalúa objetivamente a la persona que se desplaza los 50 kilometros de la ciudad, en estos términos, tendría que cargar con “X kilos de productos”, para suplir las mismas necesidades/funciones con algo que pesa alrededor de 140 gramos. En el primer supuesto, no tiene lugar el evaluar la calidad de algunas de las funciones que suple un sólo dispositivo, porque es evidente que la calidad de un Tv plasma, es mucho mejor, al igual que las fotografías que se pueden lograr con una cámara réflex; aquí se trata de lo básico, de las funciones básicas y cómo ellas en su conjunto pueden generar una mayor experiencia, satisfacción y bienestar en el usuario con un menor peso y volumen.

Fig.5 Caso de diseño – teléfono inteligente (iPhone 4). Fuente: (iMore, 2016)

Al respecto, Wahl & Baxter (2008), citando a Buchanan (1992) destacan el que el poder creativo detrás del pensamiento de diseño se encuentra en *"pasar a la modalidad de imposibilidad"*, y reconocer que lo imposible "realmente sólo puede ser una limitación de la imaginación que puede ser superada por el mejor pensamiento del diseño". Además, también sugiere que el pensamiento de diseño en este contexto es "no pensar dirigido hacia una "solución tecnológica rápida" en hardware, sino hacia nuevas integraciones de signos, cosas, acciones y el ambiente que aborden las necesidades concretas y los valores de los seres humanos en diversas circunstancias". Para ello, es necesario analizar la relación entre los aspectos motivacionales de las personas y lo que caracteriza a la sostenibilidad "hoy en día", para encontrar las verdaderas motivaciones en el uso de productos y servicios y "no" lo que las empresas suponen o sugieren. En este sentido, se podría seguir adelante y cambiar la perspectiva, olvidando el producto o servicio en sí mismo y pensar acerca de las funciones que los usuarios/consumidores necesitan.

5. Discusión

La *dimensión inmaterial* en productos y servicios, es una realidad y está presente en la actualidad. No se puede dar por sentado, a priori, que la gente conoce el concepto "*inmaterial*", se cree que la gente puede comprender que hay un *contexto material* y un *contexto inmaterial*, no solamente porque esté de acuerdo o no, sino porque efectivamente está ocurriendo. Hay un proceso de desmaterialización y de cubrir más necesidades con menos productos, lo cual puede ser evidente en los sistemas producto-servicio. Como ejemplo de ello están, Ascensores Schindler que cambian a vender servicios de transporte vertical en lugar de ascensores; o la empresa Rank Xerox, quienes ofrecen servicios de reproducción a la medida del cliente en vez de vender solamente fotocopiadoras (Stahel, 1998). Este fenomeno se presenta en la actualidad desde empresas que cambian de ofrecer y vender productos a ofrecer servicios, hasta los actuales smartphones y tablets, que integran varios elementos y productos, mediante sus aplicaciones en uno solo. Esta nueva forma de interpretar el actual desarrollo de productos y servicios, está basado en anañlizar “*lo que la gente quiere y aspira”*, así como “*el por qué lo necesita”*. Aquí cuando se habla de aspiraciones, necesidades, motivaciones, se refiere a lo que motiva a la gente a adquirir algo, lo cual va en línea con esa *dimensión inmaterial*.

Volviendo al caso de Xerox, la marca no desarrolla su estrategia desde la óptica de la sostenibilidad, sino desde una perspectiva de negocio mediante la cual pudieran mejorar sus servicios, y que al mismo tiempo esto se viera reflejado en el aumento de sus ingresos; al parecer sin darse cuenta, que ese modelo al mismo tiempo favorece la sostenibilidad.

… ahora, según el actual desarrollo de las cosas/objetos/dispositivos, la relación de los usuarios, con base en sus aspiraciones, necesidades y motivaciones, y reconociendo la existencia de ese *contexto inmaterial* y su posible relación con la sostenibilidad, es necesario preguntar:

¿La generación de menos objetos pero con más funciones, realmente estaría relacionado con la sostenibilidad?

¿Tienen los procesos actuales de desmaterialización y digitalización o informacionalización de productos y servicios, una relación con una mayor sensación de plenitud de esas funciones?

¿Cuál es la tendencia de la sostenibilidad, en relación con esa valoración de lo inmaterial?

Desde el punto de vista de tendencias, se cree que hay una tendencia hacia la dismiución productos, pues anteriormente eran necesarios más productos que satisficieran -cubrieran- las necesidades de la gente, mientras que hoy en día, en algunos casos esta satisfacción se puede alcanzar con un solo producto (multifuncionales, smartphones, tablets, etc.). Lo anterior se puede traducir en que, hoy en día , “con menos productos, la experiencia individual aumenta, porque se pueden realizar muchas actividades, mediante las funciones y servicios integrados en un solo elemento”. Muchas cosas cambian de formato y dejan de ser tangibles, para convertirse en intangibles.

6. Conclusiones

A través del desarrollo de los contenidos tratados, se asume que el aporte del presente estudio, además de reconocer la existencia de un *contexto material* y un *contexto inmaterial* desde una perspectiva sistémica, es el de identificar desde la *intangibilidad*, algunos puntos clave generadores de sostenibilidad. Para este propósito, se ha analizado cómo ésta realidad del *contexto inmaterial*, que además es tendencia, puede apoyar la sostenibilidad, por el “sólo hecho” de ser características, aspectos, rasgos a los que la gente le da valor; a modo de alcanzar las expectativas y motivaciones más profundas de los usuarios, lo cual puede coadyuvar a que se demande mucho más la sostenibilidad.

Anteriormente los usuarios experimentaban una fragmentación de la relación uso-función con los productos/cosas, esto significa que un producto realizaba “una y sólo una función” por lo que eran necesarios más productos que realizaran funciones específicas; esto si se toma desde la perspectiva de la sostenibilidad significaría la utilización de más materiales y por consiguiente, más volumen y más peso; lo cual a su vez, hacía que la experiencia individual fuera menor porque estaba más fragmentada. En la actualidad se presenta un fenómeno opuesto, en donde, con menos productos se puede alcanzar una mayor experiencia individual; ya que en algunos casos sólo un dispositivo, puede abarcar un mayor número de los dispositivos, productos o elementos que en otros tiempos se utilizaban; lo cual está directamente relacionado con la sostenibilidad. Resultado de lo anterior se concluye lo siguiente:

"Hay una relación directa de la desmaterialización y digitalización o informacionalización de productos y servicios con las motivaciones (necesidades, emociones y valores) de los usuarios; en donde, por medio de una reducción de materiales - volumen y peso-, un menor consumo de materias primas y energía en producción y uso, además de la optimización funcional –entre otros–, se favorece la sostenibilidad, y al mismo tiempo componen ese contexto inmaterial que involucra aspectos emocionales de satisfacción y bienestar de los usuarios".

Por último, aunque se reconoce una *dimensión inmaterial* que está relacionada con las necesidades, aspectos emocionales y/o valores de los usuarios/consumidores, en donde dinámicas de desmaterialización *y digitalización* o *informacionalización* han contribuido a la desaparición de algunos productos, mientras que otros, han evolucionado pasando de ser elementos materiales a ser elemenntos inmateriales o servicios, es probable que en algún momento de la interfaz PRODUCTO/SERVICIO-HUMANO, sea necesario tener en cuenta elementos materiales (p. ej. teléfono móvil, tablet, ordenador, televisor…) como medios que permitan la interacción entre el humano y el producto o servicio, así como otro tipo de conexiones (p. ej. energía, internet, datos, fibra…) que consoliden la plenitud de la experiencia y la satisfacción de las demandas, necesidades, emociones y valores de los usuarios/consumidores. Lo anterior refleja que desde un enfoque de *diseño inmaterial*, así como de dinámicas de *desmaterialización y digitalización* o *informacionalización* de productos y servicios, se contribuye a la redución del impacto ambiental causado por el consumo intensivo de elementos materiales.

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Opportunities and challenges in teaching Systemic Design
The evoluation of the Open Systems master courses at Politecnico di Torino

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Abstract

The contamination between design and theory of systems as a field of development of new design processes is nowadays consolidated. However, the issue concerning the methodology to apply in teaching systemic design remains an open question.

The approach adopted in the Master Degree in Systemic Design at Politecnico di Torino is based on the assumption that the teaching method must itself be systemic. Alongside designers, the degree course has involved from the very beginning experts from different disciplines (i.e. chemistry, physics, mechanics, history, economy and management) as teachers, in order to create a multidisciplinary environment for the development of projects. Born as master degree in academic year 2002-03 at Politecnico di Torino (Italy) from the close collaboration with Gunter Pauli, the course has changed name and form but not the content, until it reached the current title (a.y. 2015-16): master degree "Aurelio Peccei" in Systemic Design.

The Open Systems course has enabled students, in early years, to experiment the design of production processes. This was the case of the systemic project done with NN Europe, a company engaged in manufacturing ball bearings, in which the output management allows a positive economic impact. Over the years the course has shifted its focus from the production process of a single product to the wider company context. In 2010, the approach has been applied to the agricultural enterprise Ortofruit: starting from agricultural production, the students have defined the production system and the relationships with the market. Systemic Design, during this course, has experienced the transition from the design of industrial processes that are closely linked to the territory, and then enhance local resources, to the design of the whole territorial system.

The work done by the students of the course in recent years has led to the definition of scenarios about fields usually distant from the traditional design world. For example, the definition of the economic model, the corporate model that is built around relationships on cooperation with different disciplines.

This transition, from the product to the entire territorial system, allows the exploration of new contexts, but it also puts the designer in a complex and challenging position in according with complex theories.

Keywords: *systemic design, education, sustainability*

1. Background

Teaching, and learning, is a complex process that involve many variables with non linear accumulative effects (Dhindsa et al., 2010). The complexity doesn't decrease with the higher level of education, neither when the content of the lectures is related to the the Complexity Theories. That is exactly the case that we are going to discuss in this paper, because we analize the educational model in teaching Systemic Design Theories and its relation with the other Complexity Theories at Master Degree level (Politecnico di Torino).

More studies bring the research-practice gap in education changing research methodologies that modify the teachers as collabborators (Krockover & Shepardson, 1995) or the teachers as researchers (Pekarek, Krockover, & Shepardson, 1996). Krockover & Shepardson, in their introduction of the Journal of Research in Science Teaching (1995) underlined the need of "a more holistic image of education in which researchers investigate the interplay among the learner, the teacher, and the nature of the curriculum, instruction, and assessment". The new figure of teacher has a systemic view of schools and community, in order to develop a collaborative relationship with students.

From the classical meaning of the word education, it derived from the Latin ex-ducere, so "draw forth from within". This concept emphasize the fact that the teacher should not put in information in students, but the learner build internal representations of new experiences in relation to past experiences (Anderson 1992). This kind of education was formally defined as Costructivist Learning Theory (Piaget, 1950), with its psycological applications, for axample with Bodner, 1986; Driver & Oldham, 1986; Novak & Gowin, 1984; Von-Glasersfeld, 1988. This theory is based on the active role of the learner in costructing interpretations of experience and in sharing with others common cultural experiences, in order to organize a set of informations. In that perspective, "the most important single factor influencing learning is 'what the learner already knows' " (Ausubel et al. 1978). Building a knowledge in memory is strictly connected with the ability of reasoning, understand concepts, and connect them with prior conceptions. Those kind of activities are crucial for effective learning, because they require a process of setting many information at a time, which is facilitated by the organisation of prior knowledge (Mitchell & Lawson, 1988). Hence, the teaching tecniques should help the students to organize their knowledge in memory and enhance learning of complex scientific ideas. The students should be actively involved in order to reconciliate disparate prior conceptions with more scientifically accepted new information in order to resolve inconsistencies, represent scientific content in a conceptual way, and build the knowledge organisation (Ebenezer and Gaskell 1995; Linder 1993; Nieswandt 2001; Smith et al. 1993). Therefore, in this process in which new information are built, the previous knowledge may be subjected to transformations, such as conceptual growth or, even, change because the learner actively attempt ways to merge new insights within existing frameworks.

The Constructivist Learning Theory comes from the same theroetical basis of the more recent Systemic Design Approach, that is the content of the lectures we are going to analyse and discuss. The use of Constructivist Learning Theory in theaching Systemic Design is coherent and effective.

The complexity theories evolved on the basis of the General Systems Theory by Karl Ludwig von Bertalanffy (1968), so some of the next rationales applied this theory on different artificial systems, such as the Generative Science. This trans-, inter-, and multi-disciplinary theory explores the natural world and its complex behaviours as a generative process (McCulloch et al., 1948; Wiener, 1948). From General Systems Theory have grown ideas within diversified areas, exemplified by the ecosystem ecology by Eugene Odum (1975), the living systems by Fritjof Capra (1997), the organizational theory by Peter Senge (1990), the financial research related to human resource development by Richard A. Swanson (1988), and so on.

The Systemic Design theory considers productive industrial organization as complex adaptive systems with the same behavoiur as the Nature has, where there is no waste because all the substances are used as resources by another natural reign. This approach comes from the Cluster Theory (Porter, 1990), the Industrial Ecology (Frosh & Gallopoulos, 1989) and the Industrial Symbiosis (Chertow, 2000).

The content of those theories are complex and need a large number of information already in the prior knowledge of the learner, so they were usually taught at Master of Science level of degree. At Politecnico di Torino, the academic curriculum in design has three levels, and in the first one (bachelor degree) just some theoretical basis on Systemic Design are taught, but in the second level (master degree) is totally focus on it, not by chance its name is "Systemic Design, titled to Aurelio Peccei", and in the third level (PhD corse) the research and the learning in that topic is mixed. In that paper we are going to go in deep with the teaching and learning of Systemic Design in the Master degree because it is the most crucial moment for learners.

2. Aims and Objectives

This study aims to examine the educational model used to teach complexity theories at university training and its benefit in the professional carriers of the students in different working activities. In additon, the specific analysis on the master degree courses in Systemic Design at Politecnico di Torino is used to answer the following research questions:

1- the use of teaching/learning theory close to complexity approach, like Costructivist Learning Theory, is beneficial in teaching/learning the complexity theories, like Systemic Design topic?

2- What are the competences needed for teachers and students?

3- What are the tools and the tecniques used by teachers in the process of new information acquisition by the learners?

2.1 Methodology

The subjects of this study were the students and professors of the Master Degree at Politecnico di Torino in Ecodesign, since academic year 2002-03, and then in Systemic Design, since academic year 2015-16. The students are about 100 per year (except for the first three years, where we can see an esponencial growing from 20 students to 80), and they are coming half from the other italian universities and half from the rest of the world with different academic and cultural background. Prior to being in the master classes, they had different academic curricula, not only in design but also in architecture and engineer. The lessons were in English despite it is the second or third language for both students and teachers. To have a complete documentation about the nature of the experimentation, we have collected data using observation instruments and students' visual mapping and reports.

The observation is made up of two components: the former is the historical evolution of the structure and content of the master courses in Open Systems at Master Degree in Ecodesign/Systemic Design (Politecnico di Torino), the latter is the actual learning model used in the lectures by different professors in the same course. The historical evolution analysis considers the wide changes in the organisation of the courses and the content of the project during the years (from academic year 2002-03 to 2015-16), in order to verify if there is an increasing of complexity also in the way to face the Systemic Design projects. The analysis on the actual learning model goes in deep on the taught methodology, in order to understand the convergence between the model and the content.

The limit related to these two observation is the absence of comparison with other courses in some other institution, but unfortunatly any other university in the world has an entire master degree course lasting two years in that topic with the contribution of many disciplines. Many other universities have singular course on Systemic Design and Complexity Theories that last one year, at maximum.

The final considerations of these two observation are enriched with the Alma Laurea's data about the rate of satisfaction of students and their rate of employment after the degree, in order to understand the real benefit in their career and what kind of information pass through the long term memory. The Alma Laurea is an Italian consortium that groups 72 university in the Country, with the purposes of collect the evaluation from graduates and of publish their curricula to match with the job market. This data set is extremely interesting because it collects first hand information from the primary engaged actors and because it keeps track of time and its changes.

3. Results and discussion

The Master Degree in Ecodesign/Systemic Design at Politecnico di Torino has involved from the very beginning experts from different disciplines (i.e. chemistry, physics, mechanics, history, economy and management) as teachers, in order to create a multidisciplinary environment for the development of projects. Born as master degree in academic year 2002-03 at Politecnico di Torino (Italy) from the close collaboration with the economist Gunter Pauli, in the last year, the course has changed name and form in Systemic Design, titled to "Aurelio Peccei". This master degree was organized in 4 modules: Virtual Design, Innovation, Product Components, and Open Systems (in chronological order, once a semester). Those modules have an increased complexity in the taught contents, and especially the first one gives the basic also for the visual representation of multiform concepts. Each semester a single complex project should be designed by the students with the help of different disciplines, explained by different professors.

In the last years, one more modules was added (Atelier inside/outside) in collaboration with the master degree in Architecture, so students can freely choose between this one and Innovation. The enlargement in the academic offer it is a way for the students to define better their competences and curricula.

The Open Systems course is mandatory and it is the last course before the degree. It includes contributions in various disciplinary fields (see figure 1): Systemic Design (design), Environmental Sustainability Processes (engineering), History and theories of Systems (humanities), and Economical evaluation of projects (economics). The core teaching in this module is the configuration of a new development model (economic and social) in which the outputs of a system become input of another one (Bistagnino, 2009).

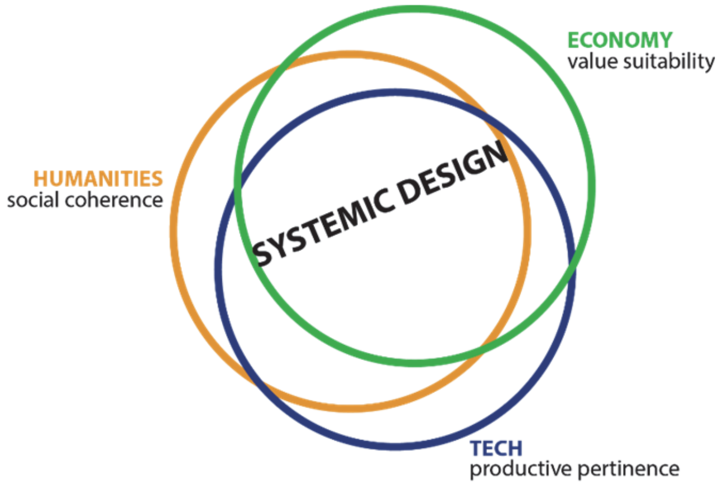

Fig. 1 Disciplines contribution to Systemic Design.

The projects developed in Open Systems module have seen an evolution in content: in early years, the students experimented the design of production processes related to single product, then of wider company context, and of industrial processes that are closely linked to the territory, and its local resources, and finally the design of the whole territorial system. The first step of this escalation was the case of the systemic project done with NN Europe, a company engaged in manufacturing ball bearings, in which the output management allows a positive economic impact. The second one, around year 2010, was the project with the agricultural enterprise Ortofruit, that has many different industrial processes and gives the chance to understand the relationships between local production and the market. The last step involves the students in the definition of scenarios about fields usually distant from the traditional design world; for example, the definition of economical model, the corporate model and other cultural paradigms (see figure 2). This transition, from the product to the entire territorial system, allows the exploration of new contexts, and puts the designers in a complex and challenging position in according with complex theories.

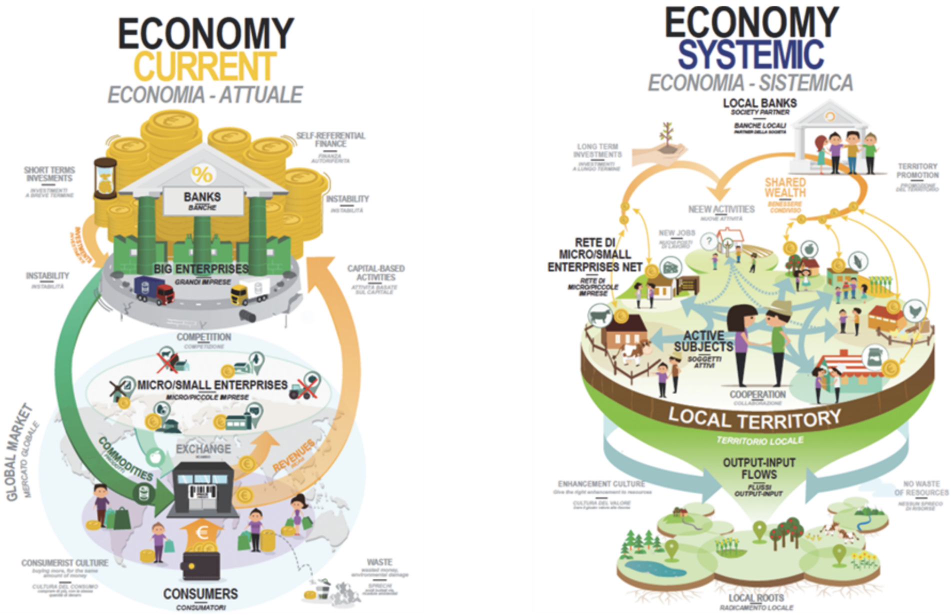

Fig. 2 Results of Open System module at academic year 2015-16 with different cultural paradigms.

The methodology taught and applied in Systemic Design project consists of a preliminary Holistic Diagnosis, the definition of design eco-guidelines, the systemic design project and its implementation. The Holistic Diagnosis considers natural, anthropic, social and economic aspects of a context and it is organised in three steps (see figure 3):

1- desk reseach on Exhisting information, with a mix of quantitative and qualitative data (from database, statistics, reports, case studies, scientific reviews, general readings, to social media);

2- field research to Integrate information, with a mix of quantitative and qualitative data (from data recording, mapping, case studies analysis, survey, perception, to emphaty);

3- research synthesis with Information Design Visualization, in order to have the data correlation and its visualisation, the list of criticalities (needs, problems, etc.) and the lists of potentialities (resources, etc.)

The first two steps derives from the theories of Celaschi and Deserti (2007) about the combination of desk and field research in design processes; especially the reiteration of these two steps is marked by the gap analysis and the visual framing in order to fulfill all the information needed to complete the holistic diagnosis. The crucial function of visualisation will be deeper faced later on in this paper.

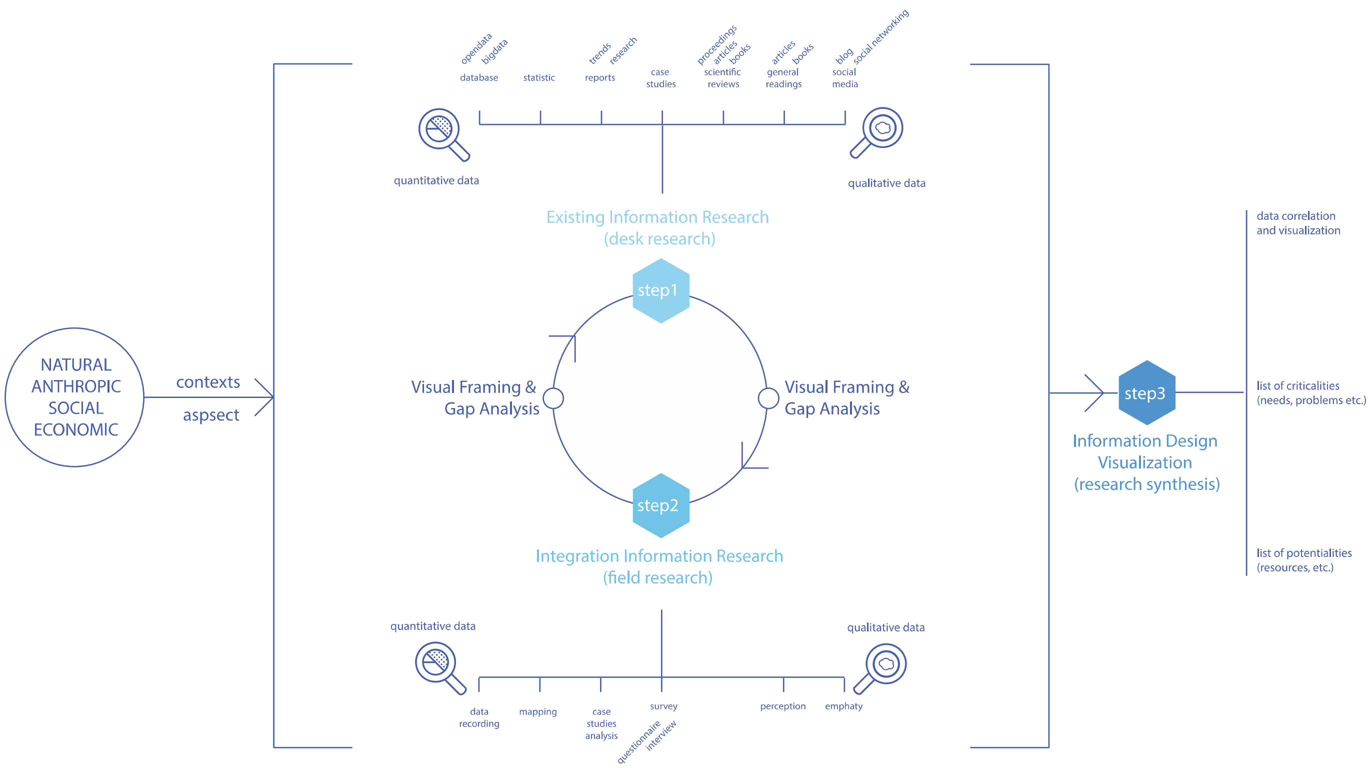

Fig. 3 Results of Open System module at academic year 2015-16 with different cultural paradigms.

With the complex data visualised in different maps and lists that underlines criticalities and potentialities, the designers can gather the design eco-guidelines in order to start the design of the entire system. The goal of the design phase is to optimize all the energy and material flows in the system and to valorize all the waste as resources, in order to obtain zero emissions. The last phase is the implementation of the system with the realization of the system in the specific context and the evaluation of the feasibility of new business plan. The implementation of the project gives a lot of new input to improve the project and let it autopoietic (Maturana et al., 1972).

During the lectures, students are challenged by new experiences that require them to rethink their understanding based on scientific evidence from past experiences. The work is organised in small group in order to foster contrasting ideas, encourage reflection on experimental data, and motivate them to evaluate again and again prior ideas in relation to emerging evidence. In this way the students are forced in a conceptual change process where the brain actively interprets new experiences based on the mobilization of stored information in memory as a framework for the new knowledge construction (Anderson, 1992). One of the crucial aspect in the development of the lecture is the use of visual mind mapping by the students, every time new information and concepts come out. This is a technique of representing knowledge by organizing it as a network or other non-linear diagram incorporating verbal and symbolic elements. In general, this technique is consistent with modern constructivist approaches to learning, and emphasize the active involvement of the learners who utilizes existing knowledge structures to construct new knowledge by inter-relating new content with existing knowledge in memory. Longo, Anderson and Wicht (2002) demontrated how this tecnique helps the students to organize their knowledge and make it more salient in long-term memory, compared to the more traditional lecture-centered format of teaching. Mind mapping teaching techniques, compared to some traditional methods that emphasize ‘‘knowledge transmission from expert teacher to novice students,’’ are more student-centered and involve students’ active participation in the learning process. During discussion, students were encouraged to share ideas and reach an agreed-upon structure for the organisation of their ideas, and to fix them in visual maps. In such a student-centered learning environment, the students have a crucial role in the organisation of learning activities, in order to build a more effective and efficient set of new knowledge. However, a limited number of organised lecture presentations are included, assuming that the teacher has taken care to determine the prior status of the students’ learning and to engage them in multi-modal learning activities. The quality of information organised in students’ cognitive structures help them to reconstruct correct information quickly and to accurately answer questions during discussions and examinations. Thus the constructivist-visual mind map teaching approach may enhance more broadly students not only in academic performance, but, better, in solving problems in daily life.

Recovering the data from Alma Laurea, we can say that this Master of Science is dense of contents, so generally students take a little more time than the convential 2 year to reach their degree. However, the final score is high, on average: about 30% students gain the 110 with honors. Furthermore, the data shows a good interection between students-professors, with highest rates about the satisfaction of students in the availability of teachers (83%). A very positive rate is given to the general satisfaction of the degree course, with the 88% of positive answers and the 63% of the graduates that state their wish to sign up again in the same master degree. To confirm this data, we have done a cross-evaluation with the data collected in “Comitato Paritetico per la Didattica” (CPD) Questionnaires by Politecnico di Torino, supervisioned by the internal Joint Committee for Education. In those questionnaires the students reveals the high utility in attendance the educational activities for learning purposes (64%).

Reflection on learning outcomes and market demand is mirrored in the results of the consultation with the professional members of the Consulta, that confirmed the validity and effectiveness of the Master Degree as a whole. About the employment status, one year after the graduation, the 73% of graduates work in the systemic design field.

4. Conclusion

We would like to especially underline that the consistent use of visual maps in a constructivist teaching environment significantly improves information organisation in students' cognitive structures. The students of the master degree in Ecodesign/Systemic Design are exposed to a constructivist teaching and learning environment, because they are actively engaged cognitively and operatively in reflectively processing information that is presented in a way that encourages the learner to relate new knowledge to prior existing knowledge in memory. The theoretical advantages of using mind maps in learning is partially rooted in scientific evidence that early visual processing systems of the brain categorise visual input into constructs of colour, shape, location and motion (Ungerleider 1995). Prior published research has documented the validity of using flow-mapping as a representation of knowledge organisation and its effects on science learning outcomes (Anderson and Demetrius, 1993; Dhindsa and Anderson, 2004). This technique also has been successfully used in a number of studies involving constructivist teaching to obtain evidence of students' cognitive structures. The benefit of using visual maps is blown for that reason the first module of the Master degree is in Virtual design.

Evaluating the results explained in previous paragraphs, we can say that the Master Degree in Ecodesign/Systemic Design at Politecnico di Torino, really embodies the complexity theory also in teaching models with the adoption of Costructivist Learning Theory, and it achieves with the practices the real sense of project. The term project derives from the Latin words: pro-jacere, so throw forward. Looking at the projects done every year by the students, we can see how their contribution to the community is very broad and pitches the next twenty years.

In the end, we can conclude the graduates are open and willing to express critical opinions towards the subject, ready for negotiations. These results suggest that the cognitive structures of master students are extensive, robust, and interconnected.

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Fixed, liquid, fluid. Rethinking the digital design process through the ecosystem model.

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Abstract

According to the visions and conceptualizations from philosophers to design thinkers such as Habermas, Maturana & Varela or Levin, the design applied to digital artefacts, products and services —due to the convergence of media, deceives and technologies— is becoming even more a bio-sphere, or, with the words of Vernadskij, a Noosphere. The cultural shifting is represented both in the process side and in the approach to the whole design materials and outcomes. On one hand, the organizational structure is moving from an "industrial" approach characterized by a waterfall-process —organized in subsequent structured phases— to an iterative activity —that cycle among ideation, prototyping, testing assessing and redesign phases before to implement and release a project— to the agile and lean approach of the information-era in which the project itself persist constantly in a work-in-progress status —where updates have replaced new releases. On the other hand, the object of the project itself is deeply changing according to a vision of a digital ecosystem and consequently to the design approach that is moving from a fixed —a two-dimensional page borrowed-model— to a liquid, then fluid solutions beside the divergences of media and devices and the convergence of user context and experience. Paraphrasing Maldonando we're moving from virtual to real, from intangible to tangible, from the web to intelligent environment, both digital and physical. In this hybrid space design plays its challenge to change process and purpose embracing both a traversal and a deep approach to single elements and the eco-system in its wide complexity. Nevertheless this transition implies design to face with the challenges of emerging and upcoming phenomena: the designer education —skills, competences, methods— in an hybrid context, the anthropological mutation brought up by the new generation of digital natives and finally the social impact and emotional implication of the confluence of virtual and real experience —mediated by technologies— that people live in their daily life.

Keywords: *digital ecosystem design, fluid user interface design, user centered-design, mobile user experience design, agile design methods.*

1. Converging phenomena and centrifugal forces

The traditional interactions, which people could experience with the different communication channels, were *naturally* linear until a couple of decades ago. The user has started doing and finalizing the tasks always in the same media channel, choosing from time to time which one was more suitable according to a multi-channel services offers. This *multi*-channel approach has been overtaken by a *cross*-media as clarified by Rosati (2011) in a post related to *pervasive architecture*.

The participative evolution of users' interactions enabled by the web 2.0, the wide diffusion of social networks, the digital mutation of communication mass-media, sets the scenario in which happens a cultural *migration* defined by Jenkins (2006) as *convergent culture* or *trans-mediality*. That means a *flow* of contents coming from different platforms, cooperation among may different sectors of the media industry and the migration of the audience looking for new entertaining experiences.

However, Jenkins perspective lacks on *media* according of the conceptualization of media as a *tool*: "*Medium* can be seen according to an ambivalent point of view. On one hand it could be a *tool* on the other a *way/manner*. Computers themselves are '*meta-medium* able to simulate others, but their essential is also the *universality* the ability of simulation' (Polillo, 1993). According to this idea, the computer — extensively the digital support and languages— is a medium, but rather a tool that mean the designer operating field who designs the modalities of access and interaction between the user and information." (Bollini, 2004: 60).

The debuts of the first Phone presented in 2007 *broke* the digital scenario, at that time *monolithic* —based on web predominance. The revolution of an integrated and mobile experience based on cloud-services introduces many variables impacting on the design process, framework and complexities. Communication becomes not only cross-channels but multi-devices too. People initiate a task using a specific device in a coherent context —for example in the subway during commuting time going from home to workplace— then they prosecute the stared process using another device —when arrived in the office with a desktop computer. And finally —at the end of the day, lying relaxed on a sofa, watching TV —they finalize the order or control the status using a tablet: a totally different context compared to the one in which they began the process.

The experiential scenario could be so over-crowded of devices, interactions and activities acted at the same time, that we could talk about a systemic-environmental-multitasking to underline not only the simultaneity of the actions but also the social and structural contextually of the experience.

The user is no more asked to choose the most suitable device to complete a task, rather he/she access, disconnects, starts over the process from the last completed step, although in another context. The interaction moves therefor —also as a design focus—from the interface space to the different *access-points*, which —if transparent— allows the user to go in and out from different context and devices without perceiving any discontinuity.

The concept of *transparency* firstly introduced by Gui Bonsiepe (1993) to define one of the highest qualities of the Graphical User Interfaces, now is extended to the whole experiential system as a synonymous of the lack of *friction* cognitive.

Design, too, should be accountable for this activities and contents migration in a segmented and multifaceted scenario of interactive tools becoming the unifying factor for the user experience. The process itself should face, at its first beginning, the need to *integrate, consolidate* and *decline* the communication issues, the uses of information and services in the different users' case and scenarios, social, and media situation.

2. The digital ecosystem

Already in the crossroad from paper and traditional communication media —off-line— designers have been manage a radical, conceptual change of consolidated paradigms and praxis, layered and established in the secular history of writing, publishing and advertising, that means in the culture of the dimensional *mise-en-scene*.

The mutant format, compared to the fixed measures of physical supports, the weak control and the poor expressive possibilities given by screen-typography, the many different and *crazy* displays results —although the same design and front end development sources— limited by platforms' standards, browsers releases; the low quality of the images and the poor resolution of the displays and saving-formats —only bitmaps that means *lossy*— are just some of the critical transitions that designer have been facing the first transition *from paper to web* —according to Zelman work (2001)— now become standards them selves to plan and project a web interface and site.

The introduction of mobile devices, smartphone in 2007 and tablet in 2010, the family of tool to access the web, Internet services has become wider and differentiated increasing user scenarios, the social interactive flow along the everyday life time.

The design challenge is doubled: on one hand, design must face and solve the parcelling of interaction environments; on the other hand it should be able to unify the user experience.

According with the *state of the art,* the cultural debate too, is no more discussing of the project of a single communication artefact —the web site, the mobile app and so on— but rather of *digital eco-systems.* That means an interconnected system, in which single elements that are part of, interact among themselves and with the environmental context.

The *naturalist* metaphor applied to the phenomenological digital world seems to refer to the *Noosphere* conceptualization firstly introduced by Verdnaskij (1926) as the highest form of evolution of the biosphere and the human intelligent system in which some authors have already identified the *collective intelligence* then enabled by the Internet. The promising outcome of this comparison between technologies and the natural environment gives both a systemic vision of the phenomena coming also from the idea brought up by Maturana and Varela in their research work *Tree of Knowledge: Biological Roots of Human Understanding* (1984) and then adopted by Maldonano; and a *gestaltic* the approach whereby the whole is more than the sum of its single parts.

As underlined by Levin, the design issues is not to duplicate the same experience —often in a simpler manner— in all the devices enabling a "everything, everywhere, anytime" access, but rather to dynamically catch the user needs and context associated with the cross-migration from a device to another. The challenge is to focus on "*right thing* at the *right place* at the *right time*" in a context-driven perspective (Levine, 2014: 3) shifting to a new method which pillars are the "3Cs framework: *consistent*, *continuous*, and *complementary*". The focus moves from technology, to people, the devices that they own, in *this* moment, in *this* context to execute a specific task.

3. From waterfall process to spiral model

The design process has been deeply influenced by this shifting from sectorial —industrial, product, graphic, multimedia, web and so on— approach to an eco-systemic perspective.

The referring point is no more a matter of scale —as stated by Rogers *from spoon to the town*— but rather a matter of focus, moving from the *object* both physical and virtual and its productive process to people and the experience that they would do of it in a *user scenario* to satisfy their explicitly and implicit needs.

The turning points are two and they referee to different level of design culture: the first pertains the subject of the design process and its out put —a unit, and artefact related to the whole ecosystemic world of the user and his/her needs in a specific context as previously described in tis paper— the second is a consequence of it. That means how the design process itself is redefined at its core to give answer to this new requirements in a progressively, accelerated and on-going changing of requirements and technological scenarios.

The project praxis was originally borrowed by the Tayloristic *assembly-line* model also due to the strong connection between design contribution and production process, just to mention the original label give to the discipline of *industrial design* according to the critical and historical evolution well synthetized by Maldonado in *Disegno industriale un riesame* in 1976. The design work was organized according to the so-called *waterfall process*. The whole project was structured along a linear sequence of phases, starting with analysis and requirements, going through concept, design, development and release. Each phase have a starting and ending date and specific documentation expecting to be transmitted to the next team. Often competences too are segmented in homogenous working group each one focalized on a limited part of the project itself and rarely able or involved from the beginning to contribute to the *big picture*.

Although this is a generalization of the waterfall process it is not so far from is more orthodox application.

This kind of approach implies a well-fixed goals; stable in time; expected out put and a very strong time management able to face with the unavoidable delay, change of course and *entropic* phenomena. Moreover it is only applied to project which outcomes have a significantly long-term life cycle due to the time-consuming effort of the whole process; otherwise it risks to deliver irrelevant *objects* by the time the project is finished.

But in the last two decades the world of design —both material and digital— has been deeply impacted by new phenomena: a wide acceleration of technologies evolution; a raising and fall of artefactual and production issues and praxis; the pollution of electronic and digital devices; virtual and augmented reality; Internet of Things where products and internet are converging; mobile revolution; *wearables*; smart-whatever and intelligent environment; auto-productions, *industrial* mini-series; *digital* art and crafts; makers movement; fab-labs; 3D-printing; robotics and automation; just to mention the most relevant emerging trends. Under the pressure of such disruptive impact the *fixed* and structured approach to design process have been radically modified moving from the sequential *flow* to a more iterative *loop.*

The introduction of the user-centered design approach in the '90s as an essential requirement in design field has forced to interrupt the linear step by step process to insert user testing and assessment activities and subsequent redesign and release circles. This kind of conceptual framework was firstly introduced by Lehman in IBM as *The Programming Process*: "The design process is […] seeded by a formal definition of the system, which provides a first, executable, functional model. It is tested and further expanded through a sequence of models, that develop an increasing amount of function and an increasing amount of detail as to how that function is to be executed. Ultimately, the model becomes the system." (Lehman 1969).

In more recent times ––2001— in the field of coders and software the core principles of the *agile* approach were defined and declared in the *Agile Manifesto.* This working method is developed and carried out by small teams which "that deliver real, working software at all times, get meaningful feedback from users as early as possible, and improve the product over time in iterative development cycles. Developing software in an agile way allows developers to rapidly respond to changing requirements. Agile developers believe that where uncertainty is high there is no such thing as a perfect plan, and the further ahead you plan, the more likely you are to be wrong." (Beck 2001)

The agile approach seems to fit perfectly the *liquid* state of the art of the design discipline in the crossroad of material, digital and virtual instances. It guarantees shorter time phases (one to two weeks) and smaller deliverables in a more controlled and verified design-testing-development cycles. At the end of every single project iteration features released —called story— have already been tested and assessed with users: "This means requirements can change quite frequently through development. Along the way, refactoring takes place from time to time in order to ensure that features fit together into a single cohesive application. […] At times, it will be necessary to jump out of the iterative flow and examine the whole system for congruency. Do components fit? If not, why? As you work through these potential problems, keep in mind the scope of your iteration and deliverables." (Anderson 2011).

Although *Scrum* is specifically an *iterative and incremental agile software development framework* (Verheyen 2013) for managing product development, it suggests a further develop of design processes. It defines "a flexible, holistic product development strategy where a development team works as a unit to reach a common goal, challenges assumptions of the 'traditional, sequential approach' to product development, and enables teams to self-organize by encouraging physical co-location or close online collaboration of all team members, as well as daily face-to-face communication among all team members and disciplines in the project." (Takeuchi & Nonaka 1986).

4. Releases vs. evolution

So, if the traditional approach to digital design evolution was a constant and accessible development for the *worst case scenario* in terms of infrastructure, OS and browser versioning and compliancy with recent W3C standards, monitors dimensions and resolutions, in 2003 at SXSW Steve Champeon and Nick Finck gave a speech titled *Inclusive Web Design For the Future* presenting the concept of *progressive enhancement* a reversed approach in front of the previous *graceful degradation*. A basic mark-up document is created, geared towards the lowest common denominator of browser software functionality, and then the designer adds in functionality or enhancements to the presentation and behaviour of the page, using the news technologies (Gustafson, 2008)

The remarkable voices and advocate of web standards such as Jeffrey Zeldman, Andy Clark or Molly Holzschlag slightly move from an orthodox and retrospective position to the new approach of *evolutionary* process become nowadays the standard in design and development work.

As well exemplified by the Facebook strategy, the progressive enhancement has become the standard *de facto* in upgrading main software platform and their interactions with the people. Facebook definitely went over successive releases when approaching the mobile development. If the first adopted strategy of disruptive turning point in its evolution were caused as well by marketing or re-branding radical changing —as happened in 2005 with the complete redesign of the user interface and experience realized by Aaron Sittig, the first graphic designer hired in FB or the to develop the *Facelift project* (Bret, 2011)— the last evolution were *smooth* and progressive after a couple of years FB were becoming a *platform* and facing the mobile revolution.

The last discontinuity has been the introduction of the *timeline* loudly disclaimed long before it becomes the new standard visualization of the post streaming. Initially people were invited to adopt the new display model to familiarize with giving the opportunity to go back in the previous *wall* until the deadline announced. When FB *went mobile* —mobile access have widely overcome the other access models— the evolution of the interface and of the interactive patterns are frequent but always partial and progressive. Small innovations allow the users to slowly adopt changes almost without noticing them and reshaping and rearranging small parts of their mental models instead of the whole picture, once, with a strong and shocking effort.

5. From real to virtual and back

If in the late ‘90s the reflection about the impact of electronic and information technologies on artefacts was focused on the miniaturization and virtualization of objects, nowadays the tendencies are both convergent and divergent.

On one hand a large number of the specialized equipment —such as computers, phones, calculators, photo and video cameras, watches, TVs, walk-man, Hi-Fi etc.— are collapsing in few single, multi-function portable devices —the smartphone above all— on the other the world around us is becoming *smart* and intelligent, able to directly interact with us and our personal digital *appendices*.

Apparently miniaturization has a threshold limit —dimensions of components and physical ergonomic measures of our bodies— virtualization has not. Information technologies are still migrating from objects to the environment and moving from specialized tools to everyday objects: supermarket shelves, ephemeral exhibition and museums, cars, appliances and the domestic landscape, the bookshelves of libraries and the books —the reading machine become virtual both in its physical form and conceptual content.

Paraphrasing the Maldonado work about *Real and virtual* (Maldonado 1994) we can now moving back from virtual to real, but with the deep difference, that this dichotomy, on the contrary, is now recomposing. Digital is a layer covering and embedding itself inside the artefactual landscape making neutral object interactive and able to begin a dialog with us mediated by our personal devices in a transparent manner. An insight of this anthropological change is given by Sherry Turkle, who firstly investigated the perception, the psychological effects and the impact of real and virtual life. According to her research and critical work we can emphasize how digital technologies are “more than just a tool, but part of the everyday personal and psychological lives […] Technology catalyzes changes not only in what we do but in how we think.” (Turkle 1995)

The ecological and systemic approach, therefor, is not only a matter of devices, media or channels among which the user migrate and switch from time to time according to his/her needs, but has also a cognitive and social meaning. Personal interactions bot in the physical world and in the digital sphere leave meaningful traces and *real* experiences in the intra-psychological life of people giving rise, in turn, to an *emotional* eco-system.

6. The cross-boundary flow of hybrid design

According to these new issues raised in the design practices the discipline itself needs a theoretical reshape and an open debate on its boundaries and challenges. The project culture is asked to open its competences to other field such as Information, Communication and Digital Technologies, Computer Science, Software Development, Coding, mark-up and scripting —digital tech side— Cognitive Psychology and Ergonomy, Sociology, Ethnography and User Research Methods —humanities and social science side— Information Architecture, user-centered and co-design and so on. This new vocational openness means a structural, conceptual, methodological hybridation. Knowledge, theories, skills traditionally divided among specific fields must combine and melt together as stated in the *Manifesto ibridi* (Giacoma, Bocchi, Damiano & Casali 2012) when explaining the trans-disciplinary attitude: “Hybrids are those people, situated in the most various professional, cultural, and scientific pathways, who are able to connect traditionally separated fields of knowledge and action” according to the four pillars of the new design challenge: *complexity, acceleration, interaction* and *mind.*

On the other side, design disciplines must converge towards the focus of their own specific conceptual core, contaminating themselves across the several *souls* and languages.

Therefor design should face with the mutation of culture in itself as well described by Baricco in the essay *I barbari* —or a hybrid pamphlet published on a daily newspaper before to become a book in 2006— from a *vertical* culture —intended as a meaningful *diving* in the depths of knowledge— to an *horizontal* one —represented by *movement* and *shifting* among superficial experience to another. Despite the skeptical vision of the author, this two axis well descrivbe the attitude that next generation must develop to be able to face the future challenges. A mutation that is atropological.

In less than ten years a new generation of students and then deigners will begin to replace the *digital migrant* pros. Millenials or *digital natives* will bring in this world a different point of view. They will be the first generarion both of users and professionals to be born in the digital era. According to the definition given by Perkins (2001) they are identified as a *new group* born after 1985 grown up with digital technologies such as computers, Internet, mobile phones and MP3s already naturally familiar with digital technologies and devices. As reported by Schmidt and Hawkins (2008) in their recent paper *Children of the tech revolution* what is changing are the values, the way they interact with the world and how they connect socially to each other. Richard Watson in his *Future files: a brief history of the next 50 years* (2010) particularly stress the way how their digital attitudes embed and raise soft skills and social values based on multi-play computer gaming, collaboration, leadership, co-operation and problem solving skills.

They are also an information-intensive generation: always connected to internet, accustomed to free access to knowledge sources such as wikipedia, news, freeware software or on line SAAS (software as a service). Generation Z and Millennials have also a strong attitude to sharing culture and collaborative relation not only in terms of collectivization of emotion and competences thrue the revolution of web 2.0 —just to mention the huge amount of tutorials, peer reviews, free lessons and resources available on Youtube or forums and Q&A groups produced and distributed both by pros and amateurs— social networks, MOOCs and peer-to-peer platforms.

This will be the cultural and social context in which it would be possible to reform and develop a new, open, hybrid and eco-systemic design culture firm and deeply rooted in its traditional basic principles and at the same time open to the material and technological evolution, not yet foreseeable but already certain.

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El Diseño adaptado al entorno de la Industria Cultural y Creativa

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Resumen

Los modelos de desarrollo tradicionales distan de la realidad de los tiempos modernos y se limitan ante nuevas posibilidades de cambio; por lo cual, las tecnologías y sus usos deben flexibilizar los procesos dando paso a un entorno proactivo que va de la mano de los integrantes del sector industrial y sus características. El desarrollo de las Industrias Culturales y Creativas [ICC] debe surgir en entornos fértiles donde las políticas, los profesionales especializados, el acceso a la tecnología, la innovación, las líneas de financiamiento y el mercado sean adecuados.

Las empresas conscientes de su entorno y de su evolución son capaces de adaptarse a nuevos escenarios, formas de producción y nuevas tecnologías para diversificar sus líneas de productos y hacer un control más eficiente en los procesos, desperdicio de recursos y la sustentabilidad. Por tanto, es necesario definir las características de una visión de mercado e industria que se proyecte a futuro, y donde el diseño desarrolle, coordine y gestione los proyectos de diseño aplicados a emprendimientos de carácter cultural y creativo.

El paso natural de la industria a modelos flexibles donde la interconexión a través de redes, la comunicación entre personas y los objetos que nos rodean a través de la nube, genera muchas posibilidades en cuanto a productividad e innovación que mejoren la calidad de los productos o servicios y reduzcan el gasto en recursos y tiempo; por otro lado, el acercamiento del consumidor al proceso creativo viabiliza un enfoque personalizado de soluciones a problemas puntuales y una mayor satisfacción. Las empresas de menor tamaño pueden beneficiarse con los nuevos modelos de negocio, donde la interacción con otros sectores manufactureros o de servicios puede generar una gran red de trabajo adaptado a segmentos y necesidades específicas, para luego reconfigurase y direccionar su producción a otros segmentos y públicos si así lo amerita el cambio constante del mercado.

Palabras clave: *diseño, empresa, Industrias culturales y creativas, tecnología, transformación.*

Abstract

Traditional development models are far from the reality of modern times and are limited to new possibilities for change; therefore, technologies and their uses should be more flexible processes leading to a proactive environment that goes hand in hand with members of the industry and their characteristics. The development of cultural and creative industries [ICC] should arise in fertile environments where policies, specialized professionals, access to technology, innovation, financing lines and the market are adequate.

Conscious companies in their environment and their evolution are able to adapt to new scenarios, forms of production and new technologies to diversify their product lines and make more efficient process control, waste of resources and sustainability. It is therefore necessary to define the characteristics of a market vision and industry that is projected in the future, and where the design develop, coordinate and manage design projects applied to projects of cultural and creative character.

The natural step in the industry to flexible models where interconnection across networks, communication between people and objects around us through the cloud, creates many possibilities for productivity and innovation to improve the quality of products or services and reduce spending resources and time; on the other hand, the consumer approach to the creative process makes possible a personalized approach to solutions to specific problems and greater satisfaction. The smaller companies can benefit from new business models where interaction with other manufacturing or service sectors can generate a large network of work adapted to segments and specific needs, then reconfigured and direct their production to other segments and public if warranted the changing market.

Keywords: *design, business, Cultural and creative industries, technology, processing.*

1. Introducción

Las ICC como emprendimientos deben surgir de la mano de múltiples sectores, cuya estructura debe ser acorde a las posibilidades actuales y oportunidades futuras en un entorno cambiante. El diseño debe integrarse en cada empresa tomando en cuenta las características que configuran a cada sector de las ICC[12], pero también debe prever la evolución de esos entornos en aspectos como la tecnología, la comunicación, los procesos, y estructuras organizacionales. El camino a seguir debe ser labrado con las bases necesarias para su crecimiento; la innovación y calidad como base para la competitividad son herramientas que permiten la entrada a los mercados globales; por su parte, el diseño es partícipe de esta industria, aporta desde la creatividad y la gestión de proyectos de diseño al desarrollo de los sectores que componen las ICC.

[12] Los sectores de las ICC son: patrimonio cultural y natural; artes visuales y artesanía; presentaciones artísticas y celebraciones; libros y prensa; medios audiovisuales e interactivos; y, diseños y servicios creativos. Unesco (2011, p.19)

2. Entorno donde se desenvuelven las ICC

Son diversos los temas que aportan en la conformación de un entorno favorable para el desarrollo de las ICC; la relevancia de cada tema dependerá del aporte que éste brinde al desarrollo de emprendimientos culturales y creativos; en este sentido, cada Estado y su gobierno debe proponer políticas que marquen pautas y tracen el camino para el desarrollo productivo, el apoyo a la cultura y a la creatividad. Solo con un marco de acción claro y viable, el diseño puede actuar y poner en marcha acciones y proyectos en beneficio de una industria en crecimiento.

Según UNESCO (2011, p.14) son seis las acciones de apoyo a las ICC:

2.1. Competitividad e Innovación

La mejora en las líneas de productos, sus procesos de producción y la necesidad de las empresas de ser flexibles y adaptarse a las exigencias actuales, son factores que las obligan a ser más competitivas. Los procesos, materias primas, la imagen, la función del producto, el enfoque hacia el público y mercado, etc., son factores a considerar al momento de lograr la competitividad; y esto se puede alcanzar desde una nueva visión de la empresa apoyada en la innovación creativa. en este sentido la UNESCO (2011) indica que el valor atribuido al producto o servicio para su comercialización ha pasado a ser un factor emocional, con importancia en cómo se lo comunica y lo que expresa en un proceso de vínculo con el consumidor (p.104). En este entorno innovador y creativo toma mayor fuerza el consumidor como parte activa del proceso; por lo que, los esfuerzos en innovación de los productos y su comercialización deben sustentarse en estudios de necesidades, gustos, tendencias e incluso se puede llegar a procesos co-creativos de diseño que integren diferentes fuentes de aporte como especialistas en otras áreas de conocimiento y los mismos usuarios.

2.2. Recursos Humanos y Formación

Las ICC al estar compuestas de múltiples sectores con diverso enfoque y origen, necesitan cubrir las distintas actividades derivadas de esta industria apoyándose en profesionales especializados que brinden el soporte e ideas que pongan en valor la creatividad y la cultura. UNESCO (2011) prioriza la necesidad de formar a emprendedores, creativos, gestores públicos y privados; y para esto, se debe tener claro el panorama de oportunidades, potenciales y capacidades que pueden desarrollarse; así también, las necesidades del contexto cambiante deben enfocado principalmente en las especificidades de los actores de esta industria y otros factores como lo social, el estado, estrategias y nuevas tecnologías (p.76). Ante este cúmulo de profesionales relacionados a las ICC, las universidades y centros de capacitación deben buscar construir el mejor perfil para formar individuos capaces de afrontar retos modernos, crear oportunidades y tener una visión global de futuro.

2.3. Infraestructuras e Inversiones

El medio donde se desarrollen las ICC debe ser adecuado para dicha actividad, ya sea enfocada en la creación, producción, promoción, comercialización; o cualquiera de las actividades propias de la industria, de las actividades complementarias y actividades relacionadas; que deben ser parte de una red de interacción y apoyo que permita su crecimiento. Para la UNESCO (2011) se requiere de instalaciones y equipos, talleres, espacios públicos, espacios de comercio y una logística e infraestructura administrativa que lo organice; es necesario un orden y planificación para lograr sinergias entre sectores productivos o clústeres y ser accesibles para todos los interesados (p.96). De esta necesidad han aparecido distintas iniciativas como las denominadas ciudades creativas[13], estos modelos de desarrollo urbano basado en las ICC se han convertido en centros de cultura y creatividad donde se desarrollan actividades conjuntas con otros sectores como el turismo o la gastronomía, esto permite acercar tanto a ciudadanos como a foráneos para lograr interés y apoyo hacia el sector cultural y creativo.

2.4. Financiación

El apoyo económico es vital para esta industria, al conformarse de sectores emergentes o históricamente poco apoyados, es fundamental realizar un cambio en la perspectiva de apoyo a los emprendimientos asociados a las ICC; para lo cual, se debe fomentar políticas que se encaminen a generar líneas de crédito flexibles y ajustadas a las características de esta industria. Esto lo evidencia la UNESCO (2011) al manifestar que las ICC carecen de acceso a crédito debido a su alto nivel de riesgo, ya que su principal capital, la creatividad es considerada un intangible; esto limita el crecimiento de empresas, el desarrollo de proyectos y la creación de suficientes propuestas que sean atractivas hacia los mercados (p.86). El estado es el llamado a controlar esta situación con estrategias que promuevan el incentivo y apoyo por parte del sector financiero, en especial a las medianas, pequeñas y micro empresas.

2.5. Marco Normativo

El ámbito normativo debe ser entendido a nivel local con el fin de establecer oportunidades e igualdad para todos; pero también se debe proyectar hacia afuera, y es en ese entorno global donde debe existir equilibrio con las normativas internacionales fomentadas por organismos a nivel global o regional y que tienen la adhesión de varios países. Al respecto la UNESCO (2011) plantea que la necesidad de un marco normativo adecuado y obligatorio para todos los actores involucrados es una condición para el desarrollo de políticas de fomento que sean eficaces; además se necesita una integración con otras normativas relativas a la producción, los mercados y la distribución que influyen también en el desarrollo de las ICC, debiendo adaptarse a esta industria donde su materia prima, la cultura y la creatividad son intangibles (p.68). Contar con reglas claras para las ICC constituye un respaldo al asegurar las condiciones que les permitan desarrollarse y lograr los objetivos trazados.

2.6. Desarrollo de Mercados

El objetivo de las ICC para posicionar sus productos y servicios es llegar a los públicos de los mercados internos y externos. UNESCO (2011) afirma que el éxito de la oferta de las ICC depende de su aceptación por parte de los consumidores, ya que su incipiente paso por el mercado sería un fracaso económico; pero la clave se presenta en el momento de generar una sociedad que valore lo propio con el fin de fomentar una identidad que debe ser asimilada desde adentro para que sea creíble externamente (p.112). El trabajo es conjunto; la sociedad, los creativos y el estado deben proyectar una idea o concepto de identidad creíble en torno a la amalgama de sectores que conformen la ICC; que sea apreciado y consumido internamente, para llegar posteriormente a potenciales mercados internacionales.

El entorno macro donde se desarrolle esta industria debe ser el resultado de una apuesta elocuente con la realidad del país, región o ciudad donde se desarrolle, no se la puede entender como una estructura que se puede copiar de otras experiencias; será necesario un mapeo de los emprendimientos culturales y creativos que permita entender que sectores existen, cuales son los potenciales sectores a futuro, cuales son las fortalezas y debilidades, así como las particularidades de los sectores y actores que formaran esa industria.

3. El entorno empresarial

[13] Según Unctad (2010, p.40) Las ciudades creativas son "un conjunto urbano donde las actividades culturales de diferentes tipos son un componente de la economía de la ciudad y funcionamiento social"

Al diseño como función de la empresa se lo debe enfocar desde su posición estratégica para el desarrollo de proyectos e innovación; para esto, se debe entender primero como es que la empresa debe manejarse con su entorno. Tasma y Loeb (1998) hablan de un cambio surgido en 1997 que nos traslada de una civilización tecnológica e industrializada, una civilización de flujos y la inmediatez, donde el individuo tiene el poder del cambio; y, el panorama de la empresa se configura bajo un fuerte dominio capitalista junto a factores de carácter: religioso, moral, estético, científico y tecnológico (p.p.136, 74). Esta situación plantea un cambio constante, un avance rápido y mediatizado donde la empresa debe interactuar con su entorno al ritmo que marca el mercado y la sociedad.

Finizio (2002) habla de un entorno basado en el mercado, donde los cambios producidos por la oferta y demanda se generan mediante una concepción clara de la realidad y una proyección en base a predicciones; esta visión proviene de la comprensión y estudio del mercado, el consumidor, la tecnología, el medio ambiente, entre otros; estos elementos en conjunto son los que dan pautas para lograr la evolución y el desarrollo de la empresa. Se debe tener una predisposición hacia el cambio y la flexibilidad; una empresa que quiera lograr comprender su entorno y adelantarse al futuro debe ser consiente que debe fortalecer su estructura, las herramientas operativas y su potencial innovador en procesos y productos (p.19).

Una empresa consiente de sus necesidades debe buscar la forma de comprender su entorno. Las pequeñas, medianas y microempresas [MIPYME] pueden ser las más afectadas al momento de identificar y estudiar estos elementos debido a sus limitados recursos; por lo que, es necesario entender esa flexibilidad y cambio como una nueva filosofía institucional que le lleve a la búsqueda de nuevas formas de trabajo en conjunto y apoyo con otros sectores y profesionales externos a la empresa; con respecto a empresas relacionadas con áreas culturales, Finizio (2002) indica que pueden estar conformadas por muchas variables y a su vez, pueden estar en conflicto entre sí; por tanto, los escenarios no son iguales para todas las empresas, siendo necesario que cada una se enfoque en buscar las estrategias acordes a su realidad (p.19)

Detectar los nuevos escenarios que la empresa debe enfrentar requiere de una capacidad de predecir los indicios que permiten entender hacia donde se mueve el mundo; la relación con factores culturales, políticos, sociales y de desarrollo del conocimiento son parte de estos indicios que generarán situaciones emergentes con las cuales poder trabajar. Para Finizio (2002, p.30), en estos escenarios "las empresas se mueven, o deben moverse, a través de un enfoque personalizado entre la globalización y la segmentación", siendo necesario una conjugación del diseño con todos las unidades de negocio de la empresa que cumplen un papel en la configuración del producto y que a su vez deben centrarse en identificar las necesidades y deseos del usuario; solo así se pueden llegar a soluciones específicas bajo una misma línea de trabajo conjunta.

Con un escenario definido por la empresa, el diseño debe enfocarse en el desarrollo de propuestas; y según lo planteado por Finizio (2002, p.30), son tres los ejes de impacto para el o los escenarios:

- Aplicación / función
- Tecnología / producto
- Consumidor / mercado

En cada escenario los ejes pueden variar o evolucionar; es decir, se puede optimizar el uso o función del objeto diseñado, así como, añadir nuevas características que lo mejoren; la tecnología avanza a pasos gigantes, modificando los entornos digitales y la industria en ciclos continuos cortos o medios. Así también, el consumidor evoluciona y se adapta a los cambios constantes, las necesidades y gustos se modifican al tiempo que se aprenden nuevas formas de uso y convivencia con los objetos y entornos.

Los ejes propuestos denotan una amplia visión global, donde se hace necesaria la presencia de especialistas en diversas áreas de conocimiento que apoyen el trabajo conjunto de la empresa. El acceso a los especialistas o fuentes de información especializada puede ser visto como un gasto importante por una empresa, por lo que se debe buscar facilidades que permitan un beneficio común a todos los sectores que conformen las ICC; en este punto se vuelve aún más significante que los sectores culturales y creativos formen sinergias que los fortalezcan al momento de interactuar con otras áreas o sectores de apoyo.

Por otro lado, Tasma y Loeb (1998, p.p.136,74) describen este nuevo escenario en base a puntos de giro como:

- Constantes cambios cíclicos y mutaciones
- Una nueva distribución del poder y la aparición de nuevas tecnologías de red
- La ciencia superando a la ficción
- Las maquinas compitiendo y superando las capacidades humanas
- Maximizar los resultados empresariales en base a mantener la rentabilidad de sus dividendos
- El poder de los que controlan el flujo de dinero, los servicios, la información, los bienes, etc.
- Perdida de la propiedad intelectual de las creaciones debido a la reproducción no controlada de ideas.
- Nuevos caminos y expresiones artísticas.

La vertiginosa dinámica presente en el escenario en que se mueve la empresa, hace que deban buscar nuevas opciones y oportunidades que les permita integrarse a los estados actuales de la sociedad y el mercado; por tanto, son las nuevas formas de producción y asociación productiva las que deben evolucionar y ser adaptadas por las empresas.

Esta estructura actual de los mercados y la sociedad presenta un cambio concordante hacia la masificación, el acceso a la información y el conocimiento gracias a la internet y las formas de comunicación de la era digital; los cambios a partir de 1997 (Tasma y Loeb, 1998), representan una búsqueda de armonía para todos, el nacimiento de las redes de información, la gestión del tiempo y la creación de tribus o simbiontes en la sociedad (p.134). El modelo en que actualmente se desarrolla la sociedad describe una división entre ricos y pobres denominada cultura tribal (Fig. 1.); esta estructura marca una diferencia entre los que tienen y los que no, y determina la pauta para la segmentación de los mercados con los que se mueven los mercados actualmente, la especialización según gustos, preferencias y necesidades lleva a las empresas a generar productos y servicios cada vez más especializados y específicos para los públicos.

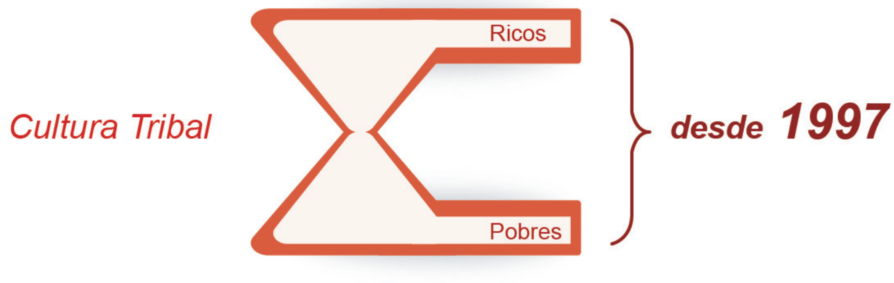

Fig. 1 Distribución de la sociedad desde 1997 (Cultura tribal). Tasma y Loeb (1998)

Esta visión propia de los modelos de negocio tradicionales como la gran industria o las MIPYME, pone en valor la necesidad de adaptarse a un estrato u otro al momento de generar propuestas de nuevos productos y servicios según el enfoque de la empresa; el diseño desde esta perspectiva, debe centrarse en buscar soluciones funcionales para cada nivel, generando una diversidad de opciones adaptadas a cada situación y posibilidades de los consumidores. Además de los segmentos en cuanto a nivel socioeconómico, también se presenta el entorno socio-cultural; Finizio (2002) destaca la importancia de marcar el mercado objetivo en base a las señales que se detectan en este entorno para poder definir el alcance del mercado, sea este local, regional o global; y determinar características y requerimientos que serán aplicados al diseño (p36). Cada uno de los segmentos o mercados determinan características específicas del producto, sin afectar otros factores comunes a todo proyecto de diseño: social, responsable con el medio ambiente, de calidad, ergonómico, funcional, intuitivo, etc.

4. Nuevas configuraciones de empresa

La industria a través de los años ha evolucionado sus formas de producción debido a los cambios sociales, culturales, avances en el conocimiento y las nuevas maneras de consumir; estos cambios del entorno externo también afectan al entorno interno de la empresa y su estructura. La empresa como una organización se estructura por unidades que trabajan en conjunto para lograr objetivos; Finizio (2002) destaca el concepto de red de empresa como alternativa a las estructuras tradicionales jerárquicas donde todas las funciones se ejecutan dentro de esta; el sistema de redes permite desarrollar funciones externamente pero con una guía y control desde la empresa, siendo esto un sistema flexible con resultados competitivos y eficaces (p.36). Las empresas deben buscar opciones para ser competitivas; limitantes de tamaño, geográficas, tecnológicas, políticas, etc., son factores que deben solventarse gracias a acciones estratégicas acordes a la situación de la empresa.

La visión actual de empresas nacidas de startups o emprendedores que se abren paso de forma independiente crea un panorama competitivo desde el momento mismo que nacen las ideas y que buscan salir adelante; inversores o alianzas son necesarias desde estados incipientes del negocio para su éxito, y debe ser una constante en el futuro crecimiento de la misma.

En la actualidad; la llegada de la industria 4.0 marca un nuevo hito en la visión de la industria, basada en el Internet de las cosas (IoT) por sus siglas en inglés, permiten una conectividad inteligente y la economía de recursos; siendo los factores la clave de esta industria (BMBF, 2014, p.16):

– Producción ampliamente personalizada dentro de entornos productivos de gran flexibilidad.

- Integración de clientes y socios en etapas tempranas de diseño y generación de valor.
- Vinculación entre la producción y servicios de alta calidad para generar "productos híbridos"

Este nuevo panorama permite el desarrollo de nuevos productos, servicios, procesos, comunicación y emprendimientos que requieren de profesionales especializados en diferentes áreas del diseño, además de servicios derivados de esta actividad creativa.

La industria 4.0 se integra acorde a los cambios sociales y culturales de pensamiento sobre nuestro entorno y el lugar que ocupamos en este mundo, la preocupación por los recursos y estar cada vez mejor comunicados son valores importantes de este modelo productivo; la convergencia del mundo real y el digital permite optimizar las experiencias y ampliarlas. Una definición derivada de la industria 4.0 es la referente a las industrias inteligentes:

Son industrias que tienen un alto grado de flexibilidad en la producción, en términos de las necesidades del producto (especificaciones, calidad, diseño), volumen (lo que se necesita), el momento (cuando sea necesario), eficiencia de los recursos y los costes (lo que se requiera), pudiendo sintonizar (de buena forma) las necesidades del cliente y hacer uso de toda la cadena de suministro para la creación de valor. Se activa por un enfoque de red-centralizada, haciendo uso del valor de la información, impulsada por las TIC y las últimas técnicas de fabricación disponibles. (Smart Industry Report, 2014)

Esta definición permite tener una idea clara de las posibilidades que se derivan del uso de la tecnología de punta y la productividad, sobre todo al momento de ser versátiles en un entorno de ciclos cortos y cambiantes.

5. El diseño como dinamizador de las ICC en un entorno de cambios constantes

De este entorno y configuración actual de la industria, se puede entender la necesidad de ver al diseño de una manera diferente a lo ya visto, los modelos tradicionales se vuelven obsoletos debido a su rigidez estructural que limita su migración a diferentes líneas de producción; otro factor es la cantidad de inversión que representaría en los modelos tradicionales implementar nueva infraestructura, que conjugada con la existente obliga a un crecimiento en cuanto a espacio y capital de producción que muchas MIPYMES no se lo pueden permitir.

Esto pone aún más en evidencia la necesidad de generar lazos entre distintas actividades productivas que se complementen y generen una simbiosis de proyectos con mutuos beneficios a las MIPYME o grandes empresas que intervengan. Una estructura funcional y adaptada para la tecnología, el cambio constante, el trabajo interactivo, la interconexión de redes y los actores o consumidores presentes, conforman los ejes que definirían una empresa de la industria 4.0; además, esto permitiría fomentar la producción local mediante unidades productivas que puedan solventar necesidades específicas sin tener que recurrir a producción en masa con su consecuente desperdicio y poca conciencia en el ámbito de la producción sustentable. El diseño por su parte, se integra en el proceso de la empresa desde la ideación de proyectos hasta el momento mismo de la experiencia entre usuario y producto; ya que en sí, el diseño configura esa experiencia y debe identificar las respuestas obtenidas.

Manzini (2015) plantea cómo se debe poner en práctica la capacidad de diseñar en función a dos ejes: el eje de actores y competencias; y el eje de motivaciones y expectativas, de donde surgen cuatro actividades:

- Organizaciones base, personas no expertas que impulsan proyectos de diseño desde la detección de necesidades o problemas

- Activistas culturales, personas interesadas en actividades, su desarrollo y promoción con un interés cultural
- Diseño y agencias de comunicación, expertos encargados en el desarrollo de productos, servicios y sistemas de comunicación
- Diseño y agencia tecnológica, expertos multidisciplinarios con un perfil técnico para la solución de diversos problemas; abierto a nuevas experiencias y procesos de diseño. (p.p.50-55)

Esta perspectiva ubica al diseño en diferentes niveles de interacción dentro de la sociedad, enfocado siempre en la propuesta de acciones; desde las organizaciones base y activistas culturales se puede obtener la información necesaria para el desarrollo de proyectos, retroalimentación de información o experiencias y la validación de los diseños; mientras que las agencias tecnológicas y de comunicación son las encargadas de poner en marcha las acciones y propuestas de diseño. Los factores existentes permiten identificar posibles configuraciones para el papel que el diseño debe cumplir en este tipo de empresas, siendo la propuesta del enfoque hacia las ICC el siguiente:

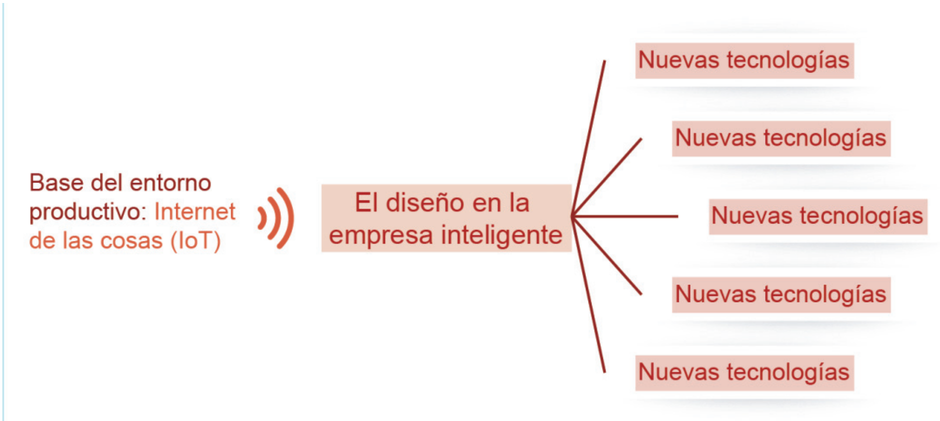

Fig. 2 Entorno productivo para las ICC.. Elaboración propia.

De este entorno se puede plantear acciones desde el diseño cómo:

- Integración de apps especializadas y dispositivos móviles para el desarrollo de ideas, bocetos, prototipos y el trabajo en equipo de la empresa.
- Trabajo en espacios amplios y configurables, que puedan ser desde un taller de experimentación hasta un salón de reuniones con el fin de generar acciones comunes de creación.
- Comunicación continua entre las unidades de negocio para la solución de problemas, control y gestión del diseño.
- Equipamiento para prototipado rápido y series cortas que permita flexibilizar la producción y abrir nuevas líneas de productos (dentro de la empresa o como servicio de diseño externo)
- El diseñador como gestor de experiencias aumentadas a los productos, mediante propuestas de servicios asociados (on-line)

- El diseñador como promotor del acercamiento y fidelización creativa de los usuarios a través de servicios complementarios (DiY)
- Gestión centralizada de procesos mediante la interconexión de equipos y dispositivos en la empresa.
- Coordinación y supervisión de proyectos mediante trabajo conjunto con otras empresas (on-line)
- Seguimiento de resultados mediante la retro alimentación de experiencias de usuarios que se contrasten con experiencias logradas en los procesos de desarrollo.
- Diversificación estratificada según el segmento o mercado, pudiendo identificar necesidades específicas de sectores de menos recursos o integrando la personalización del diseño como valor agregado a sectores más pudientes.

6. Conclusiones

En un entorno cambiante y flexible donde es necesario la respuesta y reacción inmediata, los modelos tradicionales jerárquicos presentan dificultades en la integración del diseño como eje de construcción de propuestas innovadoras, las acciones del diseño en la empresa deben tener una interacción constante con el resto de departamentos relacionados a la producción y generación de proyectos para lograr respuestas inmediatas y eficientes; esto hace necesario evitar perder el tiempo en una comunicación vertical sujeta a la toma de decisiones de los altos mandos, sino una comunicación abierta y trabajo en equipo.

El diseño debe tener su lugar en la empresa, sea como parte de esta o de forma externa; y su trabajo debe abarcar los procesos y actividades de la empresa valiéndose de todos los recursos posibles para dar apoyo y guiar los proyectos hasta su fin. Las múltiples actividades que el diseño debe cumplir en el actual panorama productivo, obliga a las medianas, pequeñas y microempresas a considerar una forma de integrarlo, siendo una posición viable el trabajo en red como una unidad externa de la empresa que gestiones sus procesos creativos y productivos, esto generaría mayor competitividad y posibilidades de ampliar su producción; aún más si desde el diseño se proponen servicios complementarios para la empresa y se refuerza su capacidad productiva.

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La prospectiva como diseño de lo intangible. El caso de CENTRO

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Resumen

Se reseña la experiencia de investigación y confección de la especialidad en Diseño del mañana, programa de posgrado destinado a la formación de expertos en solución de problemas sociales con base en los métodos de la prospectiva, conjunto de herramientas y técnicas destinadas a sistematizar la imaginación para el diseño de futuros posibles, probables o preferibles.. Se concluye que en sí misma, la experiencia aspira a constituir una solución a un problema cultural signiticativo que permea todos los ámbitos de la vida: el de la visión a corto plazo. La presentación abarca los antecedentes del proyecto, la descripción del proceso de investigación, la exposición del programa y el estado actual del proyecto, que ocurre en el marco institucional de CENTRO, institución dedicada a la profesionalización de la Economía creativa.

Entre los resultados más relevantes de esta experiencia pueden señalarse, además del programa en sí, que ya se encuentra vigente y debidamente validado por la Secretaría de Educación Pública en México, la conformación de un claustro de profesores nacionales e internacionales altamente motivados y comprometidos por la experiencia; la integración de un consejo consultivo con representación de los más importantes think-tanks *de futurología alrededor del mundo (la World Future Society, la World Future Studies Federation, Institute for the Future, entre otros) y la incorporación de CENTRO a la discusión internacional en materia de futuros, entendiendo los futuros como objetos de diseño complejos que pese a no existir, son integrados –conjurados– a la realidad material mediante narrativas, objetos, prototipos, escenarios y otras expresiones materiales que contribuyen a guiar la toma de decisiones en el presente.*

El diseño de futuros supone un reto provocador dado que CENTRO cuenta con 13 años de experiencia en la formación de profesionales del diseño, la comunicación y la mercadotecnia; como parte de su proceso de maduración, la institución ha dedicido comprometerse con el diseño en un sentido más abstracto y denso con el propósito de formar a especialistas capaces de utilizar su ingenio (y en esta medida, contribuir a la Economía creativa y a la sociedad del conocimiento) de forma sistemática para contribuir a la generación de realidades sociales más ad hoc a los futuros que consideramos deseables (futuribles).

Palabras clave: *prospectiva, diseño de futuros, pensamiento complejo, innovación social, retos del milenio*

Abstract

We present the experience of the researching and making of the Futures Design specialty, graduate program for the training of experts in solving social problems based on the methods of foresight, set of tools and techniques to systematize the imagination to design possible, probable or preferable futures. We concluded that in itself, the experience aims to provide a solution to a cultural problem that significantly permeates all walks of life: short-term vision. The presentation covers the background of the project, the description of the research process, program exposure and the current status of the project, which takes place in the institutional framework of CENTRO, an institution dedicated to the professionalization of the creative economy.

Among the most important results of this experience that can be identified, in addition to the program itself, which is already current and duly validated by the Ministry of Public Education in Mexico, the formation of a cloister of national and international teachers highly motivated and committed to the experience; the integration of an advisory board with representatives of the most important think-tanks on futurology around the world (the World Future Society, the World Future Studies Federation, Institute for the Future, among others) and incorporating CENTRO to the international discussion in the matter of futures, understanding the future as objects of complex design despite its non-existence, are integrated -conjured- to material reality through narrative, objects, prototypes, scenarios and other material expressions that help guide decision-making in the present .

The designing of futures poses a provocative challenge since CENTRO has 13 years of experience training professionals in design, communication and marketing; as part of their maturation process, the institution has decided to commit to design in a more abstract and dense sense in order to train specialists capable of using their wits (and to this extent, contribute to creative economy and society knowledge) systematically to contribute to the creation of ad hoc social realities for a future we consider desirable (futuribles).

Keywords: *prospective, futures design, complex thinking, social innovation, millennium challenges*

1. Antecedentes

Centro de Diseño, Cine y Televisión (CENTRO) es una institución educativa privada, fundada en el 2013 en la Ciudad de México con la misión de formar a profesionales de la Economía creativa, esto es, personas capaces de participar activamente en cadenas productivas que encuentran en el ingenio su principal materia prima (Howkings, 2016). En este vibrante ámbito se incluyen los diseños, la comunicación audiovisual, la industria editorial, la industria de los videojuegos, el desarrollo de software, entre otras actividades clave.

Dada su naturaleza, la Economía creativa encuentra en la propiedad intelectual e industrial uno de sus indicadores más importantes, de ahí que las universidades (más aun tratándose de instituciones con una fuerte vocación hacedora, como es el caso de CENTRO) jueguen un papel fundamental como nichos de la clase super-creativa (Florida, 2014).

Actualmente, CENTRO cuenta con 7 programas de licenciatura y 11 de posgrado, todos relacionados con este sector, capaz de propiciar el desarrollo local y regional. De hecho, México se considera un país altamente competitivo (UNESCO, 2013) en esta materia, si bien aún no alcanza su máximo desarrollo en este ámbito.

En el 2013, el equipo de la coordinación de investigación de CENTRO recibió la encomienda de diseñar un posgrado de avanzada. Para cumplir con esta empresa, el equipo realizó una investigación de la cual se dará cuenta a continuación, cuyo propósito era crear el plan de estudios al cual se referirá más adelante, logrando que la propuesta fuera tan inspiradora como para que los propios profesores que la diseñaron quisieran cursar el posgrado.

2. La investigación

El equipo de investigación a cargo de la Especialidad en diseño del mañana de CENTRO estuvo conformado por 2 comunicólogas, 1 mercadólogo, 2 diseñadores, 1 animador y 1 administradora de empresas, todos comprometidos con la causa común de diseñar un programa inspirador, provocador, radical y altamente competitivo.

En principio, el equipo recopiló y revisó minuciosamente 46 programas de posgrado nacionales e internacionales, todos orientados al desarrollo de capacidades creativas aplicadas a los negocios, al diseño de políticas públicas y al diseño de soluciones a problemas complejos, entre otras salidas. De este primer universo se seleccionaron 10 programas especialmente interesantes que en aquel momento se impartían en 9 países (incluído México), ya sea en modalidad de maestría o especialidad. Dichos programas nos permitieron identificar una estructura común que sirvió como esquema inicial para bocetar el plan de estudios.

Por otra parte el equipo analizó la trayectoria profesional de 4 egresados de dichos programas para inspirar el perfil del egresado de CENTRO y realizó entrevistas a expertos acerca de cuál es el ámbito laboral y el potencial del mercado para los especialistas en diseño prospectivo.

La etapa de entrevistas resultó crucial para orientar la investigación, ya que CENTRO cuenta con una vasta experiencia en Economía creativa pero su trayectoria en prospectiva es muy incipiente aún. Por lo tanto nos acercamos a destacadas organizaciones en este ámbito de especialidad:

1. Club de Roma. Organización sin fines de lucro fundada en 1968 por científicos y expolíticos interesados en mejorar el futuro a largo plazo. En la década de los 70 encomendaron el informe *Los límites del crecimiento*. (Rome, n/d)
2. World Future Society. Organización sin fines de lucro fundada en 1966, anualmente publica una serie de informes relativos al futuro remoto y promueve la investigación en esta materia.
3. World Future Studies Federation. Organización sin fines de lucro fundada en 1973, con presencia en 60 países, promueve la generaciónd de futuribles, el intercambio de ideas y la generación de recomendaciones para organismos internacionales en materia de prospectiva. (Federation, n/d)
4. Millenium Project. Think tank internacional fundado en 1996, conformado por 40 nodos de científicos y políticos alrededor del mundo, quienes año con año publican estudios en relación al

futuro remoto y desarrollan diversos métodos para el diseño de futuribles. Entre otras actividades, diseña, difunde y reflexiona en torno a los retos del Milenio. (Project, n/d)

5. Fundación Javier Barros Sierra. Asociación científica y tecnológica fundada en 1975 que agrupa a expertos dedicados a la prospectiva, específicamente en lo que hace al futuro a largo plazo de México. (Sierra, n/d)
6. Institute for the Future. Think tank sin fines de lucro dedicado a la investigación y la capacitación en materia de estudios del futuro. (Future, n/d)

En los primeros cinco casos, estas organizaciones cuentan con representación en México, de manera que CENTRO se acercó a sus representantes locales con excelente recepción. En el último caso, la fase de investigación coincidió con una gira de Institute for the Future a México, en la cual CENTRO fungió como sede y estableció contacto con el equipo de investigación del instituto.

Esta exploración arrojó resultados muy interesantes que a continuación se refieren.

Los estudios del futuro en México cuentan con una gran tradición que se remonta a la década de los sesenta, durante la cual destaca el trabajo de expertos como Tomás Miklos (Miklos, 1994), Guillermina Bahena (Bahena, 2012), Concepción Olavarrieta (Olavarrieta, 2014)y Antonio Alonso Concheiro (Millán, 2006) (quienes a la fecha se encuentran en activo), sin embargo en las últimas dos décadas el auge de la disciplina ha disminuido de forma significativa, identificándose pocos especialistas jóvenes en la materia. Entre los escasos nombres podemos mencionar el trabajo de Alethia Montero (World Future Society), Margarita Arroyo (Miklos, 2008) y Patricio Buenrostro (Embajadas del futuro), quienes han desarrollado su trabajo al alero de los expertos en principio mencionados y/o en colaboración con las organizaciones referidas.

¿Por qué hay tan pocos futurólogos en México? Nos preguntamos. ¿Dónde se forman los futurólogos existentes? La respuesta fue que en el extranjero o en el único programa de maestría vigente en México (en Monterrey, al norte del país). Sin lugar a dudas, la falta de oferta académica en la materia se hizo notar.

El equipo estaba en busca de inspiración y guía. Encontramos a expertos entusiastas y generosos, convencidos de la necesidad de lanzar un nuevo programa y dispuestos a colaborar su diseño; más tarde, estos expertos configuraron el actual consejo consultivo del posgrado. El análisis de las trayectorias de los propios consejeros sirvió para orientar el desarrollo del plan de estudios y crear el perfil del egresado, concebido como un experto capaz de idear escenarios futuros y asesorar a los sectores público, privado y civil en la implementación de decisiones presentes que hagan posible la consecución de los escenarios más deseables.

2.1. Acerca de los estudios del futuro

Por estudios del futuro entenderemos un "tipo de investigacion especial mente creativa, orientada a la exploracion del porvenir, con el objeto de proporcionar informacion relevante, en una perspectiva a muy largo plazo que permita apoyar la toma de decisiones" (Miklos, 1994).

El propósito de estos estudios es brindar información útil para los tomadores de decisiones, considerando los escenarios posibles, probables y preferibles como alternativa. Vale la pena destacar que este campo disciplinario parte de la premisa de que los futuros no existen y en esta medida pueden diseñarse como objetos complejos: ¿qué mejor reto para un profesional de la economía creativa que utilizar su ingenio para pensar en escenarios que no existen, pero podrían existir si trabajamos en su consecución? El ejercicio supone el uso del ingenio, pero también de procedimientos formales para fundamentar ese acto creativo.

Con su incursión en el diseño de futuros, CENTRO se propone dar un paso más en su crecimiento en la formación de *problem solvers*. Por supuesto, esto implica un gran reto, el primer de ellos consiste en instar a los estudiantes para que se alejen un poco de su zona de confort y utilicen su imaginación y su capacidad analítica para pensar en soluciones hasta entonces fuera de su marco de referencia. Con este paso, la propia institución asume el reto de diseñar soluciones para un mundo en el que quizás el diseñador ya no se encontrará en el momento de la implementación: ¿qué tipo de consumo tendrán los nietos de la generación Z? ¿cómo debe ser la indumentaria que necesitan los habitantes de Marte? ¿qué políticas públicas deben implementarse ahora para lograr un manejo sustentable del agua dentro de 50 años? ¿cómo serán las aulas en las universidades dentro de dos generaciones? Son algunas preguntas que nuestros estudiantes deben plantearse para idear soluciones.

3. El programa

3.1. Objetivos

Los objetivos del programa se enuncian así: El alumno diseñará escenarios probables, posibles o deseables en torno a una problemática social relevante y concreta; en un marco organizacional determinado; el alumno conocerá, practicará y evaluará procedimientos de análisis efectivos para el diseño prospectivo y la innovación.

En lo que hace a los objetivos emocionales, nos propusimos que los alumnos se sintieran altamente motivados, desconcertados, ansiosos, estimulados y comprometidos con la experiencia, pensada para grupos de máximo 10 personas, lo cual permite hacer adaptaciones para garantizar su carácter personalizado.

3.2. Perfil de egreso

El egresado será capaz de construir escenarios novedosos, creativos, originales aplicando diversas herramientas e instrumentos del diseño prospectivo, la invención y la innovación para la solución de problemas sociales específicos, usando como base las tendencias y certezas estructurales existentes.

Podrán ser consultores privados, asesores de los tres niveles de gobierno, guionistas de televisión, radio y cine para la elaboración de escenarios en la incertidumbre y de eventos inesperados. Los egresados de esta especialidad deben ser capaces de pensar en un objeto que no existe: el futuro. O para ser más precisos, los futuros (posibles o deseables), considerando que es una entidad que no existe, pero que puede diseñarse para fundamentar la toma de decisiones en el presente.

Fig. 1. Pieza promocional

3.3. Currícula

El programa de la especialidad tiene dos centros: la formación metodológica y la práctica de los métodos. En ambos casos se disenarón materias robustas alrededor de las cuales se concibieron asignaturas complementarias.

El primer boceto del programa fue diseñado por el equipo de investigación de CENTRO con base en los resultados del estado del arte, posteriormente fue comentado por el Institute for the Future, la World Future Society y la World Future Studies Federation. Dado que estas organizaciones no necesariamente coinciden en puntos de vista, los diferentes comentarios contribuyeron a lograr una propuesta diversa y balanceada en contenidos.

Segmento	Contenido
Propedéutico	Pensamiento de diseño
	Análisis de textos
	Aparato crítico
	Retos del milenio
	Introducción a la prospectiva
Segundo semestre	Historia de los estudios de futuros
	Antropología simbólica
	Pensamiento sistémico y teorías del cambio
	Métodos prospectivos
	Inteligencia prospectiva en la incertidumbre y la complejidad
	Construcción de escenarios

Primer semestre	Contexto geopolítico
	Pensamiento anticipatorio e innovación
	Procesos innovadores de planeación prospectiva estratégica
	Laboratorio de innovación social
	Escenarios de innovación disruptiva
	Narrativa y representación de escenarios a largo plazo

Fig.2. Estructura del plan de estudios. Fuente: Elaboración propia

El programa se imparte en 192 horas presenciales (sin considerar clases magistrales, conferencias, talleres y otras actividades complementarias) organizadas en dos sesiones semanales, durante dos semestres.

Cabe hacer notar que las personas que cursan este programa deben generar una carpeta de proyecto para graduarse y que dicho proyecto debe centrarse en una solución con alcance social. Dicha carpeta debe contener todos los entregables generados en cada uno de los cursos: futuribles narrados, futuribles representados visualmente, prototipos (dibujados, impresos en 3D u otros soportes según el caso), informes de investigación, estudios de caso, entre otros posibles entregables del diseño de futuros.

A lo largo del programa, también se insta a los alumnos para que incursionen en experiencias de diseño que de alguna manera los vinculen con la red de especialistas en prospectiva, tales como rondas Delphi, talleres para el diseño de futuribles, consultorías guiadas por sus profesores, entre otras experiencias de formación. Ello les permite familiarizarse con la visión de los expertos y sensibilizarse frente a las problemáticas que los futurólogos suelen atender.

3.4. Claustro de profesores y grupo de alumnos

El equipo de profesores a cargo del programa es diverso. Todos los docentes son posgraduados con nivel mínimo de Maestría y el 40% de la planta cuenta con formación específica en Prospectiva. Contamos con psicólogos, historiadores, filólogos, filósofos, diseñadores, antropólogos, internacionalistas y sociólogos en el equipo.

Vale la pena mencionar que además del equipo básico, todos los alumnos cuentan con un mentor nacional y uno internacional para el seguimiento de sus proyectos.

Por su parte, los alumnos de la primera generación son diseñadores, administradores y comunicadores.

3.5. Actividades realizadas hasta el momento

Al cierre de este texto, la primera generación de la especialidad concluye su primer semestre. Los alumnos están bocetando sus propuestas, mismas que serán discutidas con sus mentores en las próximas semanas.

Hasta el momento hemos realizado una conferencia magistral y tenemos programas dos más con expertos del sector. Adicionalmente los alumnos cursarán dos talleres para la práctica de técnicas prospectivas específicas y complementarán su formación con una clase magistral más.

En las próximas semanas también se llevará a cabo una mesa redonda con presentación de libros, uno de los cuales presenta el cruce perfecto entre la prospectiva y el diseño conceptual: se trata del Códice de Eduardo Terrazas (Terrazas, 1975), obra gráfica inspirada en el clásico *Los límites del crecimiento* (Behrens, 1972).

En el segundo semestre, los alumnos entrarán al laboratorio de innovación, en el cual prototiparán y evaluarán sus escenarios. Asimismo tendrán dos conferencias magistrales y un taller más antes de estar en condiciones de presentar sus carpetas finales.

En paralelo, hemos iniciado el seminario de profesores de la especialidad, durante el cual intercambiamos contenidos de interés, profesionalizamos a la planta docente en técnicas prospectivas y en general, facilitamos el trabajo colaborativo de cada miembro del staff para integrar productos significativos y congruentes con el programa.

El camino ha sido arduo e intenso, sobre todo si pensamos que la generación está conformada por seis estudiantes. Sin embargo, ya tenemos lista de espera para la siguiente generación y esta primera experiencia nos ha permitido perfeccionar el modelo educativo y por ende los contenidos y las experiencias de formación.

Lo decisivo será, bien lo sabemos, los entregables que produzcan, cuya calidad será evaluada por el consejo consultivo de la especialidad.

4. Conclusión: tan difícil como diseñar lo intangile

Comenzaré por aclarar que la denominación "diseño del mañana" es imprecisa y se estableció con fines comerciales, lo correcto sería referir al diseño de futuros. El mañana es muy inmediato, la prospectiva promueve una idea más remota de los futuros; por otra parte, el mañana es uno y los futuros posibles, probables o preferibles son múltiples.

Hecha esa precisión, se concluye que un especialista en prospectiva crea objetos complejos (lo mismo una taza que una situación o un sistema) y para ello combina su imaginación con técnicas formales para fundamentar la propuesta. Es un diseñador en toda forma que genera información útil para otras personas, incluso para sí mismo, pero que enfrenta el reto de crear algo para lo que quizás no existen referencias (materiales o tecnologías que no han sido inventadas, por ejemplo).

Nuestra mayor área de oportunidad como coordinadores del programa es resistir a la indiferencia del mercado sobre la necesidad inminente de diseñar los futuros, proclive como es la cultura mexicana al pensamiento a corto plazo. Asimismo, la profesionalización del equipo de CENTRO para aplicar las técnicas prospectivas para el desarrollo de la propia institución es aún una tarea por completarse, si bien estamos trabajando en ella.

En mi opinión, el solo hecho de que CENTRO haya tomado el riesgo de emprender este proyecto, no inédito pero sí radical en relación a la inercia de la cultura mexicana, resulta esperanzador. ¿Cómo enfrentamos esta gran responsabilidad? Con mucha imaginación, visión de largo plazo y pensamiento sistemático, como los futurólogos.

Fig.3. Estudiantes con la futuróloga Concepción Olavarrieta. Fuente: CENTRO

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From the invisible, the everyday and the unmentionable towards narrative strategies to explain, understand, remember. New Perspectives on Cultural Preservation.

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Abstract

This proposal takes into consideration three categories of unusual narrative, connected to human life - the invisible, the everyday and the unmentionable - often placed in the outer fringe of our attention or completely ignored.

The invisible: that which inhabits our world and often influences our lives, even though escaping our awareness, because active in dimensions that we cannot see or do not know to guess. The everyday: what accompanies us in every moment of our lives and that produces in us a habit that makes it obvious (and then again, but otherwise, invisible). The unmentionable: what happened at some time and somewhere, and the memory of which, for convenience, hypocrisy or convenience, has been removed or put on the edge of our life (and therefore to the visible limits),

These categories have been chosen as paradigmatic of new experiences on Cultural Preservation. The comprehension of the fundamental value of intangible cultural heritage, which came less than ten years ago to be part of the official definition of "museum" written by International Council of Museums, indeed, has opened new perspectives in the field of curating and exhibition design, often destabilizing and unexpectedly coincident. Therefore we needs updated languages, more interactive and interdisciplinary, towards the construction of a real design of the intangible cultures, able to reflect (and make reflect) on at first sight marginal phenomena, preserving their value of social and historical testimony and making it comprehensible to an audience as broad as possible. The new methods of staging these tales turn the apparent immateriality of knowledge of their socio-cultural values into occasion of development solutions, in form of exhibition design products and related services.

Keywords: *exhibition design, staging, museum, narrative*

1. Introduction

This proposal takes into consideration three categories of unusual narrative, connected to human life - the *invisible*, the *everyday* and the *unmentionable* - often placed in the outer fringe of our attention or completely ignored.

The *invisible*: that which inhabits our world and often influences our lives, even though escaping our awareness, because active in dimensions that we cannot see or do not know to guess.

The *everyday*: what accompanies us in every moment of our lives and that produces in us a habit that makes it obvious (and then again, but otherwise, invisible).

The *unmentionable*: what happened at some time and somewhere, and the memory of which, for convenience, hypocrisy or convenience, has been removed or put on the edge of our life (and therefore to the visible limits),

These categories have been chosen as paradigmatic of new experiences on Cultural Preservation. The comprehension of the fundamental value of intangible cultural heritage, which came less than ten years ago to be part of the official definition of "museum" written by ICOM (International Council of Museums), indeed, has opened new perspectives in the field of curating and exhibition design, often destabilizing and unexpectedly coincident.

«Cultural heritage does not only embrace the tangible expressions like monuments and objects throughout the years. It also includes the living expressions like the traditions that many groups and communities worldwide have been passed down by their ancestors and will continue to pass on to their descendants, mostly by word of mouth. Although it is the motor of cultural diversity, this heritage is fragile (…) Thus, ICOM commits itself to protecting the intangible heritage identifying and managing resources along with UNESCO who adopted in 2003, the Convention for the Safeguarding of the Intangible Cultural Heritage». (ICOM, 2016)

Therefore we needs updated languages, more interactive and interdisciplinary, towards the construction of a real design of the intangible cultures, able to reflect (and make reflect) on at first sight marginal phenomena, preserving their value of social and historical testimony and making it comprehensible to an audience as broad as possible. The new methods of staging these tales turn the apparent immateriality of knowledge of their socio-cultural values into occasion of development solutions, in form of exhibition design products and related services.

2. The invisible. To show what is not visible

The sight is the predominant human sense, especially in Western culture. Everything we are used to deal with daily, every situation, event, relationship is bound to the world of the “visible”. One can say that all of us we all living in a globalized society where what we see has become what "is”, in the sense of what real exist. Is not by chance that the sight supremacy is strongly connected with the fulfillment of our contemporary consumer society, totally linked to the aesthetic effect (and therefore “attractive”, in terms of commercialization) of the image. Most of communicative and expressive media we got it, so, are designed precisely in relation of the attractive and persuasive force of the images. Nevertheless there is an hidden world which often totally escapes from our view and that, therefore, we ignore, taking it for granted, or eliminating it entirely from the horizon of our awareness.

It is the level of the invisible: a place that we are hardly able to define in terms of boundaries, size and appearance, but that inhabits our world and often influences our life, even though escaping to our conscience, because active in dimensions that we cannot see and could even guess. These parallel worlds, of which we are part, almost without realizing it, often are intangible places essential for our own physical survival. Bring them to the surface and make them accessible to all, is an innovative opportunity and a precious occasion to trigger new forms of storytelling, to accelerate processes of understanding whose effects go far beyond the cultural enrichment, involving issues such as the environment and its defense, the health, etc.

2.1 The Keti Haliori *World Water Museum* project. A symbolic collection

The *World Water Museum* project, made by the Greek artist Keti Haliori is an installation that «focuses to alert people on the challenges of clear, potable water on the planet. It approaches surrealistically the vast environmental problem, presenting water as museum item» as it is written in the *Idea* page of his website. (WWM, 2016)

It is important to note that although it is an art installation, its name includes the word "museum". A choice that testifies the intention to position itself as a narrative event with its own specific physicality and temporality (the project foresees its location in a permanent exhibition at a traditional house in the Greek island of Hydra and an never-ending development, across continuous donations from around the world). Keti Haliori chooses in fact, to deal with the water exactly as an evidence to be put on display into a museum, activating, in this way, its artistic and social value as a subject to be preserved and, above all, to be placed at the center of a different intellectual attention. The water, usually taken for granted and therefore underestimated or even ignored, becomes a complex narrative system that, through its own existence, is it told as a fundamental life element itself and, in perspective, an urgent and strategic global environmental problem. The development of the *World Water Museum* collection is based on the voluntary cooperation of anonymous people, who are asked to send samples of the waters of its rivers or lakes. A collective action that activates a partnership process and, therefore, a sense of belonging and that becomes immediately a metaphor of a global feeling to the problem that the availability of water resources presents to the whole planet, and to the risks of its forthcoming shortages. The water samples received in this way are submitted to chemical analysis, then classified and finally conserved in laboratory vessels, reporting the data of their origin and chemical composition.

Fig. 1 World Water Museum, an installation by Keti Haliori. (Photo: Tassos Frangou; source: http://worldwatermuseum.com/index.html#.VzCxtztf3IU)

Again, the meaning of the museum concept is well explained into the *Idea* website page: «The project does not carry out a factual scientific research of the condition of the world rivers or lakes water sources.

Its completion will constitute a symbolic collection of the samples of water which was conducted at an unspecified place and time, so that the present space-time picture of the river waters is presented – whatever that may be – without the application of scientific criteria and selective procedures». (WWM, 2016) The main principle of this installation is to make clear something that is well rooted in the very nature of the subject of the story – the indispensability of water – but, at the same time, almost totally ignored. For this reason a small portion of 100 ml of water for each sample received by the *World Water Museum* is mixed with portions of all the others, in a separate vessel called *Earth water*: a highly symbolic object, tangible icon idea of common belonging. The interaction of multiple communication levels and the presence of different degrees of conceptual and sensorial involvement require a redefinition of the real idea of content curatorship and of the expression modes implemented with its staging strategies, remodeled to make visible what really exists behind all obvious appearances of everyday. The *World Water Museum* is a potential structure of a "museum work in progress" through an art installation that, making the water something to collect, to classify and to exhibit, reveals, precisely with these actions, its social and cultural value.

Exactly the artistic point of view from which the project originates, a project which is not intended as a scientific research, but rather a symbolic collection, generates innovative points of view looking at water no longer as pure chemical element, but, rather, as an essential factor for understanding ethnographic, economic and political phenomena of the past, the present and the future. So the water becomes a material element that reveals multiple degrees of intuition about intangible factors linked to it: events which must be revealed with the development of innovative staging methodologies. The role of artistic intuition is essential, therefore, to activate new metaphors. Not by chance the work of Keti Haliori active dialogue with the German artist Uwe Laysiepen (better known as Ulay), whose *magnum opus* is the *Earth Water Catalogue*, «a growing archive, database, library and platform, be it online or in print, available from the very outset to any user or reader; artist, scientist, engineer, civil servant, scholar, student, or simply any water consumer». (EARTH WATER CATALOGUE, 2016) *Synergies* by Ulay+Keti Haliori, indeed, alongside *Catalogue* and *Museum*, amplifying the idea of water as a natural heritage of which we should fully perceive the substance and significance.

2.2 *Micropia*, Amsterdam. Discovering the invisible life

The willingness to make visible the invisible is the subject of the complex, innovative and surprising curatorial and staging project for the *Micropia* in Amsterdam, which lasted ten years. «This museum is about the invisible world, – says the museum's creator, Haig Balian – Two thirds of the natural world on this planet is invisible. One way of making it more visible is to imagine that every human being carries almost two kilograms of micro-organisms and bacteria. Half of the oxygen that we use is made of bacteria, and when you know that you have 10 times more micro-organisms in your body than body cells then you realize that you are a part of that invisible world». (EURONEWS, 2014) Realized nearby the Artis Royal Zoo, Micropia unveils the world of micro-nature, introducing a non-specialist audience, to the discovery of microbes: undetectable dimensions living creatures, yet present everywhere, since from our own body, in exponential amounts. An "other" living world surrounding us, of which we are part, but that we know little and that we usually remember only in relation to illness and todisease, but which, however, is essential for our survival. In order to make real and understandable this narrative of the invisible, a broad team of scientists and specialists worked together with the exhibition design experts of the Dutch architects office Kossmann.dejong, in close collaboration with ART+COM Studios, a Berlin-based media design firm. The narrative and staging structure of the museum exhibition is made by a series of multimedia installations that allow visitors to confront the world of micro-organisms according to a broad spectrum of activities, which involve them constantly: in this way are activated a series of experiences that make us understand what ourselves are part of this invisible world.

Fig. 2 Micropia, Amsterdam, The Netherlands. 2014. Source: https://artcom.de/en/project/micropia/

«We have aimed for a balance between experience and knowledge». (KOSSMANN.DEJONG, 2016) The museum works as a large laboratory which reveals the presence of microbes in all aspects of our lives: the discovery of a parallel world. Entire colonies of real microbes that dwell in large petri dishes (enlarged reproduction of the typical containers for laboratory bacterial cultures) can be viewed through microscopes connected to large TV screens, revealing iridescent geometries of these collections of living organisms: true works of abstract art created by nature itself. (Something that reminds to the experiments of artists such as the australian Peta Clancy or the austrian Sonja Bäumel)

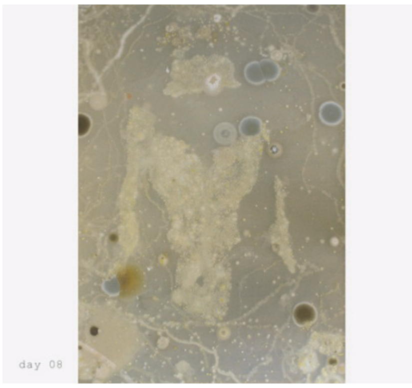

Fig. 3 Peta Clancy, "Visible Human Bodies", Australian Centre for Photography, Sydney, 2007. (Photo: Xain Milke; source: http://petaclancy.com/works/?pid=61)

Fig. 4 Sonja Bäumel, Oversized Petri Dish "Self-initiate", 2009. (source: http://www.sonjabaeumel.at/work/bacteria/oversized-petri-dish)

To tell the unsuspected symbiosis that characterizes the life of people and microbes is it possible to perform direct experiences by interacting, for example, with a full body scanner that lets you view where and how many microbes "are resident" on your body, or dealing with the "Kiss-o-Meter" to find out how many of them are exchanged during a kiss. The narrative space of the museum is therefore rewritten through the intertwining and mutual contribution of different disciplines, aimed at the script of actions, both in their uniqueness that in their sum, draw new boundaries of the exhibition design concept.

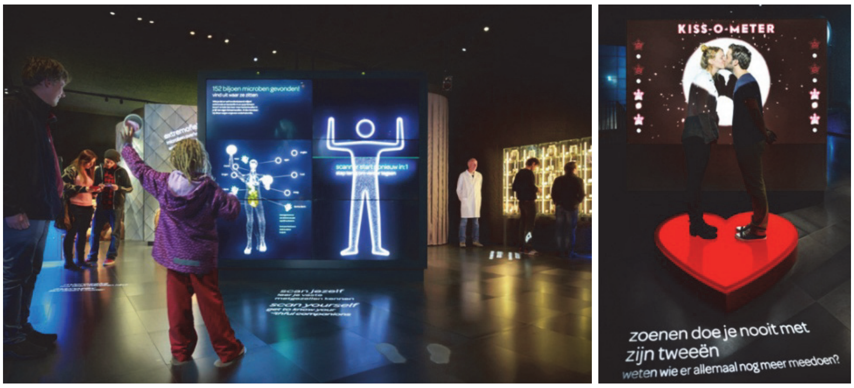

Fig. 5 Micropia, Amsterdam, The Netherlands. 2014

(source: https://artcom.de/en/project/micropia/)

«The mission of *Natura Artis Magistra* is to help a wide public discover and experience the interconnectivity of life and nature and to encourage the love of and concern for the natural world. This objective is of vital importance to our civilization: we cannot understand human identity without grasping how nature and human civilization are fundamentally bound up in and dependent on each other. It is impossible to fully understand the interconnectivity of the natural world without knowledge of the most powerful, most successful and, at the same time, the smallest life form: micro-organisms». (MICROPIA, 2016) *Micropia* is the "zoo of microbes", where narrow cages and fake scenography are replaced by the interaction and the stimulation to explore, triggered by intelligent and innovative paths of exploration. The design project exceeds the boundaries of mere exposition and become the scope of application of a systemic design, including the development of alternative mode of interaction with science, by the design concept of a media-based exhibits as well as their interaction and hardware design, prototyping and programming.

3. The everyday: the usual is not obvious

How many things happen in everyday life of each of us? And how many of them really affect our personal history? Surely everyone can subjectively respond to both questions. But if these events certainly important, but so strictly personal, hides, embedded, histories whose evocative power was so strong to take a universal value: pictures of a global story that involves us all? Recurring events, common needs and requirements, moments of joy and drama: does exist a cross-syntax that brings us closer each other by sharing similar experiences?

The idea that there are social and cultural heritages that, despite the great differences that characterize contemporary society, got common matrix – an intuition that has his most interesting definitions in the principle of *collective memory* formulated in the early twentieth Century by Maurice Halbwachs (HALBWACHS, 1925) It is now also widespread in museum design, generating ecological principles of the alternative culture. These principles raise everyday life to a privileged place of exploration and understanding of social phenomena that we have gone through and that surround us today, defining an aesthetics of everyday where the usual is no longer synonym of obvious. The Halbwachs hypothesis, in brief, states that is the collective memory that allows the constitution of an individual memory (not the other way) and thus our memories are set up in accordance of its membership of a social group. As a result the value we attribute to them individually is such as and is changeable in time, because its being closely tied to changes in the common social judgments. The combination of the traces of the past that a social group maintains, develops and transmits from one generation to the next, could be understood and represented through objects, images and habits of different historical periods and in relation to trends and traditions with which they took shape and became consolidated.

3.1 *Tidens Samling - The Museum of Everyday Life*. Please touch the objects

In this sense is paradigmatic the *Tidens Samling - Museum of Everyday Life in the 20th Century* of Odense (Denmark) that exist since 1992 defining itself the first “hands-on” museum of cultural history in Denmark. Indeed, the museum includes a large collection of objects (furniture, clothing, toys, magazines, records, etc.) that have been of common use in Denmark between 1900 and 1980. This heterogeneous collection is set within eight full-scale domestic environments, whose original interior shows its normal location in the daily life of typical Danish houses of the time. The most interesting feature of this museum, which otherwise would be very similar to a memorabilia store, is that visitors can and should interact with the environments and objects. «Our guests are welcome to make themselves at home in the living rooms where they may sit down, open the drawers, read the books, and put on music». (VISIT DENMARK, 2016) The narrative of the museum is no more static: the interaction exceeds the classic “do not touch” taboo and defines new rules of belonging between visitor and objects on display. The classic *period rooms* evolves themself from scenic settings full of objects, into places of direct experience.

Fig. 6 Tidens Samling - Museum of Everyday Life, Odense, Denmark. 1992

(source: http://www.visitdenmark.pl/pl/denmark/tidens-samling-museum-everyday-life-20th-century-gdk613063)

At *Tidens Samling* you can sit down on furniture and you can try the clothes becoming part of the collection itself: all senses are involved in a time travel made in first person and without digital artifacts: the relationship is immediate, tangible, and tactile. «*Tidens Samling* is a place for all generations to meet and exchange memories and rediscover the history of your parents, grandparents and great-grandparent's childhood. The many details give recollection of early childhood for the elderly, whilst children and young people can learn about the lives of past generations». (TIDENS SAMLING, 2016)

3.2 *Gli oggetti ci parlanno,* Reggio Emilia, 2012. Let’s listen

The placement of everyday objects in museum facilities like the *Tidens Samling* always generates a destabilizing effect because these objects are not artworks "unique" as masterpieces and so they are not included into a critical point of view which recognizes them an *aura* and, moreover, it doesn't matter their scientific-technological aspect (which is competence of the collections of scientific museums): their real nature is uncertain and hardly to define. Are they purely worthless consumer items (and therefore not worthy of museum location) or silent witnesses of different narrative structures: clues able to define different perspectives of exploration and knowledge of the multiple mix of stories that constitute the deepest sediment upon which the History (with capital first letter) can build itself?

The laboratory *Gli oggetti ci parlanno*, curated by by Italian architect Italo Rota in 2012 at the Chiotri di San Pietro in Reggio Emilia, as part of the exhibition *Lavori in corso* had launched a call for all citizens to bring to the *Musei Civici* of "Palazzo di San Francesco" objects common belonged to them and from them recognized as emblematic of some of the recent past living conditions. «Objects related to their memory but chosen with a critical act giving priority to those which in their time have meant a breakthrough, a turning point, a change» (FOTOGRAFIA EUROPEA, 2016) The initiative meant to experiment participatory cooperation methods to increase the second half Twentieth Century *period room* collections of the museum, through an act of shared reflection about the past and future of our community. Means brought to the museum by common people were photographed, cataloged and displayed with a temporary borrowing arrangements, just as real artworks. The idea of the exhibition, open to criticism for its aesthetic results and for a certain complacency in the accumulation excess, had its own clarity of purpose: to outline an insight into the social history of the Italian post-war period, through a visual proposition of daily life, urging a reflection on some open issues about the future.

The possibility of this principle to be applied to the original collections of the Reggio Emilia *Musei Civici*, hybridizing historic objects and documents to other more anonymous origin has raised great controversy at the time. An exhibition defined by multiple assembly and free association that, for many critics of the operation, if brought within the permanently collection would have subverted the philological conservation duty that is intrinsically linked to the role of the museum. An issue that certainly must be analytically dealt in the next years and which can be solve in the development of new types of professional designers of integrated system involving conservation, curation, communication and staging.

Fig. 7 Gli oggetti ci parlanno, Reggio Emilia, 2012. Source: courtesy of Studio Italo Rota & Partners

3.3 The *Museum of Broken Relationships* by Vištica and Grubišić

If the daily tracks are not included into a consolidated display structure and into a historical context and built, however, the unique and original core, as happens for the *Museum of Broken Relationships*, founded by Croatian artists Olinka Vištica and Dražen Grubišić, a highly poetic and compelling vision invests banal and anonymous objects inventing a museum that, for its originality, was awarded in 2011 for its capacity to be innovative, challenging the common perception of the role of museums in contemporary society.

«The *Museum of Broken Relationships* encourages discussion and reflection not only on the fragility of human relationships but also on the political, social and cultural circumstances surrounding the stories being told. The museum respects the audience capacity for understanding wider historical, social issues inherent to different cultures and identities and provides a catharsis for donors on a more personal level». (MUSEUM OF BROKEN RELATIONSHIPS, 2016)

The *Museum of Broken Relationships* comes from the intuition that the drama of the end of a love is a traumatic moment in people's lives, and that this event is universal: everyone, sooner or later got to facing it, no matter the age, religion, culture or geographical origin. The devastating power that this event generates can radically change our lives and often leaves a residue of intense and mixed feelings: sadness, hopelessness, anger, revenge, apathy...

Fig. 8, Museum of Broken Relationships, Zagreb, Croazia, 2007. Source: https://brokenships.com/en/about/download

The visitor goes to Museum of Broken Relationships not only to view the collection on display, but to find himself and their common experiences, observing everyday objects of little value, sometimes surprisingly ugly, but that find sense, despite their apparent randomness, in their common emotional origin, creating a universal feelings portrait, unexpectedly logical and understandable.

3.4 The *Museum of Obsolete Objects* by Jung von Matt

Everything can be narrated. What really makes interesting a storytelling is its skills to be highly original in capturing an unexpected point of view, even when dealing with a topic seemingly trivial. There are many factors that contribute to the achievement of this result: intuition and practice to the originality, intelligence and earnestness in the construction of the narrative, clearly the motives and purposes of the narrative itself. As part of the cultural preservation idea this means above all to know how to identify events marginal at first sight, a hidden dimension, that makes them key witnesses of widespread social phenomena, affecting the reality of our lives, determining it logical structure, and changes. A sensibility that identifies the intangible culture, which nestles in the marginal phenomena and makes it understandable to everyone. Then that's also a project with an extremely simple structure becomes a valuable tool for understanding complex and broad phenomena . Imagine all the objects that lie abandoned in the bottom of our homes drawers, because displaced by new technologies that have made them useless. Their destiny is most likely the dump; the lucky ones, perhaps, will end up in some modern antiques market, waiting for some nostalgic. They are the "obsolete objects", in the moment of their maximum glory desired and everywhere widespread and now totally abandoned.

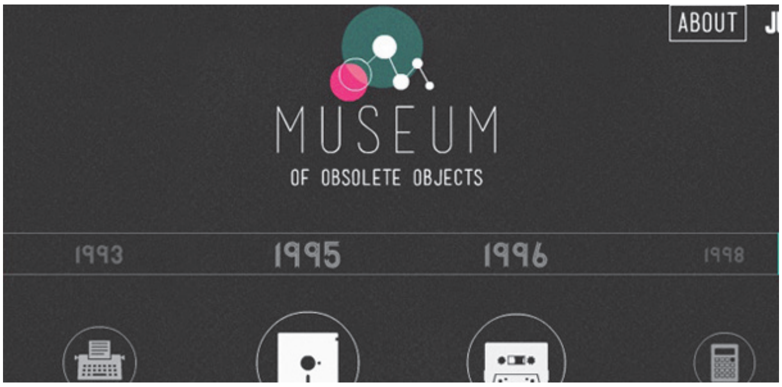

Fig. 9, The Museum of Obsolete Objects by Jung von Matt. Source: http://projects.jvm.com/mooo/?lang=en&hl=en_US

Nevertheless behind their aging you can outlining uses and customs of ages also right next door to us and, above all, one can become aware of how quickly, often secretly driven by the so-called "market laws" have changed the way we live. Above all, we can realize how contemporary society, so strongly influenced by technological advances, produces and consumes objects (and the related mass culture), that once lasted for generations and today, in a few years, appears to the youngest already unknown and incomprehensible. These are the multiple narrative structures that trigger with a visit to a virtual museum, which only exists in the web (although lately has generated many attempts to "real" copies): the *Museum of obsolete objects* designed by the German advertising agency Jung von Matt.

Made up of a *You Tube* channel (http://projects.jvm.com/mooo/?lang=en&hl=en_US) the museum displays, in fact, many objects that have accompanied our most recent history (rotary telephone, floppy disc, phonograph, compact audio cassette, etc.) organizing them, with elegance and irony, in short video clips that, like real *tutorial* of social archeology, identifying along an interactive *time line* the year of "birth" and that of obsolescence. Then it is explain how these objects works by a voice over, with metal intonation, which reinforces the impression to be time travelers who have discovered something very ancient, forgotten in who knows which computer archive. «Although a digital replacement has been found for all these analogue tasks the carms of the originals can never be replaced. Thus we have created the Museum of Obsolete Objects to house and exhibit those fading memories, not only, to jog our against brain, but to also show future generations the lost technological marvels of the 20th century» (JVM, 2016)

4. The unmentionable. Nothing should be forgotten

Since a few decades by now, on the international scene, does exist many museums devoted to events the memory and experiences of which many people, perhaps, would prefer to let disappear silently, in reason of an ambiguous sense of removal. They are places, in fact, that preserve the memory of tragic events because, aware of their ethical and social value, would transform the telling of those events into moments of deep reflection, awareness of conquest. Here on tries to make visible and above all understandable the trauma, the dramatic event, activating ways and narrative instruments to help the museum to be a vehicle for memory and not memory itself. This is an highest importance critical point: the museum does not should identify itself with the memory the things, but needs to be the place that triggers the memory, helping the story of the past to get in tune with the contemporaneity, to evoke the experiences past and make them the object of reflection in the present. *The museum is not memory itself: it is opposition to memory loss*. Taking care of what is unmentionable, what has been removed (and then rejected) and placed at the edge of our lives, these museum act as places where the dramatic dimension is not simply repeated, but rather faced and understood. A complex mission that requires the ability to apply to contemporary society, made up of multiple and different memories and perceptions that must find space for the emergence of a renewed sensitivity.

4.1 *The Museo Memoria y Tolerancia*, Mexico City.

When someone think about something unmentionable, inevitably, the first thought goes to the large quantity episodes of insane collective violence who have gone through the human history without interruption, in every time, place, and culture. If the two great World War (especially the Second one, indelibly spotted by nazi war crimes) are the most documented moments of this story of the “unmentionable”, this should not obscure the many other slaughters perpetrated in the world in the name of false ideals and real racism or deviant ideologies. Paradigmatic in that sense, is the recent Memory y Tolerancia Museum of Mexico City, designed by Arditti + RDT Arquitectos. Here, in fact, the theme of memory moves from the Holocaust, and then introduce the principle of *Genocide and Crimes against Humanity* defined by the UN in 1948 and continue the journey into the abyss of the Armenian slaughters, ex Yugoslavia, the Rwanda, Cambodia, Guatemala, Darfur. Every genocide is there, with its macabre load of blood, with the images the executioners and the victims, with the symbols of propaganda and the weapons of mass destruction. With names, portraits, crosses. Every continent bears his sad contribution. no one can feel itself “excluded”.

Fig. 10, The Museo Memoria y Tolerancia, Mexico City, Mexico, 2011 (Photo: Marco Borsotti)

« (...) every crime is different, while each genocide also refers us to an idea of unity, as if it too were part of a single immense night. It unfurls itself with a systematic, logical and inhuman nature, leaving behind it a sensation that takes us back to a single and selfsame monstrosity. Each genocide endorses the next; each mass-murder on this scale – replete with evidence and proof – justifies all the others of the same order. The Nazi executioner is complicit with the stalinist torturer, the Rwandan killer answers to the Serbian assassin, in full complicity». (OLLÈ-LAPRUNE, 2011)

Fig. 11, The Museo Memoria y Tolerancia, Mexico City, Mexico, 2011 (Photo: Marco Borsotti)

The museum's curators have brought the theme of memory to the house of each of us, making it a common duty and to do that they asked to the exhibition project to support different narratives that combine faces, phrases and objects of the killers and the victims in a shocking continuity. The museum introduces, however, also the theme of tolerance, which closes the exhibit as a light at the end of the tunnel. The narrative structure here does not indulge, however, into a too easy optimism: it recalls, instead, issues such as gender equality and the freedom of expression, culture, religion. A narrative that does not hide affirms or imposes: shows reveals, and ask willingness to consciousness.

«A museum is by definition tied to the past, setting out themes that clarify our present in the light of recent or distant experiences. From far off, the participants in appalling tragedies call to us; paths are to be found for new reflection that tells us how to envisage this relationship between the practice of the word and the rejection of the silence that accompany genocides». (OLLÈ-LAPRUNE, 2011a)

4.2 The *Museo Laboratorio della Mente*, Roma.

There are many narratives that we usually put on the borders of our consciousness and over. Events, places, people that we addresses more or less consciously to oblivion and which we does not even allow the consolation of a minimum act of memory. This absence of memory, often unconscious, but collective, is not linked only to the issues of violence more evident, than that which builds the History (again with a capital letter): often involves although apparently minor events, related to marginal conditions, which the current logic of the so-called "right-minded society" does not accept because far from usual canons of understanding. They are the border places where marginalization, ignorance, non-knowledge is limited and tolerated in reason of a sort of social contract of not visibility.

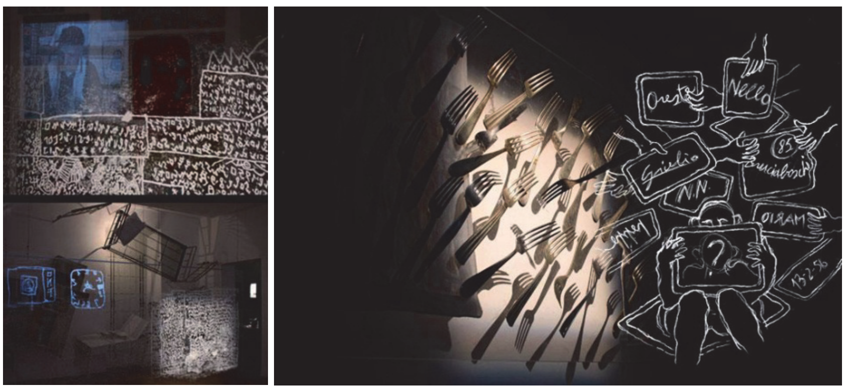

Fig. 12, The Museo Laboratorio della Mente, Roma, Italy, 2008 (Source:http://www.studioazzurro.com/index.php?com_works)

Unveil their presence therefore becomes a necessary and courageous civil act, but is often also an opportunity to discover a different humanity, rich of important values, engaging stories, and of real things that time changes, redesigns, makes comprehensible. In Rome, the project *Museo Laboratorio della Mente*, created by UOS Studies and Research Centre ASL Roma E and Studio Azzurro, revealed, through interactive video installations that wholly involve the visitor, the world of mental illness, just where this was placed and hidden from the world. It faces the hard historical truth, but also the scientific and social progress, culminating in Italy with a legislative reform that closed definitively the asylums (Law Basaglia, 1978) and especially reveals a large portrait of a forgotten humanity. The museum tries to define new communication contexts capable of give visibility to a lot of stories hidden behind the mental problems, starting from the limitations of physical freedom and the psychological constraints, up to clinical practices to contain first and then openness and understanding. But also the humanity of every day, the fears and the hopes, the unexpected and valuable poetic and artistic force of some "guests."

«The *Museo Laboratorio della Mente* was founded with the clear intention to build communicative contexts that favor the promotion/prevention of mental health through active and meaningful participation of the visitor. Within a narrative inspired by a multi-textuality and a continuous oscillation between real elements and laboratory experiments (...) the visitor is invited to reflect on social exclusion paths and to change/rethink its attitude towards diversity». (MARTELLI, 2010)

Visitors thus perform a profound learning experience, observing and listening to the witnesses of what was a parallel underwater world, dividing the attention to the narratives provided by the exhibiotio project with the space itself, which is the original one, which gradually takes possession of them, bringing people in a total immersive situation. A condition created to arise interpretation processes that lead to a conscious inner public growth.

5. Conclusion

All these innovative scenarios of exhibition designs require training of new professional figures related to the design, management and development of new products cultural, communication and technology through innovative forms of knowledge management by the continuous development of models, tools and systemic modeling based applications. so complex narrative structures requiring simultaneous management of multiple design disciplines, combined with a strong sensitivity to get in tune with the cultural and scientific content defined for the museum. In this sense, the system design and is housed in its logical and complete fulfillment.

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Design of information systems as an aid to migrants

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Abstract

Starting from the official call for the 1st Contest "Let us help those who aid migrants", by the International Committee of the Red Cross and the Universidad Iberoamericana's Program on Migration, students of the degree course on Graphic Design and an interdisciplinary group of teacher developed a "Visual communication system to promote hygiene and health in hostels lodging migrants in transit."

This teachers' group, through the use of a dialectical – reflexive methodology (Diezt, 2011) was able to analyze the social processes endured by migrants and solve their problems by applying design, using as main tool the discussion and opinion confrontation among those involved in the job in order to develop a common language for the participants in the design process coming from different disciplines, taking into account the relationship between sign and images' comprehension by users.

This paper objective is to share a teaching – learning experience by way of a case study and it shows the importance of using new tools and the feasibility of integrating different disciplines in projects with a social motivation.

The present document will develop along three main axes:

1. Situation diagnosis. The project starts questioning: Which factors must be considered in order to get satisfactory results from a design project with a social aim? Due to user's complexity, it is required an interdisciplinary approach in order to know him, so that an adequate graphic solution can be provided.

2. Systems and tools development. This section includes the description of the strategy to follow for the design carrying out, research, implementation, modification, installation and setting methods. Also, it answer to the question: Why is it important to utilize the new social tools in design processes?

3. Results and evaluation. The document ends presenting answers to: Which ones and in which way were the etnometodological tools incorporated into the project?

Keywords: *Systems, design, social, interdisciplinary, migrant*

1. Situation diagnosis

From the 90's on, the academic members of the Universidad Iberoamericana (UIA) were fully aware of the significance of forming social researchers committed and acquainted with the needs of the users for which they design. Even though the process of change and acceptance of the compromise implies grater rigorousness in the students preparation, the Design Department undertook the challenge and now its professors are totally accountable to the society. In this regard, a professional profile according new needs was generated which favor the preparation of designers more conscious of their environment and apt to overcome the work challenges imposed by users seeking a higher level of life quality and well-being.

It is for these reasons that, when we were invited to take part in the Red Cross Contest above mentioned, UIA's students and teachers as well wholeheartedly accepted the challenge of producing a proposal to get optimum results but, due to the case complexity, it was clear that new theoretical – methodological approaches were needed, taking into account the interdisciplinary and multicultural links to be established with the users.

The subject of study was migrants travelling through México toward United States of America (USA). They have a precarious economy and most of them are illiterate. Besides, they confront serious health risks like dehidratation, gastrointestinal, respiratory, urinary or cutaneous infections, grievous bodily injuries or insect and viper bites, among others. And without concern for their genre, age or origin, they are constantly abused by delincuential groups and even by certain local authorities and have to undergo public policies that try to impede their passage and violate their human rights.

Along their transit through our national territory, they find 55 hostels, which are gray and lifeless spaces, lodging from 20 to 400 people, for 24 to 48 hours. This population is composed of 4% children, 11% women and 85% men. The majority of them (60%) proceed from Honduras, followed by individuals from Nicaragua, Costa Rica, Panama, Guatemala, Belice and Etiopía. This information was supplied by the institutions sponsoring the contest by the Universidad Iberoamericana's Program on Migration in the initial meeting of the project on September 11th, 2013.

These data were essential in establishing one of the main parameters for *hygiene promotion*, a concept defined as: "a planned and systematic strategy allowing people to carry the necessary actions on to prevent or limit risks of diseases related to water, sanitary conditions and hygiene" (Sphere Project, 2016).

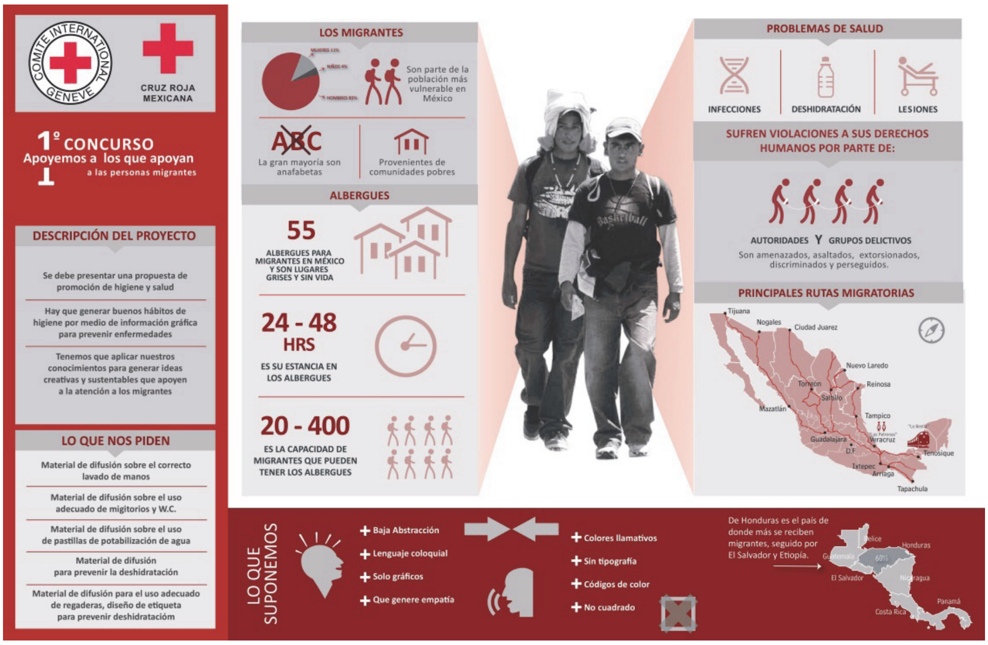

Fig. 1 ¨Infographic contest "Let us help those who aid migrants". Created by the pupil Paulette Ordoñez.

2. Systems and tools development

Creative processes of visual communication enable us to devise elements to favor the correct transmission of a problem's terms in a social environment and facilitate its solution by promoting a change in the behavior of those affected. As María Ledesma tell us: a design will generate any of three different types of attitude in the user: "To do – To read, To do – To know, To do – To perform" (Ledesma, 1997) ,where the designer function is to create elements for the easy transmission of a message, in this case, by informative cells synthesizing a long and may be complex massage, in order to obtain a favorable response. So, the designer shall focalize on the people for whom he will create in such a manner that his graphic elements are capable of modify their behavior.

However, how can this goal be achieved in a project with a social approach, when it implies that the student must directly work on an extreme situation, by far alien to his own life style? It is here that interdisciplinarity comes up as a helpful approach to get a first approximation to users' universe, allowing the designer to grasp that alternative reality. The interdisciplinary group of teachers was integrated by: the Master Sciences in Social Anthropology Tatiana Elizabeth Lara San Luis, the Political and Social Sciences Doctor Javier Urbano Reyes, the Engineer Alejandro Vergara Frutos and the Master Sciences in Education and Industrial Designer Patricia Hernández Navarro.

Anthropology has mechanisms that enable him to focus his attention on the user's observable needs, through the analysis, detection and generation of findings that are useful in conceptualizing creative elements to connect with the user. And from Social Anthropology derives Visual Ethnography, a tool selected for this project because it allows to be near the subject under study without being in its immediate physical vicinity, which is a most convenient option due consideration given to distance and lack of time and safety. The last feature incorporated into the process was visual communication, because it makes possible to establish the relationships between emmisor, message meaning and receptor, taking into account this last one skills and characteristics.

Main project's objective was to develop a pictograms system permitting the transmission of information related to hygiene promotion (information supplied by the UIA and PRAMI), its convenience and the procedures to follow, trying to change certain inconvenient behaviors of the migrants in the refuges they are received. Regarding its specific targets, they shall, by an adequate design and iconicity and creating the necessary drawing reticules, production and *dummies* for each one, to originate a system of informative cells that make the users understand, in a clear and efficient way, what actions they are expected to perform, motivating them to comply.

2.1. Work method

Already defined the points previously dealt with, we proceeded to conform work teams in accordance with the official announcement, requiring from three to five participants, supervised by an academic adviser, and registered them by e-mail. The Master Sciences in Social Anthropology, Tatiana Elizabeth Lara San Luis, a UIA's teacher of the subject, joined the project from the beginning in order to present to the students and incorporate into the research process the new instruments for remote observation. The interdisciplinary method involving Social Anthropology and Graphic Design was thus promoted.

Once they had the research results, the students recognized a specific set of problems related to the needs of the final users of the design, in which graphic language is most important in communicating the message. Accordingly, they set three main features to be considered in the process of designing, corresponding to its analysis regarding semantical, syntactical and pragmatical aspects, that is: with relation to the understanding of its meaning and representation, regarding its own structure and finally, concerning the relationship between meaning and interpretation.

The creative process brought out multiple options in shape, color and degree of abstraction, so a close filtration based on the research results was implemented. The graphic elements selected were those comprised in the figurative group of analogical motivation "representing the graphic denotation or depiction of a real subject, known within the environment in which it will be used, that could have the likeness of a human being, an object or an animal. This image is consequently of the iconic type and receives the name of pictogram." (Morris, 1982).

Fig. 2 Cells for promotion and hygiene. Morris (1982).

There were various difficulties in the graphic conceptualization process. For example, the skin color shade to be utilized, taking into account that the migrant population is multicultural and, were it too clear, the user would not identify himself with it. However, the selection of a blue background was a success, due that it gives idea of calm, and the hostels' guests are subject to a high level of stress at the time of their pass through them.

The same process was performed to select texts because, although the greater part of the migrants are illiterate, it was unavoidable to employ an universal language in which the words utilized had the same meaning for all the users not whistanding their origin, it was necessary to change: "lavarse (wash)" by "restregarse (scrub)", "mingitorios" by "urinales", "w.c." by "sanitarios", among others. The regional representatives of the users supplied us with timely observations that were utilized to make modifications and apply to the design what Umberto Eco calls *pertinent aspects* (Eco, 1974) for the proper understanding and interpretation of the images' message, which could not convey to the receptor the idea of the person who created it. Through this concept, the students were confirmed in the need to know the users in order to developed clear, functional and empathetic pictograms capable of transmitting the desired idea.

Fig. 3 Cells for promotion and hygiene. Morris (1982)

Once selected the main pictogram representing the migrant, a set of parameters was specified in order to create an homogeneous system, designing a family of images, an standard format and size and the application of the adequate color palette, making always the proper use of the iconicity and clearly promoting the actions represented in the cells. With the design approved, we defined materials and manufacturing and fastening methods and made the mechanical originals for their production and, wishing to have a complete visualization of the project, we generated photos in situ, dummies and renders of each piece, to give a clear idea of their position and function in the hostels.

For the final evaluation of each work team project, the students presented the information obtained in the research phase and submitted a document and infography to the sponsor institutions representatives, who acted as qualifying judges. The documentation submitted included: a) Letter with the names of the students integrating the work team and their academic adviser. b) Research on the migrants and its results.

c) Design of informative cells for the diffusion of the correct way to wash one's hands and the use of antibacterial gel, use of pills to make water drinkable, prevention of dehydration, labels for water bottles and bags, correct use of urinals, toilets and showers (printed and in compact disk, with all the designs). d) Letter of rights' cession for use, diffusion, exhibition, communication, spreading and reproduction.

They made observations on each report, which were most valuable for the students because, being a real project, they could defend their work, interacting directly with their "customer" and having in advance an experience they will confront in their professional life. The highest authorities of the Committee of International the Red Cross and the Universidad Iberoamericana's Program on Migration, and the Design Department were present in the awards ceremony and the award's certificates were handled the UIA´s Rector, Dr. José Morales Orozco, S. J. The winner of the informative cells was the team formed by the students: Paulette Ordóñez, Mariana Nava, Violeta Corona and Lorenza Moctezuma, while the prize corresponding to water labels and illustrative posters was accorded to the team integrated by: Ximena Torres, Ana Sofía Morales, Sofía Arana and Victoria Cojab.

3. Evaluation and results

Although there are many linked projects in the Design Department of the Universidad Iberoamericana, there are few cases like this one in which a punctual tracking of the results obtained in the final phase of the project has been done and in which, only six months after being applied extremely favorable outcome is reported. In words of the Ing. Alejandro Vergara Frutos, head of Water and Habitat Projects of the International Committee of the Red Cross, Regional Delegation for Mexico, Central America and Cuba: "In the middle of 2014 and beginning of 2015, they implemented a campaign to promote hygiene in nine hostels offering assistance to migrants in Mexico, five mobile clinics of the Mexican Red Cross and a number of shelters in Honduras. This campaign has two components: 1. A visual part allowing the migrant to follow instructions to improve his hygienic habits. Said posters have been affixed in showers, w.c., wash-hands basins and urinals in the sanitary areas of the hostels" (Vergara, 2015).

Fig. 4 Cells in hostels offering assistance to migrants in Mexico. Vergara (2015)

One of the benefits that were not expected on the initial objectives having a significant impact has been its use through visual communication systems to encourage healthy practices in meetings with people temporarily housing in refuges. The graphic presentation has been useful as an aid to facilitate each of the cleaning procedures. Using the same posters fixed in the sanitary areas, with the complement of the s – cycle diagram, it is possible to induce the migrants to change, improve or reinforce their hygienic habits. These talks are given by previously formed volunteers from the hostels and by Mexican Red Cross personnel.

Campaign results are encouraging: gastrointestinal diseases product of poor cleaning usages have decreased by various percent points, still there are no official figures published and these are the only information references we have. Common areas are respected and are maintained in better conditions, as evidenced by the following phrases taken from a CICR responsible report: The campaign has been favorably accepted by the migrants and who themselves emphasizes the importance of hygiene to keep people healthy and living together in good terms.

Fig. 4 Talks are given by previously formed volunteers from the hostels and by Mexican Red Cross personnel.

The methodology used, consisting in maintaining a dialog and reflecting together both disciplines, as well as the incorporation of etnomethodological tools generated three main features:

1. It opened the opportunity to create new didactics to teach user centered projects, in which everyone contributes specific elements of his or her area, to produce adequate solutions focused in the social environment. This project results show that the new interdisciplinary model have a positive impact to generate graphic solutions with impact.

2. Finding a work and communication dynamic was not easy. However, the involvement of designers in formation, specialists and academics proved that it is possible to establish integral-learning models, in which by means of rigorously established processes, inclusive solutions can be generated in order to modify erroneous behaviors, so as to improve life quality. As the student Paulette Ordoñez says: “In the research process, Anthropology gave me clarity and understanding about situations to which the migrants are exposed. An interesting aspect was to substitute the phases accompanying figures for ones more uneatable to them, what made me reflect that even though we speak the same language, we give the words a different meaning.”

3. The student’s rapprochement to social projects far away from their everyday experience results in a better learning and in compromise with those who have less. The experiences had by the work teams along the contest development generated a deep reflex ion about the importance that our discipline worked for the collective improvement. We, the academics, shall propitiate the creation of a social conscience in order that the students develop a critical thinking and have a bearing on changes favorable to our society. As Norberto Chavez says: *“The politicization processes should not be understood as marginal, capricious processes, alien to academic matters, but as processes consubstantial with the civic conscience of the university population”.*

Finally, we can conclude that, in generating solutions based on the "Design of information systems as an aid to migrants", we were enabled to innovate with a graphic language capable of communicate and connect with the user. In enclosing interdisciplinary and the use of tools like Visual Ethnography, we propitiated observation and detection of the incentives for people to behave in their own benefit. From the results obtained till now, we can rename the project as: "Systems that save lives".

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Regeneration through Design. Comparing old and new phases of urban renewal strategies.

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Abstract

In the last years, a new phase of economic crisis, which is concerning sectors of manufacturing industries, is affecting Europe. Focusing on Italy, sectors which have strongly characterized our country, such as textile and accessories, are facing with a fluctuating period of crisis. Also in this case, as it happened from late '80s, the urban structures and identities are seriously affected and need interventions of regeneration in order to gain new life both from social, productive and commercial point of views. Having in mind the Italian case, while the first phase identified had the characteristics of a disruptive macro-phenomenon, the second phase is more subtle and gradual.

In this paper we are going to focus on changes of design culture in light of these urban phenomena. While we can already make a first evaluation of regeneration projects developed after the crisis of heavy industry sectors, the most recent events of industrial recession and the consequent regeneration of the correspondent empty areas are still ongoing.

In order to analyze and, where it is possible, compare these two phases, we are going to look at two Italian case studies. The first is Bicocca, an area of Milan, which in the '90s was interested by a massive plan of regeneration and transformation after the closure of Breda and Pirelli industries. The second is Biella, a Piedmont Province city, which has been one of the most important centers for the textile and wool industry; the crisis of this sector strongly emerged in the first years on 2000 even if it had already begun between '80s and '90s when the biggest textile factories closed down. The differences between these two examples are not merely physical and dimensional but are clearly influenced by a different timing in the regeneration processes, which occurred in these areas (or, in the case of Biella, is still occurring). The analysis proposed in this paper will be focus on the work of research developed within two didactic experiences.

Notwithstanding the distinctions in terms of objectives and actors involved, in this paper we are going to delineate a systemic approach to study and design for the regeneration, improvement and innovation of places. We will try to understand if, through strategic design, it is possible to identify those soft levers and interventions able to rejoin the pieces of places, which lost their functionality and identity.

Keywords: *Strategic Design, Design Thinking, Design for Territories, Urban Regeneration*

1. Introduction

In this paper we are going to deal with the topic of brownfields regeneration looking at the role that design can have in these processes.

Starting from a review of the strategies put in place through different phases of industrial dismission, we will look at design approaches for (Parente, 2012):

- constructing new urban identities
- narrating and building local scenarios
- showing and communicating places

We are going to present a strategic design process developed in connection with the capabilities which design can exploit for the regeneration of urban areas. These approaches have been tested during several masters and higher education courses. In these pages we are going to present two specific case studies developed on real Italian contexts: Bicocca district in Milan and the city of Biella in the Piedmont Region.

Comparing the two cases both in terms of their positioning in the regeneration process timeline and of the strategies used, we are going to highlight the role of design for the "reconnection" of fragmented pieces, resulting from an already accomplished renovation (Bicocca), and for the start of a completely new phase of the regeneration process (Biella).

2. The phenomenon of urban brownfields from the '90s since today

In the last years, a new phase of economic crisis is affecting Europe. Focusing on Italy, sectors which have strongly characterized our country, such as textile and accessories, are facing with a fluctuating period of crisis. As it happened from late '80s, the urban structures and identities are seriously compromised and they need interventions of regeneration in order to gain new life both from social, productive and commercial point of views. Having in mind the Italian case, while the first phase identified had the characteristics of a disruptive macro-phenomenon, the second phase is more subtle and gradual.

The first phase of the industrial dismission was a huge and devastating phenomenon not only from a socio-economic point of view but also from a cultural one. Suddenly, certainties about the urban development which run the "creation" of contemporary cities, were no longer valid. In those days, cities had to face with internal "scars" and huge empty areas, abandoned by their functions, their economies and their meanings. In 1990 Bernardo Secchi wrote that the scenarios which are recalled by the "dismission", the "decline", the "emptiness" are, only in some cases, tragic and hopeless, but more often are melancholic; only recently these scenarios have been opened to hope and chance. Secchi also declared that only after a long and uneasy consideration, we can take a critical distance from the polyedric system of situations and experiences that these scenarios are referring to, in order to give a first interpretation, using a more clear perspective.

A positive and constructive vision about the dismissed industrial areas is needed, because they are potential places where to foresee new urban scenarios and a more complex reflection on the whole city. Secchi also wrote that it is probably the right time to go on with projects which were not "demonstrative" and exemplar which were able to show the paths and their goals; in addition to that it is important to develop projects which did not match contrasting “fragments” to the existing city, but to elaborate more well defined projects which:

- really involve the city, its territories and its history;
- are able to collect the results of the past experimentations
- turn accomplishments into starting points for a new urban experience, for a new reflection on the living space.

This is what the majority of the reuse dismissed areas projects are not still able to express and desire.

At the same time, the discussion about the industrial heritage and about its tangible and intangible value is going on: “In the meanwhile we have to decide if these obsolete areas are today emptiness to be filled in with new contents or full spaces with contents to be, even only partially, conserved” (Rubino, 1996: p.119). This sentence clearly synthesize an initial bifurcation in the approach toward the dismissed areas in relation with the value given to the “leftovers”, which we can sum up in two opposite visions (Parente, 2002):

- erase everything, rejecting the importance of the recent past:
    - to accomplish the return to a previous of (fake) not-artificial condition (for example the urban parks policy)
    - to start a reconstruction urban process, projection of new desires (as in the case of Paris urban transformations, such as the Parc Citröen of 1992, where only the name was saved, or the Zac of Bercy 1988-92)
- preserve everything as it was, stuck in time:
    - according to a poetic taste for an abandoned scenario
    - pursuing a “death” refuse, the “renew” to seem unaltered (as in the case of Ironbridge e and of English open-air museums)

Between these two extremes, “non-intervention” versus “absolute change”, it is possible to evaluate intermediate levels of conservative recovery, interpreting the conservation as a possible strategy for the memories transfer. The issue about the possible “ways” depends on the selection and the identification of what has to be transmitted. Then, it is difficult to identify, among the several memories of a post-industrial city, what can be the choosing criteria, as also Carlo Olmo stated:

“The problem is that each memory is relevant, because it shows a process, not a product: and the memory of a process is the hardest to be saved (...). Extrapolate a building and turning it into a museum of an industrial region or a productive sector can save consciences in distress, however it does not tackle nor solve the problem of the memories of quantities”. (Olmo, 1996: p. 20)

These are not only building, machinery, product quantities, but they also have to do with people, knowledge, culture and society.

Actually, during this first phase the huge amount of urban space freed by the dismission of industries erased urgent questions: from one side there was the environmental issue and the great costs for the clearing operations and, from the other side, there was the need for recovering from these investments thanks to the increase of the land value. In Italy this period was characterized by the dismission of several industries: Falck in Milan, Italsider in Bagnoli-Napoli, Fiat-Carapelli in Novoli-Firenze, Fiat-Lingotto in

Torino. Consequently, international calls were launched and huge estate interests emerged, which often stopped the renovation processes as in the case of Bagnoli, today still unfinished.

In the following years this phenomenon did not affect only big industries, but it became more and more diffused, widespread and pervasive. According to Istat data from 2015, in Italy the crisis has mainly interested textile, clothing, leather and accessory industries (-5,7%), factories producing metal products (-8,1%), rubber and plastic products (-2,1%); domestic electronic devices (- 4,3%); machineries and tools (-5 %).

The comparison between the already accomplished national and international renewal successful and unsuccessful experiences, together with the changing economic scenario and the international financial crisis, favoured a change in the intervention practices, which required more consideration for the social costs of these interventions. Therefore, there was a passage from the urban renewal from the '90s to the urban regeneration of the new millennium, where the change of the word (regeneration instead of renewal) represents a different consideration for all the urban, social and environmental parameters. The introduction of new city "portions" is not only a need for functionalities and forms, but also for the sustainable creation of relationships, services, meanings. Because of the lack of public fundings able to completely sustain these operational costs, the role of private business, new forms of co-design and participation of the local communities become essential. Indeed, in Italy a decree law for the co-financing of projects in brownfields is on pending approval in the Senate. We are facing a paradigmatic change: the estate based city has to be substituted with the "social and creative city" (Carta, 2014), where it is highlighted the importance of the urban recycle for the creation of more open, sustainable and equal cities; where the communities participation, also through the temporary reuse of some public spaces (as it happens in the project temporiuso.net or in the experience of BASE in Milan at ex-Ansaldo) contributes to the renovation of the meanings of places, enabling virtuous processes and new systems of production of value.

3. The role of design in regeneration processes

The change of perspective where design was independent from the place, to the objectivization of place as the main core of the design project, allows to talk about design as a human capability, able to change and improve places. The human factor is very important in defining the capacity of design to interact and intervene on places. Indeed, the people centered approach is particularly relevant when a regeneration process has to be planned (Villari, 2012). The importance of communities (of inhabitants, users and designers) is crucial in strategic design processes which have as objective the study and, eventually, the improvement of places.

According to this view, Ezio Manzini (2015) talks about Design as place maker because through design practices, which involve both design experts and "common" people in order to give answer to a specific problem or even to give "sense" to a specific territory, is possible to create a new ecology of places. The typology of projects which have origin by these collaborations are different and have mainly to do with design service, social innovation, and experience design. In this view, the actions put in place by designers can fill in the gap highlighted by Lefebvre (1991) where there are:

- representations of places, which are how professionals and experts (architects, engineers, urban planners) conceive the space. Lefebvre talks about top-down practices put in place by people owning institutional and political decision power;

- representational places, which can be identified as the "artists' spaces", these are underground spaces seeking to change. Lefebvre refers to bottom-up provocative actions set up by powerless people in order to let see how places could and should be.

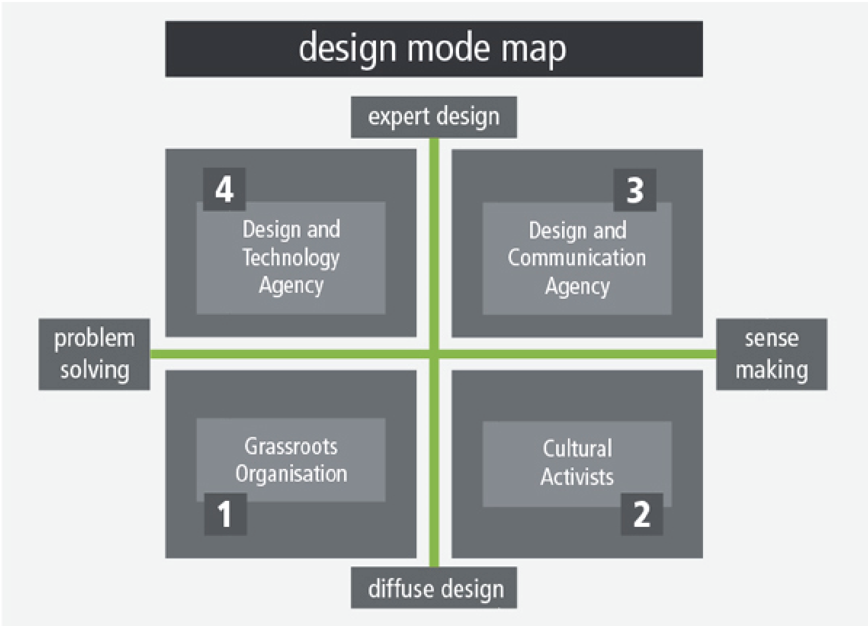

Fig. 1 The design Mode Map. Source: Ezio Manzini, (2015)

One of the purpose of this paper and also of the Research Center D4T - Design for Territories (Politecnico di Milano - Design Department) is that to systematize strategic design processes and approaches focused on places. We identified four steps of the design research process for the regeneration of places:

1. Discover and Envision: This step is focus on the identification of strategies and on methodologies to gain knowledge about a place (from the neighborhood to the national level) and then analyze this data in order to start envisioning the possibilities for involvement. This knowledge is comprised both of tangible and intangible resources, such as physical monuments or personal and collective stories and memories, all of which can be gathered both online or offline.
2. Empower: This is a pivotal moment for the Design's research focused on places. Design's goal is to uniformly connect all local activities carried out in order to empower institutions, citizens and enterprises to know, manage and take part in the culture of a specific place.
3. Communicate: Another important role that Design can play is establishing more efficient ways of communicating knowledge gathered about a place: both within the area of specific study and beyond, in meaningful way according to the given purpose of the research.
4. Re-invent and Re-produce: In this phase, specific activities take place, such as integrating service design for tourism, culture or welfare; strategic design for place and sense making, place branding or competitive position attainment; policy design for local and sustainable development; etc.

Design owns specific capabilities useful for the valorization of territories. To the model presented above, it is possible to integrate what Francesco Zurlo called "design capabilities". In particular, the capabilities of seeing, foreseeing and let seeing (showing) can be functional to the design process for the study-research of the territorial system.

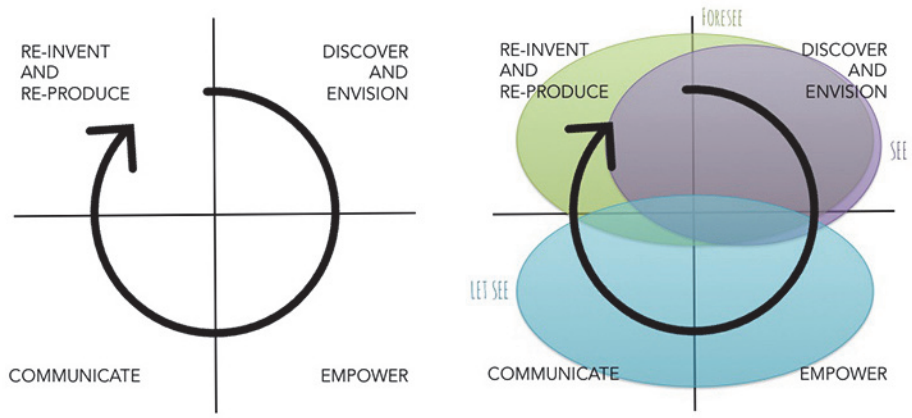

Fig.2 The strategic design process and the design capabilities

We can propose the following interpretation:

- SEE. The ability to see allows taking a critical look at the territories and sounding their physical, cultural, and social, knowledge resources, connected also to the governance system and to the contacts with the outside world. The design ability to see through its own set of methodologies, allow to read, feel and listen the territory. This capability specifically fit into the first step of the design strategic process (Discover and Envision) even if is partially present also in the Re-invention and Re-production phase.
- FORESEE. The ability to foresee go through the interpretation of the seeing action. The pre-vision can also be visualized and tell to discuss it with the actors from the territory, to activate co-design activities, to get closer the community to the decisional process and to create agreement. The capability to foresee, as the previous one, is present both in the first phase of the process (Discover and Envision) but it is particularly important and relevant for the fourth phase (Re-invent and Re-produce).
- LET SEE. The ability to let see (to show) allows to internally and externally communicate the territorial identity, not only through brand design and through the design of efficient communication artifacts, but also through activities which strengthen the territorial representative values. This capability is, instead, especially exploited during the "Empowerment and the Communication" phase.

In the following pages, in light of the above mentioned theories and approaches, we are going to present two different educational experiences carried out within the Master Progettare Cultura (Designing Culture) and the Higher Education Course BST-Branding the Territorial System.

4. Case studies

In the following sections we are going to talk about two different case studies, where the factories crisis and their consequential dismantlement caused for sure a crisis of the identity of the city, in the case of Biella, and of a specific area, in the case of Bicocca district in Milan.

Through 2015-2016 educational experiences, we tackled some specific issues. As Bicocca is concerned the focus is tighter on the specific relationship between an art institution (Pirelli HangarBicocca) which was recently installed in this area, where the regeneration process can be considered almost finished, in terms of structural interventions. However, as we will see, this process is not really finished nor accomplished in terms of social recognizement and sense making. As Biella is concerned, the city is nowadays facing with the issue of empty spaces and loss of functionalities and meanings. The regeneration process is partially begun and it is following a different approach compared to what happened for Bicocca.

We are going to look at these two educational experiences in order to understand the design process put in place, where different places have to be taken into consideration, different timing in the regeneration process are occurring, different goals have to be accomplished.

4.1 Working on Bicocca: creating connections

The Bicocca area gained its identity at the beginning of XX century when heavy industries, such as Pirelli, Breda, Ansaldo, Magneti Marelli and Falck, were installed in it.

Fig. 3 Bicocca district location on the map of Milan. Source: Students work – S.Barozzi, C.Federici, V.M.Grattacaso, F.Regorda, M.Saccocci

In early '80s several plants were dismissed and the production ceased. The Pirelli Group was enough forward-looking to start thinking about the reconversion of this area. Therefore, in an agreement between Pirelli SpA, the City and Provincial Governments of Milan, the Lombardy Regional Government and the Labour Unions, several experts were invited to participate in a contest to re-think the destination of this area. The regeneration process of Bicocca area begun in the '80s and it was formally concluded in 2005. The Studio Gregotti & Associati was chosen for carrying out this process in 1988. The settlement model was initially based on the idea of Bicocca as a science park for innovation; then the main goal shifted to the polycentric development of the city, where Bicocca should had become an additional and new city centre for the suburb areas of Milan. In order to reach this goal, the "Gran Bicocca Project" included the settlement of the University (1991), the CNR, the Teatro degli Arcimboldi (2001), residential units, public spaces and green areas. As it is evident, the followed strategy was that of the knowledge oriented renovation. Another physical element for this renovation was the opening of centre for contemporary art HangarBicocca in 2004 (now called Pirelli HangarBicocca). However, more recently, in 2005, with the construction of the Bicocca Village big mall, the consumption and leisure direction was taken as well.

Bicocca renewal is probably closest to what Lefebvre defined a representation of place. Indeed, apart from few visual elements, such as the cooling tower which was transformed in the conference hall of Pirelli HQ, a connection between the multiple layers composing Bicocca wasn't put in place.

"The sensation that in the place of the factory as an element governing the area and its rhythms there has arisen a foreign body that does not integrate with the rest, but which does not remain deliberately asiede either, thereby is generating a sense of fragmentation in the district." (Mugnano, Tornaghi, Vicari, 2005: 182)

As the scholars mentioned above declared, the disappearance of factories, which gave a real connective tissue to the whole area, left space a networking emptiness among the new realities installed on the territory. Nowadays, for sure, Bicocca is mainly identified with its university, even if we cannot talk about a university district, because there is mainly a functional use of the university as a place for studying and not really devoted to sociality. However, this transformation is (probably) still ongoing. At the same time, the relationship between these big institutions (the university, Pirelli HangarBicocca, the mall, Arcimboldi Theatre,...) are pretty missing. The disconnection among them goes together with the detachment between them and the old inhabitants. These new realities are "locked": it is hard to experience them from the outside and in some cases, as for Pirelli HangarBicocca, they are almost hidden and invisible from the outside.

Within the Master Designing Culture (Progettare Cultura) held by Politecnico di Milano and Università Cattolica del Sacro Cuore, during the academic year 2015-2016, the focus was on the Bicocca district and in particular on Pirelli HangarBicocca.

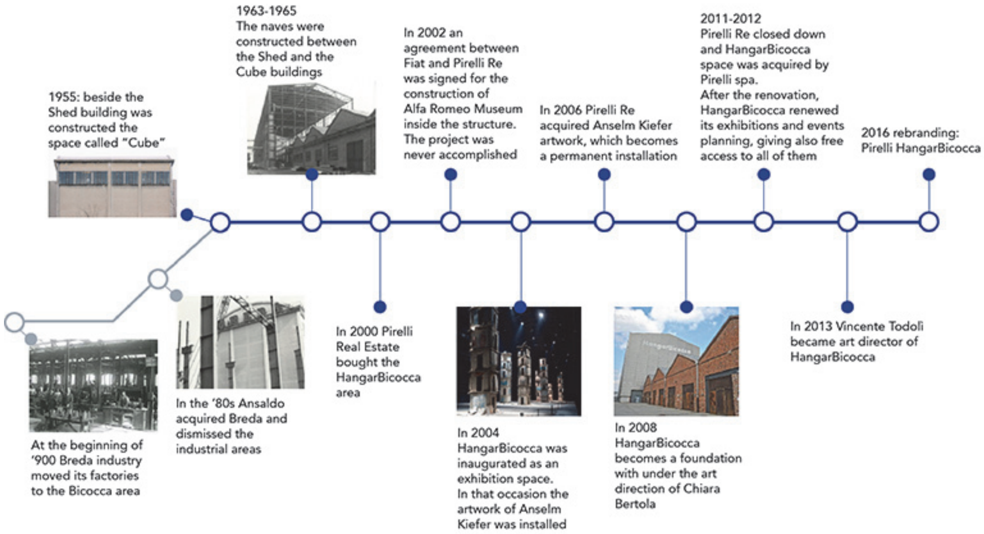

Fig. 4 Pirelli HangarBicocca born and development . Source: Students work - M.De Francesca, E.Domenichetti, V.A. Dovico, M. Fonseca

Indeed, Pirelli HangarBicocca is the customer for the project work phases of this year. The objective of the work, to be accomplished during the course, is that of reading this art institution in relationship with the neighborhood and with the young users (18-30). The final goal, indicated by Pirelli HangarBicocca, is to think and to propose design strategies in order to:

1. Improve the relationship of Pirelli HangarBicocca with the Bicocca district
2. Improve the attraction of young visitors in the cohort age 18-30

In order to do that, the students were introduced to the knowledge of both the area and the institution through frontal lessons and private meetings with the whole staff of Pirelli HangarBicocca.

The first stage of this work was mainly focused on the collection of information and data. The intermediate project work was organized splitting the class in five groups, each of which was focus on the analysis of a specific "attractor". Indeed, we identified five different territorial attractors concerning the specific target group 18-30:

- The University
- The mall Bicocca Village
- The MIL, polyfunctional space for creativity and design
- The Edificio Sedici, composed by 65 factory lofts for creative and knowledge studios and agencies
- Bars, pubs and self-managed social centers which animate Bicocca nightlife

After having developed a desk analysis about the area, the students were asked to carry out a field analysis based mainly on qualitative methods, such as observation and interviews (structured or semi-structured). Each group, after having done a general analysis of the area and the client (Pirelli

HangarBicocca) focused its attention on the young students, workers and users of the above listed attractors.

The analysis of the neighborhood returned a fragmented image of Bicocca, composed by old and new citizens, services, public spaces, etc.. In addition to that, all the groups stressed infrastructural problems which affect the district and its perception of safety, openness and welcome.

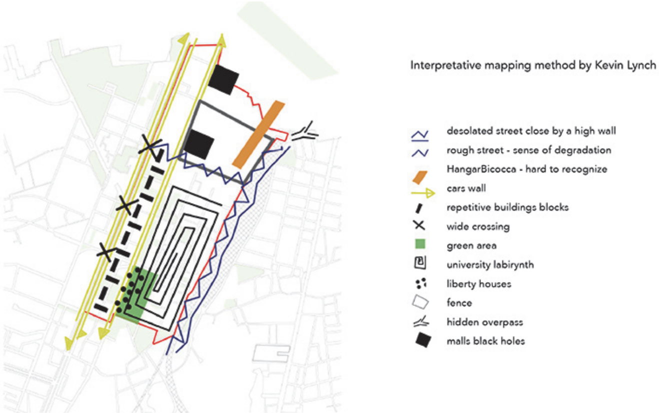

Fig. 5 Bicocca conceptual map . Source: Students work - M.De Francesca, E.Domenichetti, V.A. Dovico, M. Fonseca

From the collected interviews this spacial constraints are reflected in a small scale on Pirelli HangarBicocca.

The university students from Bicocca University (about 30), who answered to the incentive and associative question “If I tell you contemporary art what it comes into your mind?” in some cases mentioned the name of HangarBicocca. However, when asked about the institution, many of them didn’t have nor knowledge or experience of this space. Some of them even associated Pirelli HangarBicocca with the nearby mall Bicocca Village. It is evident a crucial lack of knowledge of what exactly this building is and what it is about.

Some young interviewees from the “nightlife” group, declared not to be aware about the existence of this art institution which seems to have more popularity outside of the district than in the local area where it is located.

> *“Hangar...I know that it exists, but I don’t know what it has to offer me. I didn’t know that it was an exhibition space nor that there is a restaurant in it.”* Silvia - nightlife interview

Young people who know this art space declared that it is not particularly attractive for potential users of their same age.

> *“Hangar doesn’t exist in my peers minds. It seems that it doesn’t want to involve young people. It is not attractive from the outside. It seems always closed and dark. Its advertising doesn’t go on the channels which my colleagues and I use.”* Sabrina - nightlife interview

Among the young users of the mall Bicocca Village, 43 respondents out of 55 (78%) had never been to Pirelli HangarBicocca; 18 of them (33%) do not even know about its existence.

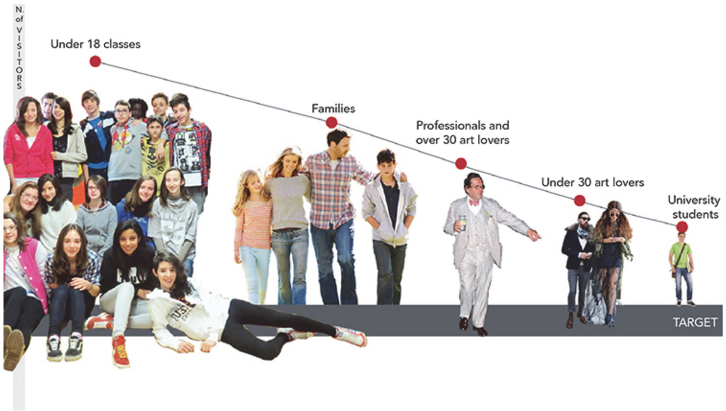

Fig. 6 Number of visitors according to the target . Source: Students work - M.De Francesca, E.Domenichetti, V.A. Dovico, M. Fonseca

In the month of June (2016) the students are going to accomplish the final project work. After a new confrontation with Pirelli HangarBicocca, also in light of the results from the intermediate pw, a need for a better communication emerged. Nowadays, Pirelli HangarBicocca is already developing some projects and actions oriented to be more open to the outside. Apart from launching a membership card to fidelize even more the already existing users, they have just run the first streetart intervention of the new program "Outside the Cube", hosting the artists OSEGEMEOS (Gustavo and Otávio Pandolfo) with their work Efêmero. It is particularly interesting the fact that the mural was inspired both by the history of Pirelli HangarBicocca building, where train locomotives were built, and by the present structure of the area, characterized by the close proximity of railway lines. Another important appointment will take place on the 27th of May: a conference titled "Education through contemporary art. New participation forms. Schools, museums and universities for an educational alliance" will take place thanks to the collaboration with the Università degli Studi di Milano Bicocca.

Since some activities open to other institutions and to the relationship with the neighborhood have already been put in place, the students will be asked to work, as already said, on the communication topic. This issue will have to be tackled from several angles, not only from an advertising point of view. The students will have to work both on the tangible and intangible levels of communication and artifacts, in relationship with the physicality of the space and with the more ephemeral, but really important, narratives about the institution, its brand and its identity.

4.2 Working on Biella: a wider approach for a new identity

Biella, a state capital of the Piedmont region, known for its textile production (specialized in the wool industry), was affected by the industrial crisis, which had as results the production decrease, the reduction of the average industrial dimension, and the dismission of some important textile factories (e.g. Lanifici Rivetti).

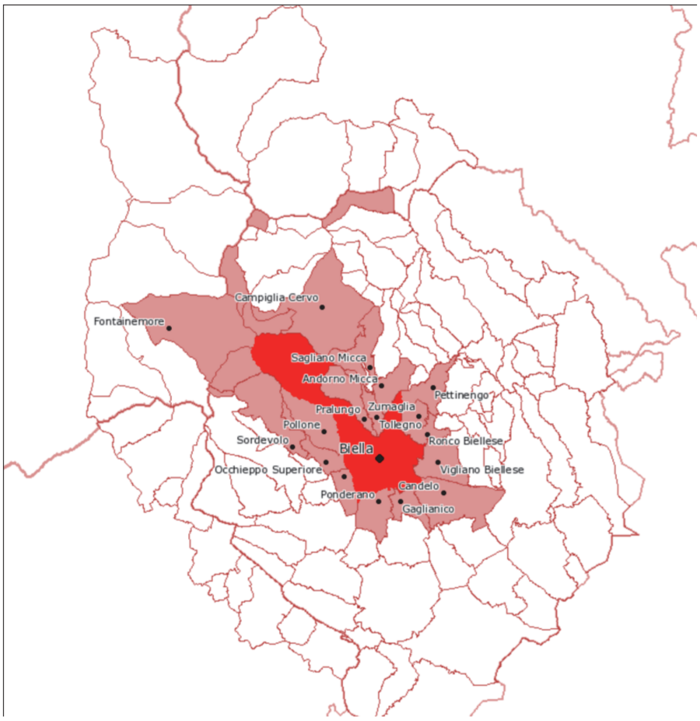

Fig. 7 Biella province . Source: comuniverso.it

However, it must be said that the textile district of Biella still exists, thanks to processes oriented towards the specialization in branches of excellence production for the high-end market sectors and the recognition of the importance of textile industries archives (Osservatorio Distretti Italiani, 2014). However, the installation of big malls at the outskirts and the displacement of the hospital, contribute to empty out the city centre.

In the past, the mono-industrial inclination, which characterized the economic development of Biella, and the closure of these places from the outside world, were strengths of this territory and really characterized its stance. Today, a deep changed scenario is forcing Biella to redefine its strategic goals also in terms of awareness and recognition from the outside, because the values of privacy and closeness are no longer useful and they are showing all their limits.

This territory has to face with big challenges because it lost its points of reference. The city has to deal with a system of empty spaces, not only physical and functional, but also of value and meaning. For this reason an evaluation of the available system of resources is needed in order to re-focus Biella objectives for growth and identity. This process, in order to be accomplished, has to be developed in light of the sense of belonging to a community, but also thanks to the collaboration and the competitive comparison with the outside world in order to renovate its own offer and value systems.

This topic was the object of interest for the activities of research and design in the VI edition (2015) of the Higher Education Course BST-Branding the Territorial System of Poli.design - Consorzio del Politecnico di Milano. The course was entirely held in Biella territory: a very interesting case study, where new initiatives in contemporary art, design and agroindustrial sectors go together with the inflection of the textile industry sector and to the empty of the production and commercial spaces. This abundance of resources was not really exploited in the past; but today these resources together with a wider openness to tourism and cultural market sectors would be the drivers for a re-thinking process.

The goal would be that of giving resonance to the specific qualities of the place, both to the historical heritage and to the most recent business initiatives, in order to build a sense making system able to:

- drive the urban regeneration processes;
- grant a strong territorial awareness;
- start new market orientations, which respected people and local stakeholders;
- valorize local knowledge.

The first section of the course, focus on theoretical and methodological modules, was immediately integrated with the acquisition of knowledge about Biella, take advantage of the opportunity of being physically on the place. In this way, the role of a "directed" design, which needs to see, ear and directly interact with local actors and places of study, was reinforced. The different modules were thematize according to four focus - Arts/Heritage/Landscape, Food, Design, Fashion/Textile - integrating theoretical lessons, focused visits and seminars, these last organized by the Associazione 015 Biella, partner of the project.

Fig. 8 The territorial analysis: Arts/Heritage/Landscape, Food, Design, Fashion/Textile. Photos by C.Sedini and C.Iemmolo

The week of the intensive project work treasured the methodological lessons and the fact-finding experiences of the previous modules to arrive to the synthesis of five project scenarios developed for different thematic fields: water, events, shopping, sustainability, make. These topics could had to be interpreted both as distinct hypothesis and as an interconnected system of actions to be developed in the mid-long term. Scenarios hinged on data and information gathered thanks to the analysis and the critical interpretation of the territory, thanks to the confrontation with the local actors, thanks to the identification of values and sleepy or forgotten potentialities. The students developed all site specific proposals which hopefully could start a dialogue among institutions, entrepreneurs and inhabitants in order to elaborate some share hypothesis of action. The next step is a new edition of the course in order to go on with the dialogue with local institutions and to deepen the concepts developed in the first year.

Fig. 9 Five concepts for Biella: place identity, storytelling and strategic plan of intervention. Source: Students projects logos

5. Conclusion

In 2003, Roditi wrote in its chapter Milano-Bicocca: da area industriale a centro urbano “nuovo” (Milano-Bicocca: from industrial area to “new” urban centre) that a walk by the streets of Bicocca, especially in the nighttime, is able to give a sense of disorientation and placeness, probably due to the difficulty of giving a specific meaning to the new urban shapes. The shapes mentioned by Roditi can be seen as the building which characterized that area: the University, the big mall, Arcimboldi Theatre and Pirelli HangarBicocca, as well. Some of these spaces conserved the old structures which were filled in with new contents, others are completely new. However all of them are closed systems, both in terms of their strongly fenced physicality and in terms of their knowable and permeable identity. Today the sense making of Bicocca has surely improved, even if it is mainly connected to the presence of university students and workers (Pettenati, 2012).

Biella case study is particularly interesting because the industrial crisis influenced first of all a redefinition of the textile sector. After the dismission of several industries, private foundations, such as Fondazione Pistoletto and Fondazione Banca Sella, appointed themselves as promoters for the reconversion and the regeneration of several abandoned spaces, using culture and art as main drivers. Differently from Bicocca case, here still are several empty spaces to be reconverted, meanings to be defined and economies to be rethought. Another difference is the diffusion and the parcelization of areas where these interventions are needed; indeed these spaces are scattered in the whole city. Since this is an ongoing process, there is the possibility to follow an integrated process which acted both on hard and soft elements of places and with participatory models, with the multiple actors involved.

As we have seen in the previous pages, design can be place making (Manzini, 2015) thanks to the strategies and processes which involve both design experts and “common” people, as for example citizens, in order to give answer to a specific territorial issue or even to give “sense” to a place. Design can play different roles. In cases, such as the Bicocca district, where the renovation process is already accomplished in terms of infrastructures (hard factors) design is able to rejoin the fragmented pieces resulting from the renovation. This goal can be accomplished going from the “Discover and Envision” step of the strategic design process, where designers (experts or not) see the territory, its tangible and intangible resources, to the “Empower” and “Communication” steps. Indeed, it is in these phases of the process that designers let see to the actors involved their potentialities and those of the place. The results expected from this work, which is specifically focus on the artspace Pirelli HangarBicocca, are those of:

- make visible the richness of the offer that the various cultural actors generate in this area
- envision innovative connections among the different local actors
- co-produce and share the knowledge generated inside these cultural institutions.

In cases, such as the city of Biella, where the regeneration process is at its beginning, design can help in looking forward, identifying common purposes of the different communities of actors. The whole society has to be involved: citizens, entrepreneurs, private foundations and businesses, trade associations, cultural and governmental institutions. In order to avoid identity and sense making problems, due to parcelized and isolated (in the meaning of disconnected) interventions to the space, it is important to combine hard and infrastructural intervention with other soft levers, which are often used in design strategies. Also in this case the first important step is “Discover and Envision” and after going through “Empower” and “Communication” phases specifically oriented for the actors involved in the design process, the crucial step of this process is the Re-invention and Re-production phase. Indeed, it is here that designers start to really foresee the possible paths to follow.

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A gestão de design na perspectiva da produção de ativos intangíveis na agricultura familiar: um estudo multicaso em joinville e blumenau no estado de santa catarina

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Resumo

A agricultura familiar é responsável por percentual significativo do valor de produção agropecuária. Enquanto a agricultura patronal gera R$ 358,00 por hectare, a agricultura familiar gera R$ 677,00 sendo, sendo 89% mais produtiva e respondendo por 10% do PIB (BRASIL, 2016). Santa Catarina contribui na dinâmica produtiva com 168.544 unidades em 2.645.088 ha. A gestão de design preocupa-se com o desenvolvimento e a gestão de processos, produtos, pessoas e serviços como elemento chave para o posicionamento e e incremento estratégico das organizações e neste contexto pode se transformar na força principal de mudança, aperfeiçoando a identidade a imagem e a comunicação, entendidos também como ativos intangíveis. O uso de bases taxonômicas neste contexto, pode contribuir a partir da organização das informações em um sistema de navegação que facilita a identificação em todos os níveis da produção agrícola familiar, para elaboração e verificação da produção de ativos intangíveis.O objetivo deste artigo é desenvolver uma base taxonômica com a finalidade de identificar os ativos intangíveis com base na gestão de design.

No que toca a metodologia este artigo caracteriza-se como exploratório e qualitativo envolvendo um estudo multicasco em 26 empreendimentos rurais em Joinville e Blumenau em Santa Catarina. Para tanto construiu-se uma base taxonômica estruturada em classe, subclasse, gênero e renque como suporte para navegação, organização e reusabilidade da informação e os resultados mostram que a valorização da agricultura familiar, nos casos em tela, pela quantidade de práticas, processos, insumos e equipamentos necessários identificados e classificados transforma entradas em saídas de qualidade, e dentro desta diversidade, é possível a valorização, identificação e proteção por meioda gestão de design.

Palavras Chaves: Gestão de design; Ativos intangíveis; Valorização.

Abstract

Family farming is responsible for a significant percentage of the agricultural production value. While the employer agriculture generates R $ 358.00 per hectare, family farming generates R $ 677.00 being, 89% more productive and accounting for 10% of GDP (BRAZIL, 2016). Santa Catarina contributes to the productive dynamic with 168,544 units are in 2,645,088 ha. The design management is concerned with the development and management processes, products, people and services as a key element for positioning and strategic development of organizations and in this context may become the main force for change, perfecting identity image and communication also understood as intangible assets. The use of taxonomic bases in this context, can contribute from the organization of information into a navigation system that facilitates identification at all levels of family farming, for the preparation and verification of production of intangible assets. The purpose of this article is to develop a taxonomic base for the purpose of identifying intangible assets based on design management. As regards the methodology this article is characterized as exploratory qualitative study involving a multihull in 26 rural enterprises at Joinville and Blumenau in Santa Catarina. Therefore built a structured taxonomic basis of class, subclass, gender and hedgerow as support for navigation, organization and reusability of information and the results show that the value of family farming, where screen, the amount of practices, processes, supplies and necessary equipment identified and classified transforms inputs into outputs quality, and within this diversity, recovery is possible, identification and protection through design management.

Keywords: *Design management; intangible assets; Valuation.*

1. Introdução

A valorização, a proteção e a identificação de pequenos grupos produtivos figuram como ativos intangíveis e como resposta das articulações da gestão de design na agricultura familiar (Merino et al, 2012; Teixeira, 2011; Neto, 2012).

A necessidade da produção agrícola familiar em atuar com produtos que viabilizem ao empreendimento rural, a permanência do homem no campo com dignidade sob a perspectiva de melhorar sua qualidade de vida continuamente e estimular o negócio sob a expectativa empresarial, proporciona a gestão de design um ambiente apropriado para a produção de ativos intangíveis que estimulam as cadeias produtivas da agricultura familiar.

A gestão de design alinhada com esta necessidade contribui para que esses ativos intangíveis estimulem o negócio, criando valores a partir de suas intervenções, tais como por exemplo na construção e gestão da marca, a partir da difusão dos benefícios funcionais e emocionais, na personalidade traduzida através do símbolo e da logotipia, bem como nas hiperconexões estabelecidas, conforme se vê na Figura 1.

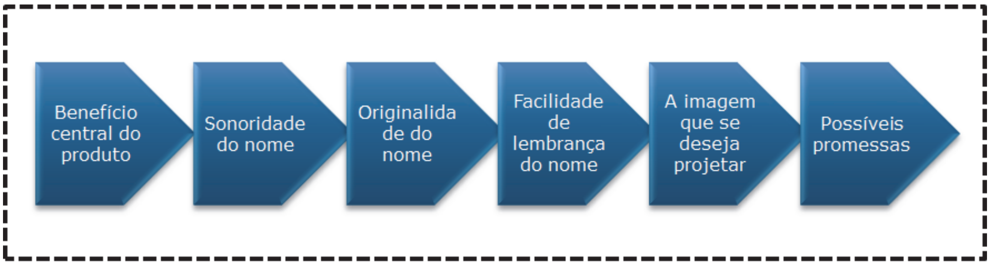

Fig. 1: Hiperconexões de valor. Fonte: NGD/LDU, (2016)

Em Santa Catarina as propriedades rurais demandam dessa assistência para interferir na capacidade produtiva para melhorar e proporcionar por meio desses ativos uma cadeia produtiva competitiva.

Os empreendimentos rurais devem administrar as incertezas proporcionadas por uma série de variantes, entre as quais destaca-se políticas públicas, transposição de fronteiras e gestão da informação, e que, ainda precisam ser eficazes no contexto do ambiente interno.

A gestão de design diminui essas incertezas, contribuindo para valorização de grupos produtivos por meio da identificação e proteção e da prática projetual, criando características que conferem unicidade aos produtos e serviços incrementando os ativos intangíveis.

Por isso o objetivo desse artigo é desenvolver uma base taxonômica com a finalidade de identificar os ativos intangíveis com base na gestão de design.

2. Metodologia

Com relação aos aspectos metodológicos este artigo se caracteriza como exploratório e qualitativo (Lakatos e Marconi, 2003). A pesquisa envolveu um estudo multicasco e para Gil (2002, p. 139), esta condição de múltiplos casos deixa a pesquisa mais robusta e "proporciona evidências inseridas em diferentes contextos, concorrendo para a elaboração de uma pesquisa de melhor qualidade".

O recorte espacial contempla, no Estado de Santa Catarina, as regiões de Joinville e Blumenau (Figura 2), compreendendo um universo de 26 empreendimentos rurais e pesqueiros. O projeto ja esta em desenvolvimento há dois anos.

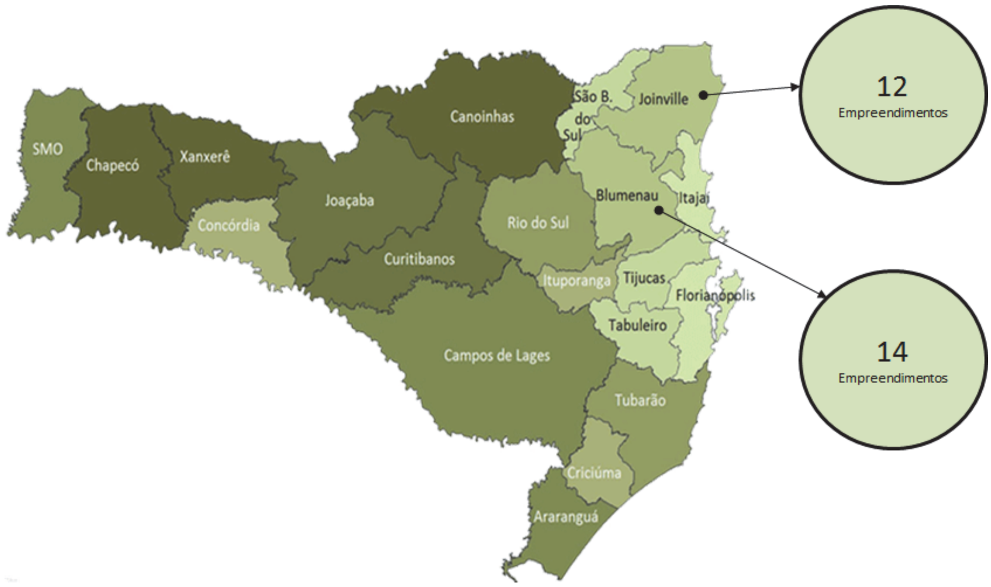

Fig. 2: Santa Catarina e as cidades de Blumenau e Joinville. Fonte: Epagri/Cepa *(2016).*

Quanto aos procedimentos metodológicos, após o delineamento da área espacial da pesquisa, definiu-se como problema a ser investigado, de que forma uma base taxonômica pode contribuir para a verificação da valorização, indentificação e proteção em pequenos grupos produtivos?

Para responder esta pergunta, procedeu-se a uma revisão da literatura em fontes primárias e secundárias. Após o levantamento bibliográfico, planejou-se as visitas, utilizando-se *in locu,* outras ferramentas como formulários e periféricos eletrônicos para coleta e registro dos dados e informações, sendo visitadas cada um dos 26 empreendimentos nesses dois primeiros anos de ações do projeto.

De posse das informações, procedeu-se ao tratamento e organização do volume de dados levantados. A fim de sistematizar as informações sem o risco de perder fatos e acontecimentos importantes, decidiu-se montar uma base taxonômica.

Para a montagem da base, utilizou-se o princípio da sequência canônica (Campos e Gomes, 2007), pois há uma ordem natural do conjunto de assuntos. Cada classe deu origem a uma subclasse de sustentação modalizada, quaternária, alfa numérica e policromática, explícita e consistente, que oferece ao leitor a possibilidade, pelo pensamento associativo, identificar o grupo, a cultura, a atividade e a perspectiva turística. A Figura 3, apresenta sinteticamente a estrutura.

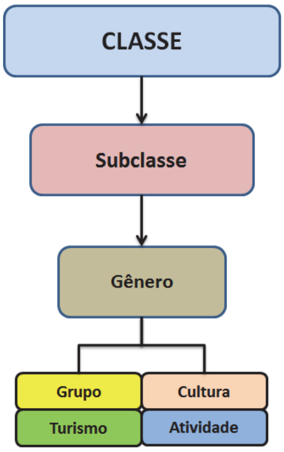

Fig. 3: Estrutura da base taxonômica. Fonte: NGD/LDU (2016).

A estrutura tipológica dos ambientes de domínio da presente base é constituída por três níveis e dois renques. O primeiro domínio chamado de classe reúne a temática de maior abrangência. É constituído pelos arranjos produtivos da fruticultura, olericultura, aquicultura e pesca, pecuária, gestão, floricultura e avicultura. A identificação dos conceitos ocorre no campo a partir do sistema produtivo da propriedade.

No segundo domínio da base, ou seja, a subclasse, 33 possibilidades de ocorrência se materializam, divididas em 15 variações na classe fruticultura, 4 na olericultura, 3 na aquicultura e pesca, 6 na pecuária, 1 na classe gestão, 2 na floricultura e finalmente 2 na classe avicultura. A modo de exemplo, as 2 possibilidades de ocorrência na classe avicultura, são nomeadamente: avicultura de corte e avicultura para produção de ovos.

O último domínio, cognominado de gênero, é estruturado em dois renques alinhados e dispostos na mesma fila e denominados de grupo e cultura; atividade e turismo (Figura 4).

Fig. 4: Dois renques. Fonte: NGD/LDU (2016).

Compõe o microambiente nomeado de grupo (quadrículo amarelo), 8 maneiras produtivas que variam da comercialização de produtos *in natura*, a prestação de serviços de hospedagem, registrados a partir de uma sequência numérica. O segundo microambiente do primeiro renque, chamado cultura (quadrículo alaranjado), indica se o tratamento econômico e climato-ambiental é permanente ou sazonal, apresentando duas perspectivas registradas com letras maiúsculas.

O terceiro microambiente qualificado de atividade (quadrículo azul), assinala qual o status que é dado a atividade econômica e agrícola. Pode ser enquadrada como uma atividade principal ou secundária. A atividade será principal quando ela for a responsável pela produção do maior número de riquezas para a propriedade. É secundária quando for encarada como uma ação adicional e que incrementa o volume de riquezas produzidas. É representada de forma numérica. Finalmente o microambiente do segundo renque estabelecido como turismo (quadrículo verde), especifica se a propriedade tem intenção ou não de desenvolver a atividade turística no espaço rural, a partir de roteiros e circuitos turísticos organizados.

A base foi estrutura em uma planilha do Microsoft Excel (Figura 6) e sua leitura é horizontalizada e sempre partindo da esquerda para direita.

3. A agricultura familiar e a gestão de design

O processo de mudança socioeconômica e o aumento desordenado das cidades tem exigido cada vez mais a produção de alimentos em larga escala para suprir as necessidades humanas.

Neste panorama os agricultores familiares buscam maneiras de se adaptar a esta realidade, oferecendo a própria cidade sua produção rural. Este espaço de oportunidades por um lado proporciona formas de ampliar os negócios, mas por outro lado as carências que via de regra permeiam os pequenos produtores, transforma uma potencial oportunidade em uma fragilidade.

A reprodução das relações sociais no espaço rural, todavia, tem se mostrado até agora insuficientes para manter o agricultor familiar no campo, visto que as técnicas de produção, controle, embalagem e comercialização comprometem o negócio.

Portanto como atividade criativa e eminentemente integradora, a gestão de design pode conduzir os agentes envolvidos para o atingimento de seus objetivos auxiliando de forma racional o atingimento dos resultados pretendidos ampliando sua capacidade de inovação. Corroboram com este fundamento (Gorb, 1990) e (Goulart, Merino e Merino, 2013).

Muito embora a agricultura familiar seja importante para a produção alimentar, as políticas públicas e o desenvolvimento de tecnologias e processos produtivos privilegiam somente a agroindústria patronal, desconsiderando a relevância do meio rural na manutenção das sociedades.

Portanto o reconhecimento da agricultura familiar como força econômica fundamental (Brasil, 2010) desenvolve um conjunto de oportunidades em que a gestão de design acelera e melhora a qualidade de vida e as relações sociais dos envolvidos, aqueles que têm mais de 80% da sua renda advinda da atividade tradicional e cuja base de trabalho está nos membros da família (Bittencourt, Bianchini, 1996).

Por consequência a compreensão da gestão de design como mecanismo agregador de valor para a pequena propriedade enseja ações que levem esses pequenos negócios, a desenvolver uma série de mecanismos que oportunizem uma alavancagem, sobretudo aos processos produtivos, a fim de melhorarem seu desempenho global e valorizar seus ativos intangíveis.

4. Os ativos intangíveis e a valorização da agricultura familiar por meio da identificação e proteção de pequenos grupos produtivos.

A agricultura familiar antes chamada de subsistência sempre apresentou papel importante nas questões econômicas estando presente na rotina das atividades produtivas do Brasil (Mattei, 2014).

Como atividade representativa, apresenta 4,3 milhões de estabelecimentos agropecuários de natureza familiar. Representa 84% do total de módulos agrícolas do território. São mais de 12 milhões de pessoas ocupando 24% do território e respondendo por 38% da renda bruta.

Assim, enquanto a agricultura patronal gera R$ 358,00 por hectare, a agricultura familiar gera R$ 677,00 sendo, 89% mais produtiva respondendo por 10% do PIB (Brasil, 2016). Santa Catarina contribui na dinâmica produtiva dessas cadeias de produção, com 168.544 unidades em 2.645.088 ha. O estado possui 90,5% desses estabelecimentos que ocupam 87% da área agrícola respondendo a 71,3% do valor bruto da produção, gerando mais de 240 mil empregos, 17% da força de trabalho.

A valorização da agricultura familiar por meio do design ocorre pela identificação e proteção desses pequenos negócios. A gestão de design se mostra catalizadora na criação de novos produtos, no incremento de produtos atuais e no desenvolvimento de identidade visual e proteção de marca através da propriedade e da indicação geográfica, e assim se transforma, para Castelão e Landim (2009), em uma ferramenta estratégica.

Diante do exposto cabe ressaltar que a identificação e proteção, proporciona aos pequenos grupos produtivos a perspectiva de se tornarem diferenciados e a competência para identificação e proteção de pequenos produtores é do Instituto Nacional de Propriedade Industrial.

A lei de propriedade industrial 9.279/96, regulamenta este dispositivo estratégico no âmbito do território brasileiro, que via de regra, atribui valor aos produtos através de sua vinculação territorial local, de acordo com o artigo 170 da supracitada lei.

O modelo avalia solo, condições climáticas, processo de produção, determinando territorialidades específicas, mas as principais questões para obtenção do título ainda são atribuídas ao conceito de coletividade, através dos fundamentos do associativismo e do território, o que implica na valorização bilateral dos dois fundamentos.

Essa mobilização associativa aliada às questões edafo-climáticas de dado território permitem a prospecção deste direito da propriedade industrial, e vem se tornando um dispositivo popular.

Niederle (2011. p. 18), defende que as indicações geográficas ensejam uma "revalorização de tradições, costumes, saberes, práticas e outros bens imateriais associados a uma identidade territorial e origem geográfica específica".

Muito embora, não tenha se utilizado, no presente projeto, a indicação geográfica estabelece uma ligação entre o produto e a localidade geográfica de produção e ou de origem, o que para Neto (2011), cria um fator diferenciador dos produtos similares disponíveis no mercado e isso "possibilita a construção contínua de uma teoria mais ampla, mais competente e mais comprometida com as variáveis de interesse social" (Portuguez, 2001, p. 60).

A indicação geográfica divide-se em indicação de procedência e denominação de origem. Ambas concedem reputação ao produto pela origem geográfica ou que tenha se tornado conhecido como produtor de determinado produto e ou serviço. No entanto, destaca-se que até o presente momento, não se desenvolveu ações de indicação geográfica no projeto, relatado neste estudo.

A generosidade da terra e a ingratidão do homem, que sempre agiu no sentido de destruir, aniquilar, consumir e enfraquecer as produções e a substância da natureza (Pádua, 2002), tem exatamente na indicação geográfica, o seu oposto, pois requer a boa prática e uma excelente qualidade ambiental dos atributos geográficos.

A indicação geográfica possibilita ao consumidor, a certeza da origem geográfica do produto com suas características finais decorrentes dessa origem, e para o produtor a garantia de longevidade comercial. Essa diferenciação aumenta o valor agregado do produto e ou do serviço, preserva suas particularidades e estimula investimentos na área delimitada pela IG, valorizando a condição humana e as características do campo pela agricultura familiar.

Figurando finalmente como mecanismo legal de identificação e proteção, ainda existe a marca coletiva que identifica produtos e serviços de uma determinada organização e a marca de certificação que oferece a evidência de uma certificação a partir de normas e especificações técnicas, caso das International Organization for Standardization – ISOs.

Estes mecanismos legais garantem a autenticidade dos processos produtivos e da identidade visual dos produtos, processos e serviços, cria um fator diferenciador e agrega valor, transformando-se nos ativos mais importantes do negócio (Neto, Teixeira e Merino, 2010).

Por estas razões Preto, Merino e Figueiredo (2011) afirmam que a planta deve incorporar a gestão de design na concepção estratégica do negócio, no design do produto e na análise de seu ciclo de vida. Como resultante desse processo os ativos intangíveis são destacados como uma contra resposta da incorporação de valor do agroecossistema.

Assim, por meio da gestão de design, todos os componentes que não são perceptíveis ao toque, ou seja, que não são corpóreos entre os quais chama-se atenção para a valorização a identificação e a proteção, passam a incorporar um ativo de capital que incrementa benefícios ao negócio e aos sujeitos diretamente ligados ao sistema.

Uma vez que está em curso no mercado a transição da valorização dos ativos tangíveis para uma supervalorização dos ativos intangíveis, entendidos como "bens e direitos colocados à disposição da empresa, que não tem existência física, mas que são capazes de gerar benefícios futuros para a entidade" (Garcia, 2001, p. 6) fica claro que a natureza física não é mais uma variante absoluta. Pelo contrário, os ativos intangíveis estimulam a percepção de perenidade que o mercado alvo passa a construir do negócio, da marca, das estratégias, do modelo de gestão consignado através de uma eficiente governança corporativa, mediada pelo design.

Ora, portanto a principal questão da valorização dos ativos intangíveis reside não em valores absolutos, mas na construção de uma curva de valor que seja e possa ser monitorada sistematicamente, uma vez a dificuldade em valorar contabilmente em modo de balança os valores desses ativos incorpóreos. Portanto, o resultado financeiro efetivo e final daquilo que é palpável está ligado diretamente como a consequência potencializadora do aumento da curva de valor avaliada sistematicamente através de uma matriz de avaliação de valor definida por atributos que sejam consistentes e comparativamente mais fortes que os concorrentes, causada pelos ativos intangíveis.

Dessa forma, estes ativos intangíveis, entendidos como tudo que não é corpóreo, tais como a preocupação com a sustentabilidade, a boa engenharia e os benefícios do produto e ou serviço, entre outros, evidenciados por intermédio da gestão de design, oferecem melhores condições de competitividade.

5. Resultados e discussão

Os empreendimentos pesquisados apresentam em média, tempo de existência de aproximadamente 17 anos. A Figura 5 apresenta a série dispersiva do tempo de existência e da quantidade de empreendimentos.

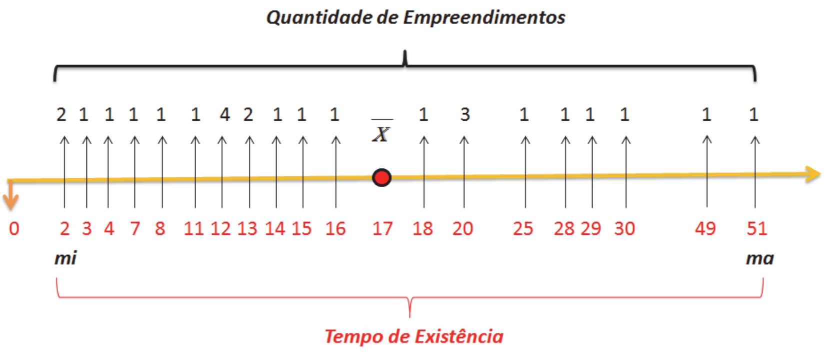

Fig. 5: Série dispersiva de tempo. Fonte: NGD/LDU (2016)

Dos 4 empreendimentos que apresentam 12 anos de existência, 3 são de Blumenau e 1 de Joinville. Dois empreendimentos estão no início do negócio, apresentando 2 anos de duração. Um é filiado a uma associação que conduz os interesses da categoria e o segundo nasceu de necessidades particulares de um dos membros, proprietários do negócio.

O empreendimento com mais tempo de vida localiza-se em Blumenau e atua na área de fruticultura e olericultura. Sua principal atividade é a plantação de cana e a transformação em melado, atividade econômica permanente, considerada a principal fonte de geração de riquezas e não querem o desenvolvimento da atividade turística. Também de forma secundária atuam igualmente na olericultura com raízes e tubérculos sendo a primeira uma atividade sazonal e a segunda permanente. A venda *in natura* de tubérculos e raízes apresenta uma atividade econômica secundária.

Um (1) empreendimento manifesta preocupação com a questão da sucessão do negócio, visto que os membros mais jovens da família agrícola não querem dar continuidade aos negócios dos pais, preferindo outras atividades não agrícolas e fora do meio rural.

Igualmente, algumas propriedades demandam assessoria na gestão em todos os níveis do empreendimento necessitando de auxílio na formação patrimonial da marca e do negócio, bem como da criação de alianças estratégicas que ampliem e reforcem o design, através de ações coletivas, inovadoras e associadas.

Os empreendimentos traduzem o potencial da produção manual através de um processo histórico e único, conferindo autenticidade ao sistema produtivo mesmo que haja certa reprodutibilidade técnica, posto que o conceito de autenticidade decorra justamente do saber que o produziu e não do bem em si (Sant'anna, 2003).

As práticas desenvolvidas são expressões culturais imateriais herdadas dos seus antepassados e são reproduzidas continuamente através das gerações que a detém, constituindo uma forma de compreensão e vivência da vida social, cultural, econômica, política e cultural dos grupos num misto de tecnologia e arte, sem perder a validade ética e estética (Benjamim, 1992).

Isso amplifica as possibilidades de utilização dessas características para empregar o design na atividade do turismo no espaço rural, já que a harmonia ambiental, a formação étnica de seus membros, o conceito campesino, o partido arquitetônico das construções aliado as atividades produtivas, lúdicas e artesanais, torna o meio rural um ambiente dinâmico o que amplifica consideravelmente a criação de postos de trabalho fomentando a multifuncionalidade do espaço rural, minimizando os efeitos deletérios das ocupações rurais não agrícolas, pela "desdiferenciação social atrelada a pluriatividade" (Laurenti e Del Grossi, 1999, p.17).

A partir das análises efetuadas, desenvolveu-se uma base taxonômica das atividades dos empreendimentos, como auxílio na organização da informação, estruturada em classe, subclasse, gênero e renque (Figuras 2 e 3) como suporte para navegação, organização e reusabilidade da informação, conforme pode-se observar na Figura 6.

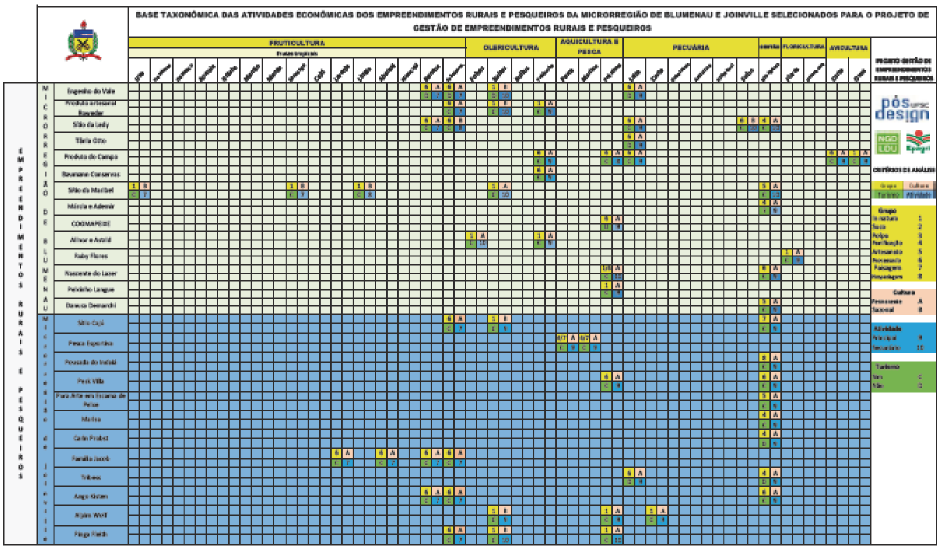

Fig. 6: Base taxonômica das atividades econômicas dos empreendimentos rurais e pesqueiros analisados. Fonte: NGD/LDU (2016).

Assim com base na composição e leitura das propriedades consignadas na subclasse da base taxonômica, apresenta-se o Gráfico 1, A e B.

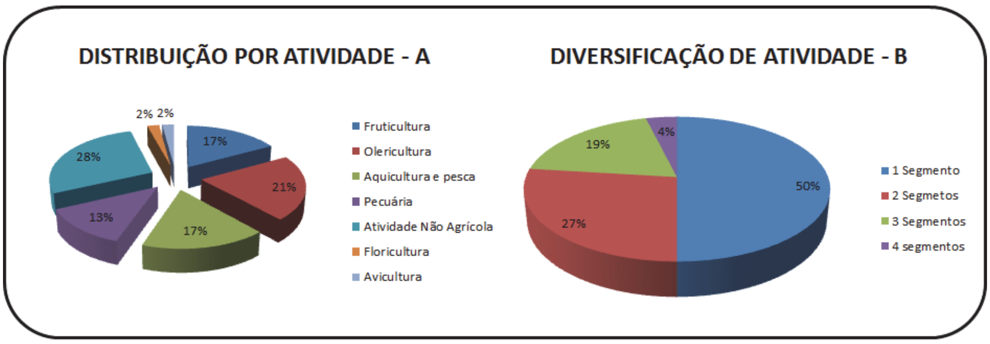

Gráfico 1: Distribuição por atividade e diversificação da oferta. Fonte: NGD/LDU (2016).

É possível inferir-se com a exposição dos dados do Gráfico A, que as atividades convergem para panificação, artesanato, hospedagem, contemplação de aves e paisagem, além de processamento de produtos *in natura* oriundos da psicultura, mas que também não se traduzem como atividade principal, vez que oferecem à produção processada de alimentos. Este estrato alcança 23% da amostra.

A segunda atividade mais executada nas propriedades é a olericultura, compreendendo um universo de 21%, seguido da fruticultura e aquicultura e pesca com 17% cada categoria. A quarta atividade mais praticada nos empreendimentos é a pecuária para produção leiteira e derivados (13%), identificada como atividade permanente. Floricultura e avicultura abarcam, cada categoria, 2%.

A sobreposição do Gráfico B, a partir do conhecimento gerado com o Gráfico A, permite deduzir que no que diz respeito ao conceito de diversificação (Ansoff, 1981), o tema apresenta-se de forma pouco explorada. Somente um (1) empreendimento atua em quatro (4) categorias, nomeadamente olericultura, psicultura, pecuária para produção leiteira e avicultura para corte e produção de ovos, todas elas, segundo declaradas por seus agentes produtivos, como sendo, atividade permanente e assumindo a principal fonte de geração de riquezas do empreendimento.

Constata-se, por meio da navegação da base taxonômica que os empreendimentos rurais localizados na região de Blumenau atuam nas 7 classes da base. Na subclasse é possível verificar a produção de uvas, morango, limão, assim como também banana e cana de açúcar, classificada na subclasse como atividade sucroalcooleira. Exceto esses dois últimos, todos os outros são comercializados i*n natura,* considerados culturas sazonais e que adicionalmente potencializam riquezas para a propriedade. Com relação aos dois últimos, no micro espaço grupo, tanto a banana quanto a cana de açúcar são processados para fabricação de geleias, doces e melado.

A preponderância nas outras classes é mantida no processamento da psicultura (Filés e outros cortes), de lácteos para queijo, natas e iogurtes, panificados e artesanato. Com relação ao desenvolvimento do turismo organizado, duas propriedades não querem adicioná-las na propriedade.

Já as propriedades rurais localizadas em Joinville, concentram suas atividades em 6 classes excetuando avicultura. Na subclasse frutas tropicais atuam produzindo laranja, abacaxi, banana e cana de açúcar. Assumem a condição de produtores permanentes e tem na atividade a principal fonte de geração de riquezas da propriedade.

Na classe olericultura, subclasse raízes, duas propriedades produzem de forma sazonal, comercializando a colheita do aipim e considerada para um como a fonte de principal riqueza, e para o outro, como sendo uma atividade secundária.

Nas classes pecuária e gestão, há uma variação quanto as subclasses, com alinhamento mimético no gênero, com somente duas propriedades contrárias ao desenvolvimento do turismo. Ainda nessas duas classes, no microespaço grupo, integrante do primeiro renque, (1) propriedade explora a contemplação da paisagem e a observação de pássaros; (1) atua no ramo de hospedagem; (3) com panificação e (1) com artesanato.

Assim, de acordo com a base taxonômica é possível afirmar que é possível a valorização da agricultura familiar, nos casos em tela, pela quantidade de práticas, processos, insumos e equipamentos necessários para a sistemática reprodutibilidade de um sistema usado para transformar entradas em saídas de qualidade. Como um sistema que opera em um layout específico dentro de uma capacidade planejada, reportando a estrutura física aos relacionamentos humanos, a partir de um conjunto de elementos com suprimentos, máquinas e equipamentos, as evidências contribuem para a valorização da agricultura familiar.

Finalmente a convergência das ações desencadeou uma série de respostas aos agricultores e como resultado da prática projetual dessas ações por meio do design, valorizam a agricultura familiar por meio da criação de identidades visuais, de embalagens e humanização dos pontos de venda, oferecendo aos consumidores, produtos diferenciados.

Os ativos intangíveis, a partir da evidência da constatação da localização, do material de comunicação, da interpretação dos símbolos através dos signos visuais e logotipos, deixam claro que a valorização a identificação e a proteção, se transformam em ativos intangíveis na agricultura familiar, e isso enriquece o apelo ao consumidor.

No entanto, considera-se como principal ativo resultante dessas ações o fornecimento sinergístico entre o ambiente interno e o externo, mas acima de tudo a evidência física e imaginária, que posiciona o negócio, a marca e o produto como agentes de qualidade.

Portanto foram realizadas melhorarias no ponto de venda para exposição atrativa das mercadorias, com ações de branding/naming, criação de marca gráfica e linguagem visual padronizada, envolvendo questões legais como o registro de marca, nome fantasia e nome empresarial e serviços para melhorar a experiência de compra e a conscientização sobre hábitos saudáveis; criação de tags informativas para os produtos; plaquinhas com nome / preço dos produtos; cartaz institucional do produtor; quadro negro com produtos do dia e cestos de vime para expor os produtos. Já em Joinville, o efeito final foi à identidade visual, nas embalagens, uniformes, papelaria, aplicações de identidade visual nos meios de transporte da cooperativa e estudos ergonômicos para despencamento das pencas de banana.

6. Considerações finais

As relações estabelecidas entre a agricultura familiar e a gestão de desing por meio da base taxonômica apontam mesmo que preliminarmente, valorização da agricultura familiar por meio dos ativos intangíveis, uma vez que as 26 propriedades estudadas desenvolvem processos produtivos, com tecnologias apropriadas e conhecimento necessário para a produção rural familiar.

Deve-se registrar que os resultados positivos na perspectiva da produção de ativos intangíveis vistas e discutidas relaciona o conceito como elemento catalisador de benefícios econômicos futuros: para o produtor e para o consumidor. O produtor com a perspectiva da convergência desses ativos em valores absolutos e o consumidor com as diversas possibilidades de satisfação de suas necessidades e desejos, a partir da compreensão e interpretação desses ativos intangíveis.

Considere-se ainda que a produção dos ativos intangíveis tais como valorização, identificação e proteção, aumentam as chances do negócio obter saúde e longevidade, mantendo o agricultor familiar no campo e diminuindo as chances desse agente produtivo sofrer as consequências negativas do abandono da atividade primária.

Alie-se a esse fato que a manutenção de pequenos grupos produtivos no espaço rural diminui a probabilidade da presença e dominância da agroindústria patronal com seu modelo de produção agressivo, comoditizado, produzido em larga escala. Esse modelo de produção aumenta a pressão ambiental e por outro lado dilata ainda mais o remoto rural, não como uma relação geográfica medida em distância, mas sobretudo a possibilidade do espaço rural perder a presença do homem e suas relações tipicamente rurais.

No que concerne à diferenciação, o desenvolvimento de novos produtos mantêm o destaque e constrói uma participação de mercado mais consistente. Contudo o principal papel determinante da diferenciação é o desenvolvimento de novos atributos na curva de valores do negócio. Também a organização e humanização dos pontos de venda, incluindo aspectos de layout afeta a capacidade de diferenciação dos produtos.

Nesse viés a autenticidade do processo produtivo e dos insumos de produção resulta na habilidade dos empreendimentos em exercer suas atividades de forma exclusiva, e isso cria valor e influencia a percepção da diferenciação. Dessa forma o projeto gestão de empreendimentos rurais por meio da gestão do design na dimensão da diferenciação, estabelece esforços apresentando os benefícios do consumo da origem familiar da produção agrícola desenvolvendo a agrobiodiversidade.

A dimensão sustentabilidade proporciona que os empreendimentos alicercem seus sistemas de atividades a partir das interconexões mais relevantes do sistema produtivo. Isso elimina custos, diminui riscos e aumenta as dificuldades de imitação dos concorrentes atuais. Esses resultados oriundos de um modelo de planejamento e gestão contribuem para a sustentabilidade, uma vez que desenvolve capacidades e habilidades específicas que reforçam o DNA do negócio, aumentando sua longevidade, manutenção e permanência no negócio. A compreensão dessa nova economia, solidária, social e popular sustenta um estilo de vida, influenciando significativamente nos hábitos alimentares mais saudáveis e na produção alimentar mais sustentável.

Por fim a construção preliminar da base taxonômica teve como objetivo o estabelecimento de uma categorização do que até o momento foi pesquisado, permitindo uma visão e leitura mais clara sobre as semelhanças e diferenças presentes entre as propriedades estudadas.

Assim as verificações apontadas por meio da base taxinômica neste estudo multicaso, pode-se afirmar que o papel da gestão de design aqui discutido vai além do desenvolvimento de embalagens e rotulagem: o papel do design neste viés consiste sempre em oferecer a melhor resposta através de um posicionamento competitivo, com linguagem clara criando compromisso entre os agentes direta e indiretamente envolvidos e isso amplifica o valor dos ativos intangíveis na agricultura familiar.

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Reciclaje de plásticos de consumo masivo. Caso comunidad de reciclaje Nashira

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Resumen

Desde sus orígenes los plásticos han revolucionado el mundo debido a su versatilidad frente a otros materiales, sin embargo, el volumen de material ha crecido ostensiblemente como se registra en los datos de Plastics - the facts 2015. An analysis of European plastics production, demand and waste data (2015), donde se afirma que 311 millones de toneladas de plástico se han producido en el mundo en el año 2014.

De otra parte, según el informe del Banco Internacional de Desarrollo (2011), el negocio del reciclaje en Latinoamérica, es en su mayoría informal. En Colombia, los recicladores desempeñan una labor ambiental importante siendo ellos quienes recolectan el 60.9% de los residuos reciclables, y obtienen una remuneración muy baja (aun cuando manipulan materias primas con alto valor económico), siendo sus ingresos mensuales en promedio 22,14 USD es decir menos de un dólar diario, lo cual, enmarca esta población en índices de pobreza extrema, lo cual establece una situación necesario de intervención con el fin de dignificar el trabajo y erradicar la pobreza extrema entrando en consonancia con objetivos a nivel mundial (Programa de Naciones Unidas, 2015).

Con estos elementos preliminares del volumen de materiales plásticos y el trabajo subvalorado de los recicladores, este proyecto propone reciclar plásticos desarrollando una extrusora que produzca la transformación del material plástico de consumo masivo desechado, en filamento para impresión 3D, -teniendo en cuenta la emergente masificación de las impresoras 3D FDM (Fused Deposition Material).

Este trabajo es desarrollado en conjunto con una comunidad de "reciclaje Nashira" en el Bolo San Isidro, corregimiento del Valle del Cauca - Colombia y plantea su desarrollo a través de metodologías de co-diseño incluyendo a la comunidad activamente en el proyecto (Sanders & Stappers, 2014), a su vez es necesario abordar los elementos claves de este proceso mediante estrategias sistémicas (Hernandis, 2015), así a partir de este enfoque se define la configuración del objeto final con el diseño como medio transformador de aspectos intangibles como el conocimiento, asociado una dimensión sociocultural donde la interacción es dada siempre por la comunidad como actor principal.

Palabras clave: *Diseño social, Co-diseño, Reciclaje de plástico, Modelado sistémico, Extrusora de filamento.*

Abstract

Since its origins the plastics have revolutionized the world due to its versatility to other materials, however, the volume of material has grown ostensibly as recorded on data from Plastics - the facts 2015. An analysis of European plastics production, demand and waste data (2015), where it is stated that 311 million tons of plastic were produced worldwide in 2014.

Furthermore, according to the report of the International Development Bank (2011), the recycling business in Latin America, is mostly informal. In Colombia, recyclers play an important environmental work being they who collected 60.9% of recyclable waste, and earn very low wages (even when handling raw materials with high economic value), and its monthly income on average $ 22.14 USD less than a dollar a day, which frame this population in extreme poverty rates, which establishes a necessary intervention situation in order to dignify the work and eradicate extreme poverty coming into line with global targets (United Nations Program, 2015).

With these preliminary elements of the volume of plastic materials and recyclers underrated work, this project proposes developing a recycle plastics extruder to produce plastics processing consumer material discarded in filament for 3D printing, taking into account the emerging massification 3D FDM (Fused Deposition Material) printers. This work is developed in conjunction with a community of "recycling Nashira" in Bolo San Isidro, municipality of Valle del Cauca - Colombia and raises its development through methodologies co-design including the community actively in the project (Sanders & Stappers, 2014), in turn is necessary to address the key elements of this process by systemic strategies (Hernandis, 2015) and from this approach, the configuration of the final object is defined by the design as a medium transformer of intangibles such as knowledge associated to sociocultural dimension where interaction is always given by the community as the main actor.

Keywords: *social design, Co-design, recycling plastic, systemic modeling, Extruder filament.*

1. Introducción

Este proyecto se desarrolla desde el diseño industrial planteado como una actividad sistémica que permite identificar las necesidades y controlar los procesos que consiguen desarrollar el producto (Hernandis & Valenzuela, 2014), se aborda el estudio de caso de la comunidad Nashira, (única formalmente constituida en la ciudad de Palmira) que lleva a cabo la actividad del reciclaje, siendo esta, una labor importante tanto para el medio ambiente como para la sociedad (Berenguer & Corraliza , 2000). Esta investigación es abordada desde dos enfoques; el primero, consiste en el trabajo conjunto comunidad – diseñadores y el segundo desde un abordaje sistémico. Desde el primer enfoque, la experiencia de la comunidad y el acompañamiento constante del equipo de diseño, permiten el acercamiento al contexto para determinar las condiciones geográficas, económicas y culturales, a partir de la metodología de co-diseño (Sanders & Stappers, 2014), que establece este reconocimiento para analizar la situación desde diferentes perspectivas. El segundo enfoque, establece los aspectos técnicos a través del modelado sistémico de producto (Hernandis & Iribarren, 2000) y se identifican de manera clara cada uno de los requerimientos de los sistemas de la propuesta objetual, basada en los insumos obtenidos de la primera fase con el grupo de reciclaje. Los dos enfoques concretan una respuesta a la problemática, surge de las ideas de la comunidad quienes al estar involucrados en el desarrollo del proyecto y crean apropiación de los resultados; el modelado sistémico, faculta el diseño, la construcción e implementación de una extrusora de filamento para impresión 3D a partir de material plástico reciclable, que permite la transformación del plástico recolectado en una materia prima que puede ser comercializado a un mejor precio del que reciben actualmente por el plástico.

2. Justificación

2.1. Social

Actualmente en Colombia el reciclaje de plásticos es una labor realizada en su mayoría por recicladores informales, y según el BID (2011) son ellos quienes hacen el mayor aporte a la recolección del material reciclable con una cifra que alcanza el 60,9% del plástico recolectado a nivel nacional. Sin embargo, dicha labor establece una remuneración tan baja que apunta a los índices de pobreza extrema con ingresos de menos de dos dólares diarios[14], aun cuando la industria del plástico reconoce el potencial económico del material plástico reciclable asegurando pérdidas de entre 80.000 y 120.000 millones de dólares cada año por envoltorios plásticos no reutilizados (Ellen Macarthur foundation, 2016).

La fabricación de filamento plástico (para impresión 3D) a partir del material reciclado por comunidades vulnerables por pobreza, crea espacios de trabajo que contribuyen al mejoramiento de la calidad de vida, a partir de mayor remuneración económica obtenida por su trabajo. Este trabajo se justifica desde lo social teniendo en cuenta las condiciones del contexto en el cual es desarrollada la labor.

2.2. Ambiental

Se resalta la importancia y la necesidad de reciclar, dado que la masificación del plástico en el mundo se ha convertido en una problemática cada vez más difícil de controlar, como lo advierten los estudios presentados en el foro económico mundial (The new plastics economy: rethinking the future of plastic, 2016), que indican que de seguir sin tomar acciones, para el año 2050 el peso de los residuos plásticos será superior al peso de todos los peces en el planeta, por tanto es imperiosamente necesario el proponer soluciones desde diferentes perspectivas para prestar atención a las alarmas y contribuir con la mejora de esta situación ambiental. Brindar una materia prima a partir del producto reciclado de desechos plásticos como PET o HDPE, que finalmente terminan en depósitos o rellenos sanitarios donde pueden tardar más de 150 años en descomponerse, justifica este trabajo desde lo ambiental.

3. Caso estudio comunidad de reciclaje Nashira

Ubicada en el corregimiento El Bolo, en la ciudad de Palmira, Departamento del Valle del Cauca, en Colombia, Nashira es una comunidad de reciclaje rural conformada por mujeres en su mayoría madres cabeza de hogar, quienes en la labor del reciclaje encuentran una alternativa para suplir sus necesidades económicas, y a su vez contribuyen al mejoramiento de las condiciones ambientales de la eco aldea a

[14] Tasa de incidencia de la pobreza sobre las bases de $1.90 dolares por día (PPA). Tomado del banco mundial y comisión económica para américa latina y el caribe - CEPAL

través de proyectos de formación y capacitación de separación en la fuente, recolección y manejo de residuos sólidos.

Su labor parte del aprendizaje empírico por lo cual está mujeres muestran un gran interés y dedican parte de a su tiempo a aprender cada día más sobre los materiales que recolectan, su debido tratamiento y cómo disponer adecuadamente de ellos, esta situación derivó en acercamientos y diálogos con profesionales, entre ellos los diseñadores.

Sin embargo, la ausencia de conocimiento e información en el negocio del reciclaje, se ha visto reflejada en las ganancias obtenidas; los ingresos recibidos por la comercialización del material recolectado son muy bajos, no cuentan con la experiencia, el recurso suficiente o el conocimiento técnico necesario para realizar procesos de transformación de los residuos que pudieran dar valor agregado al material.

Por ello este trabajo se encuentra oportuno para brindar herramientas que ayuden a la consolidación de los procesos de reciclaje, haciendo uso de herramientas metodológicas de diseño participativo (Sanders, 2013) para desarrollar capacitaciones específicas y plantear la implementación de transformación del material recolectado para aumentar las ganancias, es así como se plantea la construcción de una extrusora (para filamento de impresión 3D) en un proceso de construcción que involucra a la comunidad de forma activa, que contribuye al mejoramiento de su calidad de vida y que dignifica la labor tan importante que realizan en cada jornada de recolección siempre en búsqueda del bienestar humano (Ramirez, Cardozo , & Lecuona, 2012).

4. Metodología

Se trabaja en esencia con 2 metodologías de diseño para lograr el cumplimiento de los objetivos, en una primera instancia se trabaja bajo los parámetros definidos por Sanders (Sanders & Stappers, 2014), haciendo uso de metodologías de co-diseño, esta metodología sugiere el abordaje con la comunidad y el trabajo con la misma, permitiendo el desarrollo de talleres que ayudan al reconocimiento de las materias primas recolectadas y a la capacitación, comprensión desarrollo y apropiación de la máquina extrusora.

Posteriormente se aplican metodologías de una adaptación de los autores al modelo planteado por Hernandis (Hernandis & Iribarren, 2000) en cuanto se refiere a sus modelados de producto y empresa, junto con metodología de caja negra expuesta por (Cross, 2003). Este enfoque permite visualizar desde lo general -la comunidad-, el planteamiento de un modelo, que debe ser rentable y sostenible y desde lo particular el desarrollo de un producto para transformar el material plástico recolectado.

4.1. Workshops y trabajo con la comunidad

Bajo el planteamiento de workshops, se logró el acercamiento con la comunidad en dos oportunidades, la primera "workshop de materiales" (Fig. 1) fue la apertura de espacios de capacitación sobre características de materiales, usos convencionales y métodos de fácil reconocimiento y clasificación, del cual se obtuvieron paneles gráficos construidos en conjunto, con los cuales pudieran interactuar y que albergaran la información requerida por el grupo en el momento de realizar las pruebas las cuales fueron aplicadas a probetas de tres materiales (PET.HDPE, y PP) y llevadas a cabo por primera vez en compañía de las cinco integrantes del grupo de reciclaje en una sesión de tres horas, donde las pruebas que se usaron para el reconocimiento de los materiales consistieron en exposición al fuego directo mediante el uso de un encendedor, siendo los resultados a tener en cuenta el color y la forma de la llama, el color del humo y el color del goteo del material; adicionalmente se realizó una prueba de densidad en agua, de la cual los resultados posibles consistían en si la probeta permanecía en la superficie del agua o por el contrario llegaba al fondo del recipiente.

Fig. 1 Workshop de materiales

Fig. 2 Formato y diagramación del panel

Para este desarrollo se estableció que la construcción de elemento gráfico daría pautas básicas sobre los materiales y las pruebas, por lo que el equipo de diseño preestableció el formato y la diagramación (Fig. 2) de los tres paneles diferenciados entre ellos por medio de colores, dejando los espacios pertinentes para que las integrantes de la comunidad fueran construyéndolos haciendo uso de adhesivos que contenían la información y los resultados de las pruebas en los materiales, a medida que estas se realizaban.

Posteriormente se llevó a cabo el segundo ejercicio con la comunidad “workshop de formas básicas”, con el objetivo de llegar a propuestas formales a partir de la construcción de volúmenes básicos que pudieran ser reinterpretados como componentes del sistema de extrusión, cuya finalidad fue incentivar la participación de las integrantes en el proceso de configuración morfológica de la máquina, promoviendo la apropiación por el proyecto con el planteamiento de ideas propias y aumentando las expectativas sobre el resultado formal con la reinterpretación de sus propuestas, por lo que para este taller se propuso llevar a cabo la actividad en 4 partes (Tabla 1) en una sesión de tres horas de trabajo.

Tabla 1. Contenidos de las actividades.

ACTIVIDAD	CONTENIDO
Contextualización	Procesos de reciclaje actuales, uso de maquinarias y alternativas de uso del filamento plástico.
Explicación	Funcionamiento general de máquinas de extrusión, otros procesos de transformación y alternativas mecánicas para procesar materia prima.
Construcción	Elaboración de modelos con formas básicas como reinterpretación de las partes de la extrusora.
Socialización de resultados	Muestra de resultados en grupo y retroalimentación del proceso para aclarar posibles dudas.

1. Contextualización: en esta primera etapa se realiza una explicación sobre los procesos actuales de reciclaje, posibles métodos y maquinaria usada a nivel industrial de los cuales el grupo no tuviese conocimiento y finalmente la posible disposición o uso que podría tener el filamento fabricado.

2. Explicación: para llevar a cabo el taller se realizó una explicación introductoria al proceso de extrusión del plástico, maquinarias usadas, y principios básicos de funcionamiento con el fin de brindar la información que fuera necesaria y pertinente para esta etapa del proceso.

3. Construcción: se construye con el grupo un modelo representativo de una máquina extrusora, donde se identificaron sus partes y el orden en que el sistema debía ser construido, teniendo en cuenta algunas propuesta que surgieron del grupo en cuanto a la disposición de elementos como la tolva, respecto al tornillo de extrusión y su forma.

4. Socialización de resultados: en un escenario de participación y discusión, algunas integrantes del grupo dieron sus aportes hacia el modelo construido, proponiendo cambios en la forma y brindando alternativas de solución a partes técnicas del sistema a medida que se socializaban los resultados de la actividad.

En este workshop se evidenció la motivación por el proceso de capacitación (Fig. 3) y la apropiación de la información brindada en las explicaciones y charlas realizadas desde los primeros encuentros; con esta información el grupo realizó un modelo representativo (Fig. 4) y expuso sus ideas con las demás integrantes sobre la interpretación del proceso de extrusión.

Fig.3 Capacitación sobre el proceso de extrusión.

Fig.4 Construcción de modelo representativo.

4.2. Modelado del sistema

Paralelo a este proceso se inició el análisis de la máquina desde la perspectiva sistémica, estableciendo inicialmente los sistemas y subsistema existentes como flujos de información a través de una "caja negra" (Cross, 2003) que descompone la función principal en funciones secundarias y esenciales con sus respectivas variables de entrada y salida (Fig. 5 y Fig. 6).

Acto seguido, frente al abordaje del análisis preliminar del diseño de una extrusora se decidió escalar ampliamente y se optó por ampliar el estudio a procesos previos a la extrusión, teniendo en cuenta las variables que podían incidir en la toma de decisiones sobre la construcción o implementación de algunos procedimientos como lavado y peletizado, que pudiesen complementar la producción del filamento, entendiendo las posibilidades resultantes como modelos de negocio alternativos a la venta de la materia prima.

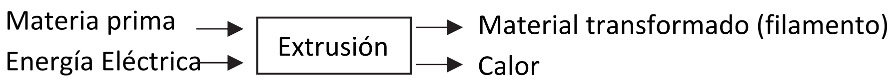

Fig.5 Modelo de sistemas de la "Caja negra" elaborada para el sistema de extrusión.

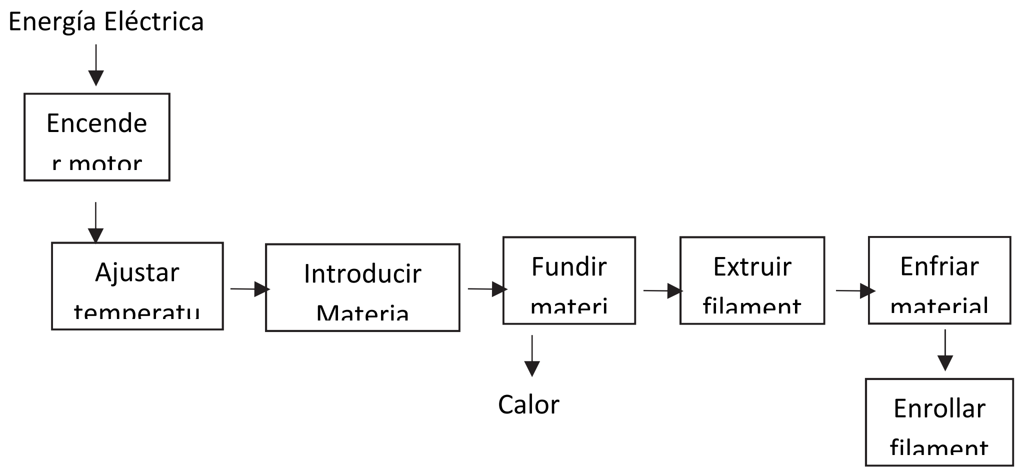

Fig.6 Descomposición de funciones para el sistema de extrusión.

Dado que el sistema de extrusión estaba comprendido por un número reducido de pasos generales, se aplicaron conceptos de escalabilidad que permitieron establecer la necesidad de procesos previos para el debido tratamiento de la materia prima, entendido desde la recolección del material reciclable, hasta el almacenamiento del producto final siendo la extrusión un subsistema del proceso de reciclaje del plástico, esto con el fin de identificar aquellos pasos que pudieran ser llevados a cabo por la misma comunidad sin necesitar otros recursos, especialmente aquellos que significaran una inversión o gasto elevado como energía eléctrica para el funcionamiento de máquinas adicionales o agua para el lavado y enfriado del material, de esta manera se propuso un sistema de producción en línea que tuviese en cuenta los procesos como son llevados a cabo actualmente (Fig. 8). Para esto se desarrolló un esquema sinóptico (Fig. 8) que tuviese en cuenta las posibilidades de comercializar el material en mejores condiciones, eliminando la dificultad de almacenamiento que representaba el no estar peletizado ni pesado y que tuviese en cuenta la propuesta de fabricación de filamento plástico tanto para venta, como para usos alternativos que la misma comunidad pudiese plantear.

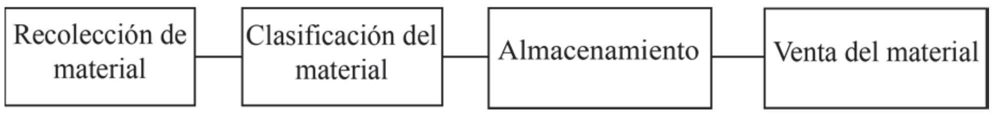

Fig.7 proceso actual de reciclaje.

En este análisis, las variables tenidas en cuenta para la toma de decisiones sobre la disposición del material se basaron en dos aspectos, el primero que consiste en la forma de cómo se comercializa el material reciclable actualmente, donde el precio de venta se define según el peso sin los procesos de prensado ni lavado y por otro lado, la alternativa de producción de filamento con el material reciclable una vez que este que cumpla las características necesarias; en este caso en el proceso actual se identificaron actividades que podrían convertirse en cuellos de botella por la falta de espacio para el almacenamiento como es el caso del material que es lavado y almacenado sin ser peletizado, el cual ocupa grandes cantidades en volumen, pero NO en peso, lo que se traduce a poca ganancia. Por ello, se replanteo el esquema de producción modificando el orden de las actividades actuales con sus correspondientes variables, adicional a esto, el proceso de secado que no es llevado a cabo por su complejidad y que sería solucionado realizando el peletizado previamente (Cuadro de modificaciones en la figura.8).

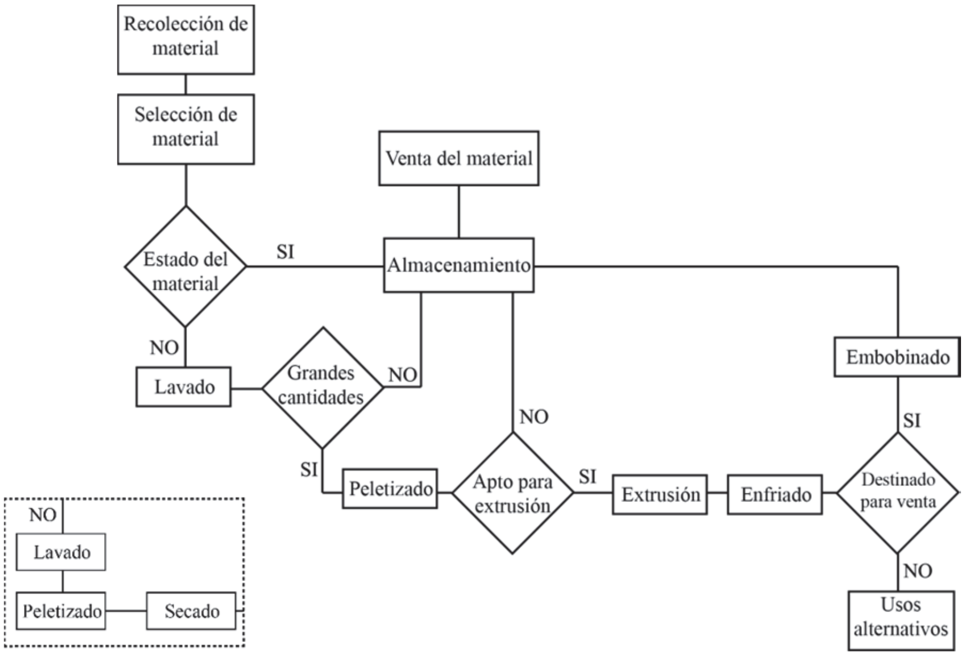

Fig.8 Esquema sinóptico para la fabricación de filamento-en línea discontinua las modificaciones posteriores.

A partir de este procedimiento se identificaron aspectos técnicos, que contribuyeron a la fijación de requerimientos, los cuales fueron relacionados directamente con un sistema funcional que permitiera solucionar una problemática específica organizadas bajo criterios de orden jerárquico de acuerdo al momento en el que son llevadas a cabo en el proceso de transformación, entendiendo que para comprender la estructura se deben examinar tanto su composición a nivel interno como las funciones que desempeña, su relación con el entorno y cada uno de los sistemas específicos con los que interactúa y que a su vez componen la función global.

4.3. Desarrollo de la propuesta

Una vez llevado a cabo el proceso de análisis de las condiciones de la comunidad se dio inicio a la construcción de la maquina extrusora, para esto se tuvieron en cuenta dos aspectos, el primero fueron las propuestas resultantes de los dos workshop realizados con la comunidad, con el fin de llegar a una configuración formal diferente a los existentes, y la segunda basada en los aspectos técnicos que constituyen el proceso de extrusión dividido en subsistemas funcionales y los elementos que corresponden a cada uno (fig. 10).

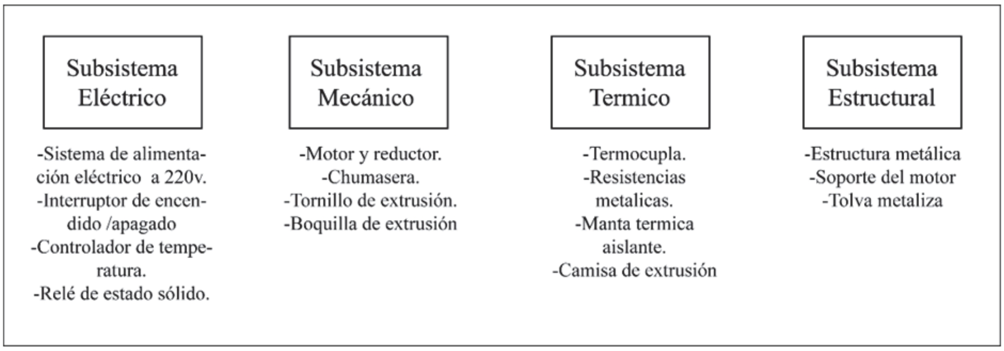

Fig.9 Subsistemas de la máquina de extrusión.

De esta manera se establecieron los requerimientos de la máquina y así mismo se adquirieron las partes según las especificaciones necesarias. Realizado dicho proceso se analizaron los elementos de la máquina en los cuales se podía intervenir de acuerdo a las apreciaciones hechas por la comunidad en espacios de participación anteriores, siendo las propuestas aplicadas a los subsistemas a través de colores que permitieran identificar de manera fácil cada uno de los elementos de la maquina (fig.10); haciendo uso de esta información, se determinó la posibilidad de usar múltiples colores para definir cada una de las partes de manera que comunicara el cuidado que se debía tener en las zonas de algunos sistemas, como lo es el subsistema térmico donde se manejan temperaturas elevadas, zonas de alimentación como la tolva en caso de atascamiento de material o mal funcionamiento del motor por posibles fallas en el sistema de alimentación eléctrica o conexiones en los componentes electrónicos.

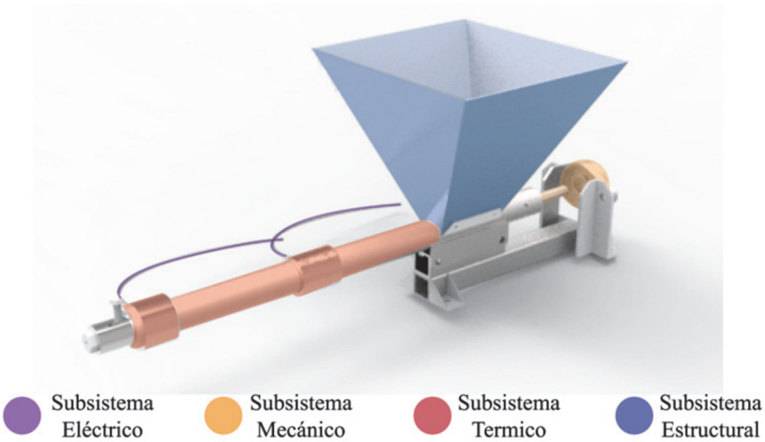

Fig.10 Identificación de los subsistemas de la máquina a partir de colores.

5. Conclusiones

Actualmente, en el mundo es necesario recapacitar sobre los problemas mayores que nos acogen, este trabajo aborda dos de ellos: la pobreza y la acumulación de residuos sólidos, en el caso particular el plástico. Ambos fenómenos desde una comunidad puntual en un país Latinoamericano, donde desde el diseño se aporta con soluciones centradas en tratamientos sistémicos y participativos, logrando soluciones impactantes en el contexto local con un alto nivel de apropiación.

El uso de metodologías participativas aumentan la receptividad y la apropiación de los proyectos realizados para las comunidades, hacer uso de ellas requiere de disposición, de trabajo en equipo y de coordinación entre la comunidad y los diseñadores. Crear sincronía en el desarrollo de estas dinámicas hace que se genere confianza en los procesos y para que los resultados puedan realmente implementarse es necesario hacer acompañamiento y seguimiento.

El uso de las metodologías sistémicas permiten un abordaje íntegro del problema, escalando la visualización del mismo y logrando impactar mucho más en las actividades de reciclaje llevadas a cabo por la comunidad.

El diseño es una profesión que permite mejorar las condiciones de vida de las personas vulnerables, este pensamiento emerge en los años 70s y hoy en día hace parte de una de las líneas de investigación y desarrollo de este siglo.

6. Agradecimientos

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Tangible interaction in museums and temporary exhibitions: embedding and embodying the intangible values of cultural heritage

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Abstract

Moving from a design perspective, the paper explores the potential of tangible interaction in giving shape to intangible contents in museums and temporary exhibitions.

Going beyond tangibility intended in the strict sense of touching assets we use here a wider interpretation of tangibility that considers touch in the sense of embodied experience. In this way we consider as tangible all those experiences that foster a strong involvement of the body when interacting with digital content. This includes objects-based and gestures-based interactions.

Tangible interaction is interpreted as a practice able to multiply the levels of the narrative, to make the visit experience memorable and to give materiality to intangible values. This approach uses tangible interaction as a way to let the audience experience practices and rituals linked to the contents and representative of the intangible values embedded in the assets.

The potential of tangible interaction to foster the intangible values of cultural heritage is discussed starting from a provisional classification of tangible interaction case studies. In particular four different categories are identified that are: smart replicas/originals, symbolic objects, codified gestures and performing gestures.

In conclusion, two possible design strategies that employ tangible interaction for enabling the experience of intangible values of cultural heritage are highlighted. These are:

Embedding meaning: it consists in creating sensorised objects that embed in themselves meanings related to intangible values of cultural heritage, and that communicate explicitly this meaning in their physicality;

Embodying meaning: it consists in integrating a meaning related to intangible values in gestures, so that intangible values are communicated implicitly in the action performed by the visitor.

Keywords: *tangible interaction, intangible values, design-driven approach, cultural heritage, exhibit design.*

1. Introduction

The application of interactive technologies to museums and temporary exhibitions has been for long time a topic of research in Interaction Design, Human-Computer Interaction (HCI) and related disciplines. One of the last trends in the field has regarded the research of technological solutions that allow for a fuller integration between the technology, the materiality of the objects and the physicality of the visit experience (Bannon et al., 2005; Petrelli et al., 2013). The importance of the physical engagement with heritage has been also highlighted by various works in museum studies (Chatterje, 2008; Pye, 2008; Dudley, 2011). This had led to the design of mixed reality installations that make use of technologies like augmented reality (e.g. Vlahakis et al., 2002), augmented virtuality (e.g. Hall et al., 2001) and tangible and embodied interaction (e.g. Rawat et al., 2005; Taylor et al., 2015) with the purpose of designing technologies that are better integrated with the real physical world and that require interactions similar to those people carry out in the real world.

This paper focuses on tangible and embodied interactive systems. Going beyond tangibility intended in the strict sense of touching assets, we use here the wider interpretation of tangibility as it has come to be considered today in the technological world (Hornecker et al., 2006). This interpretation considers as tangible all those experiences that require a strong involvement of the body when interacting with a digital system. Indeed, in tangible interaction systems the visitors interact by manipulating tangible objects or by making actions through gestures or the whole body.

In particular this paper aims to explore a peculiar aspect of tangible interaction, that is, its potential in giving physical shape to the intangible values of cultural heritage. First, the concepts of tangible and embodied interaction will be illustrated along with an overview of related works in the cultural heritage field. In order to lay the groundwork for the discussion of our research, the concept of intangible values and how it has been used in the exhibit design practice will be described. Then, a provisional categorization of different tangible interaction systems will be presented and used as a starting point to investigate and discuss the ability of tangible interaction to foster intangible values of cultural heritage. To conclude, different design strategies that make use of tangible interaction as a means to foster intangible values in cultural heritate will be highlighted and explained.

2. Tangible interaction, Embodied experience: definitions and related works in CH

Tangible interaction is a field of research inside HCI and Interaction design. Research in this field is part of a trend that became prominent in the mid 90s aiming to overcome the limits of desktop computers and virtual reality, particularly the fact that they estrange people from the real world (Shaer et al., 2010). A firm belief emerged at that time that instead of enclosing people in a virtual world, effective technical solutions should be developed to integrate digital functionalities directly in the real world (Wellner et al., 1993).

Technologies that integrate the digital and real world are globally referred to as mixed reality (Milgram et al., 1994; Coutrix et al., 2006). Augmented reality and augmented virtuality systems are examples of technologies that allow for an integration between the two dimensions – real and virtual - from a visual point of view. In the former, the real environment is augmented by overlapping digital information to it, while in the latter, direct representations of reality are inserted into virtual reality environments.

Tangible interaction emerged as a way to allow for an integration also at the level of the interaction (Ishii et al., 1997). Different disciplines have contributed to what is now known as tangible interaction, namely Computing and HCI, Product and Industrial Design and Arts. For this reason the expression *tangible* *interaction* has come to be considered today as an umbrella term encompassing “a broad range of different systems and interfaces relying on embodied interaction, tangible manipulation and physical representation (of data), embeddedness in real space and digitally augmented physical spaces” (Hornecker et al. 2006, p. 437). In other words, tangible interaction systems propose a kind of interaction with digital systems that is similar to the way people interact in the physical world, that is, through specific physical objects or through gestures and full-body movements, and not using generic devices like the mouse, the keyboard or the joystick. It is important to point out that the expression embodied interaction is sometimes used by some authors in place of tangible interaction especially when referring to the whole-body or gesture interaction (Hornecker). This expression has become popular in Human Computer Interaction after the publication of the book Where the action is (Dourish, 2001). A recent overview on the application of the notion of embodiment to HCI is provided by Marshall et al. (2013).

Mixed reality technologies have become a topic of research also in the cultural heritage field (Bannon et al., 2005) because of their potential of overcoming one of the issues regarding the application of technologies to museums and exhibitions, that is, the distraction and disengagement of visitors from the real objects and their materiality (Ciolfi, 2003; Vom Lehm et al., 2003; Stevens, 2004). Therefore, augmented reality systems started to be employed in the cultural heritage field for their ability to overlap digital information directly on the objects on display (e.g. Vlahakis et al. 2002;). Similarly, augmented virtuality systems were developed to augment virtual environments with a representation of real objects (Hall et al., 2001). In parallel with an increasing interest in the materiality of the visit experience shown in museum studies (Chatterje, 2008; Pye, 2008; Dudley, 2011), also tangible and embodied interaction systems have been applied to museums and exhibitions in their different forms. These include technological systems like tangible tabletops (Hsieh et al., 2010), smart objects (Rawat et. al, 2005), and smart physical places (Ciolfi et al., 2005). Although different in forms, all these systems require similar interaction styles: through the manipulation of specific tangible objects (object-based interaction) or through free gestures (gestures-based interaction).

Pioneering research in the field of tangible interaction applied to cultural heritage started in the early 2000s with the European SHAPE (Situating Hybrid Assemblies in Public Environment) project (Bannon et al., 2005). SHAPE aimed to develop assemblies of hybrid, mixed reality artefacts in public spaces like museums and exploratoria and to examine the behaviours of visitors in relation to them. Two public exhibitions were developed and tested through visitor studies and some guidelines for the design of similar experiences were discussed (Fraser et al., 2003; Ferris et al., 2004; Ciolfi et al., 2005).

The still on-going European meSch projects (Material EncounterS with digital Cultural Heritage) is also dealing with tangible interaction (Petrelli et al., 2013). Started in 2013, its main goal is exploring new prototypes of tangible interaction (e.g. Petrelli et al., 2014) with the aim of bridging the gap between heritage and digital content, and also creating a platform that allows cultural heritage professionals to design, make and maintain interactive artefacts. Many reflections about the application of co-design methodologies in museums have also emerged as part of meSch (Ciolfi et al., 2016). Besides the two European projects, other tangible interaction systems have emerged both from research and museum practice, so that today the field is characterized by a strong variety.

What emerges from this overview is that so far the research in the field has been mainly practical and focused on the design and evaluation of new interactive systems, while not many theoretical works have been developed. With the aim of overcoming at least partially this gap one of the authors of this paper is currently developing a PhD research. As part of this on-going research, many projects that make use of tangible interaction in the cultural heritage field have been collected for analysis. The collection includes both projects coming from research activities and design practice. The case studies that will be presented and discussed in this paper represent a subset of this collection.

3. Intangible values of Cultural Heritage in the exhibit design practice

The value of the cultural heritage is not only related to the connotative features of a specific cultural asset (such as the authenticity, the rarity, the preciousness, the manufacture, the prestige of the artist...) but also to its intangible significance (such as the circumstances of its realization, the stratification of its belonging to different owners, its symbolic and archetypal identity, its being object of traditions or oral narratives ...). This latest aspect – the intangible value – can be made evident by some of the strategies typical of the exhibit design practice. In this paper tangible interaction is interpreted as a practice able to multiply the levels of the narrative, to make the visit experience memorable and to give materiality to intangible values. This approach uses tangible interaction as a way to let the audience experience practices and rituals linked to the contents and representative of the intangible values embedded in the assets. Therefore we can identify "gesture-through" and "object-through" interactions able to enhance the visitor experience and the understanding of cultural heritage. In this context the word "mediation" represents a crucial point because it means the potential of the expository artefacts and the technological devices in multiplying the narrative of the cultural asset. Putnam - in his book Museum as medium (2009) - pinpoints some models of museums (such as Wunderkammer, Open Archive, Creator-Curator...) aimed at representing the tangible and intangible value of collections. The crucial concept that he suggests is: "replacing the value". This approach takes into account the potential of the displacement in stressing the relationship between the tangible and the intangible value of the cultural asset exhibited. "All museums through their chosen mode of displaying, using the traditional devices of plinth, vitrine and label, have the potential to transform almost anything they exhibit into a work of art." (Putnam, 2009, p. 36). On the one hand, this way of showing artefacts takes advantage of the traditional display (vitrine) in order to reinterpret the meaning, but on the other hand vitrines are the most "celebratory" expository elements that do not allow a tangible interaction with the object. Therefore this use of them is interesting because it opens to different interpretations of the perception of the cultural object and the potential to transmit its intangible value. "The vitrine reinforces the notion of the unique, untouchable and unattainable and, perhaps significantly, has its roots in the medieval church reliquary. It therefore enhances the inherent visual power of an object to catch a viewer's attention and to stimulate contemplation. The effect of placing something in a vitrine is to "museumize" it: the glass scates not just a physical barrier but establishes an "official distance" between object and viewer." (ivi). In this essay we are challenging this distance in support of a "dynamic" interface able to activate various narratives around the object exhibited.

In this perspective we can mention the installation *Object de Guerre 1-4* (2000-2006) by the young artist Joreige who focuses her works on testimonies about the war in Lebanon. She asked to each person involved to choose an object meaningful for his daily life or for its symbolic value in order to trigger the narrative about his experience. The result is a plural photograph that aims at portraying a plethora of points of view around a unique and intense topic: the memory of the war. The exhibit consists both of real objects exhibited in vitrines with label that mentions the owner's name and his video-testimony; this last one becomes active when visitors get close to the vitrines. The combination of the multimedia language and the "traditional" expository element (vitrine) appears as a contrast: on the one hand the video-testimony gets close visitors to the witness because it stages his way of speaking and his way of narrating himself through the object like a "public intimacy"; on the other hand, the vitrine isolates the object in order to celebrate, decontextualize and offer it to the glance of visitors away from its physical and emotional habitat.

The mediation between object and visitors and between object and space is an important topic able to reflect the communicative and narrative vocation of the object exhibited. Designing the cultural experience means indeed designing the relationship between visitor and cultural asset.

The concept of the "object-through" mentioned before is perceptible and understandable thanks to new communication registers and new media-relational requirements of daily objects. The *Whispering Table installation* (TheGreenEyl for the Jewish Museum in Berlin, 2009) use the "chance" of the object - an object with a high gradient of ritual such as one present in a set decked table - in order to cope with the topic of the religion by means of food and objects around it. The space is almost dark equipped with black tables on which white, lighted kitchen objects stand out. Visitors can seat down around the table, take the objects and get them close to their ears: the objects reveal some sound narratives telling the symbolic meaning of food, rituals and religious belief. The objects communicate also among them: according to their disposition on the table, they tell stories about differences and similarities among cultures. The visitor arranges the things and listens to the stories like an actor of a renewed ritual. The memory of the bodily movements in the space allows to sediment knowledge in a permanent way.

In both the examples mentioned before, the tangible interaction moves the visitor's attention from the objects exposed to their intangible value. The intangible dimension triggers three levels of cultural experience: the memory, the stratification of contents and the emotive engagement.

Tangible interaction can act as a vehicle in fostering the attention and incentive towards an emotional cultural experience. The use of multimedia and interactive technologies can generate a sort of "virtuous destabilization" that stages a new concept of diffuse performativity. As designers that give shape to the relationship between visitors and the cultural asset we have to consider a crucial issue: the risk of the excess of the semiotic saturation in the communicative interface. Therefore in designing this "mediation" we have to consider that new technologies foster the dematerialization of exhibit systems and objects (Balzola and Rosa 2011). Both interaction and interactivity are key points in designing cultural experiences: according to Balzola and Rosa (ibidem) on the one hand interaction is a direct relational form among two entities or more that communicate to each other and that transfer emotions, narratives and other information in a specific moment; on the other hand interactivity is an intercepted interaction because the process of the relation is recorded by a digital device.

In this perspective we are moving towards an aesthetics based on behaviours and not only on shapes. For this reason, the effect of the device interface through which we interact with the cultural asset is such important as the consistency of the interface itself. Sometimes if the interfaces are "natural", the audience engagement is immediate. Actions, natural for humans, like blowing, shouting, clapping, touching can become means to trigger contents in a meaningful and, at the same time, simple way.

4. Investigating the ability of tangible interaction as a means to foster intangible values of CH: a provisional categorization

Manipulating, touching, moving, rising as well as other bodily gestures are becoming common means of activating and controlling digital interpretations of the artworks as well as actions aimed to elicit the intangible values the assets bear with them.

Analysing these novel ways of interacting with cultural assets, it emerges a clear distinction between those experiences that prompt visitors to touch objects and those that rely on bodily movements without physical contact. This distinction is commonly identified in the field of Interaction Design with the two terms embedded interaction and embodied interaction, referring the first to the incorporation of sensing and computational capabilities within objects and the second to the ability of systems of reading and interpreting gestures and full-body movements.

Translating embedded interaction in CH field means enabling an object-through interaction, being the object a smart copy of the artwork in exhibit, an object imbued with symbolic meaning or a simple smart object with no reference to the assets. The manipulation is the major means of interaction with the objects that, according to what visitors do with it, activate digital interpretations.

On the other side, systems based on embodied interaction enable a gesture-through interaction, using the human body as controller of the digital world. By reading gestures or full-body movements the digital system can modify accordingly, being the gestures simple movements of a hand, codified gestures (e.g. recreating in the air those we usually do with fingers on a touch screen) or articulated movements involving all the body.

As already stated, the aim of this study is to analyse the potential of tangible interaction in eliciting the intangible values of cultural assets. That said, the simple distinction between embedded and embodied interaction seems weak in describing the relevance of the objects/gestures in relation to the values the interaction elicits. Therefore, we propose four categories for grouping experiences of tangible interaction, here listed and described in the following: (1) smart replicas/originals, (2) symbolic objects, (3) codified gestures and (4) performing gestures, being the first two mostly related to embedded interaction and the last to embodied interaction.

4.1. Smart replicas/originals

The category smart replicas/originals collects those experiences based upon technology-enhanced objects. These objects can be:

- *smart replicas*, that are copy of artworks on show, usually realized through digital manufacturing, that embed sensors;
- *smart originals*, that are original artworks and assets enhanced with digital technology and sensing capabilities.

What these categories share is a direct and easily understandable relation between the technology-enhanced objects and the artworks they are augmenting and interpreting and the possibility to touch and handle objects.

In the case of smart replicas, by manipulating real-size or scaled reproduction of artworks embedded with buttons and sensors visitors can (1) activate and control digital contents and eventually (2) experience sensorial aspects of the object such as the superficial finishing.

The copies of the untouchable original artworks are usually obtained acquiring digitally the shape of the original (typically through laser scanning or photogrammetry), modifying it in order to host sensors and controllers and then reproducing it in the most appropriate scale with 3D printers or milling machines.

An example in this sense is provided by the VIRTEX presentation method, by Daniel Pletinckx, firstly proposed at the Archaeological Museum Ename in Belgium in 2007 and then integrated in the *Keys to Rome* exhibition at the Allard Pierson Museum of Amsterdam in 2014. The first example consists of a bigger replica of a small ivory cross embedded with a gyroscope that allows users to move a 3D model by actually moving the replica, and buttons – recognisable as black dots – that trigger video contributions when activated. The same interaction model is proposed in the *Keys to Rome* exhibition that exposes two "sensorised" replicas of the Ara Pacis and of the Augusto of Prima Porta, whose originals are both in

Rome. The two monuments are proposed in a small scale in order to allow visitors to manipulate them, and set near to a plaster copy of a bass relief (Ara Pacis) and of the statue (Augusto of Prima Porta).

Smart originals, as the name suggests, propose the same interaction model but instead of using replicas, the real artworks and assets are embedded with sensors. A relevant example in the field is provided by the temporary exhibition Fragments of memory (Frammenti di memoria) by Gabriel Rapetti, that uses smart originals related to the farming. By touching the objects of the exhibition visitors can start light effects and activate stories of farmers told by the objects that evoke the atmosphere of past times in a whimsical way.

4.2. Symbolic objects

Interacting with the original artworks or with their copy is not the unique way of allowing visitors to handle smart objects and gain interpretation: smart objects can indeed be somehow related to the exhibit without having a strict formal relation with the assets on show.

We categorise these experiences as symbolic objects, since we include those projects that employ smart objects, icons or elements imbued with symbolic meaning as a vehicle to reach the intangible value of the cultural asset. In other words, the smart object itself, beyond its capability of activating contents on manipulation, becomes symbolic in itself by means of its shape and evocative power.

The exhibition *The Hague and the Atlantic Wall: War in the City of Peace* at the Museon in The Hague, realised in the context of *meSch project* (Marshall et al., 2016) provides a good example of *symbolic objects*. The exhibition focused on the impact of the construction of the Atlantic Wall on the city and its citizens and aimed to provide, starting from ten museum objects, three different points of view on the story: Dutch civilians, Dutch civil servants, and the German soldiers. Six objects have been chosen to tell the three stories in Dutch and English: a tea bag (Dutch) and a sugar packet (English) for the civilian, a travel pass (Dutch) and an armband (English) for the civil servant and finally a drinking mug (Dutch) and a dictionary (English) for the German soldier. The objects are selected by visitors at the beginning of the exhibition and, by placing them close to displays across the exhibit, video and audio contents are activated. Albeit the six smart objects are replicas of assets on display in the exhibition, they do not activate interpretive contents about themselves but become metaphor of a particular point of view. They are therefore employed for their evocative power and for their ability to represent and symbolise a character of a story.

The objects are, on the one hand, activators of stories able to contextualise the assets in the exhibit and to convey their intangible value, and on the other, are symbolic of that intangible value: by selecting one of the six objects at the beginning of the exhibition, the visitor acknowledges the meaning they embed.

4.3. Codified gestures

The category *codified gestures* collects those experiences that employ gesture-based interaction to control and activate interpretive contents about the objects on show. We include here projects that ask visitors to perform specific gestures (e.g. raising a hand, stepping, turning their head …) to access digital contents. Gesture-based interaction is usually allowed by sensors (motion and proximity sensors) or by devices able to read the movement of the full body (e.g. Microsoft Kinect).

A relevant example in the field comes from the project *Etruscanning - Digital Encounters with the Regolini-Galassi Tomb* (Ray & Vos, 2013) that allows users to explore and navigate a 3D reconstruction of an Etruscan tomb by using gestures. Explicit and codified movements, captured by sensors, let visitors virtually move within the tomb and experience a digital encounter with a highly realistic VII century B.C.

construction. In this case, the human body becomes the input device and the gestures are the inputs given to the system.

In other projects the body becomes the means to sort artworks or to emulate them: the *Gallery One* exhibition at the Cleveland Art Museum by Local Project is an example (Alexander et al., 2013). In the *Sculpture Lens* installation, the facial expressions of visitor are caught and artworks with similar expressions are shown. On the contrary, the installation *Strike the pose* asks visitors to assume the same pose of sculptures and paintings of the collection with the aim of reaching the best accuracy of the pose.

The three projects described share an instrumental use of the visitors' body since it acts as activators of contents: in the first case it is just a controller of movements in a virtual environment while, in the two others, it acquires the role of sorter and imitator.

The performed gestures are meaningful in respect to a codified list of stored poses but not necessarily add to the comprehension of the artworks or help in conveying the intangible values connected to them.

4.4. Performing gestures

The *performing gestures* category shares with the previous one the use of the body to trigger digital interpretation of artwork but it adds meaning to the gesture itself.

The category collects indeed those experiences that ask visitors to perform meaningful – in respect to the asset on show – gestures to trigger specific effects able to stage the narrative of intangible contents. The gesture itself, beyond its ability to activate digital contents, is imbued with meaning since it becomes representative and symbolic of an intangible value connected to the object on show.

This grouping recalls the classification of technology-enhanced heritage (Lupo et al., 2014) proposed with the European research project Mela* that identified as *performing heritage* those experiences that call visitors to act and perform gestures able to recall cultural practices as well as to foster the intangible values of cultural assets.

An example that well suits within this category is the *Drinking symposium* installation at the Allard Pierson Museum of Amsterdam. Born within the European research project MeSch, it is made of a wall projection representing virtual characters taking part to a drinking symposium in the Ancient Greece, a 3D printed replica of a Greek drinking bowl (kylix) and a reproduction of a Greek daybed. Both the kylix and the daybed are embedded with sensors and modify the state of the virtual world when activated. By lifting the kylix, visitors animate a virtual character that lifts his kylix, toasts and drink wine. When the bowl is put down a woman in the virtual scene plays the flute and when a visitor sits on the daybed one of the animated figures shoots a drop of wine from his cup toward a stand in the middle of the room, a game which was popular in ancient Greece (*kottabos game*).

The gesture of raising and placing back the bowl as well as that of laying on the daybed are therefore inputs for modifying the state on the virtual world but are meaningful in themselves. They make visitors experience actions that have roots in an ancient past and help them to grasp not only the aesthetic quality of the assets on show in the museum but also their intangible value such as their use and relevance within a ritual.

5. Emerging tangible-interaction oriented design strategies enabling the experience of intangible values of CH

The four categories of tangible interaction described in the previous chapter highlight different ways of providing interpretive digital contents during cultural experiences. They share the will to involve actively visitors in bodily experiences, asking them to touch and manipulate objects and to perform actions with the hands or with the full body.

Despite this common ground, we can recognize differences in the strategies employed. The first two categories collect experiences that attach great importance to the physical manipulation or instrumental use of objects, being them original assets, replicas or symbolic objects. The paradigm of interaction they refer to is therefore that of *embedded interaction.* The last two groups of projects shift instead the focus on performed gestures as triggers of interpretive contents, referring therefore to *embodied interaction.*

Dissimilarities exist also within these two homogeneous groups. Analysing each category in detail we can recognise how the first and the third category – *smart replicas/originals* (i)*, codified gestures* (iii) – employ tangible interaction as a simple trigger to activate interpretive contents. Beyond the added value of handling original objects (i) or to use the body instead of input devices (iii) the act of touching or performing gestures does not necessarily add to the communication and comprehension of the intangible values connected to the assets on show. The design action simply attaches to tangible interaction the role of trigger: the meaning is entrusted to the interpretive contents activated by the interaction, being it embedded or embodied interaction.

The strategy is different for the second and fourth categories – *symbolic objects* (ii)*, performing gestures* (iv) – which attach meaning (related to the intangible values of the objects on show) to the object to be manipulated and to the gestures. The projects encompassed in these groupings employ tangible interaction not only to activate contents related to the intangible values, but also *embed* (ii) and *embody* (iv) *meaning* respectively in the sensorised object and in the gesture. The design action attaches meaning and includes the intangible values to be communicated directly into the object and in the gesture, and therefore acts as a translator of meaning.

We can therefore highlight two design strategies of employment of tangible interaction for enabling the experience the intangible values of Cultural Heritage: *embedding meaning* and *embodying meaning.*

The first strategy, *embedding meaning*, integrates explicitly the meaning into sensorised objects and focuses on their physicality. The object itself, for its significance in relation to the context in which it is employed, embeds directly and overtly meaning in respect to intangible values. Beyond its interactivity, it becomes a *representative object*, able to communicate in itself the intangible values it embeds.

The second strategy, *embodying meaning,* integrates implicitly the meaning in the gesture, focusing therefore on the act rather than on the object. The performed gesture, for its relevance to intangible values connected to the cultural assets, acquires meaning in itself. By performing a gesture, such as miming a ritual gesture in the *Drinking symposium*, visitors implicitly understand an intangible value of an asset, the value of use and its symbolism in this specific case.

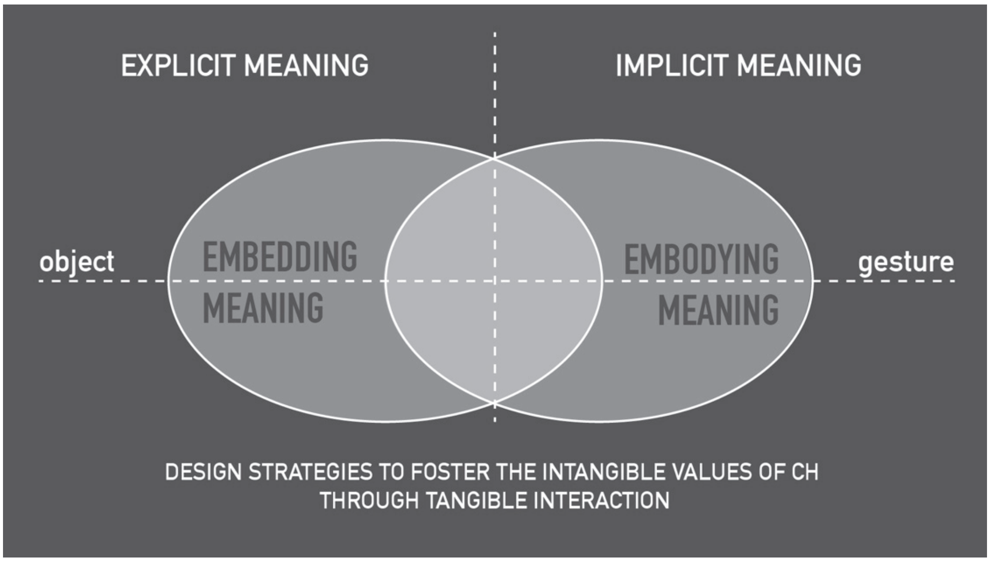

Fig. 1 Schema summarising the two design strategies to foster knowledge on the intangible values of CH through tangible interaction

The two strategies here highlighted are necessarily permeable and can coexist within the same experience: the *Drinking symposium* cited above is a clear example. The focus is indeed on the gesture of raising the bowl and sitting on the daybed but the two objects themselves embed meaning, being them replicas of assets exposed in the museum. A very different result would be obtained changing them with a contemporary glass and bench.

6. Conclusions

In this paper tangible interaction has been analysed from a peculiar perspective, that is, from the point of view of its ability to enable the experience of intangible values in cultural heritage. Starting from a collection of case studies, different categories of tangible interaction have been identified and then discussed in relation to their ability to foster intangible values. In addition, two design strategies that allow the achievement of this goal have been highlighted. These strategies, that can be referred to as *embedding meaning* and *embodying meaning,* differ for the way the meaning related to an intangible value is conveyed (i.e. emphasis on the object or on the gesture, explicit or implicit integration of meaning). Through this paper we have tried to provide a theoretical contribution to the understanding of the potentials of tangible interaction in enabling certain kinds of experience in cultural heritage. In doing so, we have tried to shift the focus from the interaction through the technology in itself to the results in terms of the experience enabled by certain design choices (Hassenzahl et al., 2013).

The theoretical contribution provided by this paper, beyond providing a conceptualization of a specific aspect of the use of tangible interaction, could be useful for designers and cultural heritage professionals. In particular, it can support them in the choice of certain design solutions according to the effects they want to obtain or the type of intangible value they want to communicate.

However, it has to be acknowledged that this work represents just a preliminary theoretical contribution to the field. Indeed, so far, the research in the field of tangible interaction in cultural heritage has been mainly characterized by the creation and evaluation of practical projects, while not many theoretical contributions have been provided. This makes the field very new, complex, and open to different kinds of explorations. Therefore, this paper is presented as a starting point for a theoretical reflection that will possibly be developed further in future works.

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Design de produtos para homenagear pessoas *post mortem*

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Resumo

As unidades cemiteriais são locais de práticas sociais do quotidiano e de culto, sendo o tumulo o lugar onde a saudade pode ser exteriorizada e a memória da pessoa falecida reverenciada. Nas sociedades ocidentais podemos encontrar uma categoria de artefactos que pretendem evocar a memória ou homenagear pessoas falecidas. Neste paper tomam-se como referência três exemplos de produtos que possibilitaram uma reflexão sobre os conceitos que deram origem às suas formas, e que se arrisca a enquadrá-las numa nova "cultura material", no sentido em que poderão ter criado uma rotura com o sistema tradicional de códigos e padrões partilhados pelas sociedades, e as suas manifestações, no que respeita às criações físicas desta categoria de produtos. Este trabalho oferece uma reflexão sobre o Design de Produtos. O que provavelmente o torna particular é o campo onde ele se situa: o design de produtos em memória de alguém post mortem. Geralmente feito de rocha granítica ou mármore, os produtos tradicionais possuem a forma de placa ou tabuleta, livro aberto ou folha enrolada. Sobre uma das faces possuem uma fotografia da pessoa que pretendem homenagear e inscrições. O pensamento de design inerente a este trabalho colocou de um lado o intrincado conjunto de emoções que este tipo de produto pode gerar, e do outro as componentes à partida mais acessíveis e que dizem respeito à forma, função e interações do objeto com os utilizadores e com os ambientes de uso. Na definição do problema considerou-se como requisitos obrigatórios: a diferenciação, o valor acrescentado e a durabilidade como principais objetivos. Os dois primeiros deveriam manifestar-se nas várias componentes/atributos do produto. A durabilidade estética e material/estrutural do produto implicava necessariamente a introdução de termos qualificativos e pesos quantitativos, que condicionam positivamente a geração e avaliação de conceitos tendo por base o conjunto de 10 Princípios para o Projeto que originaram uma Matriz Operativa enquanto instrumento de auxílio à conceção de produtos. A definição concreta de um público-alvo foi igualmente importante. Nesta fase, a perspetiva da psicologia e da sociologia como disciplinas com aptidão particular para compreender os indivíduos e os fenómenos sociais, respetivamente, foi crucial. Conclui-se que o projeto de um produto para homenagear uma pessoa post mortem, deve abandonar os hábitos e costumes mais tradicionais para se focar na identificação de novos públicos. Ainda que no presente momento se possam considerar residuais, acredita-se que no futuro poderão crescer, bem como o seu interesse por este tipo de produtos.

***Palavras chave:**: design, memória, homenagem, metodologia, durabilidade.*

Abstract

Cemeteries are places of daily social practices and worship, with the grave being the place where loss can be expressed externally and the deceased person commemorated. In Western society we find a series of artefacts that aim to evoke the memory or pay respect to the deceased. This paper takes three examples of products as references, which allowed reflection on the concepts originating their forms, and dares to set them in a new "material culture". In this sense, they could have created a break with the traditional system of codes and standards shared by societies, and their demonstrations, regarding the physical creations of this product category. This work provides a reflection on the Design of Products in a deceased person's memory. Generally made of granite or marble, traditional products take the form of a plaque or tablet, open book or scroll. On one side there is a photograph of the deceased person and inscriptions. The thinking inherent in the design of this work placed on one hand the confused set of emotions this type of product can create, and on the other the elements apparently more accessible at the outset concerning the form, function and interactions of the object with users and environments of use. Definition of the problem considered the requirements of: differentiation, added value and durability as the principal objectives. The first two should be visible in the product's various components/attributes. The product's aesthetic and material/structural durability necessarily implied introducing qualificative terms and quantitative weights, with a positive effect on the generation and evaluation of concepts based on the set of 10 Principles for the Project, which gave rise to an Operative Matrix as an instrument aiding product conception. Specific definition of a target public was also important. At this stage, the perspective of psychology and sociology as disciplines particularly suited to understanding respectively individuals and social phenomena was crucial. It is concluded that the project of a product to commemorate a deceased person should abandon the most traditional habits and customs to focus on identification of new publics. Although these may be considered insignificant at the present time, they may well grow in the future, as well as their interest in this type of product..

Keywords:: *design, memory, tribute, methodology, durability.*

1. Introdução

1.1. A consciência da finitude humana e o local de culto

A morte e o morrer levanta um conjunto de questões que geralmente se debatem no seio das áreas da psicologia e antropologia. O tema não é no entanto exclusivo de profissionais ligados às ciências sociais. Poetas, cineastas, pintores entre outros, sempre se sentiram inspirados pela morte e pelo que pode representar: perda, separação, sofrimento, rutura, desintegração, mas também fascínio, mistério ou alívio. Refletir sobre este tema poderá representar um estado no qual o sujeito se conhece enquanto tal, e se distingue das outras espécies. "O homem é um ser mortal, cuja principal característica é a consciência da sua finitude (...)"(Kovács, 1992, p.2). Segundo vários autores, a morte faz parte do desenvolvimento humano desde a mais tenra idade. Na adolescência e na idade adulta, a interpretação que se faz, e o significado que adquire, vai se alterando, atingindo uma maior consciência da sua inevitabilidade em idades mais velhas. Segundo Kovács, (1992, p.9) pode-se preparar para morte, vivendo intensamente; obviamente não estamos a falar de negar a morte,(...), mas de conviver com ela em busca do seu significado.

A dor causada pela morte ou pela perda de alguém dá origem a um processo de luto. Segundo Morin (1970, cit. in Kovács, 1992, p.29) é nas atitudes e crenças diante da morte que o homem exprime o que a vida tem de mais fundamental. (...) Para a espécie humana, a morte está presente durante toda a vida e faz-se acompanhar de rituais. Na idade média as igrejas eram o local de sepultura. Posteriormente, o enterro nas igrejas foi destinado unicamente a pessoas de estatuto social elevado, sendo que o lugar mais valorizado ficava proximo dos altares. No exterior e em areas circundantes ao edificio eram colocadas as pessoas de classes sociais mais desfavorecidas. Com o crescimento das cidades e da população, e por razões de salubridade, estes locais de culto passaram a ser deslocados para fora das cidades. Atualmente encontram-se unidades cemiteriais construidas em parques, tornando-se além de locais de enterro, também lugares de passeio, descanso e oração. Os tumulos assinalam o lugar onde fica o corpo e podem exibir recordações sobre a imagem física da pessoa, que pode ser representada por uma escultura e, mais recentemente, por meio de fotos. Esses elementos fisicos realçam a importância que as pessoas dão à morte e não deixam de ser formas de homenagem e exaltação da memória. Segundo Freire (2005, p.65) “a freqüência das visitas dá-se primordialmente pela necessidade de cultuar o parente que ali está sepultado - fato proveniente da sensibilidade e da individualidade imbuídos no processo de luto no século XX.”

1.2 Definição do problema de design

Tipicamente este processo de design começou com a definição do problema (Boeijen et.al., 2014; Morris, 2009). O problema definiu-se como o design de novos produtos de homenagem ou em memória de alguém *post mortem*, em três vetores: diferenciação, valor acrescentado e durabilidade. O valor acrescentado deveria manifestar-se nas várias componentes/atributos do produto. A durabilidade estética e material/estrutural do produto implicou a introdução de 10 Princípios para o Projeto que originaram uma Matriz Operativa enquanto instrumento de auxílio à conceção de produtos e que remete para a geração e avaliação de conceitos.

A definição concreta de um público-alvo foi nesta fase igualmente importante. O projeto de um novo produto na categoria em que este se insere, deveria abandonar um setor da sociedade de hábitos e costumes mais tradicionais para se focar na identificação de novos públicos, nos seus desejos e nas suas expetativas, e como esses fatores podem manifestar-se nos seus comportamentos.

A problemática mais dominante no âmbito desta investigação, objetivou verificar a capacidade de se gerar produtos que se mantenham em pleno funcionamento pelo menos durante tanto tempo quanto a sua durabilidade material, contribuindo assim para a redução da necessidade de consumo por mudanças de gosto, por exemplo, e para sustentabilidade ambiental.

Para a análise do problema utilizou-se a checklist WWWWWH: Who, What, Where, When, Why, and How (O quê, Quem, Quando, Onde, Como, e Porquê) adaptada de Boeijen, et al. (2014, p. 125).

2. Análise do problema

2.1 O que é o produto

O produto pertence à tipologia de objetos que pretendem lembrar uma pessoa *post mortem* e que contêm uma inscrição, ou epitáfio, em homenagem e em memória de alguém falecido, geralmente colocados sobre a sua campa ou tumulo. Este produto insere-se numa categoria de artefactos que se encontram em recintos exteriores designados de unidades cemiteriais. Geralmente feito de rocha granítica ou mármore, possuem a forma de placa ou tabuleta, livro aberto ou folha enrolada. Sobre uma das faces possuem uma fotografia da pessoa que pretendem homenagear e inscrições (nome, data de nascimento/falecimento) ou frases de familiares, amigos ou colegas, gravados ou em alto-relevo (**¡Error! No se encuentra el origen de la referencia.**).

Fig. 1 Exemplo de placa/tabuleta de mármore com inscrição gravada e fotografia (Propriedade e foto do autor).

Pelo que foi possível observar empiricamente em diferentes unidades cemiteriais nacionais, este tipo de produto preenche massivamente esses recintos. Este facto levou a que se procurasse identificar as razões para uma tão grande uniformização. Pelas visitas efetuadas a lojas da especialidade, concluiu-se que a oferta deste tipo de produtos em Portugal resume-se a variantes de forma, cor, textura ou dimensão que se podem considerar muito pouco diferenciadoras. A procura por produtos de valor acrescentado (estética, funcionalidade, versatilidade, etc.), segundo alguns comerciantes auscultados é muito residual, não havendo por isso interesse em novos modelos. Julga-se por este facto que quaisquer propostas de novos produtos, não se destinam a preencher imediatamente uma lacuna de mercado, mas poderão estar a antecipar futuras necessidades.

2.2 Quem é o público-alvo

Neste ponto, a experiência do autor serviu de base para esboçar a caracterização do público-alvo tradicional e de um novo que poderá estar a surgir e vir a constituir-se como um *nicho de mercado* na terminologia do Marketing (Lindon, et al., 2011). Ao longo de 24 meses foi possível observar empiricamente em unidades cemiteriais um conjunto de pessoas com características e comportamentos muito semelhantes. Maioritariamente adultos séniores, do sexo feminino, e aparentemente pertencentes a uma classe social média, esta massa de pessoas poderá representar a tradição de usos e costumes neste campo da vida social e cultural de um povo, cujos produtos participantes nestes rituais parecem cumprir sem questionamento a sua função. Prevê-se no entanto, que uma nova geração de frequentadores destes espaços com diferentes necessidades, exigências e perspetivas, possa exigir mais dos artefactos quanto, por exemplo, à sua eficiência ou representatividade da pessoa homenageada.

Tendo presente que o sucesso de um produto depende da sua aceitação por parte dos potenciais utilizadores, e que as alternativas geradas pelo designer dependem em grande parte da clara definição de um público-alvo (e das suas necessidades reais), utilizou-se neste passo a técnica “Personas” (Martin e Hanington, 2012; Rodgers e Milton, 2011). Para isso caracterizou-se um utilizador arquétipo (*Fig. 2*) e se descreve a seguir, no que respeita a critérios demográficos, geográficos, sociais, pessoais e comportamentais.

Fig. 2 – Representante fictícia do público-alvo (Foto Hill Street Studios/Gettyimages)

Isabel, de 48 anos, é licenciada em enfermagem mas exerce a sua atividade profissional como professora. A longa carreira no ensino trouxe-lhe um estatuto que lhe permite participar ativamente nas decisões da sua organização, o que abona em favor da sua pro-atividade e motivação. Casada, mãe de dois filhos, reside e trabalha numa cidade portuguesa de média dimensão no interior do país. Grande parte do seu tempo semanal é passado com os seus alunos quer em sala de aula quer em sessões de tutoria e orientação. Profissionalmente exigente, aposta na formação continua que considera ser indispensável para o sucesso profissional. O seu carácter extrovertido aliado a uma vontade grande em ajudar os outros fá-la passar algum do seu tempo livre em trabalho de voluntariado. Uma situação económica estável permite-lhe deter bens próprios que considera de qualidade e viajar em família duas vezes por ano. Os seus gostos passam pela leitura e jardinagem. As suas preocupações centram-se no sucesso escolar e no futuro dos seus filhos. Tem uma atenção especial e diária aos pais e sogro. Uma vez por semana, desloca-se à unidade cemiterial local para homenagear a sua sogra já falecida e com quem mantinha uma relação de mãe e filha.

2.3. Quando é usado o produto

Da observação e questionamento efetuado pode-se concluir que o uso ou contacto com este tipo de produtos acontece geralmente em períodos de tempo semanais e pontualmente em ocasiões especiais de aniversários ou outras como o Dia de Finados

2.4. Onde é usado o produto?

O produto destina-se a ser usado no exterior em unidades cemiteriais (UC) públicas ou privadas. Em muitos países Ocidentais, as UC, enquadradas na zona verde urbana, não são apenas locais para inumar os falecidos mas também locais de lembrança e lazer. Algumas UC tornaram-se pontos de interesse turístico, como é o caso do Cemitério Nacional de Arlington e Cemitério de Nova Orleães, nos EUA, o Cemitério de Woodland, em Estocolmo, e o Cemitério de Montparnasse, em Paris. (Huang cit. por Oliveira, 2009)

A importância histórica ou artística de determinadas UC de vários países europeus, levaram à criação da *Association of Significant Cemeteries of Europe* (ASCE) que tem por objectivo promover estes espaços, públicos e privados. Um exemplo das actividades promovidas pela ASCE é a "Semana Europeia para Descobrir os Cemitérios" na qual se realizam eventos para atrair a população a estes recintos. Relativamente a Portugal, apenas o Cemitério do Prado do Repouso e o Cemitério de Agramonte, ambos no distrito do Porto, pertencem a esta associação.

Segundo Oliveira (2009) as UC podem ser de quatro tipos: unidade cemiterial *tradicional* (convencional, clássica ou horizontal), compostas por alamedas pavimentadas que contêm sepulturas, jazigos, crucifixos, imagens, monumentos fúnebres e pouca ou nenhuma arborização; unidade cemiterial tipo *parque* (ou jardim), formadas por gavetas no solo cobertas por relvado e árvores e isentos de construções tumulares; unidade cemiterial *vertical*, conjunto edificado de gavetas individuais e contíguas construídas acima do nível do solo, sem contacto com este; unidade cemiterial *natural*, que oferece um ambiente rural sem lápides, vedações nem portões. Em alguns países europeus estes recintos parecem apresentar-se com diferentes configurações e composições como é possível verificar por fotografias desses locais. Em cidades de países do norte (Alemanha, Finlândia, Suécia ou Polónia) são possíveis de observar as UC do tipo parque ou jardim (*Fig. 3*). Espaços relvados e arborizados são preenchidos de lápides aparentemente em granito ou outras rochas enterradas e envoltas por flores plantadas. Esta aproximação à natureza instituída pelos cemitérios-jardim, é segundo Freire (2005, p. 35) com o intuito de estimular as visitas.

Fig. 3 Unidade cemiterial de Hietaniemi em Helsínquia (Finlândia/Foto http://www.traveladventures.org/)

Em países do sul da Europa (Grécia, Itália, Espanha ou Portugal) as UC implantadas nas cidades capitais que se visualizaram, apresentam recintos mais tradicionais preenchidos de campas (*Fig. 4*).

Fig. 4 Unidade cemiterial de la Almudena em Madrid, Espanha (Foto Luis García/ Wikimedia Commons)

Em Portugal, as UC, pelo menos as mais tradicionais, seguem esta ultima tipologia. Os recintos são ocupados por campas de pedra granítica ou mármore sobre as quais estão colocadas lápides ou placas de várias formas com inscrição e uma fotografia, jarras, floreiras lanternas, velas ou outros artefactos simbólicos (*Fig. 5*)

Fig. 5 Unidade cemiterial paroquial de Paranhos, Porto, Portugal (Foto autor)

De assinalar neste tipo de UC as diferenças sociais que se podem constatar de acordo com a imponência dos túmulos ou alterações arquitetónicas (Freire, 2005, p. 34).

2.5 Como é usado o produto?

Este ponto remete-nos para as funções do produto e para a relação que estabelece com os seus utilizadores. Na prática esta peça identifica e homenageia a pessoa falecida que representa. A forma como tradicionalmente o faz foi explicada na resposta à questão "O que é o produto?" O utilizador limita-se à sua visualização e inspeção cuja avaliação poderá originar ações de manutenção (limpeza ou restauro, p. ex.) e embelezamento (colocação de flores)

2.6 Porque é usado o produto?

A tradição, ou seja, a transmissão de práticas de geração em geração, poderá justificar plenamente a manutenção e a continuidade da existência de produtos deste tipo. Recordar e homenagear pessoas defuntas parece ser um conceito e uma prática transversal a vários estratos sociais ainda que com diferentes necessidades e expetativas. Para a avaliação da necessidade, valemo-nos da constatação da contínua procura/oferta deste tipo de produtos em lojas da especialidade e da sua manutenção nos locais de uso. Neste sentido, parece assim justificável que este tipo de artefacto seja ele próprio objeto de questionamento tendo em vista o surgimento de novos produtos mais adequados aos requisitos de um público-alvo mais exigente, no que respeita às funções estética, simbólica ou prática.

3. Pesquisa e Investigação

A pesquisa dirigiu-se para as componentes formais, funcionais e materiais que constituem um produto deste tipo. Ainda que se possa considerar insípida por falta de referências nesta vertente do design de produto, pretende-se neste ponto apresentar alguns trabalhos que influenciaram as propostas de conceção de novos produtos. Esta fase serviu para tentar encontrar justificações para a manutenção de formas tão semelhantes nos produtos existentes e conhecidos, bem como a refletir sobre a possibilidade de emprego de novos materiais e tecnologias na produção de novas soluções.

O facto de tradicionalmente a indústria nacional transformadora de rochas ornamentais como o granito, o mármore ou o calcário especializarem-se na produção maioritária de produtos (construção civil e outros) a partir de chapas destas matérias-primas, poderá justificar a forma de placa (quadrada ou retangular) que a maioria dos produtos observados apresenta. Esta limitação começa agora a poder ser ultrapassada com o recurso a tecnologias mais versáteis como a CNC (fresagem, torneamento ou corte) instalada em algumas industrias do setor.

3.1 Material e forma

Na procura por um material que conferisse ao produto, o peso, a dureza e a resistência necessárias, quer no seu manuseamento quer a variações ambientais (temperatura, luz e humidade), o cimento apresentou-se como uma matéria-prima com as características desejáveis. O baixo custo/unidade (±1,00 euro/Kg), a disponibilidade no mercado, a acessibilidade, a possibilidade de se trabalhar manualmente e por molde, a cor e os acabamentos superficiais, foram igualmente fatores decisivos para a seleção deste material como potencialmente alternativo à utilização de rochas ornamentais. O seu caráter versátil aliado à contemporaneidade da sua aparência final e flexibilidade de utilização, quer na sua forma mais simples quer em combinação com outros materiais, torna-o um material apetecível para o design de produtos. Com a mistura de aditivos, aglutinantes, adjuvantes ou pigmentos, o cimento adquire outras propriedades mecânicas ou estéticas que poderão ser exploradas.

3.1.1. As formas de(o) cimento

De um número considerável de produtos que foi possível conhecer, selecionou-se uma amostra que se julga ser representativa das potencialidades e versatilidade de aplicação deste material e algumas variantes. A *Fig. 6* mostram um par de bancos feitos em cimento e ferro, e alguns dos materiais utilizados na sua produção, respetivamente. Os bancos são definidos por uma estrutura de suporte de três varões de ferro dobrados (pernas), combinados com uma base de cimento (assento) moldada a partir de um recipiente de plástico vazio reutilizado.

Fig. 6 Bancos HRS feitos de cimento e ferro reaproveitado de obras de construção civil. Moldes em plástico (Design e produção de Sebastían Hoepner, Javier Rojas e Federico Sartor, 2013/Foto HRS)

Esta aparente simplicidade da conformação do cimento permitiu antecipar alguma facilidade em trabalhar artesanalmente com este material.

A designer Mikaela Dörfel utilizou o cimento para a produção de um produto com dupla função: banco e mesa de apoio (Fig. 7). Neste exemplo, de aspeto relativamente mais leve e elegante, a conformação do material parece garantir a segurança e a resistência necessárias quando utlizados, enquanto a sua boa aparência e acabamento superficiais poderão levar ao seu uso também em espaços interiores, segundo opinião da autora.

Fig. 7 – Banco e mesa de apoio "U-STOOL" (Design de Mikaela Dörfel/IntoConcrete, 2014)

A *Fig. 8* mostra um produto à escala da mão e por isso, acredita-se, facilmente manuseável no que respeita à sua dimensão e peso. É possível verificar pela forma e aparência deste produto a versatilidade do material cujo bom nível de acabamento formal e superficial é geralmente facilita o seu manuseamento.

Fig. 8 Contentor térmico para garrafas (Design de Fran Corvi, PPi3D Studio/IntoConcrete, 2013)

Outro exemplo onde se pode verificar o rigor dimensional e formal que se pode obter com o cimento é na Lapiseira "Contour" (*Fig. 9*). Neste objeto que combina cimento com aço inoxidável, a reduzida dimensão parece não ter impedido a aparente qualidade do produto final. O escurecimento e o desgaste (suavização da forma) do corpo da lapiseira provocados pelo uso frequente do objeto em contato com a mão, são fatores que os autores advogam fazerem parte do conceito do produto. Desta forma intencional cada lapiseira assume as características do estilo de vida do proprietário ao longo do tempo.

Fig. 9 Lapiseira "Contour" com invólucro de betão (Design de 22 Design Studio, 2012)

Como referido anteriormente, a cor pode ser um contributo importante na apreciação do produto de cimento como um artefacto contemporâneo. Para além das cores naturais (branco e cinza), a adição de pigmentos permite um conjunto de outras cores que poderão ser consideradas no design e produção de produtos em cimento (*Fig. 10*).

Fig. 10 – Amostras de cimento nas cores naturais e com adição de pigmentos (22 Design Studio, 2014)

3.2 Memória e homenagem

Nas sociedades ocidentais podemos encontrar uma categoria de artefactos que pretendem evocar a memória ou homenagear pessoas falecidas. Não se pretende neste ponto apresentar a diversidade de produtos que se conhecem, mas antes servir para equacionar caminhos criativos para o processo de pensar e desenhar este tipo produtos. Para isso escolheram-se três exemplos de produtos que possibilitaram uma reflexão sobre os conceitos que deram origem às suas formas, e que se arrisca a enquadrá-las numa nova "cultura material", no sentido em que poderão ter criado um rotura com o sistema tradicional de códigos e padrões partilhados pelas sociedades, e as suas manifestações, no que repeita às criações físicas desta categoria de produtos.

Em 2009, os designers Ákos Klimes e Peter Kucsera apresentaram uma pedra tumular feita de cimento repelente à água a que chamaram "SeeYou" (Figura 12). Sobre a face superior da base paralelepipédica, surge uma referência à forma humana e à cruz, simbolo universal da crença e culto religioso. Klimes e Kucsera definem-na como "...uma interpretação contemporânea de significados tradicionais e valores intemporais."

Fig. 11 Pedra tumular "Seeyou" (Design de Ákos Klimes e Péter Kucsera/IVANKA, 2009, Foto Katalin Ivanka)

A revista de arquitetura e design "Ottagono" referiu-se à obra como aquela que "…representa uma forma criativa de interação entre aqueles que vão e aqueles deixados para trás, entre os seres humanos e as forças da natureza." (Ottagono, 2009). A água é outro elemento que participa no conceito do produto. O espelho que se cria, reflete o mundo exterior ou as pessoas que se debruçam sobre a campa. Depreende-se que este efeito possa originar várias interpretações à volta do tema da vida e da morte. Outros elementos como folhas, neve ou flores próprios das estações do ano, assinalam a passagem do tempo e ajudam a harmonizar a peça com o ambiente exterior. Sobre este aspetos em particular os autores do projeto afirmam: "Fenómenos e elementos da natureza são convidados a envolverem-se e criarem uma interação. A aparência do objeto muda com as estações do ano e o tempo." (Seeyou project, 2013). A *Fig. 12* mostra a peça exposta em ambiente de inverno. A neve que preenche a concavidade realça a forma humana a cruz que pretende representar.

Fig. 12 Pedra tumular "Seeyou" (Design de Ákos Klimes e Péter Kucsera/IVANKA, 2009, Foto Katalin Ivanka)

Contrariamente à intenção de reconhecimento universal que o projeto anterior denuncia, o memorial ao designer gráfico norte-americano Paul Rand (1914 - 1996), conhecido pelo desenho de marcas que criou como a IBM, UPS e ABC, exprime na sua forma aspetos ligados à obra e à vida profissional do autor. Antes de morrer, Paul Rand pediu ao designer gráfico suíço Fred Troller para lhe desenhar uma lápide que superasse os clichés habituais. O monumento resultante deste pedido é composto por dois cubos sobrepostos (*Fig. 13*). No cubo superior em mármore, rodado sobre o seu eixo, foi gravado o nome do homenageado e as datas de nacimento e falecimento num tipo de letra sem serifa "evocativa da sensibilidade modernista" do designer homenageado. O cubo inferior apresenta uma inscrição em Hebraico lembrando a tradição judaica do designer. "O memorial destaca-se entre fileiras de lápides tradicionais no cemitério Connecticut pela sua económica beleza, subtil engenho e tipografia elegante." (Heller, 2008, p. 92). O desenho deste memorial parece fazer justiça à ideia de Paul Rand proferiu publicamente no MIT Media Lab alguns dias antes de falecer de que o "Design is so simple, that's why it is so complicated."

Fig. 13 - Memorial a Paul Rand (Design de Fred Troller, 1996)

O terceiro caso faz uso de tecnologias de comunicação recentes e de comportamentos sociais que parecem cada vez mais comuns: gerar e guardar elementos da memória pessoal ou coletiva em formato digital. Hyuna Shin aproveita o facto de as pessoas possuírem cada vez mais dados digitais sobre a sua vida, como fotografias, vídeos ou blogs para criar um produto que não é mais que uma interface que liga o visitante à pessoa homenageada através de um código gráfico QR (Quick Response) gravado numa face de um cubo de rocha (*Fig. 14*).

Fig. 14 - Lapide de família "cloud" com código QR inscrito (Design Hyuna Shin/Designboom, 2013)

Este código de barras bidimensional, gerado a partir de um software próprio, é depois capturado pela camara fotográfica de um smartphone que através de uma aplicação o converte automaticamente num endereço URL dirigindo o utilizador para um sítio na Internet criado para o efeito. Este sítio permite assim o armazenamento selecionado de elementos de memória com o objetivo de constituir um acervo digital representativo da época em que a pessoa viveu. Segundo a autora, este sítio poderia conter os dados de outros membros da família que faleceram antes, para que as gerações futuras pudessem visualizar momentos das suas vidas, contribuído para o conhecimento da história da família.

4. Geração de ideias e conceitos

O processo sistemático de geração de ideias resultou num número de três propostas. Nesta fase, esteve presente todo o conhecimento obtido nas fases imediatamente anteriores, e que ajudaram a caracterizar o sistema utilizador-produto-ambiente, e um conjunto de 10 principios para o projeto (Matriz Operativa) que conduziram o processo de elaboração de conceitos de produto: Simples, Inovador, Ergonómico, Elegante, Funcional, Robusto, Acessível, Variável, Versátil, Combinado. Para além desta base operativa, foram ainda equacionadas 3 ideias chave que resultam de uma reflexão crítica sobre o conjunto maioritário de artefactos existentes:

1. *Desenvolvimento de uma peça multifuncional com a integração simultânea das funções de jarra, vaso ou floreira, suporte para a inscrição, e moldura para fotografia;*
2. *Redução da quantidade de elementos naturais (p. ex. flores) habitualmente usados no ritual de visitas periódicas;*
3. *Utilização de plantas espontâneas e sazonais em alternativa às flores de viveiro (redução de custos).*

4.1 Conceito de Produto 1

O primeiro conceito resultou da combinação material de 3 peças, sendo constituída por um corpo cilíndrico com um furo escalonado não passante onde é inserido um tronco de cilindro com aplicação de uma fotografia na base superior inclinada face ao plano de base. A moldura é fechada por uma tampa em vidro transparente embutida até à face superior do corpo. A peça prevê a colocação no seu interior de uma quantidade máxima de pétalas e folhas de uma rosa (por exemplo) e inscrições na sua face cilíndrica. A figura 15 mostra o modelo da peça em cartão e acetato com flores e fotografia.

Fig. 15 – Conceito 1

4.2 Conceito de Produto 2

Esta peça é composta por dois elementos: um prato circular e um corpo cónico que assenta pela sua base inferior no interior do prato. O corpo principal é trespassado por um furo conduzido por um eixo inclinado face à base de suporte. No interior da base superior do tronco cónico está embutida uma fotografia tapada por um vidro de diâmetro igual à base. A figura 16 mostra os modelos em poliestireno das peças deste segundo conceito.

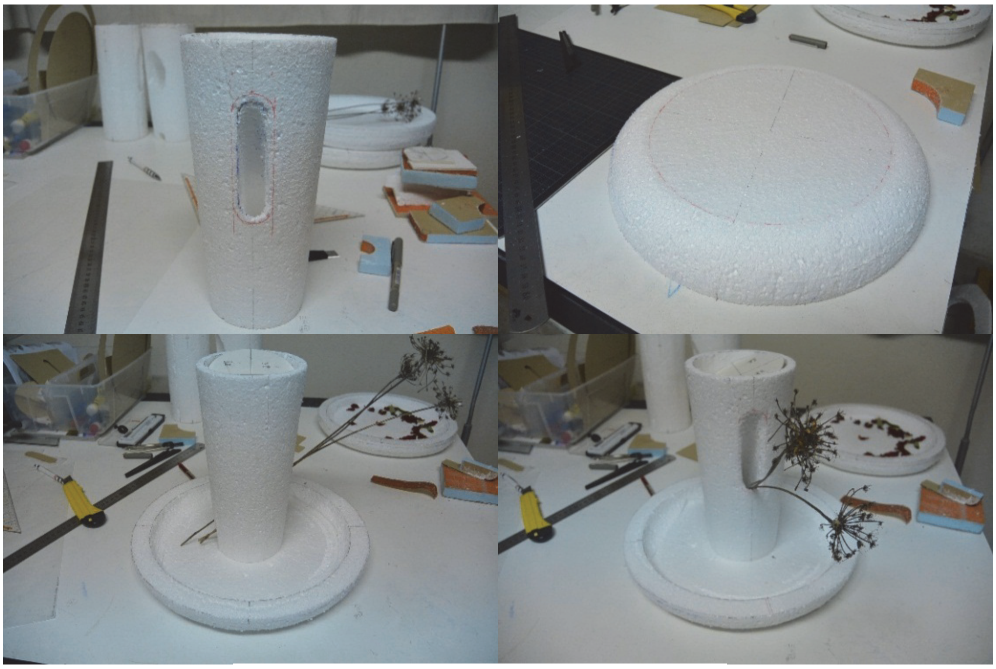

Fig. 16 – Conceito 2

4.3 Conceito de produto 3

Este conceito segue as ideias-chave equacionadas no início do projeto e propõe a multifuncionalidade. Duas peças cilíndricas "fundem-se" numa só com a sobreposição da de menor diâmetro (moldura) no interior da maior em posição concêntrica. Apesar de idêntica no seu conceito, esta proposta põe em evidência o efeito estético que se pode criar com diferentes cores e formas de plantas. Estas plantas cortadas a meia haste são colocadas no sulco inundado de água que circunda a peça e a moldura. A fotografia assenta num plano inclinado para que se apresente de frente para o utilizador, facilitando a sua visualização em ambiente de uso. A figura 17 mostra o modelo em poliestireno das peças que formam este terceiro conceito.

Avaliação dos conceitos (uso de Matriz Operativa)

Fig. 17 – Conceito 3

Para este momento utilizou-se a Matriz Operativa para a comparação dos conceitos gerados (C1; C2; C3) e sua avaliação, tendo servido como instrumento de apoio à decisão (Figura 18). A avaliação respeita os 10 princípios para o projeto e respetivos atributos que lhes foram associados. Cada item é avaliado de 1 a 3 atribuindo-se o seguinte signifi-cado: 0 - não se verifica; 1 – Não satisfaz; 2 – Satisfaz; 3 – Satisfaz totalmente. Os resultados quantitativos são mostrados. Mantendo-se a hierarquia determinada, o valor obtido por cada conceito resulta do somatório dos parciais obtidos em cada um desses princípios depois de aplicada a ponderação. Assim o adjetivo "Simples" vale 100% enquanto que o adjetivo "Combinado" pesa 10% para a pontuação final por ser o menos importante dos 10. O Conceito 1 foi o que obteve maior pontuação (73,3) e o Conceito 2 a menor (57,2). O resultado obtido pelo Conceito 3 (66,5) aproxima-o do primeiro. Depreende-se, por ter semelhanças formais e dimensionais. A figura 19 mostra o gráfico de barras horizontais desta comparação tendo a escala de valores (1 a 3) sido convertido em número de quadrados coloridos.

Matriz Operativa: avaliação de conceitos

		C1	C2	C3
Simples	Íntegro	3	1	3
	Organizado (Configuração)	3	2	3
	Não complicado	3	3	2
	Modesto	3	1	2
	Sem luxo	3	1	2
	Reduzido (suficiente)	3	1	2
	Desacompanhado	3	1	2
	Sem fingimento/disfarce	3	3	3
	Despojado/depurado	3	2	3
	Familiar	2	1	2
	Geometria (Estético-Formal)	3	3	3
	Pontuação parcial (100%)	**32**	**19**	**27**
Inovador	Incremental	3	3	3
	Radical	0	0	0
	Disruptiva	0	0	0
	Pontuação parcial (+90%)	**3**	**3**	**3**
Ergonómico	Seguro	3	2	3
	Eficiente/Eficaz	3	3	3
	Tolerante	2	3	3
	Primeiro contacto	3	3	3
	Confortável	3	2	3
	Prazer	3	3	3
	Pontuação parcial (+80%)	**17**	**16**	**18**
Elegante	Proporcionado	3	2	2
	Harmonioso	3	2	2
	Delicado	3	3	3
	Pontuação parcial (+70%)	**9**	**7**	**7**
Funcional	Prático	3	3	3
	Utilitário	3	3	3
	Pronto	3	3	3
	Pontuação parcial (+60%)	**9**	**9**	**9**
Robusto	Resistente	3	3	3
	Estável	3	3	3
	Perceção	3	3	3
	Pontuação parcial (+50%)	**9**	**9**	**9**
Económico	Material	3	2	2
	Produção	3	3	3
	Acessórios	3	3	3
	Transporte	1	1	1
	Comercialização	0	0	0
	Ciclo de vida	3	2	1
	Educação	3	3	3
	Pontuação parcial (+40%)	**16**	**14**	**13**
Variável	Mutável	3	3	3
	Contexto	3	3	3
	Pontuação parcial (+30%)	**6**	**6**	**6**
Versátil	Adaptável	0	0	0
	Finalidade	0	0	0
	Pontuação parcial (+20%)	**0**	**0**	**0**
Combinado	Ordem	3	2	3
	Harmonia	3	3	3
	Pontuação parcial (+10%)	**6**	**5**	**6**
	Pontuação total	73,3	57,2	66,5

Fig. 18 - Tabela com os valores obtidos na comparação dos conceitos gerados (Matriz de Avaliação)

Fig. 19 – Gráfico de comparação dos conceitos gerados

Esta autoavaliação dos conceitos gerados possibilitou verificar a validade deste instrumento de auxílio à decisão da escolha de um para prosseguir o seu desenvolvimento.

5. Realização do protótipo

Nesta fase consolidou-se o conceito selecionado no que respeita ao seu dimensionamento, componentes e funcionamento, funções, testes com potenciais utilizadores, processos e equipamentos para o seu fabrico. A produção de um modelo próximo das características reais do produto foi essencial para a verificação e correção de algumas questões que não se puderam confirmar com a maquete de estudo. A construção física do protótipo dotado de todas as partes nos mesmos materiais do produto final afigurou-se assim como o passo seguinte para testar funcionalmente a interação com potenciais utilizadores finais, e a sua relação com outros equipamentos em ambiente de uso. A figura 20 mostra vários momentos da construção dos moldes em poliestireno extrudido para utilização com a argamassa de cimento.

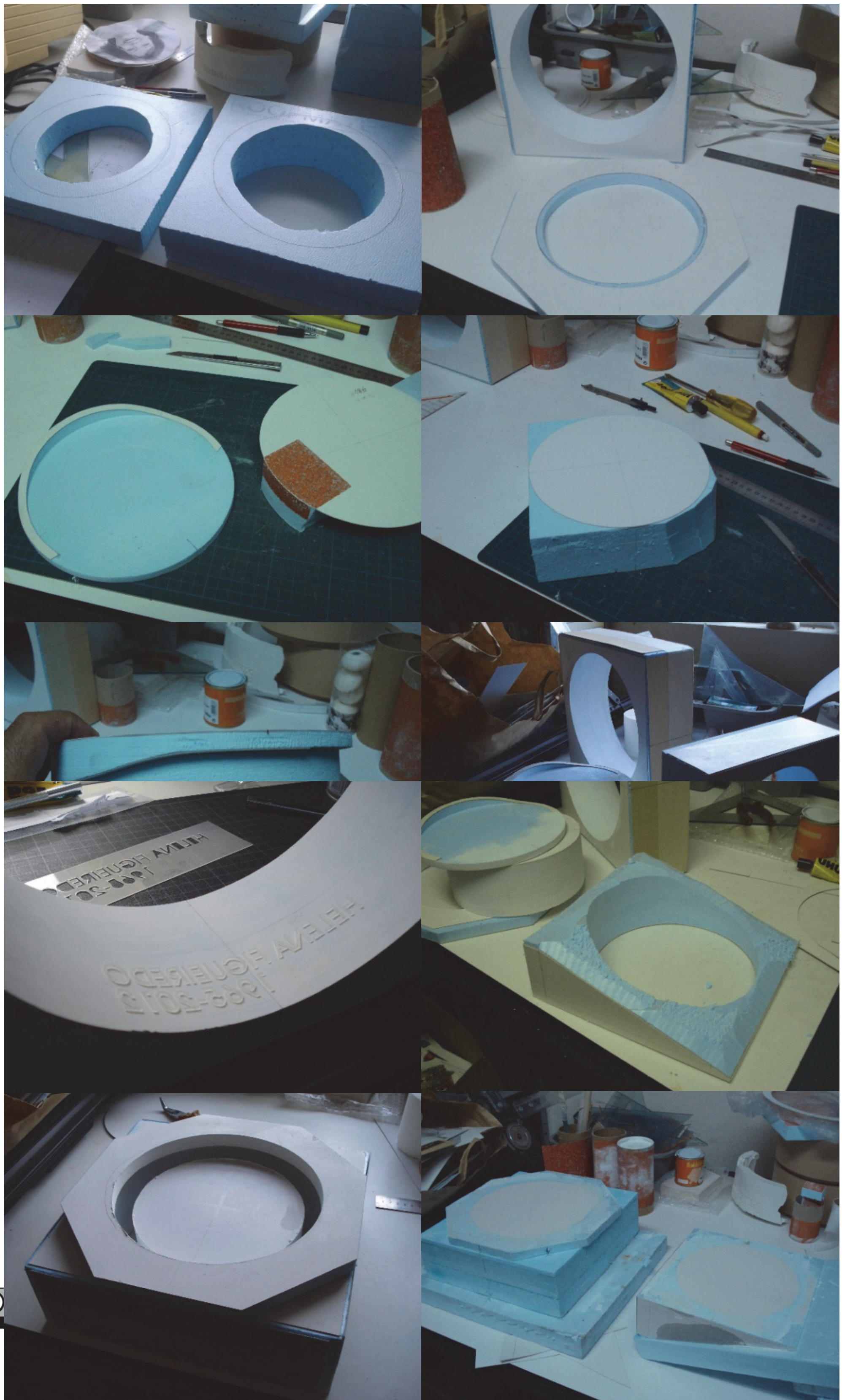

Fig. 20 – Produção do protótipo

6.1 Produto final

No final deste trabalho de prototipagem ficou-se a perceber a máxima sobre o desenvolvimento de protótipos de que Baxter (2008, p. 245) é defensor "Só faça se for necessário". A construção artesanal do protótipo, mesmo com o mínimo grau de complexidade e sofisticação, consumiu uma grande quantidade de tempo (cerca de 150 horas em blocos diários médios de 5 horas) só justificada pelo grau de certeza que foi aumentando à medida que o projeto passava pelas várias fases e momentos descritos anteriormente. A figura 21 mostram o resultado final deste trabalho.

Fig. 21 - Protótipo

7. Conclusão

Com o protótipo físico e estrutural do conceito de produto selecionado, foi possível realizar testes específicos à forma, função e estética, que até aqui não tinham sido possíveis de realizar. Uma inspeção primária possibilitou verificar que a utilização dos mesmos materiais do produto final (cimento e vidro) e a sua combinação apresentam uma boa convivência ainda que deva ser considerado a colocação de uma junta com propriedades elastómeras na zona de contacto entre a tampa de vidro e o corpo de cimento para evitar riscos e infiltrações de águas pluviais. Algumas falhas iniciais identificadas (dimensionais, superficiais) poderão ser evitadas com a correção ao desenho inicial e a utilização de processos de fabricação menos artesanais. A estética produzida pela cor da peça e o bom acabamento superficial poderá remeter o observador menos atento para outros tipos de materiais como a pedra moleanos. Novas cores naturais e outras poderão ser testadas com a adição de pigmentos à argamassa, na procura pela diferenciação ou até pelo aumento do contraste quando sobreposto em superfícies igualmente brancas como o mármore.

Ao fim do ano de utilização pode-se constatar que a durabilidade estética já ultrapassou a durabilidade estrutural. A *Fig. 22* mostra várias fissuras na parede da peça.

Fig. 22 - Fissuras na parede do protótipo

Durante o mesmo período foi possível de verificar a facilidade de uso e a economia no consumo de elementos florais quer pelo número reduzido que necessita para completar a zona própria e prevista no projeto, quer pela utilização de plantas espontâneas com flor que é possível encontrar (*Fig. 23*).

Fig. 23 - Utilização da flor de Mimosa (planta espontânea)

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Cuantificación y cualificación del diseño en la formación de ingenieros- Una nueva perspectiva.

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Resumen

El desempeño profesional en ingeniería está vinculado con el diseño, el producto y los procesos asociados, el cálculo y funcionamiento de máquinas, equipos, procesos, estructuras, entre otros, abordados desde una concepción lógica basada en la formación dada por las ciencias matemáticas y físicas. Si bien su formación de base en estas ciencias ha sido de características perennes y la evolución técnica ha puesto a su disposición herramientas para facilitar su aplicación en aspectos tecnológicos, su adecuada utilización frente a desafíos de nuevos conocimientos permitió asombrosos y vertiginosos avances mediante su aplicación ética y responsable asociada al diseño.

El diseño, más allá de la utilización de herramientas informáticas facilitadoras de este proceso, necesita una revisión en la formación en ingenierías que permitan trasponer estos límites, abordándolo desde la productividad y el medio ambiente asociado al ciclo de vida del producto que hoy el pos grado da accesibilidad.

El interés de este trabajo es profundizar el concepto de formación ingenieril vinculada al diseño, investigando la necesidad de este cambio, en un concepto que lleve implícito un nuevo abordaje de sus diseños curriculares que lo cuantifiquen y cualifiquen.

Palabras claves: *ingeniería, diseño, ciclo de vida de producto, industria, diseño curricular*

Abstract

Professional performance engineering is linked to the design, product and associated processes, calculation and operation of machines, equipment, processes, structures, among others, addressed from a logical concept based on the training given by the mathematical and physical sciences . While his training base in these sciences has been of perennial features and technological progress has made available tools to facilitate their application in technological aspects, its proper use face challenges of new knowledge allowed astonishing and rapid advances through its ethical application and responsible associated with the design.

Design, beyond the use of enabling tools of this process needs revision in training in engineering that allow transpose these limits, approaching it from the productivity and *the environment associated with the product life-cycle management that today the post-graduate It gives accessibility.*

The interest of this work is to deepen the concept of training related to engineering design, investigating the need for this change, a concept that embeds a new approach to their curriculum that quantify and qualify.

Keywords: *engineering, design, product life-cycle management, industry, curriculum design.*

1. Introducción

Un factor importante a considerar en la valoración del diseño en el desempeño profesional de los ingenieros está vinculado no solo a sus sólidos conocimientos en las disciplinas específicas de su titulación sino también a aspectos que cortan transversalmente al proceso ingenieril asociado a la productividad y el desarrollo de productos (ya sean estos nuevos, sustitutos, de paridad o mejorados) que permiten concebir al producto asociado a la mercadotecnia, de la cual parte el concepto de su ciclo de vida.

Si bien esta mejora formativa, a partir de considerar aditivamente a su formación un mayor contenido en diseño vinculado a todas las etapas del ciclo de vida de un producto, es importante para la industria en general, lo es particularmente para los sectores industriales en el área de las Pequeñas y Medianas Empresas, que si bien cuentan con profesionales formados en áreas específicas, tienen demandas por necesidades emergentes que requieren de un desempeño profesional capaz de concebir un producto para todo su ciclo de vida, con una formación integral que evite su recurrencia a profesionales de otras disciplinas acarreándoles un aumento de mano de obra indirecta con impacto directo en los costes del producto.

Si bien este es el caso de los profesionales de la ingeniería vinculados con la producción eléctrica, mecánica, química, electrónica, industrial, entre otras, en relación de dependencia, es extrapolable para quienes realizan un desempeño profesional independiente en estas y otras áreas de la ingeniería asociadas con la construcción de obras civiles e informática, en servicios de consultoría o por cuenta propia, para quienes se genera una situación similar en cuanto a sus posibilidades de ejercicio profesional vinculado al diseño.

Desde el punto de vista de la mecánica formativa los componentes principales de diseños curriculares actuales determinan el funcionamiento en su conjunto basado en sistemas individuales de ejes temáticos troncales por disciplina, cuya configuración se asimila a un sistema en paralelo, con un grado de formación que será resultante de la sumatoria individual de los sistemas que lo integran, con materias anuales integradoras que realizan una integración sistémica de conocimientos, sin abordar el concepto producto y su ciclo de vida asociado a la mercadotecnia que sería de gran importancia implementar en los años finales de carrera permitiendo así una visión de conjunto de verdadera importancia.

2. Objetivos e Hipótesis

El interés de este trabajo está centrado en la profundización del concepto del diseño para el ciclo de vida del producto en la formación profesional de ingenieros, investigando la percepción de los sectores involucrados de la situación planteada desde las áreas académica y productiva.

Se plantea como objetivo determinar el grado de necesidad en ambos sectores en cuanto a contar con ingenieros dotados de conocimientos de diseño asociado al ciclo de vida del producto, a partir de la hipótesis que esta formación es de significativa importancia por ambos en cuanto a una mejor cualificación y cuantificación del desempeño profesional del ingeniero asociado al diseño.

3. Descripción del área de estudio

La estructura organizativa del sector académico tiene un sistema basado en cuerpos colegiados de gobierno que legislan las actividades de planeamiento universitario y aspectos académicos entre otros, siendo estos los más importantes a considerar para esta propuesta investigativa. Los sectores productivos están agrupados por cámaras empresariales asociadas a tipologías industriales, con características particulares dadas las improntas particulares de cada región del país. Este estudio se centra en la ciudad de San Francisco de la provincia de Córdoba de la República Argentina que cuenta con uno de los Parques Industriales más importantes del mencionado país, caracterizado por su industria metalmecánica PyMe, y en la Universidad Tecnológica Nacional Facultad Regional San Francisco caracterizada por sus carreras de ingeniería y principal proveedora de profesionales de la ingeniería a ese sector productivo.

Ambas tienen un elemento en común, los profesionales en ingeniería graduados en la Facultad Regional San Francisco y un fuerte compromiso regional asociado a la productividad y el desarrollo regional.

Las ingenierías dictadas en la Facultad Regional San Francisco tienen una relación directa con el sector industrial con la siguiente distribución de graduados por especialidad.

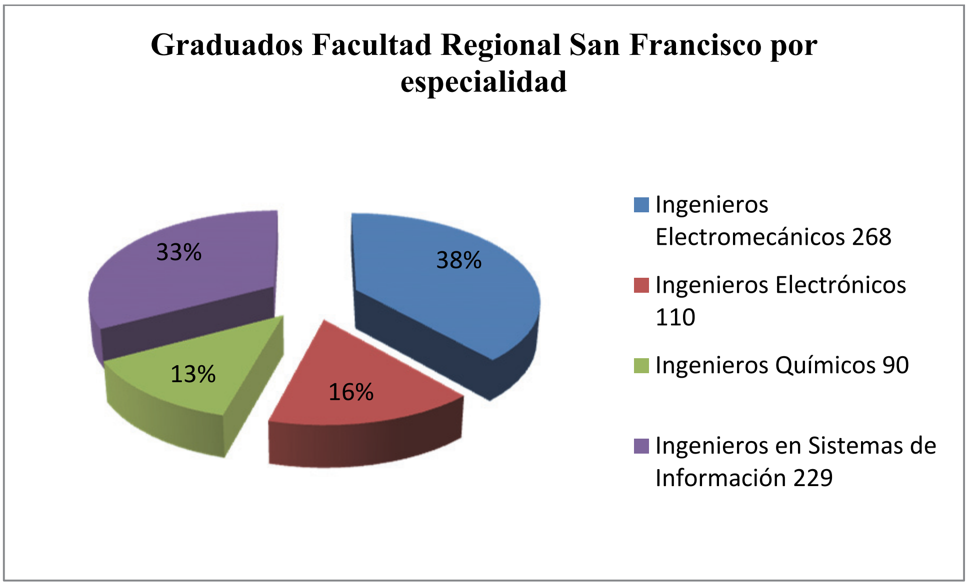

Fig. 1: Distribución de graduados de la Facultad Regional San Francisco por especialidad. Elaboración propia (2016)

Si bien todas las ingenierías dictadas en la Facultad Regional San Francisco tienen relación directa o indirecta con la industria metalmecánica, la figura 1 deja de manifiesto que la carrera con mayor número de graduados es ingeniería electromecánica, la que a su vez es la de relación directa con ese sector y la que mayor involucramiento posee con el análisis efectuado en este trabajo.

4. Metodología

Para efectuar el análisis de necesidad e interés en el sector productivo se efectuó una encuesta con variables de evaluación que determinan la importancia asignada al diseño en pequeñas y medianas empresas y la necesidad de contar con ingenieros formados en diseño para el Ciclo de Vida del Producto.

El interés y factibilidad de dar respuesta por parte del sector académico universitario se determinó mediante la realización de una encuesta con variables de evaluación que determinan, la formación actual en diseño en la Facultad Regional San Francisco en cuanto a diseño que contemple el Ciclo de Vida del Producto, si el diseño debe ser concebido para todo el Ciclo de Vida del producto y la necesidad de inclusión del diseño para el Ciclo de Vida del Producto en los actuales diseños curriculares.

Las encuestas tuvieron como objetivo definir la significación e importancia, por parte de los sectores productivo y académico, del desempeño profesional del ingeniero asociado a una formación que contemple al diseño concebido para el ciclo de vida del producto para su mejor cualificación y cuantificación.

4.1 Muestra

La muestra se centró en la industria metalmecánica y en los miembros de órganos de gobierno universitario de la Facultad Regional San Francisco con un tamaño que contempló una población de 92 posibles encuestados con un grado de confianza del 95%.

5. Resultados

Los resultados obtenidos responden al análisis de variables asociadas al diseño en los ámbitos académico de la Facultad Regional San Francisco e industrial metalmecánico de la Pequeña y Mediana Empresa de la ciudad de San Francisco. Se considera importante determinar la importancia asignada al diseño y la necesidad de disponer de ingenieros formados en diseño para todo el ciclo de vida del producto en el sector industrial y vincular las mismas a la formación actual del ingeniero en cuanto a diseño en la Facultad Regional San Francisco, la opinión académica en cuanto a la concepción del diseño vinculado al ciclo de vida del producto y la importancia conferida a la formación de ingenieros dotados de herramientas que contemplen al producto para todo su ciclo de vida como vía de posibles cambios curriculares para satisfacer las necesidades detectadas.

5.1. Resultados que determinan la importancia asignada al diseño en las Pequeñas y Medianas Empresas de producción metalmecánica de San Francisco

En primer lugar se considera importante evaluar la consideración del diseño por parte del sector productivo de la pequeña y mediana empresa metalmecánica en cuanto a su significación e importancia, constituyendo este el punto de partida para avanzar en aspectos específicos vinculados al mismo en función de los resultados obtenidos. Sólo se podrá avanzar en el análisis del objeto de estudio si existe, como punto de partida, una significativa mayoría con una alta valoración del diseño.

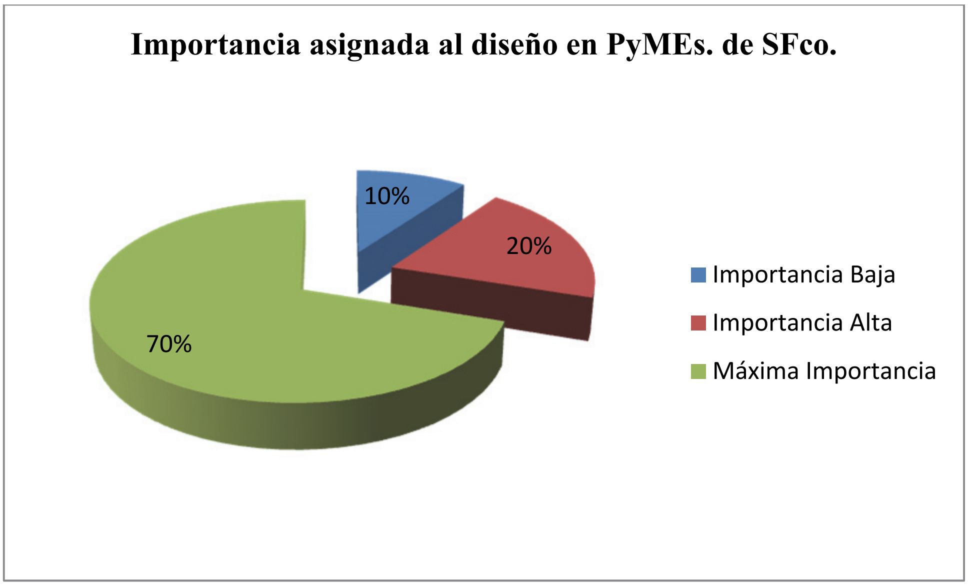

Fig. 2: Distribución importancia asignada al diseño en Pymes SFco. Elaboración propia, (2016)

De acuerdo a los resultados obtenidos que se plasman en la figura 2 se determina que el 90% de los encuestado considera con los valores más altos la importancia asignada a la variable diseño. Este resultado deja sentadas las bases que permiten avanzar específicamente en la evaluación de su necesidad vinculada al diseño para el ciclo de vida del producto y su demanda de profesionales de la ingeniería formados en esta concepción del diseño.

5.2 Resultados que determinan la necesidad de contar con ingenieros formados en diseño para el ciclo de vida del producto.

A partir de la significación conferida al diseño en el sector productivo metalmecánico de la pequeña y mediana empresa de San Francisco y habiéndose asignado una importancia significativa a esta variable, es importante evaluar la necesidad del sector de contar con ingenieros dotados de herramientas que contemplen el diseño para todo el ciclo de vida del producto. Su evaluación indicará si se debe avanzar en la factibilidad concreta de dar respuesta a la misma desde el sector académico de la Facultad Regional San Francisco.

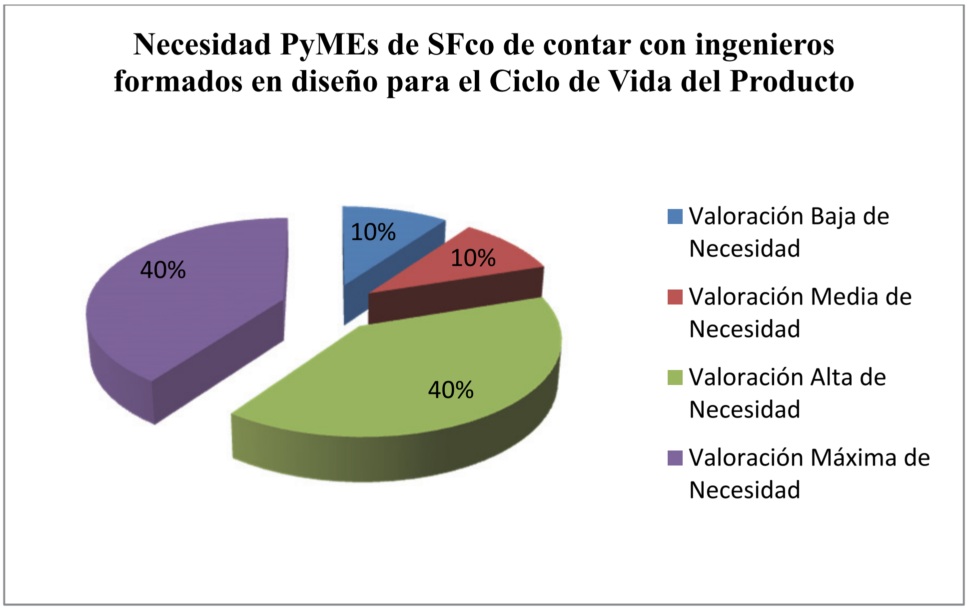

Fig. 3: Distribución necesidades en PyMEs SFco. en contar con Ingenieros formados en diseño para el Ciclo de Vida del Producto. Elaboración propia (2016)

La figura 3 pone en evidencia que la variable diseño de productos que contemplen su ciclo de vida es una necesidad de las Pequeñas y Medianas empresas puesta en evidencia en el 90 % de los encuestados, que consideran con los valores más altos de ponderación su necesidad de contar con ingenieros con esta formación. Esto indica que se debe dar respuesta por parte del sector académico a esta necesidad latente

5.3 Resultados que determinan la formación actual de ingenieros en la Facultad Regional San Francisco en cuanto a diseño que contemple el ciclo de vida del producto

Para avanzar en posibilidad de satisfacción de necesidades detectadas en el sector productivo involucrado en este análisis, es prioritario considerar la formación actual en diseño vinculado al ciclo de vida del producto en las carreras de ingeniería de la Facultad Regional San Francisco relacionadas al sector productivo metalmecánico. Su evaluación permite determinar la formación específica en este campo y en función de los resultados obtenidos analizar la factibilidad de implementación de cambios curriculares a partir de la concepción del diseño en el ámbito académico.

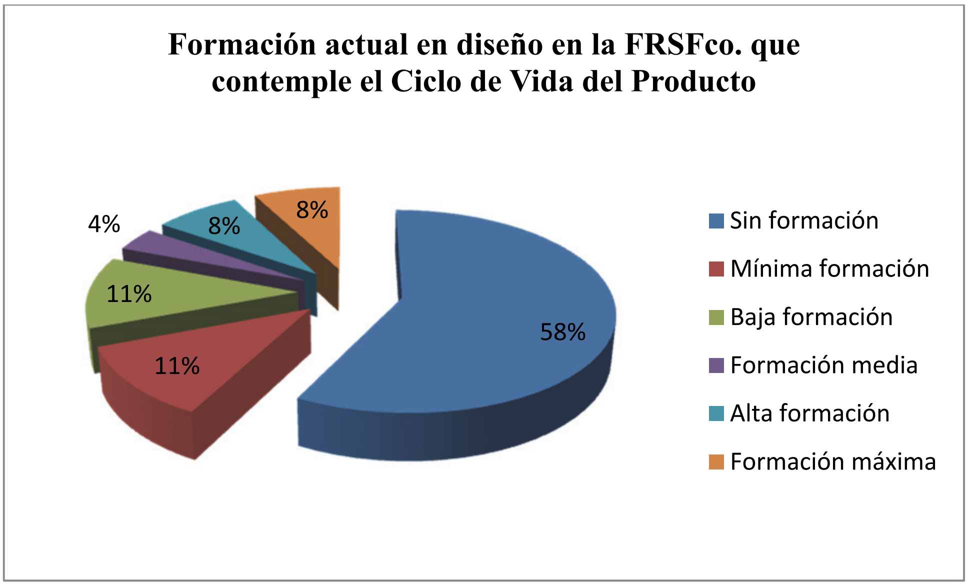

Fig. 4: Distribución formación de ingenieros en la FRSFco. en diseño que contemple el Ciclo de Vida del Producto. Elaboración propia (2016)

En la figura 4 se pone en evidencia que la formación en diseño en la actual currícula de ingenierías de la Facultad Regional San Francisco vinculadas a la industria metalmecánica no considera al diseño para todo el ciclo de vida del producto, dado que el 80% de los encuestados le asigna a esta variable los valores más bajos, de los cuales el 58% le asigna valor cero.

Este análisis deja en claro que para satisfacer las necesidades detectadas se debe partir de un cambio en la formación académica, la cual será viable sólo si en el campo académico se concibe al diseño desde la perspectiva del ciclo de vida del producto.

5.4. Resultados que determinan en la Facultad Regional San Francisco si la formación de ingenieros en cuanto diseño debe concebir al mismo para todo el ciclo de vida del producto.

Analizada la formación actual en diseño y antes de determinar la viabilidad de un cambio curricular, es prioritario considerar la opinión del ámbito académico relacionada a si el diseño debe ser considerado para todo el ciclo de vida de un producto, toda vez que sólo se podrá avanzar en la posibilidad de dar la respuesta académica correspondiente para satisfacer las necesidades detectadas, si la opinión es mayoritaria en cuanto a esta concepción del diseño.

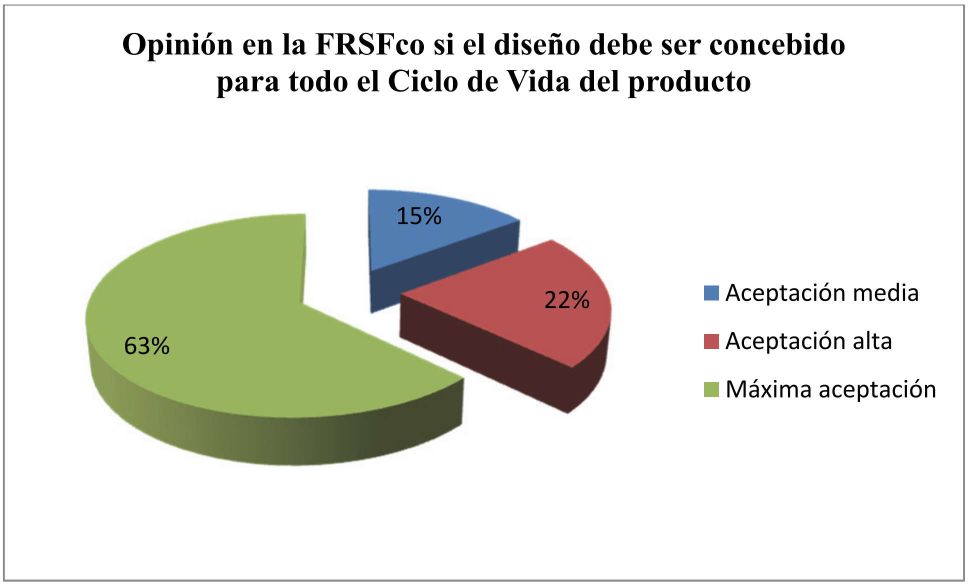

Fig. 5: Distribución concepción del diseño asociado al ciclo de vida del producto. Elaboración propia (2016)

Esta variable arroja aspectos sumamente significativos evidenciados en la figura 5, en la cual se percibe claramente que el 100% de los encuestados considera que el diseño de un producto debe concebirse para todo su ciclo de vida. El 15% le otorga una ponderación media mientras que el 85% lo considera en sus valores más altos.

El análisis de esta variable permite determinar que existe una total aceptación en el ámbito académico que el diseño debe ser concebido para el ciclo de vida del producto, permitiendo entonces avanzar en la posibilidad de adecuaciones curriculares que surgirán de la determinación de la importancia conferida por el sector académico a su inclusión en las carreras de ingeniería vinculadas al sector productivo metalmecánico.

Resultados que determinan la importancia asignada en la Facultad Regional San Francisco a la inclusión de formación de ingenieros en cuanto a diseño que contemple el ciclo de vida del producto

Habiéndose determinado que la concepción académica del diseño en la Facultad Regional San Francisco establece que el mismo debe contemplar al producto para todo su ciclo de vida, es fundamental evaluar la importancia asignada a incluir este concepto en la formación profesional. El análisis de esta variable determinará en forma concreta la posibilidad de satisfacer desde la Facultad Regional San Francisco la necesidad detectada en el sector productivo metalmecánico de las pequeñas y medianas empresas de San Francisco.

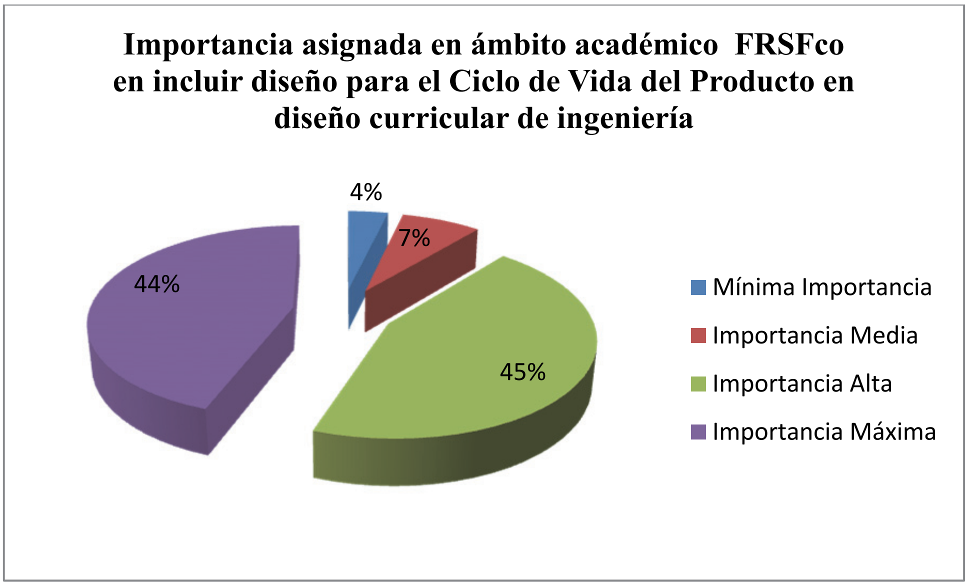

Fig. 6: Distribución importancia asignada al diseño para todo el Ciclo de Vida del Producto en el ámbito académico. Elaboración propia (2016)

La valores detectados mediante la variable importancia que se asigna en incluir concepto de diseño de productos para todo su ciclo de vida en el ámbito académico es altamente significativa, solo el 4% lo valora con baja ponderación, mientras que el 7% le da un valor medio y el 89% le otorga los másaltos valores de importancia, evidenciando la necesidad y factibilidad de implementación de esta concepción de diseño en los actuales diseños curriculares.

6. Discusión

En función de los resultados obtenidos se puede inferir la importancia asignada al diseño vinculado al ciclo de vida del producto en la formación de ingenieros, la que surge del análisis de variables en el sector productivo de la pequeña y mediana empresa y en el sector académico. La vinculación de estas variables permite determinar un aditivo impacto cualitativo y cuantitativo de formación profesional vinculado con la importancia asignada al diseño en las Pequeñas y Medianas Empresas y su necesidad de contar con ingenieros formados en diseño para el ciclo de vida del producto, atendiendo la formación actual de ingenieros y la visión académica en cuanto a la formación en diseño de ingenieros concibiendo al mismo para todo el ciclo de vida, lo que permite evaluar positivamente, con la variable importancia asignada en la Facultad Regional San Francisco, la necesaria inclusión de formación de ingenieros que contemple el ciclo de vida del producto.

7. Conclusiones

El análisis de las variables indica que el sector industrial metalmecánico le asigna importancia significativa al diseño, con necesidad específica que el mismo contemple aspectos mercadotécnicos asociados al ciclo de vida del producto, como así también en el orden académico se evidencia la necesidad de realizar adecuaciones curriculares en este sentido en función de la importancia conferida al diseño en general y en particular en su relación con el ciclo de vida del producto.

En función de los resultados obtenidos podemos inferir que la cualificación y cuantificación del diseño desde una nueva perspectiva que considere al mismo para todo su ciclo de vida en la formación profesional de las ingenierías es una necesidad latente en los sectores productivos de las pequeñas y medianas empresas, quienes le asignan un valor superlativo al diseño y están en estado de formulación de la demanda para satisfacerla.

Asimismo en el sector vinculado a la formación académica se pone de manifiesto el mismo tipo de necesidad incluyendo la implementación de cambios curriculares que contemplen esta nueva dimensión del diseño, que se constituye en una nueva perspectiva que cualificará y cuantificará la formación de los graduados en ingeniería en función de la importancia asignada al diseño concebido para todo el ciclo de vida del producto.

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Percepción de la confiabilidad de un producto agroindustrial

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Resumen

Las máquinas que trabajan en la agricultura y sus partes componentes están predestinadas a cumplir las funciones asignadas en determinadas condiciones de producción y explotación técnica. El estado técnico de las maquinas durante el proceso de explotación cambia, así como cambian de nominal al límite los valores de los parámetros que lo caracterizan.

Una forma de caracterizar la maquinaria agrícola que se produce, es aplicando el concepto de sistemas, el cual según la cantidad de sistemas que la conforman y el grado de nivel tecnológico de los mismos podemos definir: Productos de alta tecnología: Tractores, Cosechadoras; Productos de media Tecnología: Sembradoras, embutidora de granos, extractora de granos; Productos de baja tecnología: Implementos observándose una estrecha relación entre la confiabilidad y la caracterización tecnológica. Productos de alta tecnología son más confiables que productos media y baja por razones múltiples entre ellas gestión del diseño, procesos de fabricación, acceso a tecnología del conocimiento, nivel de facturación de la empresa origen, organización empresarial, valor del producto, competencia.

El interés de este trabajo es profundizar el concepto mecánico de confiabilidad, investigando como tal la percepción de la misma en el usuario, como concepto globalizador donde estará implícito el concepto mecánico; abordándose la problemática desde dos puntos de vista: la confiabilidad como factor de compra y la confiabilidad en función de la operatividad de la máquina.

Palabras clave: *confiabilidad, caracterización, productos agroindustriales, usuario, gestión de diseño.*

Abstract

Machines working in agriculture and its component parts are predestined to fulfill the functions assigned under certain conditions of production and technical operation. The technical condition of the machine during operation changes, and change the limit nominal values of the parameters that characterize it.

One way to characterize agricultural machinery produced, is applying the concept of systems, which according to the number of systems that conform and the degree of technological level of the same can define: High-tech products: tractors, harvesters;

Medium-technology products: Drills, stocking stuffer grains, grain extractor; Low-tech products: simple machines observed a close relationship between reliability and technological characterization. High-tech products are more reliable than medium and low products for multiple reasons including design management, manufacturing processes, access to knowledge technology, level of turnover of the company source, business organization, product value, competition.

The interest of this work is to deepen the mechanical concept of reliability, investigating how such perception of it in the user, as globalization concept where the mechanical concept is implicit; the problem from two perspectives: reliability as purchasing factor and reliability depending on the operation of the machine.

***Keywords**: reliability, characterization, agro-industrial products, user, design management*

1. Introducción

Uno de los factores determinantes en el éxito de un producto agrícola es el grado de confiabilidad del mismo, otros tienen que ver con la performance, precio de adquisición y reventa. En su conjunto estos factores forman el intangible de la Calidad del producto. (Bragachini, 2010).

En términos estadísticos la confiabilidad se define como la probabilidad de que un producto, parte de un equipo o sistema, lleve a cabo su función esperada en un período establecido de tiempo bajo condiciones especificadas de funcionamiento es decir que la confiablidad de un producto es una noción dinámica a través del tiempo. Desde el punto de vista puramente económico es deseable una alta fiabilidad para reducir los costos totales, ya que es inquietante el hecho de que el costo anual para mantener ciertos equipos y sistemas de funcionamiento ha llegado a ser varias veces mayor al costo original del equipo. (Shkiliova et al., 2007).

Las máquinas que trabajan en la agricultura y sus partes componentes están predestinadas a cumplir las funciones asignadas en determinadas condiciones de producción y explotación técnica. El estado técnico de las maquinas durante el proceso de explotación cambia, así como cambian de nominal al límite los valores de los parámetros que lo caracterizan (Shiliova et al., 2011). Cuando al menos un parámetro estructural sobrepasa su valor límite, esto puede provocar un deterioro o la pérdida de la capacidad del trabajo de la máquina o sus partes componentes. Las partes componentes de las máquinas se regulan, recuperan y sustituyen para lograr que sus parámetros técnicos no sobrepasasen durante el proceso de explotación el valor límite y los agregados no alcancen su estado límite. Precisamente es por esto que se utilizan en la documentación técnica normativa el sistema de los valores permisibles de los parámetros, que permitan prevenir las fallas y/o las consecuencias de las fallas de las piezas en el proceso de explotación hasta llegar a la próxima reparación o control de su estado técnico. Las maquinas modernas agrícolas (tractores, combinadas y otras) están constituidas por decenas de miles de piezas, cada cual potencialmente puede fallar por uno o varios parámetros de su estado técnico. Sin embargo, es conocido en la práctica de explotación que solamente hasta un 5% de las piezas representan la fuente principal de las fallas. Debido a esto es que en la práctica durante el proceso de dirección del estado técnico y de confiabilidad de las máquinas, generalmente, se trabaja con 100-200 piezas, que condicionan el nivel de trabajo sin falla, durabilidad y con un nivel bajo de mantenimiento de las máquinas agrícolas (Shkiliova et al., 2011).

Es decir que desde un punto de vista mecánico los componentes principales de una máquina agrícola son aquellos que determinan el funcionamiento en su conjunto, estos componentes forman parte de sistemas individuales no redundantes cuya configuración se asimila a un sistema en paralelo (J Shigley,2004) por lo que la confiabilidad será igual al producto de las confiabilidades individuales de los sistemas que lo integran.

Una forma de caracterizar la maquinaria agrícola que se produce, es aplicando el concepto de sistemas, el cual según la cantidad de sistemas que la conforman y el grado de nivel tecnológico de los mismos podemos establecer del siguiente modo: Productos de alta tecnología: Tractores, Cosechadoras; Productos de media Tecnología: Sembradoras, embutidora de granos, extractora de granos; Productos de baja tecnología: Implementos, observándose una estrecha relación entre la confiabilidad y la caracterización tecnológica. Productos de alta tecnología son más confiables que productos media y baja por razones múltiples entre ellas gestión del diseño, procesos de fabricación, acceso a tecnología del conocimiento, nivel de facturación de la empresa origen, organización empresarial, valor del producto, competencia.

2. Objetivos e Hipótesis

El interés de este trabajo es profundizar el concepto mecánico de confiabilidad, investigando como tal la percepción de la misma en el usuario, como concepto globalizador donde estará implícito el concepto mecánico; abordándose la problemática desde dos puntos de vista: la confiabilidad como factor de compra y la confiabilidad en función de la operatividad de la máquina.

Como objetivo se planteó determinar cuáles son las variables principales que influyen en cada caso, considerando como hipótesis que el servicio técnico prestado por la empresa fabricante funciona como una variable de equilibrio, lo que explicaría el fuerte arraigo territorial de las empresas agroindustriales.

3. Descripción del área de estudio.

La organización empresarial de las mayoría de las industrias agroindustriales de la Región Centro de la República Argentina tienen una base familiar concentrada en " manchones territoriales " influenciadas directamente por el peso de la agricultura y de la ganadería , tratándose de un mercado complejo y heterogéneo según la particularidad de la zona. Este conjunto de empresas tiene un denominador común: una extensa localización territorial acorde con las demandas productivas regionales. Sobre este total, la gran mayoría son básicamente pymes, con un promedio de 30 años de antigüedad, cuyo tamaño va desde 10 hasta 300 empleados por empresa (hay algunas pocas excepciones que superan ese límite). El resto del mercado se distribuye en los segmentos de mayor valor económico y complejidad tecnológica.

3.1. Distribución porcentual de máquinas de media y baja tecnología fabricadas en la Región Centro

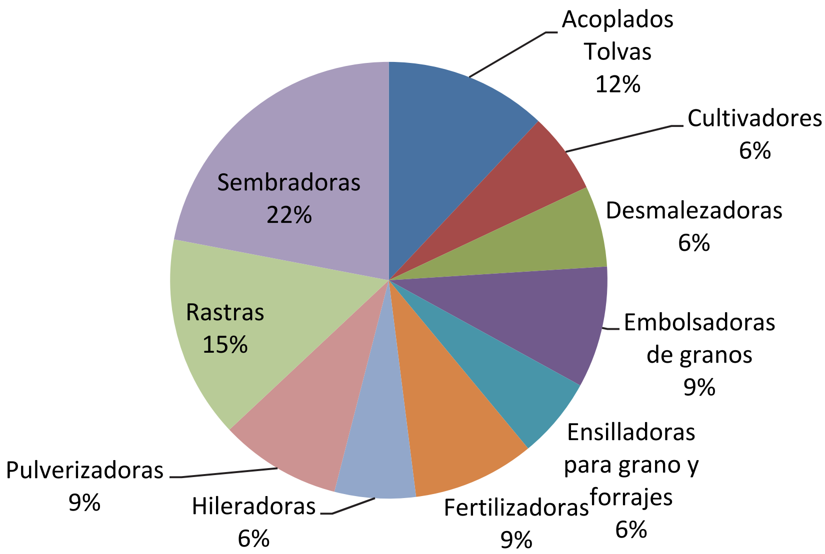

Fig.1 Distribución porcentual de máquinas de media y baja tecnología fabricadas en la Región Centro.(fuente propia)

4. Metodología

Para analizar la confiabilidad como factor de compra, se realizó una encuesta en la cual se propusieron como variables de evaluación: Referencia por otro usuario, marca conocida en la zona, conocimiento del vendedor (relación personal), conocimiento de la fábrica (establecimiento donde se produce el producto agroindustrial), económico.En el análisis de la confiabilidad según la operación de la máquina, se realizó una encuesta en la cual se propusieron como variables de evaluación: Referencia por otro usuario, marca conocida en la zona, conocimiento del vendedor (relación personal), conocimiento de la fábrica (establecimiento donde se produce el producto agroindustrial), valor económico. La variable servicio técnico se analizó estratificando las encuestas desagregando las explotaciones agropecuarias según el siguiente criterio: productores de menos 200 ha, entre 200 y 600 ha, de entre 600 y 1500 ha y de más de 1500 ha. Las encuesta consto de un cuestionario de 15 preguntas de las cuales 10 fueron cerradas cuantificables y el resto abiertas, se llevaron a cabo durante la exposición agroindustrial "Agroactiva", en Mayo del 2014 en la ciudad de Oncativo provincia de Córdoba República Argentina. Los objetivos de la encuesta fueron: Definir y cuantificar las variables que involucran la percepción de confiabilidad en el cliente y establecer el rol del servicio técnico en la percepción de la confiabilidad.

5. Muestreo

El total de productores y contratistas entrevistados asciende a 600 con un nivel de confianza del 95,5%, el universo por lo tanto lo constituye todos los productores y/o contratistas propietarios de por lo menos un producto agroindustrial de media o baja tecnología.

6. Resultados

6.1. Percepción de la confiabilidad del producto según el entorno

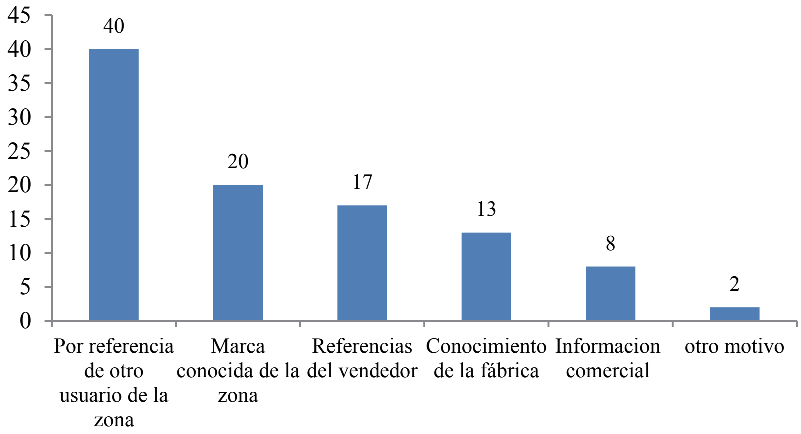

Fig. 2: Porcentaje de opiniones afirmativas respecto a las variables de confiabilidad del producto de acuerdo al entorno.

Según los resultados (Fig. 2) y considerando que la confiabilidad es un factor importante a la hora de adquirir un producto agroindustrial las variables “referencia de otro usuario “ y “ marca conocida” son las que más influirán más en el momento de la decisión de compra. Ambas suman el 60 % del total. En tercer lugar se ubica la variable “referencias del vendedor” con el 17 %, indicando que la reputación técnica comercial es importante en la percepción.

6.2. Valoración del servicio técnico como variable influyente en la percepción de la confiabilidad

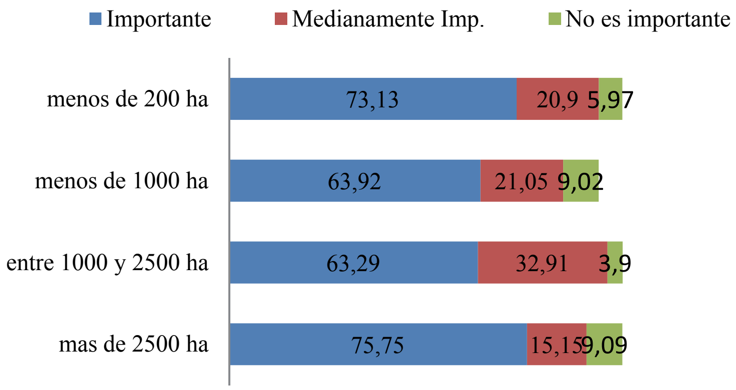

Fig. 4: porcentaje de opiniones afirmativas respecto a las variables de confiabilidad del producto de acuerdo a la importancia de la prestación del servicio técnico.

6.3. Variables sensibles de la percepción de la confiabilidad

Las Variables Sensibles de la percepción de la confiabilidad de un producto agroindustrial según el orden de importancia son: “bajo índice de roturas imprevistas y desgastes prematuro” (variables agrupadas por su origen mecánico), “referencia de uso”, “disponibilidad en tiempo”y “forma del servicio técnico por parte de fabricante”. (Fig. 5).

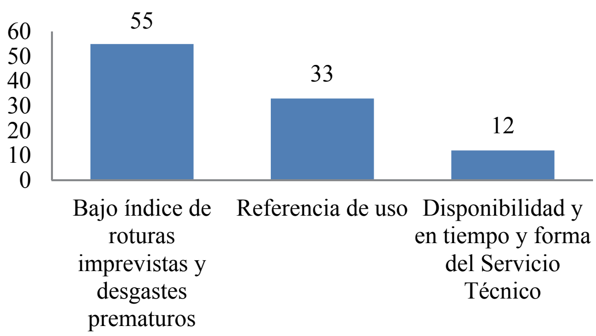

Fig. 5: Porcentaje de opiniones afirmativas respecto a las variables de confiabilidad del producto de acuerdo a la importancia de la prestación del servicio técnico.

De acuerdo a los resultados un producto se percibe como confiable (figura 5) cuando éste tiene en primer lugar bajo índice de “roturas imprevistas” y “desgastes prematuros” con un 55%, en segundo lugar si existe “referencias de uso” en la zona más allá de conocer su performance operativa real. Es decir que el usuario conoce la existencia de máquinas similares en su zona pero no las prestaciones reales de la máquina por propio uso, variable importante como factor de decisión de compra.

El tercer factor: “disponibilidad en tiempo y forma del servicio tecnico” con 12 %, actuando ésta última como variable de equilibrio entre las dos primeras, esto se pone de manifiesto cuando los productores expresan *“La máquina tiene algunos problemas de roturas y desgastes pero el servicio técnico es bueno por ese motivo la compré”.*

7. Discusión

A vista de los resultados podemos decir que la percepción de confiabilidad de un producto agroindustrial como factor de compra está influenciada en primer lugar por la referencia del producto aceptando que mucha veces hay una distorsión en el mensaje. El productor no es un comprador que compra sin referencia, para el caso de las empresas que necesitan introducir su producto en una región territorial usualmente consignan una máquina a un productor radicado en el lugar para que la pruebe y la valore, en caso que esta cumpla con los objetivos de venta será la referencia para iniciar la actividad comercial. El conocimiento de la marca se ubica en el segundo lugar como factor de peso. Una marca puede ser conocida a través de una campaña publicitaria pero a la luz de la percepción de la confiabilidad como factor de compra, una es consecuencia de la otra. Las referencias positivas técnicas comerciales del vendedor/distribuidor en cierta medida se trasladan al producto que se comercializa esta asociación también se hace con el establecimiento fabril en el plano comercial, se evidencia en la variable información comercial, también sujeta desvíos respecto a la realidad.

El conocimiento de la fábrica puntualmente en el aspecto técnico, o sea como se fabrica el producto también es una variable que aporta a la percepción, pero muchas veces el productor desconoce los procesos de fabricación en detalle por lo que no relaciona la estabilidad de los mismo con la calidad final del producto, solamente aprecia la dimensión o la estética del mismo, de todas formas muchas pymes mediadas muestran sus procesos productivos ya sea a través de visitas guiadas o mediantes campañas publicitarias.

La percepción de la confiabilidad según el uso de la máquina va más allá de un concepto mecánico y económico, esta se construye y complementa primeramente cuando el producto no presenta "roturas imprevistas" ni "desgastes prematuros" . Esta variable se asocia al concepto mecánico de confiabilidad y a la noción dinámica, habiendo una relación entre los esfuerzos límites y a la duración de las piezas, teniendo como parámetro el tiempo otorgado como garantía por parte del fabricante.

La variable "servicio técnico" se puede considerar como una variable de equilibrio, explicando por qué máquinas de mayor calidad técnica pero con un servicio técnico que no satisface al cliente no tienen éxito en una determinada región. La variable facilidad de reparación también se puede considerar de equilibro, cuando el servicio técnico no es consecuente a la demanda.

Productores de menos del 200 ha en un 70 % opinan que la variable servicio técnico es importante debido principalmente a las restricciones tecnológicas, no de tiempo. Por su parte, los productores de más de 2500, también opinan que la variable servicio técnico es importante (70%), en este caso debido principalmente a las restricciones de tiempo (datos no publicados).

Es evidente que las variables "roturas imprevistas" y " desgastes prematuros" se relacionan directamente con la gestión del diseño (Ortuño et al., 2000).También lo es la "facilidad de reparación" jugando un rol importante de equilibrio para aquellas empresas cuyo servicio técnico no satisface al potencial cliente por cuestiones logísticas y debe ser atendida como factor clave para la expansión empresarial.

8. Conclusiones

La percepción de confiabilidad de un producto agroindustrial como factor de compra está influenciada en primer lugar por la referencia del producto y por el conocimiento de la marca, existen otros que contribuyen en menor grado: referencia del vendedor/distribuidor, conocimiento de los procesos industriales del fabricante, información comercial. La percepción no se construye con una sola variable aislada.

La percepción de la confiabilidad según el uso de la máquina va más allá de un concepto mecánico y económico, esta se construye y complementa primeramente cuando el producto no presenta "roturas imprevistas" y " desgastes prematuros".

La variable "servicio técnico" se puede considerar como una variable de equilibrio.

Las variables "roturas imprevistas" y " desgastes prematuros", "facilidad de reparación" tienen una relación directa con la gestión del diseño.

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Design education learning: developing skills of observing and managing intangible systems in young generations

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Abstract

There is consensus among researchers regarding how managing and designing in complexity multidimensionality represents one of the mains challenges and constants of contemporaries' processes of innovation (Manzini, Baule, Bertola, 2004). *This systemic distinguishing peculiarity makes impossible to standardize the design innovation processes because every problem needs to be solved by adopting different strategies (Celaschi, Deserti, 2007). Nevertheless, those innovative processes can be developed and managed by referring us to tools and practices of design into the paradigms of multidisciplinary and multidimensional.*

However, what happens when professors have to transmit those concepts to young students of design faculties? We have to consider that normally those students are coming from second-degree schools, which programs usually still insist on content rigidly divided in disciplines and don´t consider how the contemporary relation between space and time has overturned for them (Morin, 2001). Young students generally disclaim their past in the meaning of heritage, values and techniques knowledge; they live in the present, a time that does not exist; a time that today results enormously expanded by globalization processes. They still living in a reality of which territorial capital subsystems are characterized by an entropic strong dichotomy of entities in opposition but, on the other hand, in balance within themselves, as for example topics as material/immaterial, collective/identity, culture/industry, etc. So, which are the design didactic challenges to provide horizontal skills for allowing young students to understand complexity and manage knowledge of the reality?

This article will discuss the case study of the perception among design of a newly generation admitted at the Innovation and Design Engineering Degree of the Universidad Panamericana – Guadalajara Campus. As expected, in this new generation we can especially observe a resistance to consider the sociocultural, business, technological and territorial dimensions as systems that strategically characterized and affected plural aspects of the design innovation processes. The contribute then proceed in analyzing case studies of didactic activities for creating skills and sensibility able to develop this capability to observe, select and manage the intangible in order to optimize the design of the tangible in the young generations.

The investigation, through the experimentation and comparison of informal didactic model, bring to the identification and promotion of special extra-ordinary didactics experiences oriented to the complex project and able to resalt the designer mediation role among the innate and dualistic tension between polarities able to resalt the intangible aspects which characterized contemporary design processes.

Keywords: *design education, management of intangible, young generations, learning process, Universidad Panamericana.*

1. Introduction

«Se dice cada vez más a menudo "eso es complejo" para evitar de explicar. Es necesario proponer una verdadera ruptura y poner de manifiesto que la complejidad es un reto que el espíritu debe y puede conquistar» (Morin, Ciurana, Motta, 2003).

There is multidisciplinar consensus among the need to rethink the profile of futures designer professionals by growing their capabilities of managing and solving complex problems. This need arises from the (pos)posmodern demand of heighten the number of factors, indicators and variables to take into account in advanced design process focused to anticipate futures and to bring man at the center of the project by contempling primary factors that modern societies didn't considere as environmental, cultural and social issues, etc. (Celaschi, 2000). The analysis of best practices of professional advance design works, underlines several common factors: «the barriers between various fields (research, academia, business, environment, public administration, population) were cancelled thus opening new transfer and sharing channels, enable the knowledge exchange. The design of various relationship took a determinant role […]» (Fanzini et al., 2014).

One of the most prominent voices who have faced this issue from the educational point of view is the anthropologist, became philosopher, Edgar Morin. As father of complex thinking paradigm, Morin suggests a dualistic approach to integrate the «analytic vocation of positivist sciences with the transdisciplinary and problematizing vocation of substantive philosophy» (Romero-Pérez, 2003, p.2). In his "Seven complex lessons in education for the future" (Morin, 2001), the author explains crucial problems which are needed to teach in the schools of every country. Among these, we should highlight the "Principles of pertinent knowledge" which statement is to encourage, through innovative education methods, the innate human propension to insert partial and circumscribed knowledges of different disciplinar areas in relation within thems and with the whole. Morin suggests to move on from old traditional education models for enabling in students the ability to restore relations and reciprocal influences betweens parts and total, where total is referring to the context, the global, the multidimensional and the complex; as well as strengthen the aptitude to set and solve essencial problems (i.e. general intelligence). Rebuild relationships between the parts and the whole means to overcame reduction and disjunction between humanistic and hiper-specialized science discipline and to finally take into account intangible and no measurable elements which were tradicionally eliminated during the phase of simplification of a problem (reductionism).

The urgence to form in young generations the ability of managing and solving complex problems is also expressed by the World Economic Forum as the most important of the ten skills professional need to thrive in the Fourth Industrial Revolution (Gray, 2016) .

The statement we are discussing is also well explored and expressed by Pier Giuseppe Rossi in his book "Tecnologia e costruzione di mondi: post-costruttivismo, linguaggi e ambienti" (Rossi, 2010). Rossi underlines how the paradigm change from linear to complex scientific approach requires to transcend the disciplinar division of Western cultures and to design finally new pervasive technologies for education process. The author stresses the need to leave linear and reductionist approaches in favor of complex, eco-systemic and enactive ones. Rossi recognize that contemporary cognitive processes are oriented to wordls construction and knowledge production rather than acquisition of informations. The changing paradigm also impact into researches, which move on from a model hipotesys – experiment – test, to a model design – action – thought.

This premise leads us to interrogate among various statements. If young generations are coming from second-degree schools, which programs usually still insist on content rigidly divided in disciplines and don´t consider how the contemporary relation between space and time has overturned for them, how professors of design faculties can manage the learning process for fostering and developing in them the skill of observing, synthetizing and managing complex systems? Is it possible to identificate best practice which helps professor to fostering student's skills of detecting and working on the intangible factors which affect a complex system?

2. Methodology

The article is conceives by referring to metadesign methodology in the disciplinar frame of Advanced Design Cultures, which process refers to differentes phases.

First, we observed reality by inquirying three group of the newly generation admitted at the Innovation and Design Engineering Degree of the Universidad Panamericana – Campus Guadalajara (Mx) about their percepcion among design definition to identify cultural constants in their thoughts.

Second, we conduced a multidisciplinary literature analysis which led us to isolate some fundamental principles. This activity allowed defining the complex project approach as centre of the (design) education debate. On the basis of this investigacion a learning experience was designedand experimented within the students of the Politecnico di Milano (Italy) and the Universidad Panamericana – campus Guadalajara (Mexico).

Third, we recollected and analyzed several high significative education activities realized in a selection of Latin American Design Faculties or countries which permit to experience managing solving complex problem skills.

2.1 The perception of design in newly generation admitted at the Innovation and Design Engineering Degree of the Universidad Panamericana – Campus Guadalajara (Mx)

In August 2015 we conduced a capillary enquest which aim was to investigate the percepcion about design in newly generation admitted at the Innovation and Design Engineering Degree of the Universidad Panamericana – Campus Guadalajara (Mx). Before starting the didactic activity of "Design¨Principle" course, it was asking to the sixty young students crossing that discipline, to define the therme "Design" in a short text. Moreover, those definition were elaborated to extrapolate keywords with the aim to facilitate a comparison between the concepts expressed.

Fig. 1 Word cloud that synthetize the definition of design provided by the students of the course "design Principle" of the Innovation and Design Engineering Degree of the Universidad Panamericana – Campus Guadalajara (Mx) in August 2015.

Has we can observe in the Figure 1 - where the dimension of every word depends on the number of repetitions of each relative to the total of the definitions - the percepcion of this statistic sample about the meaning of design lacks of numerous important concepts comparing to the design definition purposed by Flaviano Celaschi (Germak et al., 2008): «[design is] the way in which, in the contemporary system of trade, results are achieved in the form of products, services and experience, in which the significance, value, form and function are integrated and bring about universally recognised effects that lead to the exchange of these commodities on the market». The focus of the meaning of design expressed by young students, despite their digital nativity, is clearly oriented to a culture of tangible product rather than a culture of proyect (also oriented to achieve services and experiences results), where function and form are the main statement to balance with creativity for resolving a problem and where there is no perception about context or operational assessment (market, industry, technology,...) and contemporary intangible aspects as meanings, values, processes, time, culture, multidisciplinarity, and so on.

The collective definition of design suggested by students obviously find a connection with the design perception of non-experts, as they are when entering to a design school. Nonetheless we should identifying at least two factors, local and global, that should had an impact in their definitions. First, they are living in a country that, as the majority of Latin American nations, has a strong original arts and crafts tradition, rather than industrial one, as USA or Germany for example, have. This consideration, joined with the analysis of literature about Mexican design school evolution, shows how Design «has experienced slower development by local circumstances where, for historical reasons, innovation for the creation of goods and production has been marginalized for political reasons, and the national market subject to a culture based on the copy or inspiration in ways of life foreign to ours» (Flores, 2010). Second, exactly as it happens to students of all other the world, young designers are coming from second-degree schools, which programs usually still insist on content rigidly divided in disciplines which are not considering how the contemporary relation between space and time has overturned for them (Morin, 2001).

So, which are the design didactic challenges to provide horizontal skills for allowing young students to understand complexity and manage knowledge of the reality?

2.2 Highlits from the current debate on design education innovation

Due to the evolution from industrialized to knowledge based society, advanced industrialized companies have developed counciousness nearby informations and operative judgment are becoming necessary to produce innovation. Univeristies are stilling evolving in this contexts, trying to anticipate future needs of our societies by investing intellectual and economic resources for growing knowledge and disseminating it by training.

The focus that this article would to attempt, lead us concentrating on this second statement, i.e. on the dissemination of knowledge in the practice of design education as a priority. As the chapter "Research for design education: some topics" of the book "Innovation in design education" (Formia, 2012) well highlighted, we can identify from literature and case studies, some strategic and correlated themes at the centre of design education research debate. According to the author Antonella Penati, the theory/practice relationship should be identified as the core of design reflections and has generated several studies and approaches with the aim of integrating boths aspects for developing what Jane Abercrombie (Abercrombie, Patella, Giordano, 2003) has defined as "operational judgment". Penati's contribution facilitates the individuation of dydatic approaches that we identified in the diagram shows below.

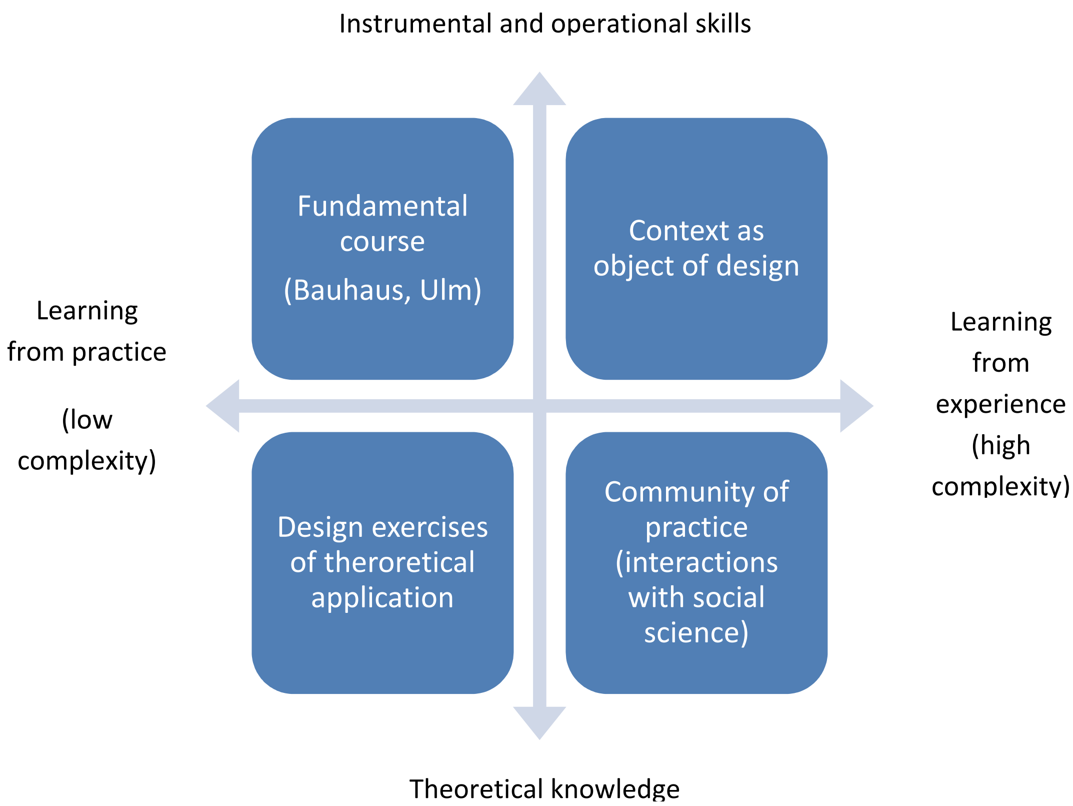

Fig. 2 Dydactic approaches of design education

The scheme objective, despite its simplicity, is to emphasize how recent debate among didactics education seems move from the learning with practice approach to the learning with experience approach, answering to the contemporary need of increasing complex problem solving student's capabilities by introducing activities able to develop skills as analysis of context and by transforming it in object of design. The main challenges in design education that literature is purposing refers therefore to two primary issues answering to the statement of knowledge as basis of good design recognized by Flaviano Celaschi (Germak et al., 2008, pp. 29-30) which are: «have very good knowledge of the phenomenon on which one is working in order to find the innermost essence of the problem that is to be solved; use a language of synthesis of the phenomenon that is capable of preserving the essence of the problem».

The postulation of metadesign process as apparatus of design practice innovation, provides us a frame of tools and methods which enormously improve the phase of a design process: the knowledge of the phenomenon by stimulating the literary sources and context investigation, also in disciplinar field and areas which are not stricty related to the problem analyzed (Celaschi, Deserti, 2007).

Referring to the visual thought, as underlined by Antonella Penati, the italian design research literature identified two main areas of interest: on the one hand, the research line concerning the product identity communication which is going further the visualization of tangible qualities for including in the construction of scenarios all intangible qualities related to communication, emocions and senses; on the other hand, the research line concerning the design of scenarios of possible futures (intangible) which is explored by innovative design processes which requiring the designer talent of implementing «new values, behaviours, methods of use, functional solucion and possibilities of services» (Formia, 2012, pp.64-65).

2.2.1 Pedagogic issues in the complex paradigm

The pedagosist literature is plenty of authors who analyze the epistemological principles that sustain the paradigm of complexity for detecting new theroretic and methodologic models which should aid the scientific community to elaborate theories more fitted to the reality. Due to the nature of complexity, it seems quite impracticable, from the scientific point of view, to define exact methodological recepies that precisely defines the path to take for teaching in the systemic paradigm. Robinson Roa Acosta, in his dissertation on "Formación de profesores en el paradigma de la complejidad" (Roa Acosta, 2006), rather than remember that professors should be themselves educated in the complex paradigm for well developing their educative missions, indirectly suggests guideline helpful to understand primary elements to take into account for correctly design systemic educational methodologies. Between them we highlight:

- develop a vision and a shared mission with students;
- propender for the development of academic activities, establishing the largest possible number of relationships with other fields of knowledge;
- select, organize and structure resilient academic curricula that promote learning related to reality;
- develop laboratory practices through problem solving that allow, in unison with the theory, the appropriation of contextualized conceptual elements:
- students do face real problems of disciplinary and interdisciplinary work;
- seek the participation of students in the formulation, development and management of research and knowledge from and between different fields of knowledge;

- allow colleagues and students to make decisions regarding the educational activities of a class (participacion logic);
- plan an evaluation system of activities to assess the impact of the class and help improve them.

2.2.2 What do we expect from a design training model?

The design literature is rich of recent dissertations regarding design training models and pedagogical aspect. So the objective of this part of contribution, more than wanting to be exhaustive, it's to resume the main aspects to take into account for understanding the complexity of design a Design career.

First, it is strategic to define the profile of the designer that we want to educate for the future. According with the concepts previously expressed, Claudio Germak (Germak, Bozzola, 2010; Germak et al., 2008) traces an anatomy of the professional profiles of designers, which he calls "exploring designers", in relation to the exploration activities that a project requires. Based on twenty years of experience of the Politecnico di Torino (Italy), the author identifies three alternative/evolutionary/complementary professional profiles:

1. The conscious designer. His/her products have cultural value and are based on the purpose and accuracy of the performance provided.
2. The scenario designer. He/She works in collective research connected with other areas of specialization to produce scenarios in which «contextual values are accumulated to form critical mass: social, cultyral, ethical, biological and technological values»
3. The navigating designer. Proactive figure with inexhaustible curiosity in search of new territories of project. He/She is an innovator because is able to go further the common sense and has developed a wide range of multi/interdisciplinary, sociocultural and material references.

According with various schoolars (Penati, 2015; Maldonado, 1974), design process of learning consists of a broad variety of methods which are on complementarities but at the same time in opposition each other, as sohwn in the image below.

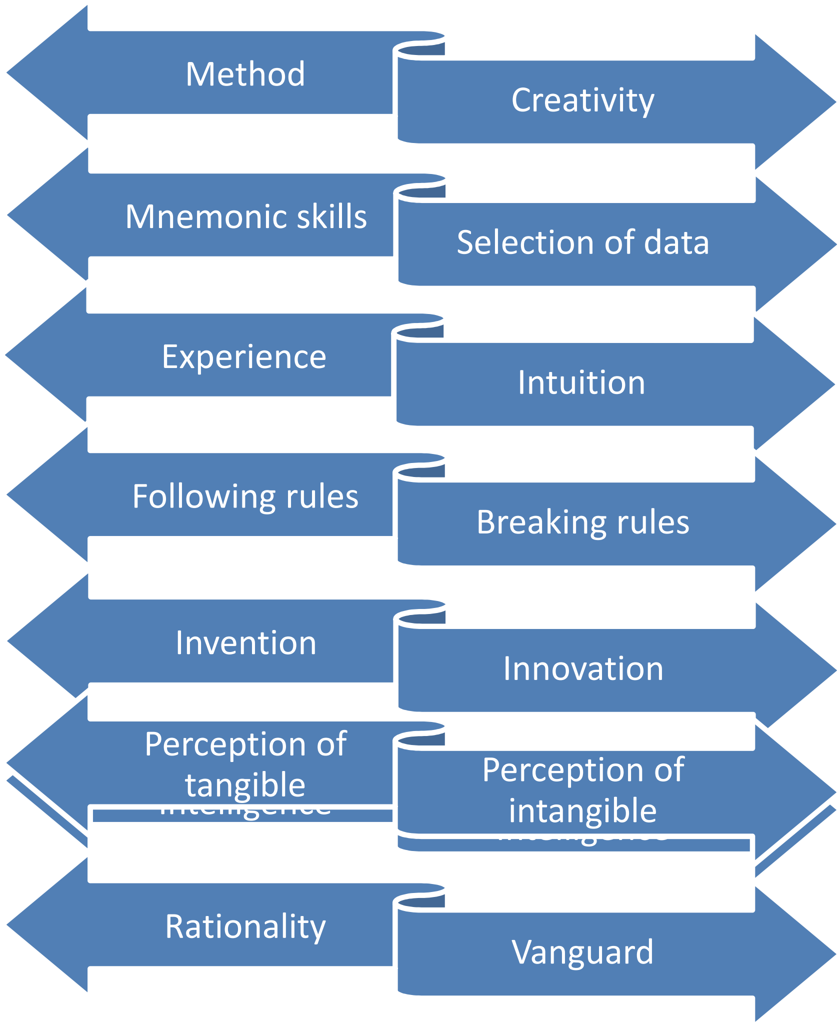

Fig. 3 Antithetic/Dialectic relationship between strategic designer skills

The tension between dualistic forces in balance is the core of design process. The antinomy and complementariety between concepts, rules and methods should be indentified as extreme consequence of complex thinking paradigm (Morin, Ciurana, Motta, 2003). Depending on how much the educators/designers stress those forces and are able to make more strong the curiosity of student, they should get different professional profiles. With how much educators want to achieve an innovator designer profile, how much the strategic designer skills showed above have to coexist in the same individual.

Also due to the progressive dematerialization of products, the need to form in young student the capabilities of analyzing and managing intangible factors of a system, as one of strategic designer skills to achieve innovation, is growing. According with several authors (Germak et al., 2008; Penati, 2015; García-Garrido, 2015; Papanek, 1977), it remains primary to include a set of humanistic discipline into design school curricula.

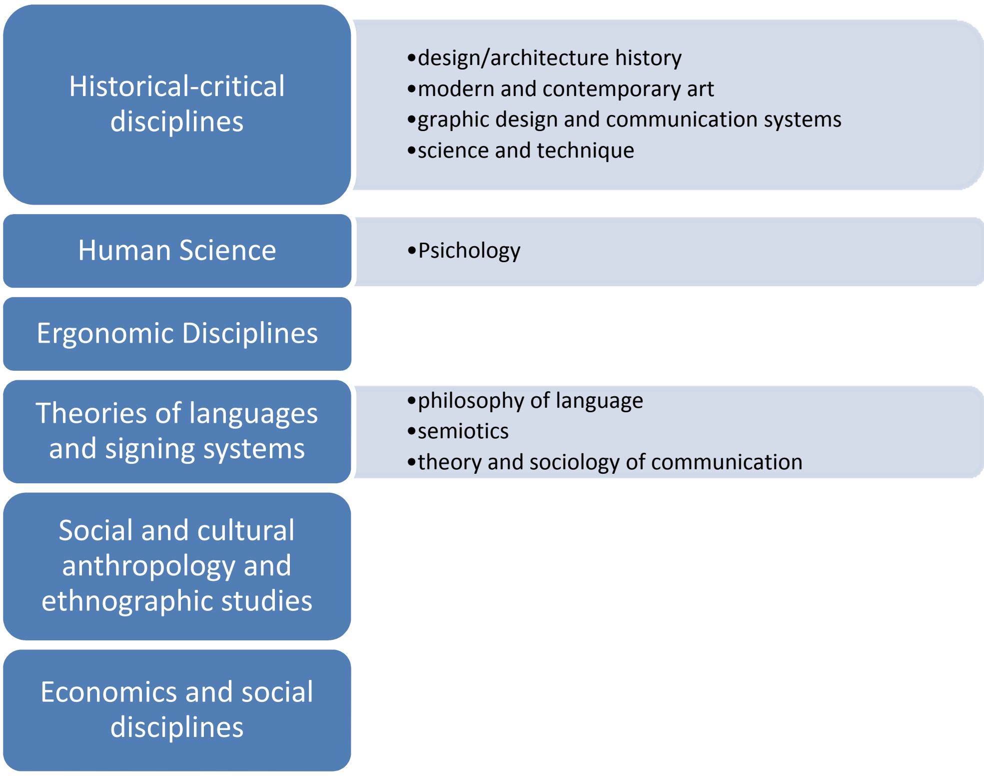

Fig. 4 Humanistic Discipline contributing to a Pedagogy of design. Fuente: (Penati 2015, pp.77-79)

2.3 Intangible context factors

Scholars are recently starting to explore the strategic potential of Design to imagine and communicate tactic and scenarios for the change, by operating with agent activators that work on a territory (Celaschi, Germak, 2009). Approaching the context from the point of view of a design project means to understand the evolving tangible and intangible parts of which it is composed as well as the relationships between themselves.

One of the most interesting contemporary approach analizing the local context is recognized in the researches on the territorial capital lead by Roberto Camagni (Camagni, 1999). Camagni´s assessment were been officialy included in the regional development EU politcs of the Organisation for Economic Co-operation and Development (OECD), with the report Territorial Outlook 2001. The report demonstrates that every region have its own specific territorial capital which is able to make certain types of investments more effective compared to others. The factors that play a key role in the territorial capital definition are geographic location, size of the region, climate, natural resources, quality of life and economies of scale. To these other factors affecting the traditions or local and regional costumes are added, as well as, the quality of governance, which includes issues such as mutual trust and informal rules that enable different actors to work together under conditions of uncertainty according to principles of solidarity and mutual assistance (social capital). Lastly, into the territorial capital are coming into play immaterial factors defined by the OECD report as "something in the air or environment", arising from the interaction of institutions, rules, practices, producers, researchers and policy makers that facilitate the conditions for the development of creativity and innovation, namely what is defined as "quality of the milieu" (Zonneveld, Waterhout, 2005).

According to the definition proposed by the OECD, Francesco Zurlo summarizes the territorial capital as «the combination of physical and intangible elements available to the area that can be strengths or real constraints, depending on the aspects taken into account» (Zurlo, 2003). The Zurlo's concept of territorial capital implicates all the integrated elements that form regional prosperity:

- Know-how, which is the set of knowledge and skills necessary to perform certain work, research and development activities;
- Human resources;
- Physical resources, which is the set of natural objects, cultural and infrastructure;
- Forms of governance;
- Markets and relations with the exterior.

A more detailed taxonomy of the assets that characterized the innovation processes of territorial capital has been more recently published by Roberto Camagni (Camagni, 2008)

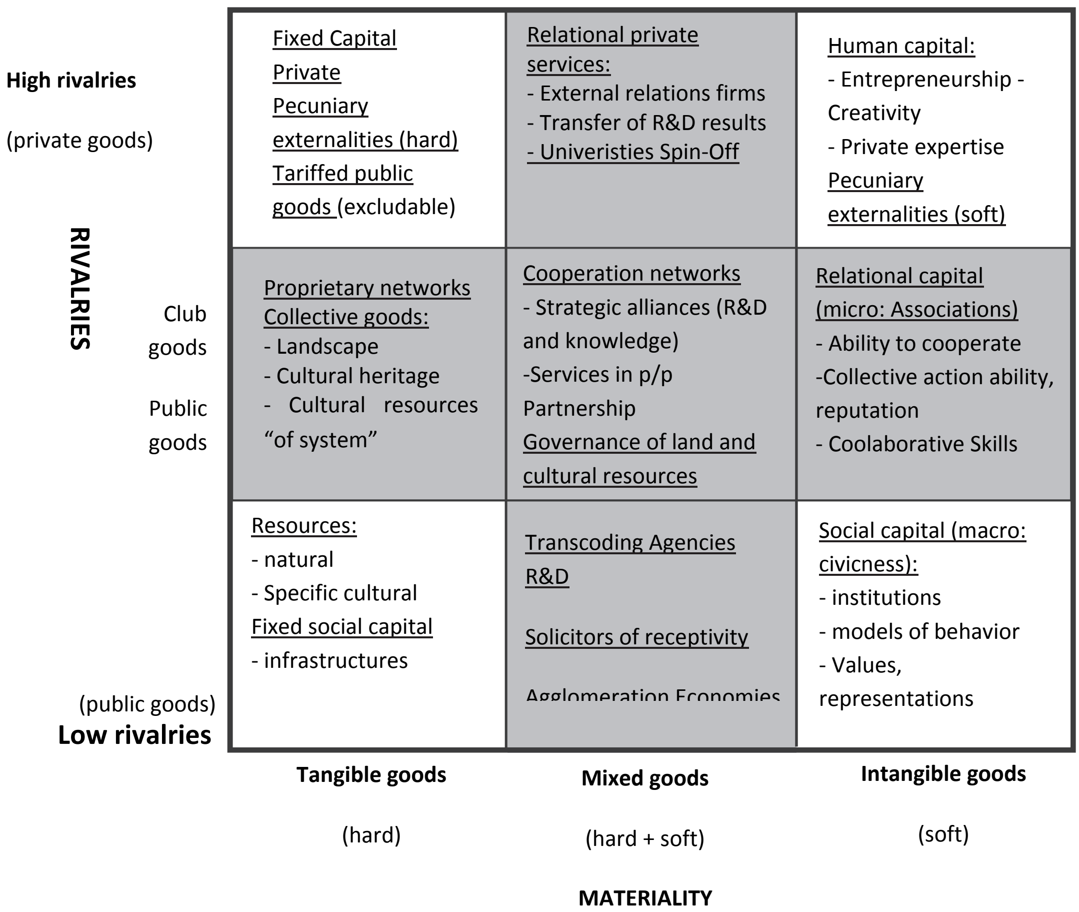

Fig. 5 Classification of territorial capital as a function of materiality issues and rivalries Source: Camagni (2008)

The elements that Camagni considers are divided according to their materiality. At the corners of the matrix (resources, social capital, human capital, private capital) there are the simplest elements to be determined, i.e. those which normally come in themselves working for a traditional land transformation process. The elements placed in the gray fields are otherwise characterized by more diaphragmatic limits and more complex definitions. They are formed by intermediate classes of goods that require strong elements of relationship with the other elements of the territorial context and that can assume strategic roles in the governance of local development processes. They usually result from complex cognitive processes that have taken place over time on a territory, generating in the local community the ability to learn from the experiences conducted. In the center of "innovative cross" the author recognizes the strategic importance of alliances for Research & Development (R&D) and for the creation of knowledge, supported by transcoding agencies, those that designers define mediators. Camagni's definition of territorial capital offer a wide and exhaustive panorama about the systemic nature of a local context.

The contents of the intangible column: human, relational and social capital bring us back to those humanistic statements which were mentioning above, while in relations with other paradigmatic elements of a place. A human centered focus of design practice, as cultural act, should not separate the man from the context during the phases of a design process.

Referring the territorial capital concept to the Design concepts expressed by Flaviano Celaschi we could thereforme affirme that context is a strategic and irreplaceable factor that contain elements which guide designer in shaping products, experiences and services (Celaschi, Germak, 2009).

2.3. Learning from a real context

In the practice of design educations, students are called to develop a wide selection of activities. In this part of the contribution we want to identify tipologies of design education activities which are experimenting the growth of complex thoutgh abilities in student which are coursing project centered academic career. This analysis does not pretend to be exhaustive, but suggests the possibility of enhancing the international relations created starting from the Latin American of Design network to share information on teaching practices that provide the development of skills within the complex thought, as well as on extraordinary activities that allow students to go beyond the "limits" of the Academia for coming into direct contact with the real context and/or professionals of different disciplines and experiences.

A first cathegory of this kind of activities it's usually realized from professor trained to the complex thought who use building and/or cultural/social context as design' object. It's the case of the majority of doctoral workshop held by the ABC Department of Politecnico di Milano (ITA)[15], or as, for example the design courses led at the Faculties og Innovation and Design Engeneering of the Universidad Panamericana campus Guadalajara (MX)[16]. The list were be very large.

A second cathegory of experiences could be related to the fact that in the contemporary university contexts all other the world is quite commun to find a system of validation of student performances by recognizing formative credits. This means that exist facilities that allow students to undertake, with greater simplicity, national and international interchange programs in other Universities or participate in extra-curricular educational activities of various kinds. This opening led us to detect other kind of extracurricular experiences which undoubtedly could have a stronger impact in the professional growth of design students. We are referring to a wide variety of temporary events as workshops, summer schools, design driven incubators that are managing with multi and infradisciplinarity, multiculturalism as well as, the dualistic soul of our contemporaneity, i.e. local and global. Those kind of activities also help students

[15] Cultural Heritage conservation and Valorization Workshop: students were called to design projects for the relaunch of cultural district of Oltrepo Mantovano Region (Italy) as concluding act of a participated project process which involved local institutions and culturale stakeholders. The output of the process were adopted by the cultural district governance for the search of new public and private funding.

[16] Taller de innovación y diseño estetico: metadesign practice for the regeneration of the Zapopan Centre, Historique Centre department of Zapopan governemt involved; Taller de innovación y diseño ergonomico,– Development of products for improving the life quality of children with disabilities, Hospital CRIT Teleton Guadalajara involved.

on one hand to understand the uncertainity of reference context and social/cultural/economic players and on the other hand to detect the main global innovation corridors. In the table below we are schematically illustrating few impacting best practice to which we are referring.

Tabla 1. Extracurricular activities case studies

Experience tipologies	Reference	Reality investigated	Subjects	Characteristics
Extracurricular activities promoted by University	Design now summer school	Milan future fab city	Bachelor and master students of various faculties	Context as design object, Anticipation, infradisciplinarity
Extracurricular activities promoted by University	ROMA 20-25 Nuovi cicli di vita della metropoli, workshop and exposition	Envisioning the future of Rome	National and International Universities	Context as design object, Anticipation, infradisciplinarity multiculturality
Extracurricular activities promoted by firms	Innovation Workshop de Continental	Future vehicles	Students of various faculties	Anticipation, infradisciplinarity
Extracurricular activities promoted by universities and Association	Future ways of living Charrette -	How technologies will impact future ways of living	Institute without Boundaries (CA), Meet the Media Guru (ITA), students professional, scholars	Anticipation, infradisciplinarit, multiculturality
Extracurricular activities promoted by informal networks	Global Service JAM – internacional streaming workshop	Design services	Universities, scholar, students, profesionals, citizen…	Multiculturality, infradisciplinarity

3. Conclusion

Sociological, pedagogist and design scientific scholars recognize the strategic urgent need to find ways for cultivating and enhancing in young generations the skill of managing and solving complex problem with the hope of forming professionals able to find more economic/social/ambiental sustainable and ethic solutions to problems. Despite the investigations, the same nature of complex thinking inhibits investigators to achieve exact recipes for resolving the pedagogical need of developing educacional methods able to strengthen in young generations the systemic thought.

From the point of view of design education, the model of metadesign process should answer, from the didactic and professional point of view, to the exigence of guiding designer into the project complexity by stressing and dilating the phase of investigation which anticipates the same design phase. Design discipline also is moving from the learning with practice approach to a learning with experience approach. This means that the activities that more develop into students the capacity of dealing with high complexity are recognizable in two main achieve: working with the context as object of design and working immersed into communities of practice. Undoubtely both events should accelerate the process of student immersion into reality, the experimentation of what means intangible and develop the innate curiosity to understand the parts in relation with the whole.

Despite the lack of tools for verifying the rise of complex thinking into young design generations, which suggest new routes for multidisciplinary investigation, it seems obvious to recognize, especially in the extracurricular activities led by universities, with the partnership of firms and/or formal/informal external organizations (or viceversa), an excellent start point to mature multidisciplinary, multicultural, advanced and intangible factors sensibility.

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A Research on Designer Roles in Industries

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Abstract

In this study, possible differences for roles of designers in different industry systems were explored. It was studied if expectancies from designers change according to industries they work. This study is linked with a prior study which has investigated general expectancies from designers to get a hint about their work environment.

In a prior study done by the authors, it was investigated if concepts such as design thinking had any effect on requirements from designers. Since design thinking advocates designers to take active roles in managerial issues, and also require them to work with consumers as a team, it was hypothesized that recent job announcements may require capabilities related with these concepts. Also, when recent studies are evaluated, it can be seen that designers may take several different roles in companies. Therefore, it was investigated if capabilities referred in job announcements hinted any of the designer roles. It was found that companies asked for skills that addressed capabilities for designer roles such as team manager and process managers. However, the effects of industries' differing environments on requirements were not explored.

In the scope of this study, it was aimed to interview representatives from different industries to understand how different business systems affect design, and how designers transform themselves for different roles. Therefore, how business dimension along with type of products and services a company provides affect and change roles and requirements from designers was studied. A total of 50 companies were studied; 10 companies from 5 different industries with diverse characters were briefly interviewed to understand industry effect on requirements from designers. Interviews were thematically coded to define capabilities each company required. Industries included were shoes & bags, furniture accessories, jewellery, packaging and advertising & exhibition. It was found that requirements from designers differed according to the industry a company operates. Companies seem to emphasize different skills in relation with their business systems.

Keywords: *Design management, design thinking, designer roles*

1. Introduction

Recent studies suggest that designers get more involved with managerial issues and designers' capabilities are adapted to decision making processes, therefore organizations encourage their managerial staff to develop designers' skills. (Cooper et. al., 2009). This trend can be evaluated together with design thinking, which also hints that both managerial problem solving and design problem solving processes are "wicked" by nature, and the capabilities needed to manage them are alike (Dorst, 2011).

In this study, design thinking concept and its' relevance to demanded designer skills according to industries will be explored through interviews. Former data gathered from job announcements will also be shared. The role of the designers in the organizations will be analized through required characteristics that are not strictly linked with design action.

2. Design Thinking Concept and Roles of Designers in Organizations

Design thinking suggests that designers' problem solving abilities has a function in business environment. Design thinking concept also supports the idea of designerly problem solving being used along with user oriented competition strategies (Brown, 2008). Hobday et. al. (2011) also state in their studies that "...the treatment of design as a human-centered, core creative activity in business challenges the overly scientific, rational view of the firm and, with it, many of the standard intervention tools of innovation management.". They hint that design's solution oriented approach does not resemble other human-centered approaches; business, society and economy can benefit from design thinking (Hobday et. al, 2012).

Researches on designers' abilities also provide insights about designers' capability to carry out various problem solving techniques. Dorst (2003) suggests that designers work with three types of problems; defined, underdefined and undefined. Defined problems mostly deal with objective issues, while undefined problems are generally subjectively solved by designers' own taste and talent; however underdetermined problems, which forms the majority of the problems in a design process, are mostly formed during design process and designer deals with these problems by considering possible problems and solutions (Dorst, 2003). The concept on underdefined and undefined problems seems to suit with Cross (1990, 2001), who supports the idea that dealing with uncertain situations is involved in design problems. Cross (1990) also declared that designers can (1) create unique and unusual solutions, (2) work with incomplete data (3) work with uncertainty, (4) solve practical problems by using their imagination (5) solve problems by using drawings and other visualization equipments. This statement is also compatible with the others suggesting that design mainly deals with "wicked problems" that are difficult to define (Rittel & Weber,1973; Buchanan, 1992).

Studies on different designer roles may indicate that designers' abilities on problem solving can lead them to have more involvement with other functions in the organizations' environment. Valtonen (2005) argues that while designers have always worked in product development process, they increased their role in the area and business in general. In her study on how designers' role evolved in Finland, one of the design-solution providers she quoted declares that the corporate directors say they need to change companies' strategies; but they don't know why and how, and design-service providers deals with these situations (Valtonen, 2005). This statement briefly expresses the way design is implemented to companies' strategies to create value. It may also suggest that the designers' capabilities about dealing with unclear problems can help executives to clarify strategies.

Another study on designers' roles in organizations defines three different roles a designer may take in a company (Perks et. al., 2005). Referred study mainly categorizes these three roles as shown below.

Table 1. Design roles and their descriptions, derived from Perks et. al. (2005) study.

Design Role	Main Actions	Required Skills in General
Design as Functional Specialism	They concentrate purely on design and are evaluated as resource	Traditional skills (aesthetics, visualization, technical skills, etc)
Design as Part of Multifunctional Team	Generate interaction between team-members, being a key member in a team	Skills to enable interaction and communication, flexibility and team building
Designer as NPD Process Leader	Getting more involved with marketing studies to set the direction, managing new product development process and informing other functions.	Non-functional skills such as business analysis, research, project management, motivating others, communication skills.

"Design as a part of multifunctional team" and "design as a NPD process leader", may express the design thinking effect on designers' roles. Team-building skills and overall process management skills are compatible with the suggestions that design supports product development process through designerly thinking and designers' familiarity with wicked problem concept may help them when they deal with process related issues.

In this study, the qualities that are not directly linked with core design abilities will be coded. Therefore, the roles and requirements other than main design function practice were tried to be identified.

3. The Research

In a prior study job opportunities announced in Coroflot website job board was read and coded and evaluated. The results for the codes in the prior study are explained below. Afterwards, the probable differences for different industries will be evaluated by the current study.

3.1. Results of the Prior Study

During the prior research, behavioral qualities and expectations were coded into groups listed and described as below (Authors, 2015).

- *Working in teams/cross-functional teams* stands for employer expecting designers to work with teams. "Cross-functional teams" and "teams" were not coded separately as it is not clear in most of the jobs if the word "team" refers to a cross-functional team or a monofunctional team. So, the base for the code was being able to function as a team in a design environment.

- *Working independently/self-manage/self-motivated* refers to the ability of managing own work, without constant instruction and direction from a manager.
- *Working closely with executives* hints being able to work directly with executive staff.
- *Mentoring/leadership* implies to the ability of mentoring colleagues.
- *Marketing research* means doing marketing research activities.
- *Brand management skills* indicates the ability to build and/or manage a brand. Brand identity application abilities (to the product and services) are not included in this category.
- *Business management skills* refers to being able to handle managerial issues; dealing with subcontractors, accounting issues, etc.
- *Multi-tasking/flexibility* hints the qualifications required for handling multiple projects at the same time and switching projects when needed.
- *Working in a fast paced environment* implies ability to work with tight deadlines.
- *Project management and organizational skills* means being able to keep up with and direct a project within defined timetables and budgets.
- *Working under pressure* refers to being able to handle stress in daily work environment.
- *Self starter/proactive* indicates abilities for acting entrepreneurial and innovative without being told; being able to take initiative.
- *Problem solving* points out ability to deal with process oriented problems at work. Design related problem solving skills were not included in this code.
- *Client interaction/ management* means being able to handle client accounts, presenting to and meeting with customers directly.
- *Communication skills* indicates having positive interpersonal skills and handling process related communication issues in a constructive way. Design related communication skills such as visual and verbal presentation skills are not included in this category.

When the job announcements in Coroflot website was coded; the frequencies for the codes given were derived as follows.

Table 2 Derived from the prior study by writers. (Authors, 2015)

Category	Managerial (out of 228)	Senior (out of 243)	Regular (out of 912)	Intern (out of 43)	Total (out of 1430)
Working in teams/cross-functional teams	172 (75%)	190 (78%)	610 (%62)	22 (51%)	994 (69%)
Working independently/self-manage/self-motivated	41 (17%)	52 (21%)	242 (27%)	16 (37%)	351 (25%)
Working closely with executives	13 (5,6%)	10 (4,1%)	31 (3,3%)	2 (4,6%)	56 (3,9%)
Mentoring/ leadership	111 (48%)	70 (29%)	65 (7,1%)	0 (0%)	246 (17%)
Marketing research	22 (9,6%)	22 (9%)	62 (6,7%)	3 (6,9%)	109 (7,6%)
Brand management skills	33 (14%)	23 (9,4%)	46 (5%)	1 (2,3%)	103 (7,1%)
Business management skills	45 (20%)	22 (9%)	46 (5%)	0 (0%)	113 (7,8%)
Multi-tasking/flexibility	52 (23%)	57 (24%)	208 (23%)	8 (19%)	325 (23%)
Working in a fast paced environment	56 (24%)	67 (28%)	265 (29%)	13 (30%)	401 (28%)
Project management and organizational skills	169 (73%)	133 (55%)	450 (49%)	12 (28%)	764 (53%)
Working under pressure	13 (5,6%)	19 (7,8%)	48 (5,2%)	1 (2,3%)	81 (5,6%)
Self starter/proactive	35 (15%)	40 (16%)	131 (14%)	8 (19%)	214 (15%)
Problem solving	47 (20%)	53 (22%)	151 (17%)	5 (12%)	256 (18%)
Client interaction/ management	77 (33%)	77 (32%)	152 (17%)	4 (9,3%)	310 (22%)
Communication skills	135 (59%)	151 (%62)	448 (49%)	16 (37%)	750 (52%)

When the results are evaluated together with Perks et. al.'s (2006) model, it can be seen that the most required qualifications fit for team leader and process manager roles.

Table 3. Derived from the prior study by writers. (Authors, 2015)

Groups	Qualifications and Total Frequencies	Number of Announcements That Require at Least One of The Categories
Design as Part of Multifunctional Team	Working in teams/cross-functional teams - 69% Communication skills - 52%	1179 (82%)
Design as NPD Process Leader	Working closely with executives -3,9% Mentoring/leadership - 17% Marketing research - 7,6% Brand management skills - 7,1% Project management and organizational skills - 53% Problem solving - 18% Client interaction/management - %22 Communication skills - 52%	1169 (82%)
Designers' Working Environment	Multi-tasking/flexibility - 23% Working independently/ self-manage/self-motivated - 25% Working in a fast-paced environment - 28% Working under pressure - 5,6% Self-starter/proactive - 15%	826 (58%)

However, in this research, codes were not evaluated according to industries. Also the evidence about why organizations demanded these qualifications was limited.

3.2. Research Method

A total of 50 companies were interviewed in this study. Companies were chosen among 5 industries, each designing their own products. It was aimed to ask organizations their expectancies from designers, so each of these firms employ designers either regularly or project base. Therefore, purposive sampling was used as the sampling method (Robson, 2002).

Companies were interviewed mostly at industrial exhibitions; packaging industry at Avrasya Ambalaj 2015, furniture accessories at Intermob 2015, shoe & bags at Aymod and jewellery at İstanbul Jewellery Show Ekim. Advertising & exhibition industry was interviewed through e-mail. Due to the medium and environment, interviews were kept short and evolved around one single question. Duration was between 5-20 minutes; coding was done during interviews and notes were taken when necessary.

Initial question was "What are the qualifications you demand in a designer that you employ, other than the functional designer abilities?". Most of the respondents answered this question by basically explaining their work environments. Additional questions were asked when needed.

4. Results

Results of the study will be evaluated by industries.

4.1. Bags and Shoes Industry

The codes for the shoe & bags industry can be seen below.

Table 4. Codes for shoe & bags industry

SHOE & BAGS	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**Total**
Working in teams/cross-functional teams	X					X			X		3
Working independently/self-manage/self-motivated											0
Working closely with executives	X		X						X		3
Mentoring/ leadership							X				1
Marketing research	X	X			X	X	X	X		X	7
Brand management skills											0
Business management skills											0
Multi-tasking/flexibility											0
Working in a fast paced environment											0
Project management and organizational skills		X		X			X	X	X	X	6
Working under pressure											0
Self starter/proactive											0
Problem solving				X							1
Client interaction/ management				X							1
Communication skills				X				X			2

Shoe & bags organizations can be evaluated within fashion industry. They work on season base and produce their own products to be sold by retailers.

The top two codes for this industry is "project management and organizational" skills with 6/10 frequency and "marketing research" with 7/10 frequency. As the designs in this industry is strongly related with trends, companies mostly demand that designers do their own market research and bring their insights about fashion trends to the firm; so they require marketing research capability from a designer. Firms also mostly request project management and organizational skills but somewhat in a limited way. Companies demand designers to deal with design process by themselves, but only until model sketches are drawn.

"*They should bring us many, many model drawings… tens of. The production is our task. I can produce what they draw, and even if 5 or 10 of them is sold in the market, their job is done*" C2

Time and pace based requirements like working in a fast paced environment; multi tasking and working under pressure are not mentioned by interviewees. This may be because the industry's pace is already set by seasons and long term planning can be done.

One of the companies, C4, was mostly working with a boutique style, so required designers to bring alternative ideas to current trends. This included with working with customers for related projects, and effects can be seen on communication skills and problem solving skills requirements.

4.2. Furniture Accessories Industry

The codes for the furniture accessories (handles, wheels, foots, etc) industry are as follows:

Table 5. Codes for furniture accessories industry

FURNITURE ACCESSORIES	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	Total
Working in teams/cross-functional teams	X		X	X	X		X	X	X	X	8
Working independently/ self-manage/self-motivated											0
Working closely with executives						X	X		X		3
Mentoring/ leadership						X					1
Marketing research							X	X	X		3
Brand management skills											0
Business management skills							X				1
Multi-tasking/flexibility					X	X		X	X		4
Working in a fast paced environment											0

Project management and organizational skills	X	X	X	X	X	X	X	X	X	X	10
Working under pressure											0
Self starter/proactive											0
Problem solving	X										1
Client interaction/ management		X		X		X		X	X	X	6
Communication skills	X	X	X	X	X	X		X	X	X	9

The most required qualifications in furniture accessories industry are working in cross-functional teams with a frequency of 8, project management skills with a frequency of 10 and communication skills with a frequency of 9 over 10.

Furniture accessories industries have a mixed customer base, as they can both design products for a specific furniture producer or design their own products to be sold by retailers. As designers do not define qualifications of the products just by interpreting trends, qualifications for working with other counterparts were demanded, such as working with teams and client interaction skills (6/10). This also diminishes the request for marketing research skills, when compared to industries driven by fashion trends.

"*Our marketing team deals with the needs of the customers. Designer just needs to turn them into products to be realized by our production team*." C5

As sometimes designers have to work with their corporate customers' pace, multi tasking is required by some of the companies. But most of the companies declared that custom designs for other companies do not form the majority in their total design work, effects of this criterion is limited.

4.3. Jewellery Industry

The frequencies for the jewellery industry are as follows:

Table 6. Codes for jewellery industry

JEWELLERY	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	Total
Working in teams/cross-functional teams				X	X	X		X			4
Working independently/self-manage/self-motivated			X				X				2
Working closely with executives	X		X		X	X			X		5

Mentoring/ leadership											0
Marketing research	X	X			X			X	X	X	6
Brand management skills											0
Business management skills		X		X	X	X				X	5
Multi-tasking/flexibility											0
Working in a fast paced environment									X		1
Project management and organizational skills	X	X	X	X	X	X	X	X	X	X	10
Working under pressure											0
Self starter/proactive		X		X				X		X	4
Problem solving		X		X							2
Client interaction/ management	X	X		X				X			4
Communication skills	X	X	X	X	X	X		X	X		8

Jewellery industry resembles shoe & bags industry, as it is related to trends; they also both work with end users and retailers. However, since the materials used in the sector are quite expensive and amount of material used is very decisive in the final price of the product, designers have a closer link with production teams and customers.

The most required three qualifications in jewellery sector are marketing research with a frequency of 6, project management skills with a frequency of 10 and communication skills with a frequency of 8.

Similar to bags & accessories sector, marketing research and project management skills are two of the most demanded qualifications. However, especially when designing boutique products for exclusive customers, designers get in contact with end users or retailers.

"*It is designers' job to get in contact with customers.. We expect designers to follow market and add their insights to products*." C9

Since the industry works with a seasonal pace, just like shoe & bags industry, schedule is not tight. Therefore qualifications addressing adapting to tight schedule are not frequently requested. However, producers require designers to take more initiative by demanding them to get more involved with business management aspects, work with executives and be a self starter, when compared to shoe & bags industry.

4.4. Packaging Industry

The requested qualifications for the packaging industry can be seen in the table below.

Table 7. Codes for packaging industry

PACKAGING	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	Total
Working in teams/cross-functional teams		X		X		X	X	X			5
Working independently/self-manage/self-motivated	X		X	X					X		4
Working closely with executives	X	X		X			X				4
Mentoring/ leadership	X										1
Marketing research	X	X						X		X	4
Brand management skills											
Business management skills	X					X					2
Multi-tasking/flexibility								X		X	2
Working in a fast paced environment				X	X	X		X			4
Project management and organizational skills	X		X	X		X	X	X		X	7
Working under pressure						X		X	X		3
Self starter/proactive					X						1
Problem solving	X		X			X	X			X	5
Client interaction/ management	X	X		X		X	X		X		6
Communication skills	X	X	X	X			X	X		X	7

Packaging industry is strongly defined by corporate customers' demands. Companies work with defined demands by customers, and pace of the organizations fluctuates according to demands from the market. Unlike furniture accessories industry, companies almost always act according to demands; project periods are shorter and production quantities are higher.

The most asked qualifications are mentioned by slightly more than half of the organizations interviewed; project management skills has a frequency of 7, client interaction and management have a frequency of 6, while communication skills is mentioned by 7 companies. Also, problem solving skills and working with teams were hinted by half of the companies.

Time constraints are one of the major factors that affect expectations of companies from designers. Some of the companies mentioned existence of pressure in the work environment and multitasking as factors designers should deal with. Also client interaction skills is requested both for more accurate outcomes and to manage time constraints.

"*They should be able to communicate with customers… Because we don't have time for it.*" C4

Unlike other sectors, packaging firms demand their designers to expand their process management skills to production process.

"*The top agencies in the industry do not deal with production. However we are more like an overall service provider, so our designers have to deal with production also.*" C6

4.5. Advertising and Exhibition Industry

The codes for the advertising and exhibition (fair stands, product stands, etc.) industry is as follows:

Table 7 Codes for advertising and exhibition industry

ADVERTISING AND EXHIBITION	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	Total
Working in teams/cross-functional teams	X	X	X	X				X		X	6
Working Independently/ self-manage/self-motivated	X								X		2
Working closely with executives	X	X	X	X					X		5
Mentoring/ leadership	X								X		2
Marketing research	X	X	X	X					X		5
Brand management skills											0
Business management skills	X	X							X		3
Multi-tasking/flexibility	X	X		X	X	X	X	X	X	X	9
Working in a fast paced environment	X	X	X	X	X	X	X	X	X		9
Project management and organizational skills	X	X	X	X	X	X	X	X	X	X	10
Working under pressure	X	X		X							3
Self starter/proactive	X	X							X		3
Problem solving	X	X	X	X	X	X	X	X	X	X	10
Client interaction/ management	X	X	X	X	X	X	X	X	X		9
Communication skills	X	X	X	X					X		5

Advertising and exhibition sector is also strictly constrained with corporate customer demands and time tables. Unlike other industries, some of the products such as fair stands can be custom produced for once according to the stand area and budget. Workload also fluctuates according to customer demands.

Six of the mentioned codes were requested by more than half of the companies. Problem solving skills and project management skills are demanded by all of the companies, while 9 of the interviewed organizations also demanded multi tasking and flexibility, working in a fast paced environment, client interaction and management. Ability to work in teams was also mentioned in 6 interviews. Communication skills, working closely with executives and marketing research have moderate frequency, while business management, working under pressure and being a self-starter were mentioned just below the average frequency.

"...we prefer face to face communication, rarely a project may be given through e-mail. We care for a continuous communication" C2

"When needed, brainstorming is done with chiefs or executives by the relevant designer on the project or the design team." C1

"Being able to work with flexible work hours is required." C8

"Production pursuance is done when necessary" C1

From the codes and comments, it can be interpreted that companies mostly work with pace of the customers, therefore designers should be able to adapt to the conditions with minimum supervision. Also, designers get involved in a larger percent of total product development process, as they get involved in the process from customer brief to production stage.

5. Conclusion and Further Studies

When results of the current study are investigated, it may be suggested that requirements from designers can change according to industries they work. Therefore, a system effect in business dimension can be seen on roles that designers take.

Shoe & bags and jewellery industries require more functional specialists more than other sectors. Marketing research and project management skills are required in more than half of the companies in both industries. Jewellery organizations also require communication skills, as designers have to work closer with marketing staff and production team; as the industry is more price and production sensitive than shoe & bags industry. In these sectors companies' main expectation is to produce fashionable products, so they need to rely on designers' functional capabilities. Most of the time companies declare that they only request drawings from designers and they can go on with the rest of the process without the involvement of designer.

Furniture accessories sector has both own design production and custom design production for furniture firms. So this industry requires communication skills more than fashion related industries. Also companies require designers to be a team player, as production of furniture accessories is usually by molding and most of them go through a finishing process; unlike jewellery or shoes & bags. Therefore companies require designers to get more involved with the production and marketing staff. The role that best suits to a designer in this industry could be designer as a part of a multifunctional team.

Packaging and advertising & exhibition industries are more corporate customer related, so the work pace is mostly defined by customers. In the interviews, organizations declared that most of the time sales staff does not have the time for pursuing the complete product development process, therefore they demand that designers follow through this process. So, the qualifications they require are process management, communication skills, problem solving, being a team member and client interaction, hinting the role designer as NPD process leader.

Therefore, the systems that companies work within seem to effect requirements for designers. As a result, designers take different roles in companies according to business dimension. Designers seem to have managerial roles within industries that require working closely with customers on project bases. However, industries that can control their own pace that work on seasonal periods require functional skills more than managerial skills, as they rely heavily on designers' capabilities on perception of trends and fashion.

Due to the limited time and length of this study, 5 industries were studied through 50 firms. Research can be expended with more interviews or by coding more job announcements through different industries. Also, industries can be studied further in terms of work pace and environment in order to match qualifications better with related industries.

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Determinación sistémica de valores tangibles e intangibles y atributos clave para el desarrollo de productos-joya

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Resumen

Análisis de los aspectos clave que influencian la determinación de atributos tangibles e intangibles contenidos en aspectos para el diseño de producto-joya contemporánea, como potenciadores de valores diferenciales de comportamiento y preferencias por parte del consumidor, así como, por las propias organizaciones del sector en términos del fortalecimiento del capital intelectual, competitividad e identidad, a través del diseño y la gestión del conocimiento.

La metodología consideró en primera instancia la recogida de información mediante distintas fuentes documentales (revistas científicas y profesionales, informes, instituciones, eventos especializados, libros, entre otros). A continuación, se emplearon métodos cualitativos para analizar la opinión de expertos y consumidores en América Latina y Europa, a los efectos de contrastar la importancia de los resultados obtenidos mediante información documental y sesiones grupales. Además, se observan las tendencias en entornos de desarrollo e interacción con el producto a través de distintos canales de comunicación especializados para analizar factores como el diseño, materiales y procesos que contribuyen en la toma de decisiones de compra.

Se destacan los hallazgos sobre componentes relacionales en el producto-joya contemporánea y su contexto en cuanto a la innovación, así como la actuación de atributos clave en la definición del diseño y desarrollo del producto, para el consumidor y los productores del sector. Desde la comprensión de valores tangibles e intangibles, se esboza una caracterización del producto, en el marco de un modelo sistémico de gestión del conocimiento, en el que se presentan evidencias relevantes que pretenden favorecer la toma de decisiones del proceso inicial de diseño de joyería contemporánea, en un campo donde la literatura es limitada. La muestra de expertos es consistente y fiable, se logró consolidar datos en siete países, sin embargo, se espera continuar explorando más contextos geográficos y culturales. Se considera que la diversidad en el origen y procedencia actúan como grupos de control multidisciplinar. El estudio busca reconocer los insights del usuario para contribuir con su satisfacción individual y colectiva, mediante una configuración oportuna del producto.

El estudio posee gran valor especialmente para pequeños fabricantes y diseñadores de joyería como por ejemplo de autor, que buscan mayor participación en el mercado. Los aportes realizados se centran en el ámbito empírico, técnico, académico y empresarial relacionado con el producto-joya contemporánea, así como las aportaciones de relevancia *detectadas para el investigador y el diseñador; también pueden servir como base para otros estudios enfocados en el diseño y la gestión en sectores productivos basados en los oficios artesanales.*

Palabras clave: *knowledge, design attributes, intangible values, jewellery industry, identity.*

Abstract

Analysis of the key aspects that influence the determination of tangible and intangible attributes, which are contained in aspects of product design jewel contemporary, as enhancers differential values of behavior and preferences by consumers, as well as by the organizations themselves the sector in terms of strengthening the intellectual, competitiveness and identity capital through design and knowledge management.

In the first instance, the methodology considered the collection of information through distinct documentary sources (scientific and professional journals, reports, institutions, specialized events, books, etc.). Then qualitative methods were used for the analysis the opinion of experts and consumers in Latin America and Europe, in order to contrast the importance of the results obtained through documentary information and group sessions. In addition, trends are observed in development environments and interaction with the product through different communication channels specialised for the analysis factors such as design, materials and processes that contribute in making purchasing decisions.

The outstanding findings on relational components in the product-jewel contemporary context in terms of innovation and performance of key attributes in the definition of design and product development for the consumer and producers in the sector. From the understanding of tangible and intangible values, product characterization was outlined as part of a systemic model of knowledge management, in which relevant evidence intended to promote decision making initial process design contemporary jewelry are presented in a field where literature is limited. The expert panel is consistent and reliable. Data were consolidated into seven countries, however, it is expected to continue to explore more geographical and cultural contexts. It is considered that diversity in the origin and source of multidisciplinary groups act as control. The study seeks to recognise the user insights to contribute to their individual and collective satisfaction, through timely product configuration.

The study has great value especially for small manufacturers and jewelry designers such as Signature jewellery, who seek greater market share. Contributions to focus on empirical, technical, academic and business related to the product scope contemporary jewel. The most important contributions are focused on the researcher and designer; they can also serve as a basis for other studies focused on the design and management in productive sectors based on the crafts.

Keywords: *a short list with a maximum of five keywords will be included. For example: design, systems, methods, processes, etc. They will be separated by commas.*

1. Introducción

En el presente trabajo se ha considerado un conjunto de factores como recursos estratégicos que pueden influir significativamente en la variación y los desarrollos del producto joya; mediante la consideración de contenidos sociales y culturales: el conocimiento como recurso metodológico, tecnológico e inmaterial y la carga simbólica del objeto, ambos, componentes potenciales de innovación que influencian los resultados del diseño y son determinantes en la diferenciación de la joya.

El objetivo principal propuesto en este artículo, se orienta a la valoración de los aspectos clave de diseño como fuente de intangibles (conocimiento, expectativas y deseos, reflejados en los atributos) en la innovación del producto joya contemporánea y su contexto organizacional. El análisis metodológico desde una perspectiva cualitativa y cuantitativa, implicó observar los resultados obtenidos tanto desde la visión del diseño como de los valores propios y culturales del objeto. Se desarrolló un cuestionario dirigido al experto, el cual consideró la intervención de diversas áreas del conocimiento como recurso aportador en la creación de valor del producto, de la innovación y del diseño.

Mediante la información basada en la revisión documental y el análisis de los resultados obtenidos: la opinión del experto en joyería contemporánea, del diseñador con conocimiento específico (modelo sistémico de diseño) y de las expectativas del consumidor, se detallan los atributos de diseño configuradores del producto joya contemporánea contribuyentes, con la innovación y la creación de nuevos productos.

Por otra parte, en la clasificación de los atributos finales; se consideran criterios específicos definidos en forma, función y ergonomía (Hernandis & Iribarren, 2000) para la determinación de objetivos específicos y portadores clave de información en la fase creativa para el desarrollo del producto-joya contemporánea. En los siguientes epígrafes, se presentan los componentes que aproximan los aspectos considerados en este estudio y su valoración específica.

1.1. Componentes intangibles y capital intelectual en el desarrollo del producto joya

1.1.1. El conocimiento como recurso estratégico y diferenciador: capacidades y habilidades

Las capacidades y habilidades en el desempeño metodológico y tecnológico se basan tanto en el conocimiento como en la experiencia. Vicente Lorente (2000, p. 114) sostiene que las habilidades individuales idiosincrásicas y la prueba y el error en el proceso conforman el buen hacer del artesano y por lo tanto su experiencia; para esto cita a Barney (1991) en la afirmación referente a que el recurso humano puede constituir ventajas competitivas, siempre y cuando se cumpla con una serie de criterios, para la solución de un problema, por lo que la producción de conocimientos es esencial para mantener el éxito competitivo y organizacional. La capacidad de la organización para renovar y lograr formas novedosas e innovadoras de ventaja competitiva se convierte en lo más importante (Ramezan, 2011, p. 93).

Gil y Bedolla (2009) en búsqueda de nuevas estrategias de aproximación al usuario, para el sector artesano, destacan que contar con las distintas áreas del conocimiento en el trabajo colectivo favorece el emprendimiento para la competitividad, evita la inestabilidad y la pérdida de tradición en el sector. Al igual que el «stock» de recursos tecnológicos, el capital humano puede asociarse a situaciones de especificidad, complementariedad, dependencia histórica y ambigüedad causal que aseguran su inimitabilidad y valor (Becker y Gerhart, 1996 en Vicente Lorente, 2000, 114).

Con relación al diseño, Hernandis e Iribarren (2000: 42-53), plantean el conocimiento como recurso de gestión (a niveles de: explotación, gestión, evolución y mutación) para el desarrollo de productos (en fase teórica, fase constructiva y fase informática), y así, la ejecución del proceso se define a partir de distintos niveles y etapas en la fijación y el logro de los objetivos propuestos. La metodología se sustenta en el análisis, la descripción y la detección de problemas al igual que posteriores correcciones en el diseño industrial, ya sean de tipo técnico, de mercado o del conocimiento.

Por otra parte, en el campo cognitivo y emocional sobre productos tecnológicos, se expone que los atributos del objeto están referidos a sus características propias tangibles e intangibles (prestaciones, usos y funciones) que le determinan como objeto multi-atributo y que la combinación de sus atributos, no necesariamente afectan de la misma manera a consumidores y usuarios. Bajo este criterio, sustentan que un producto puede ser percibido desde cualquiera de sus dimensiones, definidas en: la esfera funcional (la novedad tecnológica y la congruencia), simbólica (la similitud visual de los productos existentes), y estética (producto atractivo) Rindova y Petkova, 2007 en Lee, et al. (2011, p. 1196); las cuales pueden ajustarse a características propias del producto joya, debido a su capacidad relacional y comunicativa de los aspectos tecnológicos y simbólicos que representan sus desarrollos y sus formas.

En el marco de los valores que componen el capital intelectual, desde la perspectiva de recursos humanos, know-how y relaciones de la empresa con el entorno, se hace especial referencia al capital relacional que ofrece información acerca de las tendencias o intereses que muestran los agentes de su entorno, los cuales resultan cruciales para detectar oportunidades tecnológicas o de mercado que guíen su proceso de desarrollo de nuevos conocimientos (Martín de Castro, et al., 2009, p. 87). Según Edvinsson & Sullivan (1996) citados por Hsu & Fang (2009, p. 668), el capital intelectual mejora el desempeño en el desarrollo de nuevos productos, ya que transforma el conocimiento en valor, pero Hsu & Fang van más allá al afirmar que los beneficios de nuevos productos provienen más del capital relacional que de la inversión en capital humano o estructural. (2009, p. 673)

No obstante, otro de los recursos intangibles a los que se hace mención, se refieren especialmente al conocimiento acumulado por la empresa (know-how entre otros tipos de conocimientos), donde la fuente principal es el factor humano (Conner, 1991) y se propone el conocimiento (sus dominios y especialidades) como recurso intangible asociado a factores específicos, sociales y culturales (Vecco, 2010) que asegura la creación de valor en los productos, facilita la creatividad, direcciona a la innovación (Pollalis & Dimitriou, 2008, pp. 310-311) y contribuye con aspectos importantes vinculados al contexto del producto-joya, como por ejemplo, la personalización del objeto mediante la adaptación y experimentación de la técnica y el material (Moraes, 2010).

Además de las consideraciones epistemológicas es importante destacar que estos recursos pueden ser medidos y contabilizados desde la perspectiva de algunos autores como Guthrie, et al. (2012, p. 70) que proponen la contabilidad del capital intangible (ICA por sus siglas en inglés) como una tecnología de gestión, contabilización y rendición de informes hacia el entendimiento, midiendo y reportando los recursos del conocimiento tales como, competencias de los empleados, relaciones con los clientes, marcas, relaciones financieras y las tecnologías de la información y la comunicación, en el desempeño técnico, creativo y de aproximación al consumidor.

1.1.2. El conocimiento en el marco del producto joya

Mc Phail expresa que el conocimiento, la característica definitoria de esta nueva época, es ahora considerado como el principal recurso económico, con los nuevos medios y tecnologías de la comunicación, como facilitadores principales de su uso (2009, p. 804). En este contexto, las herramientas tecnológicas se comportan como un medio tangible, que dinamizan las formas del conocimiento (recurso intangible) basadas en la especificidad, la complejidad y la personalización.

En sectores tradicionales donde los procesos idiosincrásicos conforman la identidad y la esencia del producto como sucede con la joya, la inserción tecnológica y sus avances deben proponerse como herramienta-puente a la modernidad sin ser el reemplazo del recurso humano (artesano, diseñador, creador de joyas, etc.). Esto implica la conservación de la técnica y de las cargas simbólicas y culturales, características inherentes al objeto, en la definición de los valores intangibles como parte de la significación cultural y de las tendencias actuales de consumo, al mismo tiempo que la adaptación de los procesos demandados por el entorno como lo propone Vecco, (2010); de esta manera, puede garantizarse una vía a la estabilidad del sector joyero en la detección de las nuevas expectativas del usuario (sociales, culturales y emocionales). El valor de las relaciones que mantiene una empresa con los diferentes agentes del entorno con los que se relaciona (principalmente clientes, aliados, proveedores, así como otras empresas e instituciones) o capital relacional, sirven como fuente de información y conocimiento para la propia empresa. (Martín de Castro, et al., 2009, p. 92)

En consecuencia, el conocimiento adquirido como factor que influencia los desarrollos y sus resultados, debe asimilar las oportunidades tecnológicas para la creación de nuevas ideas. Esto apunta también desde una visión organizacional, a la reafirmación del recurso humano como recurso crítico que permite desarrollar y mantener ventajas competitivas basadas en una mayor flexibilidad y capacidad de adaptación al entorno. (Markides y Williamson, 1996 en Vicente Lorente, 2000, 115)

Lo anterior se complementa con la afirmación de Hernandis e Iribarren (2000, p. 53) sobre la gestión del recurso técnico que supone la consideración de características y medios adaptables al alcance del entorno en que se esté trabajando; lo cual necesita contar con el dominio especializado de la técnica y de las herramientas mediadoras para el mejoramiento de la exhibición comunicativa del objeto y el desenvolvimiento creativo. A su vez, los cambios tecnológicos favorecen la exploración técnica y material (experimentación creativa), la aproximación al usuario, la adaptación a ecosistemas actualizados y la creación de ventajas competitivas, que no siempre demanda la pérdida de la tradición, ya que puede ser adaptada a distintos niveles de complejidad necesarios para el sector.

Por lo tanto es necesario destacar que en entornos como el de la joya, debido a su capacidad de conservación, se busca la acentuación de características orientadas a lo único, lo artesanal y lo cultural del objeto como valores intangibles culturales y simbólicos; elementos que resaltan lo propio y lo auténtico (Medina & Hernandis, (2012, p. 71), como camino para la creación de nuevas ideas. Una empresa con una mejor capacidad para adquirir e integrar conocimiento se desempeñará mejor en el proceso de desarrollo de producto, logrando así un mejor rendimiento en el desarrollo de nuevos productos. (Hsu & Fang, 2009, p. 673)

1.2. La experimentación del contexto simbólico de la joya

Un valor que desempeñan marcas joyeras como por ej. Majorica-España o la plata de Taxco-México (AL Invest IV, 2010) con la marca país, designan a la indicación geográfica un atributo intangible basado en el origen, señal intrínseca relacionada con el producto (Auger, et al., (2010, p. 141) que se imputa a la estética del objeto (Bense en Dorfles, (1972, p. 41); Löbach, (1981, p. 62) y asociada a otros ámbitos vitales que le afirman como condición estratégica de competitividad dentro del sector joyero, donde los componentes materiales son dignos representantes de sus entornos creativos, productivos y de uso.

La experimentación consciente de la técnica y del material como elementos asociados a la carga sígnica del objeto (Barthes, 1993 en Santisteban, 2009), conlleva al desarrollo de características emblemáticas basadas en lo autóctono y lo auténtico. Esto ha permitido que en ecosistemas artesanales como el de la joya (diferentes a los de productos agrícolas o alimenticios, como por ej. vino, café, entre otros) la denominación de origen, también constituya un sistema de características propias del producto (atributos).

De acuerdo con esto, Auger, et al., (2010, p. 145) se refieren a algunos autores en la importancia de la marca considerada como una señal de información importante o atributo intangible (Aaker, 1991; Wernerfelt, 1988), que actúa de manera específica en la caracterización e identificación del usuario a través del objeto; y Richardson et al. (1994), describen la marca como un trozo de información que representa un compuesto de la información, reproduce roles dentro del proceso de toma de decisiones de los consumidores, pero la mayor parte de esas funciones giran en torno a una reducción en la incertidumbre.

De acuerdo con lo anterior, Dorfles (1972, p. 69) define el redescubrimiento actual de materiales naturales un hecho participante con la restitución del valor simbólico al objeto gracias a cargas sígnicas, que al igual que las palabras, cobra vida; así las particularidades como el olor o el color, simbolizan pensamientos y creencias (Falchetti, 1999), conforman el sistema comunicativo del objeto (Codina, 2009), y son definidos como incidentes en la personalidad del individuo y del grupo étnico (Korzybski en Dorfles, 1972, p. 85).

En consecuencia, se determinan aspectos clave que regirán los resultados de este estudio: el conocimiento y las adaptaciones tecnológicas, como recursos tangibles e intangibles fundamentales en el desarrollo del producto joya y su contexto relacional, además de atributos que deben estar contenidos en los objetivos de diseño tanto formales, como funcionales y ergonómicos, según el planteamiento sistémico de Hernandis e Iribarren (2000). Asimismo, se plantean las siguientes hipótesis:

H1. El análisis de los componentes relacionales del producto joya y su entorno cultural aporta elementos configuradores clave de innovación y diferenciación para el experto creador de joyas.

H2. Los atributos hacen parte de una o más categorías y pueden actuar bajo dos o más criterios simultáneamente, en términos de forma, función y ergonomía.

H3. A partir de la comprensión de los tangibles e intangibles caracterizadores del producto joya contemporánea, se plantean las cargas predominantes del objeto a partir de valores que se corresponden con categorías estéticas (forma) preminentemente relacionadas con sus cargas simbólicas propias.

2. Metodología

La importancia procedimental de este trabajo se enfoca entre otros aspectos, en la presentación de los resultados específicos de la opinión del consumidor y en segunda instancia, del desarrollo metodológico que implicó el tratamiento de las encuestas a expertos en diseño y joyería. Por esta razón, el proceso ha tenido en cuenta la investigación cualitativa y cuantitativa de tipo experimental (Blaxter et. al., (2000); datos e información precedentes, el estudio del consumidor y la información sobre expertos presentados en este artículo, los cuales fueron recogidos principalmente de la revisión documental y de la aplicación de un cuestionario.

La extracción de categorías de los atributos. En esta fase se llevó a cabo un panel compuesto por expertos relacionados con dos campos: el diseño y la joyería, en este último se incluye tanto al artesano joyero como al empresario. Al final del proceso, de acuerdo con las gestiones de análisis realizadas a nivel grupal y perceptual, los atributos más apropiados fueron determinados a partir de categorías sistémicas de diseño definidas en forma, función y ergonomía según el modelo de Hernandis e Iribarren (2000). Los componentes de diseño arriba definidos, son considerados para el análisis del producto joya contemporánea, desde la congruencia de cada uno de estos con el objeto y sus desarrollos.

A partir de la técnica grupal, de la que se realizaron varias sesiones, se determinaron los atributos en tres pasos: en primer lugar, creación de una lista básica de atributos por parte de los expertos (Kleij & Musters, 2003), en la cual se generaron setenta y tres elementos; en segundo lugar, modificación de ésta lista mediante una petición a los participantes para que expresasen sus opiniones acerca de la importancia de los ítems, lo que simplificó el listado. Por último, los expertos generaron un listado final de acuerdo al preliminar y a las opiniones de los participantes (Vigneron & Johnson, 2004, p. 494); de lo que se obtuvieron treinta atributos, abordados mediante la técnica de diferencial semántico (Osgood et. al., (1957). También se determinan los componentes categóricos de diseño (estética, materia prima, viabilidad técnica, control de calidad, mercado, psicología), basados en la información obtenida a partir de la revisión documental y del contexto. Esto dio lugar a la determinación de los atributos considerados en el cuestionario final.

2.1. Recogida de datos

El proceso de aplicación del cuestionario y el contacto con el experto en joyería contemporánea. Este desarrollo incluyó preguntas directamente relacionadas con los atributos específicos y otros factores propios del producto-joya (metodología, tecnología, innovación). El perfil del experto en joyería fue uno de los aspectos importantes a abordar (ver Tabla 1). La construcción del cuestionario, aplicación y recopilación de datos se hizo entre junio de 2011 a enero de 2012; y la puesta en práctica involucró participantes de Latinoamérica y Europa previamente seleccionados (según su experiencia y trayectoria). La asistencia a eventos relacionados con la joya (concretamente en Madrid y Valencia), llamadas telefónicas, el envío del formato online, video conferencias y visitas convenidas en el lugar de trabajo del experto fueron necesarias para la obtención de veinticinco respuestas, con las retroalimentaciones correspondientes. El formato incluyó una guía breve de presentación e introducción, los cuales fueron traducidos (español, inglés y alemán) para una mejor comprensión y la obtención de los datos esperados.

En relación con los atributos configuradores de la joya contemporánea, se planteó un listado inicial de 30 pares opuestos de adjetivos como lo plantearon Vigneron y Johnson, (2004, p. 494) lo que permitió obtener, por parte del experto en joyas un total de trece atributos "totalmente importantes". Estos fueron contrastados con resultados previos obtenidos con base en la opinión del consumidor, (catorce atributos) para observar las respuestas coincidentes, que determinaron un listado de diez atributos finales (ver Tabla 2).

La opinión del experto en joyería. A través de la literatura se identificaron tres ítems que afectan los desarrollos de la joya contemporánea definidos en: las metodologías como conceptos estratégicos de inspiración y la tecnología como las nuevas maneras del crear y del hacer, planteados como vectores hacia la innovación (conceptos materiales y herramientas) en la creación de valor del producto; los cuales rigen el cuestionario dirigido a expertos en joyería.

Con respecto a las metodologías, los expertos opinaron que satisfacer la demanda del cliente y proponer una mayor variedad de productos al mercado (n=9; 36%) son las principales ventajas de su uso para el desarrollo de productos (ver Gráfico 1).

La tecnología como herramienta de apoyo a los desarrollos en el sector joyero (en referencia a tecnologías de información y comunicación, herramientas y maquinaria actualizadas, medios de distribución, etc.), donde las ventajas más representativas se puntualizaron en la redefinición de los medios de promoción y distribución y la aparición constante de materiales nuevos y adaptables a las joyas (n=23; 92% respectivamente). La mayor desventaja se determinó la minimización de la exclusividad (ver Gráfico 1).

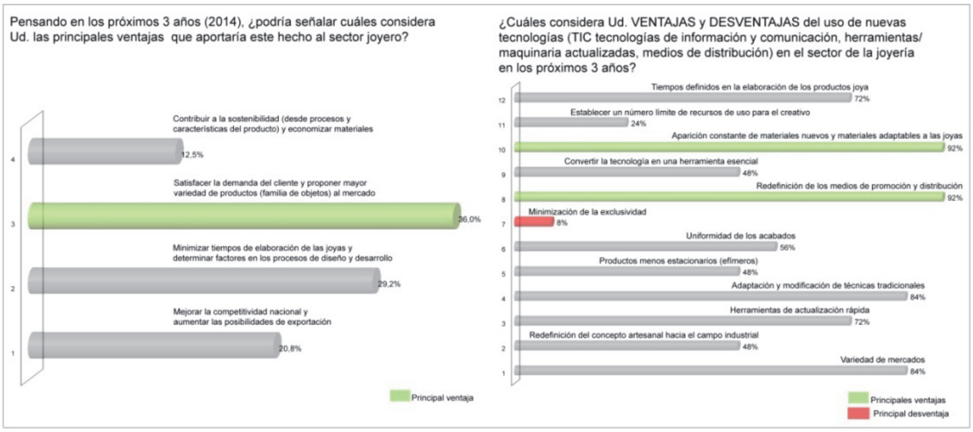

Gráfico 1. Ventajas y desventajas en los desarrollos del experto

Atributos-objetivo de diseño. La definición de atributos que deben estar contenidos en los objetivos del proceso de diseño, constituyen una dimensión cualitativa que se lleva a cabo para evaluar la idoneidad funcional y no funcional de alternativas del producto, frente a diversos criterios tal como lo proponen Sen, et al. (2009, p. 5274). Así, desde la metodología abordada en este estudio, se detallan los atributos finales (ver Tabla 2), basados en la relación atributo-criterios de diseño definidos en forma, función y ergonomía, según el modelo de Hernandis e Iribarren (2000) y son atribuidos a valores porcentuales (ver Gráfico 3) que coadyuvan en la determinación del siguiente paso, en el planteamiento de objetivos que verifiquen los alcances del cumplimiento, la colaboración y la comunicación en el desarrollo de los procesos.

Se exponen conceptos desde la perspectiva del diseño según Hernandis e Iribarren (2000, pp. 60-66), debido a la afinidad entre los términos y relaciones con el producto y el contexto de la joya contemporánea. Los componentes utilizados para este análisis (estética, materia prima, viabilidad técnica, control de calidad, mercado, psicología), son definidos por los autores como variables influyentes en el proceso de diseño y desarrollo de productos; a través de los cuales se determinarán los objetivos formales, funcionales y ergonómicos, como criterios específicos que definen un objeto de diseño. Con base en estos planteamientos, se analizarán a posteriori los objetivos globales pertenecientes a cada uno de los sistemas fundamentales, así como los subobjetivos consecuencia inmediata de la tarea a cumplir por los componentes detectados (Hernandis & Iribarren, 2000, p. 68).

3. Resultados

3.2. Análisis de los resultados

El análisis de los datos se hizo mediante Statistical Package for the Social Sciences 11.5 (SPSS). En el listado de atributos el cálculo del coeficiente alpha de cronbach (α =0,92) fue necesario para comprobar la fiabilidad de la escala utilizada (IBM, 2012). Se hallaron frecuencias y medias para confirmar la hipótesis uno (H1), que define el listado final de atributos específicos de diseño, como características propias del objeto y configuradores del producto joya contemporánea.

Perfil del experto en joyería contemporánea. Se analizaron un total de veinticinco cuestionarios aplicados a expertos en joyería con el siguiente perfil:

Empírico (n=4), técnico (n=7), académico (n=10) y empresa (n=4), áreas de mayor desempeño en el sector. La ubicación geográfica se consideró según 1) la importancia cultural y artesanal en los objetos de joyería; y 2) el reconocimiento del trabajo contemporáneo y experimental con otros materiales distintos a los más tradicionales. Bajo estos principios se definieron también Latinoamérica (n=9; 36%) y Europa (específicamente de España (n=9; 36%) y Alemania (n=7; 28%) como los lugares de interés. El principio geográfico se tuvo en cuenta, con el fin de implicar diferentes perspectivas en distintos contextos con particularidades idiosincrásicas, como factor influyente en el desarrollo de la joya. En consecuencia, se obtuvo el contacto con expertos en joyas de Argentina, Brasil, Colombia, México, España y Alemania como lugares donde la joyería contemporánea ha hecho presencia de manera importante e innovadora (ICEX, (2012); Eurostat, (2009); LEGISCOMEX, (2007); ESADE, (2011)); el aporte participativo europeo se concentró de la siguiente manera: España con nueve expertos (Valencia, n=4 y otras ciudades, como Madrid, Barcelona, Córdoba, Andalucía n=5); Latinoamérica con una muestra igual, y Alemania con siete participantes. Esto permitió un equilibrio entre el panel de expertos.

Tabla 1. Perfil experto en joyería

		n	%
Ubicación geográfica	Valencia	4	16
	Resto de España	5	20
	Latinoamérica	9	36
	Europa (Alemania)	7	28
	Total	25	100
Experiencia	3-5 años	2	8
	6-12 años	11	44
	13-19 años	3	12
	20-30 años	4	16
	> 30 años	5	20
	Total	25	100
Formación *	Especialista	9	36
	Profesional	14	56
	Técnico	8	32
	Artesano	15	60
	Cursos específicos	9	36
	Otros	8	32
	Total	25	100
Área	Empírico	4	36
	Técnico	7	56
	Académico	10	32
	Empresa	4	60
	Total	25	36
Principal actividad *	Tienda	13	54,2
	Taller	20	83,3
	Marketing	8	33,3
	Investigación	7	29,2
	Distribuidor	5	20,8
	Otros	4	16,7
	Total	25	100

* Aspectos en los que el experto se ubica en más de una categoría

La experiencia en el tema de las joyas oscila entre 6-19 años (56%). El nivel formativo se define en dos o más categorías entre especialista, profesional, técnico, artesano y cursos específicos, lo que permitió conocer el tipo de conocimientos entre el recurso humano (ver Tabla 1).

La principal actividad se determinó también en más de una categoría entre tienda, taller, marketing, investigación, distribuidor; lo cual puede deberse a la definición actual y no tradicional sobre la actividad organizacional correspondiente al término empresario (gerentes, consejeros e industriales), bajo el concepto que más que ser personas de negocios independientes se caracterizan por la ejecución del hecho o los hechos que dan sentido a la palabra y la realización de nuevas combinaciones (Schumpeter, 1963, pp. 84-85). La elección del panel consideró para la evaluación, la adecuación de contenidos específicos propios del estudio, en favor de la información requerida a partir de distintas perspectivas en el ámbito de desempeño. Puesto esto en consideración, se valoró formación y experiencia en las áreas correspondientes al campo empírico, académico, técnico y organizacional.

Atributos de diseño configuradores del producto joya contemporánea: la opinión del experto en joyería. Los atributos incluidos en una escala de Likert de siete puntos, donde 1 es nada valorado y 7 totalmente valorado, fueron reducidos a trece como "totalmente importantes" para el experto en joyería, entre los que se obtuvo una media de cinco o superior. Estos fueron definidos en: natural (m=5,00), diseñado (m=5,96), distinción del empaque (m=5,64), moderno (m=5,92), único (m=5,76), exclusivo (5,88), artesanal (m=5,84), alta calidad (m=6,04), seguro (m=5,96), especializado (m=5,40), innovador (m=5,80), auténtico (m=5,92) y cómodo (m=5,68) (ver Tabla 2).

Tabla 2. ***Atributos de configuración para el desarrollo de una joya contemporánea***

(α= 0,92)	Media	n	%		Media	n	%
elegante (c)	5,20	7	28	emblemático	4,24	3	12
natural (e);(c)*	5,00	8	32	artesanal (e);(c)*	5,84	14	56
brillante	4,04	4	16	alta calidad (e);(c)*	6,04	15	60
permanente (c)	3,96	5	20	complejo	4,16	3	12
diseñado (e);(c)*	5,96	16	64	seguro (e);(c)*	5,96	11	44
distinción del empaque (e)	5,64	11	44	tecnológico	5,04	4	16
moderno (e);(c)*	5,92	12	48	especializado (e)	5,40	8	32
único (e);(c)*	5,76	14	56	innovador (e);(c)*	5,80	13	52
detallado	4,08	2	8	prestigioso	5,08	6	24
sencillo (c)	5,24	131	33,2	costoso	4,28	2	8
autóctono	4,64	2	12	de marca	5,32	7	28
exclusivo (e)	5,88	13	52	flexible	5,04	5	20
auténtico (e);(c)*	5,92	13	52	cómodo (e);(c)*	5,68	8	32
sugerente	5,00	6	24	grande	4,08	1	4
proporcional	3,96	2	8	ecológico (c)	5,16	7	28

(e) atributos totalmente importantes para el experto en joyería; (c) atributos totalmente importantes para el consumidor de joyería. * Atributos concurrentes entre la opinión del consumidor y la opinión del experto en joyería

Los resultados arriba presentados se contrastaron con las expectativas del consumidor sobre el producto joya contemporánea, determinados en: *elegante* (m=5,01), *natural* (m=5,54), *permanente* (m=5,29), *diseñado* (m=5,70), *moderno* (m=5,20), *único* (m=5,66), *auténtico* (m=5,91), *artesanal* (m=5,55), *alta calidad* (m=6,18), *seguro* (m=6,09), *innovador* (m=5,45), *cómodo* (m=6,43), *ecológico* (m=5,54) y *sencillo* (m=5,24), también con una media igual a cinco o superior.

Atributos de diseño configuradores del producto joya contemporánea: el contraste de opiniones. El análisis comparativo de los atributos convergentes entre las opiniones del experto-consumidor permitieron obtener resultados más exactos, una reducción de diez atributos: *natural, diseñado, moderno, único, auténtico, artesanal, alta calidad, seguro, innovador y cómodo*, que especifican las características propias inherentes al producto (ver Gráfico 2). Consolidados estos bajo los componentes sistémicos de diseño: *estética, materia prima, viabilidad técnica, control de calidad, mercado y psicología* propuestos por Hernandis e Iribarren (2000) como esenciales en el desarrollo de productos.

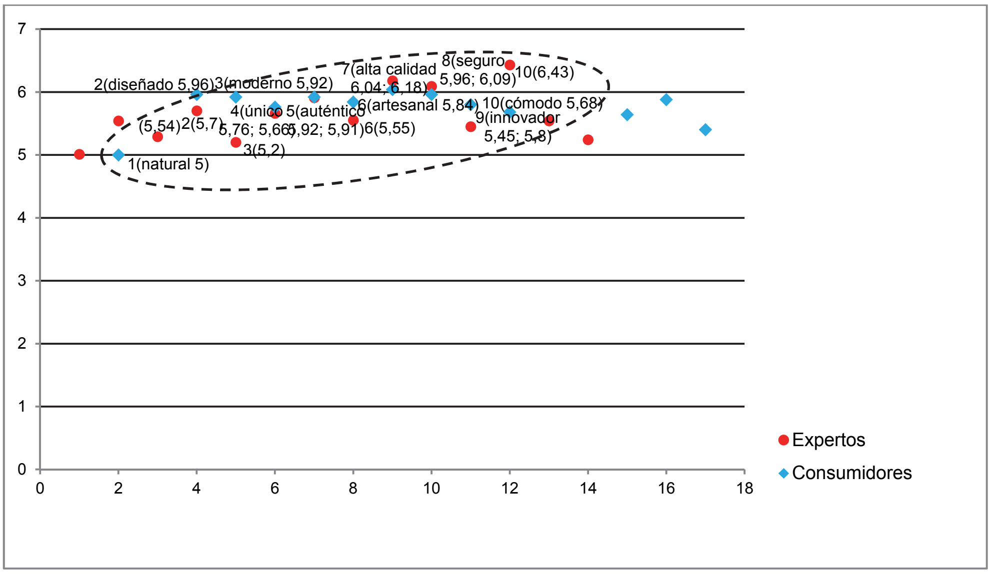

Gráfico 2. Atributos coincidentes entre la opinión del experto en joyería y del consumidor

La definición de los atributos. A partir de los resultados sobre las opiniones confluentes entre expertos (en diseño y joyería) y el consumidor, la revisión documental relacionada con el producto y el diseño (Hernandis e Iribarren, 2000) como participantes en la configuración de la joya contemporánea; el listado final de los atributos más vinculados con en el contexto de la joya, son definidos bajo componentes sistémicos y aspectos asociados al ecosistema de la joya (ver Tabla 3).

Tabla 3. Relación de atributos con componentes de Diseño

Atributo de diseño del producto-joya contemporánea	Componentes sistémicos con los que se relaciona (Hernandis & Iribarren, 2000)	Aspectos sociales, culturales y tecnológicos asociados con los desarrollos de la joya
Natural	Materia prima	Valor simbólico, adaptación al entorno
Diseñado	Estética, Materia prima, Viabilidad técnica, Mercado, Control de calidad, Psicología	Tendencias, identidad, sociedad, cultura, procesos
Moderno	Estética, Viabilidad técnica	Tendencias, entorno, procesos
Único	Control de calidad, Psicología	Carga emocional, complejidad, resistencia, fiabilidad
Auténtico	Control de calidad	Técnica, materiales
Artesanal	Estética, Viabilidad técnica	Entorno, origen, procesos
Alta calidad	Estética, Materia prima, Viabilidad técnica, Mercado, Control de calidad, Psicología	Tendencias, identidad, sociedad, cultura, procesos
Seguro	Materia prima, Viabilidad técnica	Tendencias, complejidad, resistencia, fiabilidad, procesos
Innovador	Viabilidad técnica	Valor simbólico, adaptación al entorno, procesos, cultura, carga emocional
Cómodo	Estética	Tendencias, complejidad, resistencia, fiabilidad, uso, salud y bienestar

Este análisis de relación presentado en la tabla anterior, demuestra que los atributos son mensurables a través de aspectos metodológicos y tecnológicos, que definen los componentes específicos de diseño (estética, materia prima, viabilidad técnica, control de calidad, mercado, psicología), los cuales son atribuidos a recursos tangibles e intangibles definidos en el conocimiento y la adaptación tecnológica correspondientes a los procesos de elaboración y transformación de un producto determinado y sus contextos de implicación.

Clasificación de los atributos: la opinión del diseñador. La elección del panel de expertos en diseño, requirió especial atención en la consideración de un perfil con conocimientos específicos; de esta manera se determinaron los principios de selección en: el conocimiento y la experiencia en diseño y su relación con el modelo sistémico de diseño. Esto con el fin de evaluar objetivamente los contenidos y favorecer la precisión de los resultados desde una visión más especializada.

Para clasificar los diez atributos finales correspondientes al producto joya contemporánea, se pidió a través de un formato online, su clasificación según los criterios de diseño: forma, función y ergonomía (Hernandis & Iribarren 2000:66); el proceso precisó veintinueve diseñadores docentes y estudiantes de máster en la Universidad Politécnica de Valencia, relacionados con el modelo sistémico de diseño para el desarrollo de productos. En el análisis de los resultados se calculan frecuencias para observar la mayor incidencia en cada uno de los criterios de diseño (forma, función y ergonomía). La clasificación de los atributos finales, según la opinión de los diseñadores fue definida así: diseñado (55,2%) y alta calidad (69%) como aspectos correspondientes a la función; seguro (62,1%) y cómodo (86,2%) están relacionados con la ergonomía, mientras que natural (69%), moderno (89,7%), único (62,1%), auténtico (72,4%), artesanal (75,9%) e innovador (72,4%) son atribuidos a la forma. También se observó que diseñado fue un atributo común entre las categorías de forma y ergonomía con un valor de 55,2%, respectivamente (ver Gráfico 3), lo que confirma la hipótesis 2 (H2).

Para la medición de atributos, es necesario destacar, que un atributo puede ser cuantitativo o cualitativo; sin embargo, la técnica de medición desarrollada en esta fase, fue cualitativa. Esta clasificación permitió comprobar cómo son comprendidos y percibidos los atributos inherentes a la joya, desde una perspectiva del diseño; los resultados señalan que los valores predominantes que le caracterizan, pertenecen a criterios relacionados con la forma lo que confirma la última hipótesis propuesta en este artículo (H3). Además, se ha evidenciado la importancia de cada atributo mediante cantidades porcentuales para la configuración del producto joya contemporánea.

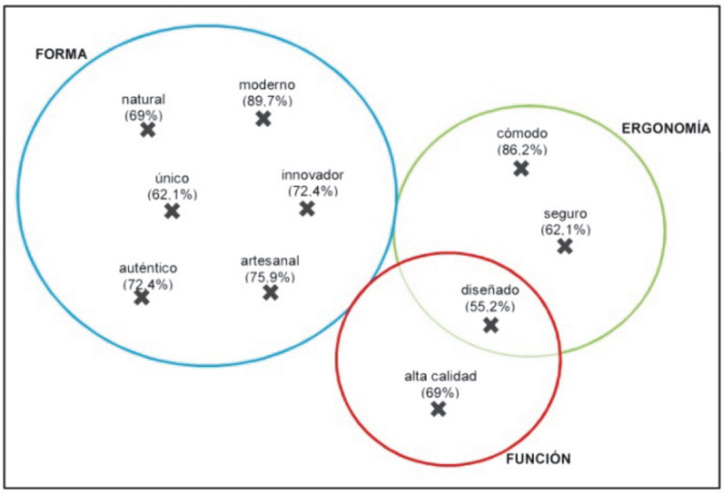

Gráfico 3. Clasificación de atributos según criterios de diseño (forma, función, ergonomía). Ejemplo de la posibilidad de interacción de atributos bajo dos o más criterios simultáneamente. En este caso el atributo diseñado en el ámbito de función y ergonomía.

Finalmente, es necesario destacar que la metodología cualitativa abordada, ha permitido hacer mensurables los atributos. Esta se basó en la clasificación y definición de los mismos, procedimiento fundamental para la indicación de cambios elementales, la toma de decisiones en el proceso de desarrollo y el suministro de información sobre problemas de calidad, comunicación y fallos. Esto permitirá la definición de objetivos considerando ciertos atributos clave, como tarea primordial para facilitar la comprensión y el desempeño de su ejercicio.

Otros análisis de relevancia. Teniendo en cuenta la importancia del empleo de métodos óptimos en los procesos de análisis, interpretación y diseño como parte esencial de la concepción y subsecuente fabricación de la joya, la tecnología como recurso actualizado que apoya la creatividad, y ambos, como vectores capaces de impulsar la innovación y la creación de valor del producto; son analizados en este artículo desde las perspectivas planteadas, pero surgen otras premisas que involucran estos dos aspectos, tales como la medición de la variable conocimiento por parte del experto en joyas, en términos de la formación, la profesión, especialidad y experiencia, para reforzar los planteamientos iniciales arriba expuestos. De esta manera, y según este procedimiento se observa lo siguiente:

- Con respecto a las metodologías, los expertos concluyen que las principales ventajas para el sector están enfocadas en satisfacer la demanda del cliente y proponer mayor variedad de productos al mercado (n=9; 36%). Esto pensando a un mediano plazo de 3 años.

- En cuanto a la tecnología, los expertos en joyas estimaron que el porcentaje actual del sector en cuanto al uso de nuevas tecnologías, corresponde a valores entre 25 a 75 por ciento (25% - 50%: n=9; 36% y 50% - 75%: n=7; 28%); siendo su principal ventaja la redefinición de los medios de promoción y distribución, y la aparición constante de nuevos materiales y adaptables al producto joya (n=23; 92%, respectivamente) y la desventaja más representativa la minimización de la exclusividad (n=23; 92%), seguida de la redefinición del concepto artesanal hacia el ámbito industrial y la estacionalidad de los productos de joyería (n=13; 52%, respectivamente).

4. Conclusiones

Las conclusiones de este artículo evidencian varias implicaciones prácticas. En primer lugar, los expertos en joyería deben enfocar sus intereses al refuerzo de los recursos intangibles que constituyen el entorno y su trabajo. En segundo lugar, este estudio pretende favorecer la toma de decisiones pertinentes al proceso inicial de diseño de joyas; esto sugiere el tratamiento de la información concreta que puede ser clave en la estrategia de la innovación; y en tercer lugar, se trata de hacer un aporte al experto en joyas, mediante el manejo de información fundamental que posee una fuerte influencia en el criterio de aceptación del producto. Los resultados de análisis cualitativo confirman la relación entre los contextos metodológicos y tecnológicos. Los aspectos y hechos que fortalecen la competitividad del sector se definen en: la experimentación, que permite la creación de otros ámbitos especializados; el dominio del conocimiento como recurso intangible del capital intelectual que propone nuevas lecturas del producto a través de transmitir contenidos emocionales, sociales y culturales; y en la innovación tecnológica como herramienta que contribuye a mejorar el modus vivendi del sector y resalta las características propias de la joya actual basadas en lo natural y lo auténtico. De la misma manera, ha permitido perfilar el listado de atributos, a través de la relación con el diseño, como medio que posibilita la innovación en los desarrollos del producto joya contemporánea.

Por otra parte, los resultados constatan que componentes relacionados con factores culturales, como las cargas sígnicas, afectan al diseño y desarrollo de las características propias del objeto; el cual puede ser interpretado, como elemento de diferenciación de la joya. Asimismo, se obtienen evidencias a favor de la simplificación de los atributos finales como configuradores del producto joya contemporánea; mediante las opiniones obtenidas en la aplicación de los cuestionarios. De esta manera, se confirma la hipótesis 1. No obstante, esta información no es absoluta ya que controlar una característica del proceso no significa necesariamente controlar el proceso; para esto es necesario además, considerar aspectos cuantitativos, que sin dejar de ser irrelevantes, no son pertinentes en este abordaje. Por esta razón, es importante comprender que los aportes presentados, se proponen como parte del todo.

En acuerdo con lo anterior, es necesario resaltar que la base de este estudio se orientó a la comprensión, observación y análisis desde una visión cualitativa. Teniendo en cuenta que, gran parte de los datos actuales existentes, se han preocupado por dejar muy bien definido el lado cuantitativo del tema joya, basados por ejemplo en mediciones, pesos, densidades exactas del material y el uso adecuado de las herramientas, también es conveniente incluir aportes que contribuyan al mejoramiento cualitativo del producto y sus procesos.

De esta manera, el estudio se direcciona a la aportación de datos relevantes para la configuración del producto joya contemporánea, mediante el análisis y contraste de los resultados entre las opiniones de expertos y consumidores. La implicación del diseño justifica los valores propios del objeto, a través de conceptos basados en el origen y la tradición como lo demuestran los atributos natural, auténtico y artesanal. Por otra lado, los aspectos considerados previamente como el manejo experimental del material y de la técnica, la especialización y la experiencia en el dominio del conocimiento y de las habilidades se plantean como ventajas estratégicas en la mediación metodológica y comunicativa de lo que se requiere y se espera de la joya (insights) en el entorno actualizado, permitiendo la generación de nuevas ideas.

El análisis cuantitativo permitió observar que los aspectos fundamentales, puntualizados en este artículo en el conocimiento y la tecnología, son comprendidos claramente por el sector joyero, como herramientas que le permitirán establecer una estrecha relación con el usuario directo (92%) y conocer la valoración de este frente a lo que el creador de joyas le ofrece. De ahí, que el sector joyero debe enfocar sus objetivos creativos y productivos en la actualización y adaptación de sus productos y procesos, mediante la creación de valor en el ecosistema del producto. Por esto, el experto en joyería debe ser consiente del uso adecuado de las herramientas apoyo, que le permitan aproximarse cada vez más al cumplimiento de las expectativas emocionales, sociales y culturales del usuario, en busca de su lealtad.

La hipótesis 2, es verificada a través de los resultados alcanzados en esta investigación, sugieren además que un atributo puede pertenecer o actuar bajo dos o más criterios simultáneamente. Esto se evidencia en la identificación del atributo diseñado, clasificado en forma y ergonomía; lo cual significa que ningún atributo es exclusivo sino que, dependiendo de las condiciones estéticas, comunicativas y del entorno del producto, un atributo puede afectar de forma integrada los resultados del proceso, no siendo incompatible con los demás atributos, sino más bien complementario. Los significados que abarcan los conceptos de conocimiento y tecnología dentro del contexto simbólico del objeto, desde una perspectiva sistémica de diseño (Hernandis & Iribarren, 2000), fueron percibidos por los diseñadores participantes, dentro de las características propias del producto joya, como signos atribuidos a la estética (forma). Esto teniendo en cuenta la clasificación realizada, a partir de criterios de diseño definidos en forma, función y ergonomía (Hernandis e Iribarren, 2000). De esta manera se valida la última hipótesis (H3) planteada.

Otro aporte clave, se define en la utilidad que supone la medición cualitativa desarrollada. La clasificación de los atributos posibilita una fácil comprensión por parte del experto en joyas sobre la información que sugiere, si esta es requerida para el desarrollo de sus procesos, esta también puede ser considerada de manera total o parcial. Los aportes que provee este estudio, cuentan con la cualidad de ser flexibles y no definitivos, en la mejora de calidad, comunicación y aceptación de producto a diseñar.

Finalmente, el estudio es de gran valor sobre todo para los minoristas de joyería, que buscan el aumento de su cuota de participación en el mercado. El enfoque de los aportes está centrado en la información específica tanto para el empírico, el técnico, académico y el empresario relacionados con el producto joya contemporánea como para el investigador y el diseñador. Además, esta investigación contribuye a la incorporación de nuevos datos en el campo de la joya, desde diferentes puntos de vista distintos a los aspectos cuantitativos.

5. Futuras investigaciones

Para concluir se pueden señalar interesantes sugerencias de los resultados hacia la investigación futura. En primer lugar, para aproximarse aún más al concepto de percepción del usuario, es importante identificar en tiempo real los insights del consumidor sobre los aspectos tangibles e intangibles que comunica el objeto. Se pretende aplicar otras medidas que superen las insuficiencias de un tratamiento verbo-céntrico que refinen la información y los resultados obtenidos hasta el momento. Para esto se propone el estímulo sensorial con un grupo definido de posibles consumidores de joyas, donde se resalten las características y posibilidades materiales en inmateriales de los atributos propios del producto joya contemporánea. En segundo lugar, con respecto a los resultados obtenidos se propone la incorporación de nuevos aportes teóricos útiles para el estudio desde la perspectiva del diseño y prácticos para el sector de la joyería contemporánea. Por último, un análisis pormenorizado de la actividad de estímulo sensorial debería revelar los aspectos que definen los objetivos de los atributos propuestos, características inherentes al producto. De esta manera, el reto que se plantea enfoca el análisis detallado de las diferentes alternativas metodológicas y de análisis que consideraron este estudio, para así poder extraer conclusiones sobre el efecto que ejercen los tangibles e intangibles metodológicos y tecnológicos como consecuencia de la innovación, así como ofrecer un lenguaje común de los resultados más importantes para el experto relacionado con las joyas.

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Design e desenvolvimento de novos produtos através da transferência de conhecimento entre Brasil, Espanha e Portugal

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Resumo

Este documento relata a experiência adquirida através de um projeto de cooperação internacional realizado entre quatro instituições de ensino e pesquisa, tendo em vista a aplicação técnica do conhecimento do design para a criação e desenvolvimento de novos produtos a partir do uso de três matérias-primas naturais distintas: fibra, madeira e pedra. Das metas almejadas buscou-se principalmente a capacitação dos discentes de Design do Departamento de Design e Expressão Gráfica da Universidade Federal do Amazonas (DEG/UFAM) para atuação e o desenvolvimento de novos produtos; a valorização de matérias-primas naturais da Amazônia, assim como o saber tradicional, cultural e do design e a troca de conhecimento, tecnologia, experiência profissional e científica entre os seus participantes. O projeto foi desenvolvido com base em pesquisas qualitativas e quantitativas, com caráter descritivo, explicativo, exploratório e experimental. Foram realizados: levantamento de dados bibliográficos e de publicações científicas sobre as matérias-primas, pesquisa in loco e estudo de casos. Também realizou reuniões em equipes e aplicou como método de investigação a técnica focus group e a prática de formulários de observação. Como resultados o projeto gerou 13 (treze) protótipos de produtos, com base no conhecimento e técnicas partilhadas entre as instiuições parceiras, 11 (onze) registros de patentes, 1.000 (mil) exemplares de catálogos apresentando as informações técnicas e científicas referentes aos produtos da pesquisa, e, por fim, fortaleceu as parcerias internacionais e institucionais envolvidas no projeto, com possibilidades de novas ações, em conjunto, para o futuro.

Keywords: *Design, Matérias-primas naturais, Novos produtos, Transferência de conhecimento, Cooperação Internacional.*

Abstract

This paper reports the experience gained through an international cooperation project carried out in four educational and research institutions, with a view to technical application of design knowledge for the creation and development of new products from the use of three natural raw materials different: fiber, wood and stone. The desired goals was, primarily, training of Design students of the Department of Design and Graphic Expression of the Federal University of Amazonas (DEG / UFAM) for performance and development of new products; the valuation of natural raw materials from the Amazon, as well as traditional knowledge, cultural and design, and the exchange of knowledge, technology, professional and scientific experience among its participants. The project was developed based on qualitative and quantitative research with descriptive, explanatory, exploratory and experimental. It carried out: survey of bibliographic data and scientific publications about the raw materials, on-site of the research and case studies. Also it held meetings in teams and applied as a research method the focus group technique and practice forms of observation. As a result the project generated thirteen (13) prototypes of products based on knowledge and shared technology between partner institutions, eleven (11) records of patents, one thousand (1,000) copies of catalogs presenting the scientific and technical information relating to products's research, and finally was strengthened the international and institutional partnerships involved in the project, with possibilities of new shares together for the future.

Keywords: *Design, Natural raw materials, new products, knowledge transfer, international cooperation.*

1. Introdução

O desenvolvimento de novos produtos é considerado como um meio importante para a criação e sustentação da competitividade (DE TONI, DEONIR; MILAN, GABRIEL SPERANDIO y SCHULER, MARIA, 2005). Identificar as oportunidades que busquem sistematicamente informações que permitam a organização adequada para a aceitação comercial de produtos e/ou serviços, pode dispor de uma grande probabilidade de sucesso, com soluções às necessidades expressas pelo mercado (PACHECO, K. M. M.; ORTUÑO, B. H.; MIRANDA, I. P. A.; NASCIMENTO, C. C. y PACHECO, A. S., 2011). O potencial existente no uso das matérias primas naturais para o desenvolvimento de novos produtos além de gerar benefícios econômicos à sociedade, também vem sendo cada vez mais valorizado pelos meios acadêmico, científico, tecnológico, e industrial. Universidades, Institutos de Pesquisas e Orgãos de Fomentos, vêem nos recursos naturais a oportunidade de valorizá-los e lhes atribuir novas funções de uso e consumo, através da colaboração mutua entre instituições que prezam pela qualidade da formação e capacitação profissional de pessoas, principalmente aquelas que se preparam, identificam ou atuam no campo de projetos e desenvolvimento de produtos a partir utilização de materias-primas naturais. Sabendo que a formação acadêmica é o primeiro grande passo para que os alunos compreendam como planejar e desenvolver um novo produto, de acordo com as necessidades do mercado, agregando a isso fatores estratégicos e inovadores que possam garantir a sua aceitação por parte dos consumidores, e que a transferência de conhecimento, de tecnologia e de experiencia são aspectos primordiais durante esse processso, o Departamento de Design e Expressão Gráfica ((DEG) da Universidade Federal do Amazonas (UFAM/Manaus-Brasil); o Laboratório de Engenharia de Artefatos de Madeira (LEAM) do Instituto Nacional de Pesquisas da Amazônia (INPA/Manaus – Brasil); o *Departamento de Ingeniería Gráfica del Diseño* (DIG) da *Universitat Politècnica de València* (UPV/Valencia – Espanha) e o Centro Tecnológico da Pedra Natural de Portugal (CEVALOR/Borba – Portugal), uniram-se através do apoio financeiro da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES/ Brasil), para desenvolver um Projeto de Cooperação Interncional, intitulado como: Design e Desenvolvimento de Novos Produtos a Partir de Matérias-Primas Naturais da Amazônia, que colocasse em prática a aplicação técnica do conhecimento do design para a criação e desenvolvimento de novos produtos a partir do uso de três matérias-primas naturais distintas: fibra, madeira e pedra. O trabalho também contemplou os seguintes objetivos:

- Valorizar as matérias-primas naturais da Amazônia, assim como o saber tradicional, cultural e do design;
- Trocar conhecimento, tecnologia, experiência profissional e científica entre os seus participantes;
- Capacitar os discentes de Design do Departamento de Design e Expressão Gráfica da Universidade Federal do Amazonas (DEG/UFAM) para atuação e o desenvolvimento de novos produtos;

2. A proposta do Projeto

A ideia para desenvolver um projeto de cooperação internacional, partiu da tentativa de relacionar e unir elementos naturais de lugares distintos para a composição estrutural de um design de produto. Com essa intenção, a proposta buscou envolver a participação de três países: Brasil, Espanha e Portugal, e com eles trabalhar uma parceria em prol do uso de matérias-primas naturais, entre elas: da Amazônia e da Europa, para a gestão e fabricação de novos produtos, de modo a valorizar e prezar pelos aspectos técnicos, científicos, socioculturais, econômicos e eco sustentáveis. Outro fator também a ser considerado para a prática da pesquisa, seria ter o design como agente gerenciador das atividades e dos processos de transformação desses recursos naturais e de outros materiais que pudessem ser necessários para a criação e o desenvolvimento dos produtos. Para a materialização da proposta foi importante identificar as instituições que poderiam fazer parte da equipe técnica do projeto e com elas definir quais as matérias-primas a serem investigadas, os objetivos que deveriam ser alcançados e as etapas necessárias para a realização da pesquisa. Os convites para compor parcerias foram feitos às seguintes instituições de ensino, pesquisa e tecnologia: Instituto Nacional de Pesquisas da Amazônia (INPA- Brasil); Universitat Politècnica de València (UPV – Espanha); e Centro Tecnológico da Pedra Natural de Portugal (CEVALOR – Portugal), que após conhecerem melhor os princípios do trabalho, aceitaram de imediato a fazer parte do mesmo. A Universidade Federal do Amazonas (UFAM), através do Departamente de Design e Expressão Gráfica - considerado o autor da proposta, foi nomeada a sede do projeto. A iniciativa obteve a aprovação por parte da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), que financiou a realização da pesquisa no Brasil, por meio do Programa Pesquisador Visitante Especial (PVE), conforme a Chamada Pública N° 61/2011.

2.1 Objetos do estudo

A opção de trabalhar com a fibra vegetal de tucumã-i (*Astrocaryum acaule*) do Amazonas, algumas espécies de madeiras naturais da Amazônia e a pedra mármore branco de Portugal com veios, como objetos de estudo, foi realizada em concordância com a Coordenadora Técnica do Projeto, a Pesquisadora Visitante Especial e a CAPES e também em função das especialidades e produções científicas das pesquisadoras principais e das instituições parceiras que dispunham das referidas matérias-primas. Os recursos naturais utilizados na proposta possuem características técnicas interessantes. E quando adaptados para produtos são capazes de oferever muitas vantagens aos consumidores e ao mercado. A seguir, alguns dos dados identificados e considerados importantes em cada um deles.

1.1.1. Fibra de tucumã-i (Astrocaryum acaule)

Esta fibra deriva do tucum originada pelo gênero *Astrocaryum* da espécie *acaule*, também conhecida por tucumã-i (Fig.1), uma classe de palmeira localizada em grande parte na região do Alto Rio Negro – no estado do Amazonas, norte do Brasil. É produzida, cultivada e processada de forma sustentável e artesanal por comunidades indígenas e caboclas (MACIEL et al., 2011). Possui características físicas plausíveis, e pode ser aplicada em diversos tipos de produtos, desde acessórios para uso pessoal como pulseiras, colares e bijuterias, até produtos com uma escala maior, como vasos, cestos e até mesmo roupas. O uso da fibra em produtos é flexível, pois é útil para diversas categorias (PACHECO et al.,2011). Além da aparência exótica e o aspecto visual atrativo, é bastante resistente, sem produzir elementos tóxicos ou mal cheiro, possibilitando uma aplicação segura, reforçada pela maleabilidade da sua estrutura que torna-se adaptável aos mais diferentes e variados tipos de produtos.

Fig. 1 Fibra de tucumã-i (Astrocaryum acaule) e sua aparencia exótica

1.1.2. Pedra mármore branco de Portugal com veios

A pedra mármore branco de Portugal com veios (Fig.2), apresenta como características inerentes: dureza, resistência e vergadas. Descrevendo-a macroscopicamente tem-se: calcário microcristalino rosado, bioclástico a bioconstruído, abundantemente fossilífero, com bastantes estilólitos, alguns deles semi-abertos, e esparitizado (INETI, 2014). O seu processo de produção envolve a mistura de alta tecnologia com o trabalho artesanal. A sua aplicação e funcionalidade são amplamente justificadas pelas suas características técnicas. Além de apresentar boas características físicas e mecânicas, resistência e durabilidade, observando o comportamento humano a partir de produtos ou ambientes criados a partir dessa matéria-prima. Além disso, possui em suas características intrínsecas, que influenciam o bem-estar humano, os fatores-chave do material na criação de novos produtos,assim como muitas outras variáveis consideradas importante a todo o processo (CEVALOR, 2014).

Fig. 2 Pedra mármore branco de Portugal com veios

1.1.3. Madeiras naturais da Amazônia

As madeiras amazônicas (Fig.3) por sua facilidade de obtenção e manuseio, são um dos recursos naturais mais utilizados pelo homem, os produtos gerados a partir delas atendem satisfatoriamente diversos tipos de mercados e consumidores, por apresentarem boa durabilidade e adaptação ao processo de acabamento, alta resistência física e mecânica, variações entre alta e média densidade (NASCIMENTO y MONTEIRO DE PAULA, 2012).

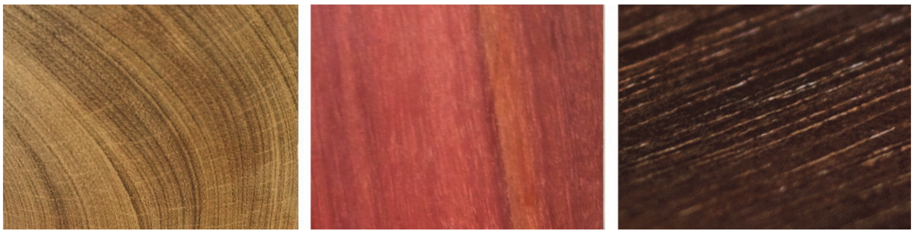

Fig. 3 Algumas das madeiras amazônicas utilizadas no projeto

Devido a grande variedade, é comum que se atribua o mesmo nome vulgar às várias espécies de madeiras botanicamente distintas, e do mesmo modo, com propriedades tecnológicas diferenciadas. Ainda que estas matérias-primas gerem resíduos a partir dos seus processos de adaptação para produtos, estes mesmos resíduos podem ser reaproveitados e transformados em novos produtos, atividade que condiz com o propósito da eco sustentabilidade.

Assim, das madeiras amazônicas selecionadas para o projeto destacam-se: itaúba (*Guarea trichilioides* L.), maçaranduba (*Manilkara huberi* Ducke Satnd), cedrinho (*Erisma uncinatum*), tanibuca (*Buchenavia huberi* Ducke), angelim-pedra (*Hymenolobium petraeum* Ducke), marupá (*Simarouba amara* Aubl), louro Aritu (*Licaria aritu* Ducke), guariúba (*Claricia raecemosa* Ruiz), sucupira (*Bowdichia nitida*), cedro (*Cedrela fissilis*) e angelim-vermelho (*Andira parviflora* Ducke).

2.2 Participação das instituições parceiras no projeto

O projeto foi estruturado com base em quatro vertentes: Ensino, Pesquisa, Tecnologia e Mercado, visando também os aspectos científicos, socioculturais, econômicos e eco sustentáveis. Para tanto, a parceria realizada com duas instituições europeias (Espanha e Portugal), uma local (pertencente à cidade de Manaus no estado do Amazonas/Brasil) e uma de fomento de caráter nacional (Brasil), foi extremamente importante e estratégica. Cada instituição envolvida (Fig.4), pôde colaborar de acordo com a sua *expertise* e proporcionar espaços, equipe técnica e materiais para a realização da pesquisa.

Fig. 4 Instituições parceiras do projeto: UFAM, INPA, UPV e CEVALOR

Das competências atribuídas e prestadas por cada instituição parceira:

- Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES/ Brasil) - Orgão financiador do projeto e investidor na formação e aperfeiçamento de recursos humanos e de alto nível no país e exterior, serve de instrumento para a comunidade universitária na busca de um padrão de excelência acadêmica para prática e desenvolvimento de projetos e pesquisas e promoção da cooperação científica internacional;

- Departamento de Design e Expressão Gráfica (DEG) da Universidade Federal do Amazonas (UFAM/Manaus-Brasil) - Sede de desenvolvimento do projeto. Como coordenação geral da pesquisa, disponibilizou 01 (um) laboratório de design: para a prática das atividades de produção de relatórios técnicos, reuniões com as equipes de trabalho, realização de briefings e demais métodos de investigação, criação das alternativas para protótipos e acompanhamento de trabalhos manuais concretizados pelos especialistas técnicos e artesãs participantes da equipe; e 01 (uma) marcenaria: para a produção de uma parte das peças idealizadas pelo projeto. O DEG foi responsável por liderar as investigações feitas sobre a fibra de *tucumã-i (Astrocaryum acaule)*, e orientar quanto a postura e conhecimento do design a serem adotados e aplicados durante às ações tomadas para o levantamento e análise de dados, definição dos requisitos e parâmetros para os processos de criação e geração das alternativas de protótipos, produção e acabamento dos protótipos, criação e desenvolvimento do material gráfico e de divulgação do projeto, planejamento e organização das exposições dos produtos e produção de relatório final com os resultados do projeto;

- Laboratório de Engenharia de Artefatos de Madeira (LEAM) do Instituto Nacional de Pesquisas da Amazônia (INPA/Manaus – Brasil), parceiro e colaborador no processo de investigação e escolha das espécies de madeiras amazônicas utilizadas pelo projeto. O LEAM foi responsável por liderar as investigações feitas sobre as madeiras amazônicas, orientou quanto os aspectos tecnológicos, processos de adaptação e produção dos produtos a partir delas. Assessorou tecnicamente na construção das informações, sobre as espeficie catalogadas e certificadas, para esclarecer a respeito do uso das madeiras nas composições estruturais dos produtos. Auxiliou a equipe técnica do projeto durante as pesquisas de campo realizadas em cidades que disponham de produtos artesanais desenvolvidos com as mesmas madeiras utilizadas no projeto. Disponibilizou mais de 15 (quinze) espécies de madeira amazônica para a realização do projeto, 01(um) laboratorio técnico equipado com ferramentas e maquinários para proceder com a fase de levantamento de dados sobre as madeiras e 01 (uma) marcenaria para a produção da outra parte das peças idealizadas pelo projeto;

- *Departamento de Ingeniería Gráfica del Diseño* (DIG) da *Universitat Politècnica de València* (UPV/Valencia – Espanha), parceiro e colaborador no processo de orientação sobre as atividades técnicas do design. O DIG, em conjunto com o DEG, forneceu informações técnicas sobre os atributos do design necessários para o desenvolvimento de novos produtos e sobre os métodos sistêmicos a serem aplicados durante as etapas de criação e geração de alternativas para os protótipos. Recepcionou a Pesquisadora Visitante Especial, nas dependências da Escuela Técnica Superior de Ingeniería del Diseño, para junto desenvolverem um workshop sobre as pesquisas levantadas no Brasil e Portugal, referentes aos objetos de estudo, e acompanharam as criações (propostas de produtos) dos alunos de design da UPV para avaliarem e decidirem os protótipos do DIG a serem confeccionados pela equipe técnica do projeto nas dependências do DEG/UFAM e LEAM/INPA ambos no Brasil, como também no Centro Tecnológico da Pedra Natural de Portugal CEVALOR, em Borba/Portugal.

- Centro Tecnológico da Pedra Natural de Portugal CEVALOR/Borba – Portugal), parceiro e colaborador no processo de adaptação e uso da pedra mármore branco de Portugal com veios para o desenvolvimento dos produtos do projeto. A CEVALOR juntamente com a Pesquisadora Visitante Especial, foram as fontes de orientações e informações sobre a pedra - um dos objetos de estudo. O centro disponibilizou a sua marmoraria com maquinário eficiente e de primeira linha, e 01 (um) técnico profissional para assessorar a equipe técnica do projeto nos trabalhos de confecção dos protótipos que possuíam a pedra mármore branco de Portugal com veios em suas estruturas. Relacionou as atividades de investigação sobre a pedra com a importância da transferência tecnológica, demonstrando as etapas de adaptação e transformação da mesma, ressaltando o bom uso da matéria-prima, formando o conhecimento e informando o diferencial das rochas ornamentais e industriais.

2.3 Formação, capacitação, troca de conhecimentos, experiências e tecnologias

O projeto inicialmente buscou preparar o conhecimento dos seus participante sobre a importância do uso de matérias-primas naturais da amazônia junto a um recurso natural europeo (pedra), para o desenvolvimento de novos produtos. Para isso, a equipe técnica do projeto (Fig.5), dividiu-se em três grupos distintos: grupo de pesquisa sobre a fibra de tucumã-i (*Astrocaryum acaule*); grupo de pesquisa sobre as madeiras naturais da Amazônia; e grupo de pesquisa sobre a pedra mármore branco de Portugal com veios. Após a referida divisão, foi dado inicio a fase do levantamento de dados sobre cada objeto de estudo.

Fig. 5 Equipe técnica do projeto em reunião para divisão dos 3 grupos de pesquisa distintos

Cada equipe (Fig.6, 7 e 8), recebeu as devidas orientações por parte de suas coordenadoras de pesquisa, e saíam a campo em busca de informações técnicas e científicas, assim como exemplos de experimentos ou estudos similares que tenham registrado dados sobre tais recursos. Os componentes de cada grupo tiveram a oportunidade de consultar, dialogar, trocar e registrar informações a respeito do objeto da sua pesquisa junto a especialistas, instituições, lojas, empresas e mercado que trabalham com o tema da investigação.

Fig. 6 Grupo de pesquisa sobre a fibra de tucumã-i (Astrocaryum acaule)

Fig. 7 Grupo de pesquisa sobre as madeiras naturais da Amazônia

Fig. 8 Grupo de pesquisa sobre a pedra mármore branco de Portugal com veios

Esses contatos, puderam relatar, mostrar e indicar a todos os participantes do projeto as oportunidades e limitações que as materiais primas poderiam apresentar com respeito ao proposito da pesquisa. Ao passo que cada grupo conseguia ir compreendendo o universo do seu objeto de estudo, produzia um relatório parcial resumindo os dados capturados a cada etapa da investigação. Tais documentos tornavam-se a bússola que direcionava os caminhos a serem percorridos mais a diante. É importante ressaltar que, a cada relatório parcial entregue, os três grupos se reuniam e cada um deles explanava o que haviam vivenciado e aprendido até aquele momento. Durante as explanações, os representantes das instituições parceiras e unidade sede do projeto faziam também as suas contribuições, de modo a ajudar às equipes nas tomadas de decisões e futuras ações para o andamento das pesquisas. Esta primeira experiência (divisão das equipes e o levantamento de dados sobre os objetos de estudo) proporcionou aos discentes, docentes, técnicos e colaboradores do projeto um aprendizado em conjunto, o que facilitou as trocas de informações e definição dos métodos e as atividades que poderiam ser utilizadas para registrar dados e melhor aproveitá-los durante as fases da criação, desenvolvimento e produção dos protótipos da pesquisa.

2.4. Proposta para novos produtos

Uma vez compreendido o universo de dados levantados sobre cada recurso natural estudado, as coordenadoras das equipes reuniram-se para definir os requisitos e parâmetros que deveriam ser trabalhados durante a etapa da geração de alternativas para a confecção dos protótipos dos produtos. Das condições estabelecidas, foi determinado que os produtos elaborados deveriam atender a ambientes comerciais de alto nível, como: hotéis, restaurantes e demais estabelecimentos com enfoques temáticos. O projeto do produto deveria contemplar em sua estrutura, no mínimo, duas das matérias primas estudadas, com o propósito de comparar a evolução e/ou o enriquecimento material e visual das peças. Dado o desafio, cada aluno deu inicio a criação da sua proposta de produto. Ainda que as propostas fossem individuais, os grupos faziam questão de se reunir e discutir sobre suas ideias (Fig 9).

Fig. 9 Alunos e professores do projeto, reunindo e discutindo ideias para a geração de alternativas

Da mesma forma, faziam questão de se aconselhar com os representantes das instuições parceiras – através de consulta local, e-mail ou vídeo, para saber o que pensavam a respeito de suas criações (Fig.10), o interesse pelas opiniões eram primordiais quando partiam das universidades, institutos e empresas colaboradoras que trabalhavam diretamente com as matérias-primas, as quais os alunos queriam utilizar em suas propostas. Mais uma vez, a troca de conhecimento e informações foi fundamental durante esta fase, inclusive com demonstrações de algumas tecnologias e ferramentas de trabalho (pertencentes a essas instituições) que poderiam axiliar na materialização das ideias. Assim, a cada orientação dada, os alunos melhoravam os conceitos sobre suas propostas e trabalhavam com mais representação os seus desenhos.

Fig. 10 Alunos discutindo suas ideias com colaboradores de instituições parceiras do projeto

É importante destacar que a geração de alternativas foi realizada tanto pelos alunos de graduação de design da Universidade Federal do Amazonas (DEG/UFAM) como também pelos alunos de pós-graduação (mestrado) da Universitat Politècnica de Valencia (DIG/UPV) na Espanha. Estes últimos, tiveram a oportunidade de participar de um workshop realizado pela Professora Visitante Especial do projeto, na cidade de Valencia/Espanha, que relatou e apresentou os resultados da fase de levantamento de dados realizados, meses antes, pelos grupos de pesquisas formados pelos alunos de design da UFAM. As atividades relacionadas à geração de alternativas resultou na produção de painéis semânticos (Fig.11 e 12), originados pelos alunos da UFAM e da UPV, com base nos requisitos e parâmetros estabelecidos e explicações técnicas e conceituais do design à materialização das suas propostas de produtos.

Fig. 11 Exemplo de painéis semânticos gerados pelos alunos participantes do projeto

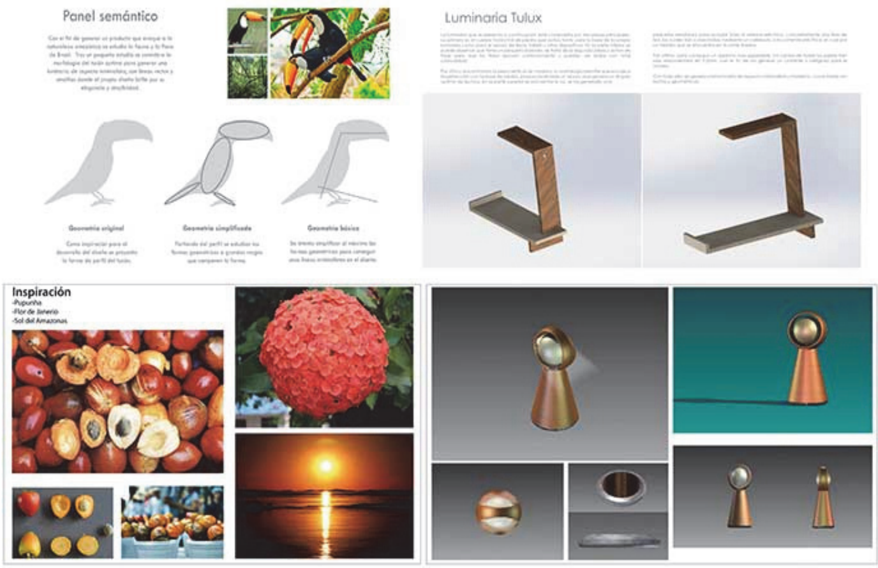

Fig. 12 Outro exemplo de painéis semânticos gerados pelos alunos participantes do projeto

As propostas geradas pelos alunos também foram inspiradas em elementos da fauna e da flora da região amazônica, o que pode ser considerado um grande enriquecimento cultural para todos os participantes, além de valorizar ainda mais a estruturação física e estética dos produtos.

3. Materiais e métodos

A pesquisa teve como propósito trabalhar com dados qualitativos e quantitativos, classificados como: exploratórios, descritivos, explicativos e experimental (Gil, 2010). Apresenta uma abordagem conceitual sobre as percepções das pessoas sobre as questões sociais e fatos sobre o estado atual do fenômeno em estudo, descrevendo a natureza das condições em uma situação (Marconi e Lakatos, 2006). Um breve estudo estatístico, cujos dados foram organizados e analisados a partir da distribuição de freqüência e o cálculo de médias, permitiu observar as opiniões coletadas, o problema e o tipo de impacto entre os seus elementos (Blaxter, Hughes, & Tight, 2002), de modo a determinar a força da associação ou correlação entre as variáveis resultantes da opnião de uma população específica. Como fontes de investigação foram utilizados: livros, artigos publicados em congressos e revistas científicas, registros de entrevistas, jornais e dados divulgados por instituições ou pesquisadores, em págnias de internet. O universo da pesquisa contemplou três grupos de participantes distintos: Proprietários e/ou vendedores de estabelecimentos de comercialização dos recursos naturais investigados, na cidade de Manaus; comunidade acadêmica do Departamento de Design e Expressão Gráfica da Universidade Federal do Amazonas, também pertencente à cidade de Manaus/Amazonas – Brasil; e comunidade acadêmica do Departamento de Ingeniería Gráfica da Escuela Tecnica Superior de Ingeniería de Diseño da Universitat Politècnica de València, na cidade de Valência/Espanha. O tempo para a realização do referido trabalho foi de um ano e meio e dos procedimentos adotados para a coleta de informações, ferramentas e métodos para o controle e qualidade dos dados, a equipe do projeto utilizou: formulários de orientação – produzidos pelas coordenadoras de cada grupo de trabalho específico, para o registro da pesquisa de campo realizada junto ao mercado de produtos naturais; reuniões semanais com os grupos de pesquisa (*focus group*) para explanação e discussão sobre os dados coletados – tais reuniões eram registradas com câmera fotográfica, filmadora e os resultados gravados em arquivos digitais para posterior produção do relatório final do projeto; questionário de observado, produzido pela coordenação geral do projeto e a pesqusiadora visitante especial, para o registro das informações capturadas durante as exposições dos produtos da pesquisa. Para o processo de criação das propostas, os alunos utilizaram das técnicas conceituais do desenho técnico, de observação, renderização, construções de painéis semânticos. Dos softwares gráficos utilizados foram: CorelDraw, Illustrator, Indesign e Photoshop. E dos softwares 3D: AutoCAD, 3D Max, Blender, etc. O processo de confecção das peças foi realizado nos laboratórios, marcenarias e marmoraría das 4 (quatro) instituições parceiras – Brasil, Espanha e Portugal, com assessoramento constante dos seus pesquisadores, docentes e técnicos. Os recursos naturais de estudos foram doados, em forma de resíduos, pelo Instituto Nacional de Pesquisas da Amazônia (INPA) – doador da madeira, Centro Tecnológico da Pedra Natural de Portugal (CEVALOR) - doador da pedra, e a empresa de artesanato Arte Tukano pertencente a duas artesãs colaboradoras do projeto, que são vinculadas à comunidade Juquira - produtora da fibra de tucumã-i (Astrocaryum acaule), no Amazonas. O projeto também realizadou 2 (duas) exposições, para as quais desevolveram-se os materiais gráficos de divulgação dos resultados e a produção de um catálogo visual com as informações técnicas e conceituais do projeto e, consequentemente, dos seus produtos – os quais foram reagistrados para obtenção das patentes junto à Pro-reitoria de Inovação Tecnológica da Universidade Federal do Amazonas (UFAM) no final do ano de 2015.

4. Resultados

O processo de confecção dos produtos foi árduo, trabalhoso e intenso. Todas as práticas foram acompanhadas tanto pelas coordenadoras das equipes e colaboradores parceiros, como por cada autor das peças. Para cada dia de produção dos protótipos eram registrados os dados da confecção. Para o processo de produção das propostas geradas, as atividades distribuíram-se entre o Laboratório de Artefatos de Madeira – LEAM, do Instituto Nacional de Pesquisas da Amazônia, e a Marcenaria do curso de Design da Universidade Federal do Amazonas, ambos dotados de maquinários, equipamentos e técnicos especializados para os procedimentos operacionais necessários à produção das peças. Os treze produtos selecionados tiveram como critério de seleção principal, a viabilidade de produção. Analisadas as formas de confecção de cada produto selecionado, foi dado início ao processo de produção dos mesmos. Os primeiros produtos confeccionados, reuniam em sua estrutura os recursos naturais de pedra mármore branco de Portugal com veios e de madeira. Assim sendo, as peças que exigiam a pedra na sua formação tiveram estas partes trabalhadas no Centro Tecnológico da Pedra Natural de Portugal (Fig. 13), na cidade de Borba em Portugal, sob a supervisão da Pesquisadora Visitante Especial e de um técnico profissional da CEVALOR. Quando as peças não apresentavam a estrutura ideial e conforme os desenhos técnicos dos alunos, o técnico e a pesquisadora verificavam as possibilidades de eventuais modificações e trabalhavam tais mudanças de acordo com o consentimento dos autores.

Fig. 13 Processo de produção de um dos produtos com a pedra mármore branco de Portugal com veios

Após confeccionadas todas as partes de peças que exigiam conter a pedra em suas estruturas, foi iniciado a produção dos produtos com a fibra de tucumã-i (*Astrocaryum acaule*), e com as madeiras amazônicas. O trabalho realizado com a fibra foi realizado no Laboratório de Design, do Departamento de Design e Expressão Gráfica da Universidade Federal do Amazonas e procedido por duas artesãs indígenas (Fig. 14), que junto a alunos e professores, fizeram a escolha dos tipos de tramas e as cores da fibra.

Fig. 14 Processo de confecção de produtos com a fibra de tucumãi (Astrocaryum acaule)

Como muitos dos produtos, embora utilizassem fibra na proposta, não possuíam o detalhamento de como as tramas de composição dos tecidos, gerados a partir da fibra, poderiam ser fixadas nos produtos, permaneceu-se na realização de ajustes e modificações ao longo da execução dos projetos, fomentando a troca de experiências entre alunos, professores e artesãs. As partes dos produtos com madeira (Fig. 15), também foram executadas paralelamente ao trabalho feito com a fibra, sendo que apresentando maior complexidade. Todo o processo foi realizado tanto no Laboratório de Engenharia de Artefatos de Madeira do Instituto Nacional de Pesquisas da Amazônia (LEAM/INPA), uma vez que este laboratório além de possuir maquinário mais atual, também é referência em tecnologia da madeira, como na marcenaria do DEG na UFAM. A princípio as partes projetadas em madeira foram confeccionadas em materiais derivados como tábuas de madeira compensada, pois as espécies doadas para o projeto ainda não haviam chegados na ocasião. Após esse primeiro experimento e a doação das madeiras, a confecção foi orientada conforme os desenhos técnicos dos alunos e conhecimento dos especialistas envolvidos.

Fig. 15 Processo de confecção de produtos com madeiras amazônicas

Finalizada a etapa de confecção dos produtos, a equipe técnica do projeto realizou o registro fotográfico das peças nos ambientes idealizados para o uso das mesmas (Fig.16).

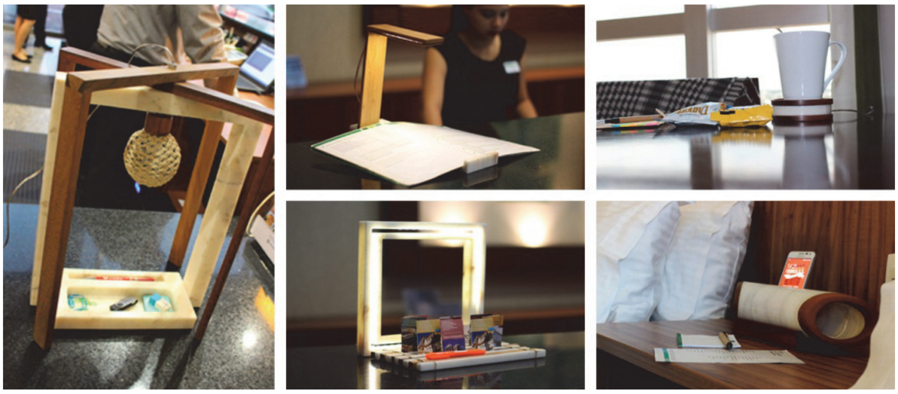

Fig. 16 Registro fotográfico de alguns dos produtos em ambientes de hotéis e restaurantes temáticos

Em paralelo a referida prática, teve inicio a produção de informações técnicas para a elaboração do Catálogo Visual dos produtos e também do material de divulgação do projeto. Durante registro fotográfico, muitos curiosos perguntaram sobre a origem dos produtos e como ter acesso a eles através da venda e comercialização no mercado. Naquele momento, não foi dada nenhuma informação a respeito, uma vez que os alunos sabiam que não era possível divulgar dados da investigação e concepção dos produtos, devido os mesmos estarem em processo de tramitação para registro de patentes na UFAM. No entanto, como parte dos resultados alcançados pelo projeto, a Pro-reitoria de Inovação Tecnológica (PROTEC/UFAM) permitiu que a equipe técnica apresentasse os trezes produtos gerados, nas exposições (Fig. 17 e 18), programadas para as comunidades acadêmicas do DEG/UFAM, no Brasil e do DIG/ETSID, na Espanha.

Fig. 17 Exposição dos protótipos na Universidade Federal do Amazonas (DEG/UFAM – Brasil)

Fig. 18 Exposição dos protótipos na Universitat Politècnica de València (ETSID/ UPV – Espanha)

Em ambas as exposições, os participantes foram consultados a respeito da combinação feita entre os materiais utilizados nas peças, os atributos do design dos produtos e os novos produtos projetados a partir do uso da fibra vegetal de tucumã-i (*Astrocaryum acaule*), da pedra mármore branco de Portugal com veios e de algumas espécies de madeiras naturais da Amazônia. De acordo com os dados registrados e analisados por meio da distribuição de freqüência e o cálculo de médias, a maioria dos entrevistados (n= 208; 100%), aprovou a iniciativa do projeto de combinar três recursos naturais distintos na formação de produtos, pois considera que o uso dessas matérias-primas na composição dos produto oferece boas vantagens com relação a aspectos como: custo/benefício, processo produtivo e benfeitorias aos campos socio-econômico-cultural das localidades envolvidas no projeto. Com respeito aos atributos do design aliados/combinados às características das materias-primas empregadas nos produtos desenvolvidos, numa escala de 1 a 4 – onde 1 significa 'pouco importante' e 4 'bastante importante', o fator 'composição' foi o mais relevante e deve ser o elemento prioritário a ser respeitado (m= 3,38), sendo reforçado pelos fatores de 'resistência' (m=3,31) e 'valor cultural' (m= 3,24). Para o universo amostral, a reunião desses três aspectos fez das propostas de produtos um diferencial para a segmentação de mercado escolhida pelo projeto, além de oferecer benefícios aos seus possíveis consumidores. Quanto aos novos produtos apresentados nas exposições, grande parte do público consultado (n= 208; 93%), afirmar a ideia transmitida pelo conjuto de objetos criações é a 'inovação', fator considerado, pelo universo amostral, como fundamental aos projetos de design que trabalham com a transferência de conhecimento e de tecnologias para a gestão e fabricação de novos produtos, acompanhadas da valorização dos aspectos técnicos, científicos, socioculturais, econômicos e eco sustentáveis, para o alcance de novos mercados. Após constatar a positiva aceitação por parte de ambas as comunidades acadêmicas, localizadas Manaus/Brasil e Valencia/Espanha, e receber os cumprimentos por parte do Instituto Nacional de Pesquisas da Amazônia (INPA) e do Centro Tecnológico da Pedra Natural de Portugal (CEVALOR), demonstrando a imensa satisfação com os resultados alcançados com a pesquisa, a Universidade Federal do Amazonas - através da equipe técnica do projeto de cooperação internacional: pedra, madeira e fibra, conseguiu estreitar os laços entre as instituições parceiras e receber convites para futuras atividades de pesquisa em conjunto. Além disso, o projeto ainda pode relacionar os seguintes resultados positivos obtidos:

- 13 (treze) protótipos de produtos, confeccionados com duas ou três das matérias-primas de estudo: pedra, madeira e fibra;

- 1000 (mil) exemplares de Catálogo dos Produtos confeccionados através do projeto, publicação cujo número do ISBN é: 978-85-7401-808-9;
- 13 (treze) Pedidos para Registro de Patentes, dos quais 11 (onze) foram aprovados recebendo aos devidas numerações que podem ser consultadas no banco de dados do Instituto Nacional da Propriedade Industrial (INPI): BR3020150058021 / BR3020150059583 / BR3020150059567 / BR3020150058307 / BR3020150058315 / BR3020150058331 / BR3020160008795 / BR3020160008809 / BR3020160011397 / BR30 20160011192 / BR3020160011184. Dos demais pedidos encontram-se em processo de avaliação no INPI;
- Apresentação dos produtos do projeto, através de exposições no Brasil e na Espanha;
- Alto grau de aceitação por parte do público visitante de ambas as exposições;
- Quatro artigos publicados em congressos internacionais nos EUA, Brasil e Espanha.

Encerrando as atividades, a coordenação geral do projeto recebeu um convite por parte da Reitora da Universidade Federal do Amazonas, para participar da solenidade de apresentação do catálogo de produtos do projeto de cooperação internacional, junto a outros lançamentos da Editora da UFAM (Fig. 19), como forma de reconhecer a dimensão da pesquisa e a importância do trabalho desenvolvido, bem como a internacionalização da produção científica da instituição. Na ocasião, toda a equipe técnica do projeto foi parabenizada pelo significativo e maravilhoso trabalho realizado em parceria com o Instituto Nacional de Pesquisas da Amazônia (INPA), o Centro Tecnológico da Pedra Natural de Portugal (CEVALOR/Portugal) e a Universitat Politècnica de València (UPV/Espanha).

Fig. 19 Coordenação técnica do projeto no lançamento do catálogo dos produtos pela Editora UFAM

Torna-se importante ressaltar que a força de vontade em atingir os objetivos traçados pelo projeto, foi grandiosa por parte dos seus componentes, algo que facilitou significativamente para a realização da fase de levantamento de dados da pesquisa e, principalmente, da produção dos protótipos. As dificuldade foram muitas, contudo foi possível alcançar além das metas atingidas. Através da união e determinação da equipe técnica, realizar muitos feitos, entre deles:

- Capacitação dos discentes de Design do Departamento de Design e Expressão Gráfica da Universidade Federal do Amazonas (DEG/UFAM para o desenvolvimento de novos produtos com matérias-primas naturais da Amazônia;
- Troca de experiência profissional, técnica e científica entre os seus participantes;
- Valorização de matérias-primas naturais regionais;
- Valorização do saber tradicional, cultural e do design;

- Incentivo a participação de acadêmicos, técnicos e docentes em projetos de pesquisa que tenho o design como fator diferencial e estratégico para o melhor uso e aplicação de recursos naturais no mercado de produtos decorativos e utilitários;
- Interesse pela realização de novos projetos com instituições internacionais.

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The Pragmatism as a semiotic route to designing – Understanding the inferential logics of sense attibution

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Abstract

The aim of this paper is to theoretically discuss the inferential logics of sense attribution to everyday objects. Such discussion takes part of our attempt to explore the possibility of development of a method for systematic research and analysis of the relationship established between users and artifacts in their context of use and specific circumstances. Taking into account the notions of sensible effects, practical bearings, and sense, the argumentation, supported by the Peircean pragmatism, tries to frame their connections with processes of logical mental mediations that emerge when design-agents (e.g., users, designers, and design researchers) deal with everyday objects. The contribution and final considerations of this paper may address issues from the fields of design (practically) and semiotics and design (theoretically and empirically) through possibly enlarging the understanding of the mediation processes, so-called inferential logics of sense attribution.

Keywords: *Semiotics inside Design, Pragmatism, Culture, Product Analysis, Methodology.*

1. Preliminary statements, definitions, and issues

The activity of design has historical, cultural, and social responsibility. From historically being an input to enhance the production of artifacts, the activity of design has been turned into an intrinsic cultural aspect of the processes of evolutionary movements/advances of the contemporary society and, consequently, had its borders of actuation extended, being employed in fields as communication, services, marketing, and so forth (Zingale & Domingues, 2015).

Inasmuch as contemporary the actuation borders of design activity had been extended, as a discipline, in our viewpoint as well as in the view of specific areas that regard the field of design, the activity of design lacks systematic approaches (Cf. Deni, 2015); in addition, even though recognized as relevant (Kotler & Rath, 1984), the design activity is also criticized due its unstable scientific foundations (Findeli, 2014), and, as stated by Borja de Mazota (2014), misses the employment of scientific reasoning in its development. Considering that, we are taking a step backward, we are *working on the basis*. Thus, the core aspect of this paper is the debate on the inferential logics of sense attribution to everyday objects. In fact, the arguments herein presented take part of a broader investigation that aims at the evolvement of a full methodological research framework. Such framework intends to explore the possibility of development of a method of *systematic research* and *analysis* of the relationship established between users and artifacts in their context of use, which aims at supporting processes of materialization of intangible features into artifacts (e.g., global products).

In the field of design, specifically *semiotics and design*, the need of development of processes that foster the systematicity is considered crucial. Deni, in the essay *For a History of Semiotics of Design Projects*, has stated: “what is still missing [...] is a *systematic* [emphasis added] reflection on the predictive capability of semiotics” (2015, p. 10).

Said that, the discussion starts with two statements: Umberto Eco’s understanding of *functions* present in the chapter *Function and Sign: Semiotics of Architecture*; and the pragmatistic maxim contained in *How to make our Ideas Clear*, by Charles Peirce.

Understanding the notion of function in the world of everyday objects may be considered a complex task. Usually artifacts are designed to fulfill specific needs, which are generally shaped by professionals commissioned to develop particular objects and projects or to solve determined problems through design. Nevertheless, by the end of product lifecycle – from conception to disposal, and reuse or recycle –, users are the ones who incorporate functions and “close” the design cycle of artifacts (Cf. Zingale & Domingues, 2015). Said that, from users’ viewpoint, it seems that artifacts do not only function, they also communicate *possible* ways of performing tasks. In this sense, from this specific perspective, designing artifacts may be considered a particular provocation to semiotics (Cf. Eco, 1980). Thus, we might be facing what Eco stated concerning the relation among communication, functions, and semiotics:

Seeing functions from the semiotic point of view might permit one to understand and define them better, precisely as functions, and thereby to discover other types of functionality, which are just as essential but which a straight functionalist interpretation keeps one from perceiving (Eco, 1980, p. 12).

Let us now retrieve Peirce’s statements on, in certain way, *possible functions*:

Consider what *effects* [emphasis added], that might conceivably have *practical bearing* [emphasis added], we conceive the object of our conception to have. Then, our conception of these effects is the whole of our conception of the object (Peirce, CP 4.402).

From the Peircean pragmatistic maxim, attention should be called to the terms *effects* and *practical bearing*[17]. Both terminologies, associated with the concept of *sense*, are of great importance to support the evolvement of the theoretical discourse that will follow. The notion of sense herein adopted is also retrieved from Peirce's writings, where the term effect also appears: "Our idea of anything is our idea of its *sensible effects* [emphases added]" (Peirce, CP 5.401). According to Peirce, the senses of any sign (e.g., artifacts, advertisings) are associated with all possible *interpretative answers* and *practical consequences* derived from *sensible effects* that they produce or could produce (Zingale & Domingues, 2015). Therefore, considering that signs can be also understood as processes of *mental mediation*, interpretative answers and practical consequences, urged by sensible effects, are direct linked to inferential logic mechanisms – induction, deduction, and abduction – in processes of sense attribution to artifacts, characterizing what we will name as a *semiosic flux* (Figure 1).

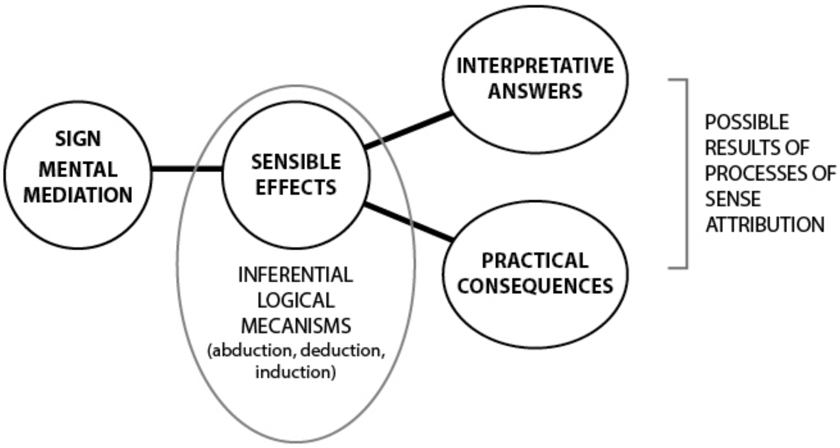

Fig. 1. General framework of the semiosic flux. Diagram by Felipe Domingues.

Such processes of mental mediation are an intangible aspect that conduces individuals, users, to a semiosic flux, that is, leads to a series of mental actions of sense attribution that, in their turn, have bonds with the individuals' cultural background. Stated that, one would ask: How to frame and analyze this sort of intangible aspects in the context of use and specific circumstances?

2. Design and the pragmatist approach

As previously stated, in semiotics functions can be seen as acts of communication, considering artifacts also communicate their *possible* functions (Eco, 1980). Acts of communication emerge from and are closely related to the cultural and social dimensions of design, specially when we focus on the semiosic flux of sense attribution, which regards to the mental action of agents[18,19] involved in artifacts fruition *and*

[17]In order to maintain reading linearity and connectivity among concepts along this essay, the term *practical bearing* will be replaced by *practical consequence*.

[18]It is noteworthy that, although many actors, or agents (e.g., industry, history, fields of study, and so forth), involved in the processes of design may be suitable for analyzes, in this essay the discussion is focused in three of them: the user, the designer, and the researcher.

[19]Actors like users, designers, and researchers will be generally named as *design-agents*, unless there is a need to specify which one we are refering to.

configuration. In such dimensions, users operate actions of standard use, redesign, invention and reinvention by expressing their free wishes in a full and unrestrained way (Cf. Deni & Proni, 2008; Bianchi, Montanari, & Zingale, 2010), but what kind of users? Considering that the term 'users' is a generic terminology, it would not be feasible to explore the possibility of framing individuals' mental logics of actions of use without defining which users we are referring to. In this essay, when using the terminology *user*, it concerns to standard and specialized ones involved in the processes of design and will be named *design-agents*, in contrast with what Zingale and Domingues (2015) named as *user-agent*. Regular-user, design-user, and research-user will be taken as sub-categories of design-agents. In our understanding, design-agents are bodied entities that are *affected* by their cultural backgrounds, and then have varying mental behaviors, which *effect* their interpretative answers and practical consequences when facing problem-solving situations.

Let us now consider that artifacts act like transmitters of personal and collective values, and, as stated by Eco (1980), communicators of possible functions, taking part of the definition of our cultural systems. Once accepted such qualities of the artifacts, due to their capability of affecting some of the individual's mental representations (e.g., beliefs), artifacts extend the social responsibility of the design activity.

In design semiotics, a better comprehension of such extended social responsibility can be reached through following a pragmatistic route started by Peirce, which can be firstly found in the pragmatistic maxim (Zingale & Domingues, 2015). In the pragmatistic approach, the notions of *interpretative answers* and *practical consequences*, which can substitute the notion of *sense*, respectively emerge as crucial matters due to their influence on cognitive and physical environments. In our viewpoint, in the design activity, the preconfiguration of sense into artifacts based on *actual* interpretative answers and practical consequences is a step further in the contemporary processes of conception, adaptation and positioning of design artifacts. Well, if, in order to place such features in design artifacts, we are fostering the need of better understanding immaterial characteristics by retrieving them from facts of everyday life, then we are also talking about searching for answers in the fields of Anthropology and Communications. It is to say that, the senses we are dealing with are not found and retrievable only in material artifacts and cannot be considered only a semantic value within a system, but a symbolic cultural feature. Therefore, differently from what Lévi-Strauss has taught us with the anthropological structuralism, the cultural understanding of Clifford Geertz, in our view, seems to better address the pragmatistic approach we are fostering. As stated by Geertz, culture is "a system of *inherited conceptions* [emphasis added] expressed in symbolic forms by means of which men communicate, perpetuate, and develop their knowledge about and *attitudes toward life* [emphasis added]" (1973, p. 89). Defined what is our actual understanding of culture, we can now turn back to Peirce, which clearly establishes the notion of meaning production in relation of systems of *inherited conceptions*, or *habits*: "what a thing means is simply what habits it involves" (Peirce, CP 5.400); and its *attitudes toward life*, or *practical bearings*: "consider what effects, that might conceivably have practical bearing" (Peirce, CP 4.402).

At this point, the theoretical link between what has being stated until now and the logics of sense attribution to artifacts must be established. Considering that even individuals located within the same cultural environment may give different interpretative answers when coming into contact with same issues, what could lead them to provide same mental and practical responses? What could conduce them to act differently in specific circumstances but facing same issues? Answering these questions seems to be a hard task due to the subjectiveness, then *how* to deal with it.

Peirce and Bonfantini seem to provide us paths to cope with such semiotic issues. The notions of *doubt*, *belief*, and *plausible hypothesis* then emerge to confront symbolic cultural issues. As stated by Peirce, "both, *doubt* and *belief* [emphasis added] have positive effects upon us, though very different ones. Belief does not make us act at once, but puts us into such a condition that we shall behave in some certain way, when the occasion arises. Doubt has not the least such active effect, but stimulates us to inquiry until it is destroyed" (Peirce, CP 5.373).

It is to say that, *doubt* has the characteristic to put us in a state of probing, otherwise *belief* makes us aware of how we should proceed when events occur. In the activity of design, such state of probing can be associated with the passage from a *problematic state* to a *solution* to a problem by the identification of an *interpretant artifact* (Zingale & Domingues, 2015).

In the using scene, users, or design-agents, interpret problematic realities. That is, face issues that are not immediately fulfilled with standard interpretative answers in state of belief conducing them to a state of doubt, which fosters design-agents to, in brief *decision-making moments*, randomly come up with *plausible hypotheses* that aim at providing possible solutions to a problem.

The mental act of turning a problem into a process of decision-making leads to the execution of inferential design processes, also understood as inferential logical processes, which take into account the knowledge of the problem and the prefiguration of a possible solution (Cf. Bonfantini, 2000; Zingale, 2012). The prefiguration is based on the search for answers by selection within plausible hypothesis, as taught us Peirce.

Taking into account the previous statements, based on the aim of this paper, one might be wondering how to research, frame and better comprehend mental actions as the ones previously described – *inferential logical processes* and the search for *plausible hypotheses*. According to Zingale and Domingues (2015), the answer or a possible methodological approach to face inferential issues, which also can be addressed as the fundament of the pragmatistic design method, can also be retrieved from Peirce. According to the author, "the only way to discover the principles upon which anything ought to be constructed is to consider what is to be done with the constructed thing *after* [Emphasis added] it is constructed" (Peirce, CP 7.220). Furthermore, Peirce indicates a possible way to support the evolvement of the so-called pragmatistic design method: "That which is to be done with the *hypothesis* [Emphasis added] is to trace out its consequences by deduction, to compare them with results of experiment by induction, and to discard the hypothesis, and try another […] which shall resist all tests" (Peirce, CP 7.220).

From this passage, considering the logical sequence purposed by Peirce, an inferential logic could be drawn: abduction, deduction, and induction, remembering that, in Peirce's Macroargument, the emerging hypotheses are the abductive processes. According to Bonfantini (1980), this is an endless process, an unlimited semiosic cycle as described in the Peircean Macroargument (Figure 2).

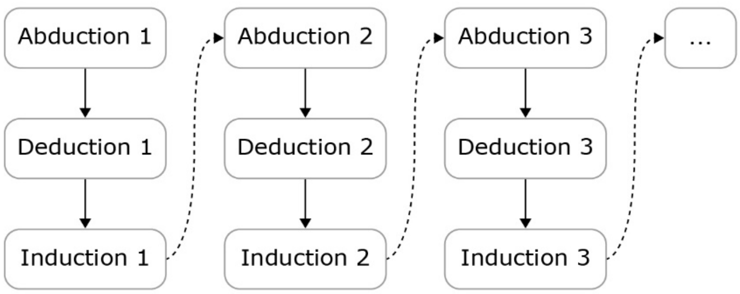

Fig. 2. Peirce's macroargument. Diagram by Salvatore Zingale.

As Peirce stated, such cycle "shall resist all tests" possibly leading to operative and productive stages (Zingale & Domingues, 2015). Though, this is an open-end process, once artifacts are placed in diverse contexts and individuals deal with specific circumstances, the tests start over and over again, and every use may constitute a new interpretant. "The inferential cycle is the 'design life' of a product and it acts before, during and after the design" (Zingale & Domingues, 2015, p. 3) and, in certain way, it involves all agents that use the artifacts (e.g., regular users, designers, researchers, and so forth).

Consequently, the senses of artifacts may be found inside cultural systems and searched within concrete consequences that they are involved in, where they in fact exist and affect individuals' minds. Therefore, once an artifact is brought into the living scene, it can become a mediation artifact, starting mediation processes that, in turn, conduce individuals to act in specific way in order to find possible solutions to specific problems (Figure 3).

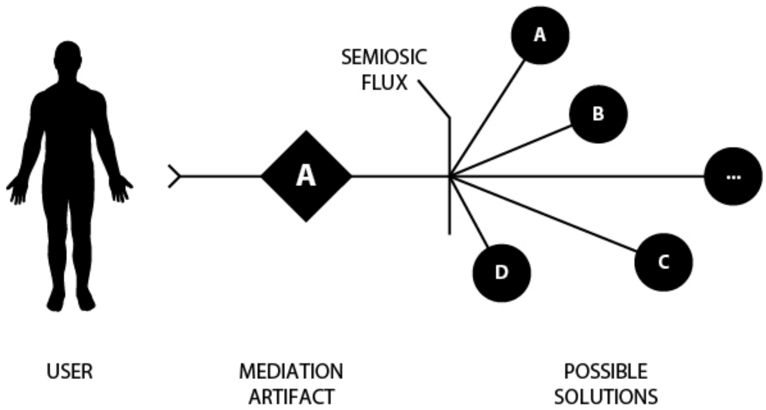

Fig. 3. Mediation artifact and possible solutions. Diagram by Felipe Domingues.

That is, the senses of artifacts change in its use, continuing and completing the meaning of them (Bonfantini & Zingale, 1999). The mental and practical consequences of using acts configure the achievement of the completion of the senses of everyday objects, fulfilling their functions in the long run. It is to say that, the use phase can be understood as an extension of the formal design phase (Zingale & Domingues, 2015). Thus, the full design process is composed by two cyclic phases: design and use phases, formal and informal design stages, respectively. In our understanding, the existence of such phases is one of the reasons that foster the need of comprehension of the logics of sense attribution in-depth, keeping in mind that, our focus is on the informal phase.

2.1 General logics of sense attribution

As previously stated, the senses of artifacts can be searched in many phases artifact development, from conception to use and consequences. In spite of that, the pragmatist approach does not regard only to search for the senses of artifacts, but also to better situate the emerging senses inside the frame of the inferential relations involving the agents of design (Zingale, 2009). In fact, considering that we understand the design activity as an open-ended process, it is needed to enlarge the notion of "design logic". Recently Zingale and Domingues (2015) stated the "design logic" placing its dialogic correlation to the interpretation of use employed by user, defined as "user logic", Figure 4.

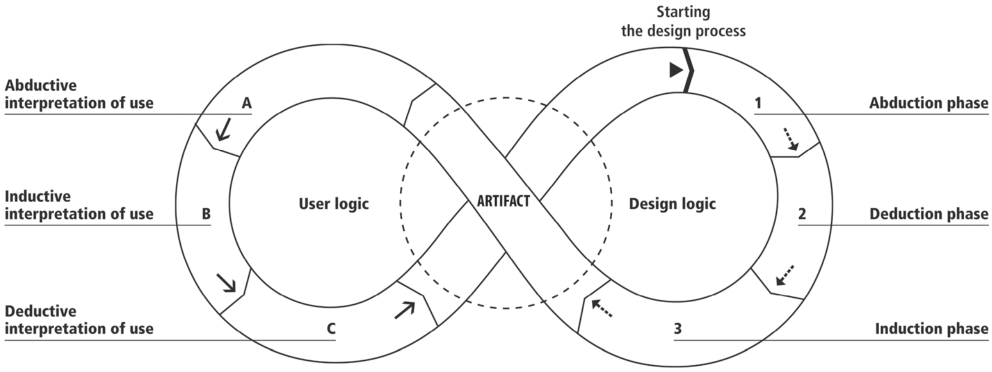

Fig. 4. User logic and design logic. Retrieved from Zingale and Domingues (2015).

According to the authors, the dialogic process may start with the initial idea of conception and production of an artifact. Subsequently, once the object is inserted in a specific context, the user is the one who perform actions employing the artifact. These performative logic actions guarantee the unlimited semiosic in a permanent design process. Moreover, due to its central position in the diagram, the artifact assumes a mediation role in the threefold process of design semiosis, becoming an "entity into which the designer *inscribes* value and from which the user *infers* value" (Zingale & Domingues, 2015, p. 4). In the diagram, a dialogical process of the design action is represented, where the former step is evolved in the designer's mind, materialized into an artifact delivered to any artificial reality, in which the user's mind take place. In its turn, the user's mind, on the basis of cultural standards and personal needs infers values.

The contribution of Zingale and Domingues (2015) to the understanding of the design logics establishes and clarifies relevant aspects of the process of sense attribution to artifacts. Nevertheless, one would ask how the *end-user's inferential responses* could be identified, analyzed, and reported back to the design(-logic) phase? This question states another key point: the role of the design researcher in the design activity as well as in discussions on design and semiotics.

At this moment, considering that this paper is a step toward a try to address the question, herein we will focus at the evolvement of what we consider part of the analytical phase: framing the logics of sense attribution. Keeping this in mind, the next topics, based on Zingale (2009) and Zingale and Domingues (2015), are our attempt to describe such logical processes by framing the logical inferential processes in the design-agents' minds.

2.2 Framing design inferential logics

The three inferential movements – abduction, deduction, and induction – contained in the Peircean Macroargument can be employed in design, as Zingale (2009) taught us. According to the author, and in the explanations that follow[20], **A** should be assumed as *antecedent* of the abductive reasoning, that is, *an* inferential logical process leads to a formal process of design, the artifact emerges; and, **C** stands to the *consequent* of the abductive reasoning, that is, during the use phase of an artifact consequences come out, new inferential cycles start. Let us now see case by case.

In the case of the *abductive inferential movement*, a hypothetical *sensible effect* or *effect of use* comes out. A consequent (**C**) derived from an antecedent (**A**), then (**C**) is considered worth for design – Figure 5.

[20] Considering that this paper is an attempt to evolve and keep up the discussion stated by Zingale (2009) and Zingale and Domingues (2015), in order to preserve the logical criteria, herein we will use exactly the same logical components: **A** stands for *antecedent*; **C** stands for *consequent*).

$$ {}_{h}C \longrightarrow {}_{h}A \dashv\!\mapsto {}_{i}C $$

h: hipothetical *i: intended* $\dashv\!\mapsto$ *: possibly*

*Fig. 5. Abductive inferential movement in design. (1) A hypothetical effect or consequence (**C**) is thought and plausible to be brought into materiality; (2) An agent evolves the understanding of how the emerged artifact (**A**) has to be designed with the aim at fostering that specific consequent (**C**); then, (3) There is the possibility of the artifact conceived (**A**) produce the intended consequence (**C**). Diagram by Felipe Domingues.*

In abductive instance *sensible effects* or *effects of use* constitute the inferential movement. As result of the inferential movement, (**A**) is the produced artifact conceived according to hypothetical consequences (**C**), that is, designed aiming at inscribing sensible effects or effects of use emerged from the use act. According the Zingale and Domingues (2015), "the design hypothesis then develops from imagining the possible consequences of the object of design" (p. 5). Let us now switch to the second inferential movement: deduction.

In the case of the *deductive inferential movement*, consider that a given artifact (**A**) leads to a consequence (**C**) – Figure 6.

$$ {}_{h}A \longrightarrow {}_{i}C \longrightarrow {}_{r}A \longrightarrow C $$

h: hipothetical *i: intended* *r: real*

*Fig. 6. Deductive inferential movement in design. (1) If an artifact (**A**) is designed, expected consequences (**C**) can emerge; (2) The artifact (**A**) is materialized and brought to the real world; then, (3) (**A**) will surely produce (**C**) consequences. Diagram by Felipe Domingues.*

The deductive movement is an exploration that starts from a hypothesis based on cultural and previous knowledge, which includes experiences. The results of such exploration are mental evaluations on the design feasibility, that is, whether the artifact of matter can be brought into the material world, whether it *functions* as intended or not, producing determined consequences in specific contexts and circumstances. That is, this instance is characterized mainly by the attempt of answering questions (e.g., If the product we have in mind right now actually existed, what kind of features would it require What kind of interpretation of use would it bring with it).

Lastly, considering that the previous movement (deductive) leads to a positive response, the *inductive inferential movement* is characterized by testing and verifying *if* (**A**) *truly has* (**C**) as a consequence. A testing phase may take place; a logical inference should be empirically probed – Figure 7.

$$ {}_{r}A \longrightarrow {}_{v}C \dashv\!\mapsto {}_{c}C $$

r: real *v: verified* $\dashv\!\mapsto$ *: possibly* *c: constant*

*Fig. 7. Inductive inferential movement in design. (1) The effect of sense is projected, an artifact is designed (**A**); (2) The effect of sense is probed: (**A**) provides consequences (**C**); (3) Perhaps the artifact (**A**) provides such consequences (**C**). Diagram by Felipe Domingues.*

The inductive movement is a phase of experimentation, is the phase of laboratory testing of hypotheses, prototypes, and models. According to Zingale and Domingues (2015), the experience-experimentation dyad is one of the core and decisive phases of design process: in the verifying phase, methods are required. Hence, the inductive inferential movement is the one that requires empirical tests; in the design phase real data should be analyzed in order to verify determined hypotheses, increasing their validity as projectable senses. But how do these inferential movements operate in the living scene.

2.3 Semiosic fluxes in the living scene

Inasmuch as the general understanding of design inferential logics has been stated, the actual issue should be now addressed to how such logics operate in the living scene, that is, now the focus is on real contexts of use and in specific circumstances.

Yet, in this kind of discussion, where the inferential interpretation is often based on partial knowledge (Zingale & Domingues, 2015), Peirce seems to provide us general guidelines: “The object of reasoning is to find out, from the consideration of what we already know, *something else* [emphasis added] which we do not know. […] The question of validity is purely one of *fact and not of thinking* [emphasis added]” (Peirce, CP 5.365). Thus, in order to make possible the theoretical framing of sense attribution, let us now consider individuals using a specific object in their cultural environment to solve a specific problem.

In the logics of sense attribution, our interest is in the something else that emerges from the fruition act, that is, in the *possible functions* identified, or conceived, by the user, keeping in mind that herein users are named design-agents. Such possible functions may be related to what Peirce stated on *Plausible Hypothesis*, discussed by Bonfantini (2000). According to Peirce, to regard a hypothesis as plausible, it must fulfill three requirements before being put into the experimentation phase: The hypothesis must be suitable for experimental tests, it must explain the surprising facts of matter, and must be economically viable (Cf. Peirce, 7.220).

Said that, starting from a suprising fact (e.g., the need to solve a problem), the mediation process is the complex of inferential processes that conducts individuals to *acts of use*, mental or practical, what Zingale and Domingues (2015) named as *user logic*. Nevertheless, such processes of sense attribution do not happen in a formal sequence in the using phase. In fact, they may occur randomly based on the individuals’ needs and previous experience, retrieving knowledge from their cultural background and hypothetical ways of use fostered by the artifact itself. Thus, keeping this in mind, to a given artifact, it is ideal that the result of the inferential processes the artifact urges is the achievement of any mental or practical desired task, that is, a *pre-figured task*. Nevertheless, as previously stated, plausible hypothesis can lead users to act in different manners. Then, let us explore how the three inferential movements, deduction, induction, and abduction, hypothetically operate and foster *possible outcomes*.

Firstly, a *deductive* process is usually guided by rules to be followed: *law*, *impaired instruction*, and a *habit*, a *tradition* (Zingale, 2009). Guided by a *law* the design-agents’ minds follow stated instructions, or cultural codes. Consequently, the inferential movements take general values as truth and are passive to juridical pronouncement. In the case of laws design-agents are restricted to almost no personal initiative. In here, mental actions may be defined as a plan to be followed to achieve a specific benefit. Differently, an *impaired instruction* is characterized by the transmission of information among individuals. In this case, the inferential movement is based on existing know-how. In its turn, a *habit*, as defined by Peirce, is a guideline that leads individuals to take stable inferential movements, following cultural patterns. According to Zingale and Domingues (2015), a habit is a result of an abduction, that is, is a *desire to have*, a rule that one accepts […] but is not necessarily obliged to follow. […] Should be intended as the invention of a practice rather than allegiance to a code: a rule that a user designs, in a sense, and adopts autonomously (p. 7).

Secondly, the *inductive* movement takes place when there is no trace of rule. The inductive movement, as in the case of the abduction, is composed by three phases of reasoning: *observation*, *experimentation*, and *verification*.

The *observation* phase is exploratory. It is the try to identify significant associations contained in an artifact. According to Zingale and Domingues (2015), significant associations are connections among things that can conduce to cognitive contents, which, in turn, lead to identification of rules and constants. Thus, the exploration remains until the solution is found. In the inductive inferential movement the *experimentation* phase occurs based on previous and current experience. That is, individuals act in accordance with previous deductive knowledge plus ongoing comprehension gained during processes of *verification*. Therefore, induction is the introduction of the sense attribution process, is the understanding of use by experimenting an artifact, a first phase of an abductive process.

In the absence of rules (deduction) as well as possibility of experimentation (induction), the inferential movement that takes place is the abduction (Cf. Zingale, 2009). In abductive inferences, individuals may *try* to find answers based on their own experience and cultural background. Thus, the logical movements in the design-agents' minds occur on the basis of *habits*. Supported by their own knowledge, individuals attempt to hypothesize rules (Bonfantini & Proni, 1980). In fact, the abductive reasoning precedes inductive experimentation, because in the attempt to use a product appropriately, the first 'stab' is always a gamble (Zingale & Domingues, 2015). Furthermore, abductive processes can be regarded as abductive-invention, or reinvention. Therefore, the abductive movement, also named *retroduction*, is a return backwards, from effect to cause, is a "projective gaze" (Zingale, 2009, p. 186). That is, "from the formal configuration of an artifact (effect) it is possible to abduct the rules of use planned into it (cause) (Zingale & Domingues, 2015). Abductive-invention usually succeeds in dealing with the limits of artifacts: suitability, feasibility, and availability. *Suitability* to purpose, the artifact does not do what it is supposed to do; *conception*, a possible use has not been envisaged; *availability*, the artifact does not exist or is impossible to find (Zingale, 2009).

3. Discussion

It is important to highlight that one of the aims of this paper is to foster discussions on the employment of the pragmatistic semiotics within processes of product development, particularly in early stages of product analyses and design. Said that, let us now retrieve the questions we stated along this essay.

The first question concerns to whether is possible to develop a method to frame intangible aspects in the context of use and specific circumstances. Even though, at this stage of the research we are taking a theoretical "stab", in our viewpoint, it *is* possible and a *valid* research our attempt to frame intangible aspects such as cultural interpretative answers and practical consequences. In this sense Peirce gave us fundamental theoretical guidelines that support the research method we are evolving. As stated by Peirce, "the question of validity is purely one of *fact* [emphasis added] and not of thinking" (Peirce, CP 5.365). It is to say that, the answers for this sort of research question are in the *living scene*, in the *consequence of things* in the users' lives. Along this essay, based on Zingale (2009) and Zingale and Domingues (2015), we have theoretically shown how users' mental behavior may act in order to attribute sense to artifacts

(Cf. Figures 2, 4, 5, 6, and 7). In spite of that, as a theoretical exploration, other questions naturally emerge, conducing the discussion to another issue.

The second question regards to user specificity. Zingale and Domingues (2015) have presented a diagram that graphically explains the endless design cycle (Cf. Figure 4). In the diagram, which has an artifact in its center as an entity where values are inscribed and inferred, the authors described the processes of design semiosis regarding *user*- and *design-logics*. Contemporary, there are academic and industrial demands for *systematic* and *scientific* research in the fields of design and semiotics (Cf. Deni, 2015; Borja De Mazota, 2014; Findeli, 2014; Domingues, 2011), thus, our attempt is to bring the pragmatistic semiotics into de field of design. In this sense our contribution to the evolvement of the already mentioned diagram, is including the figure of the design-researcher, Figure 8.

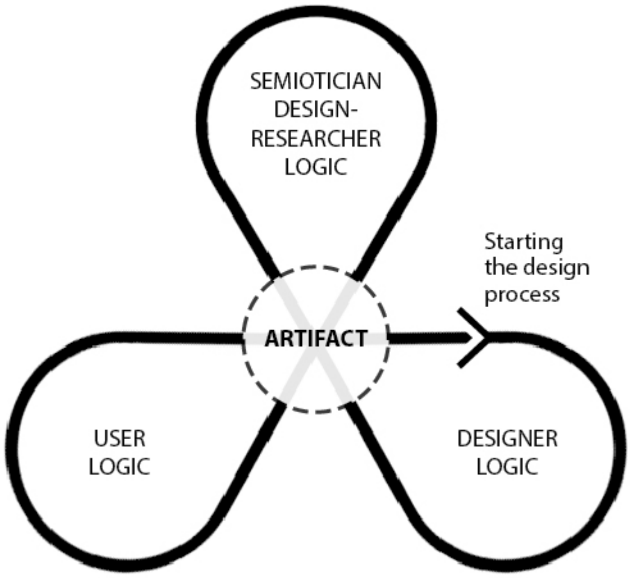

Fig. 8. The propeller model: design-agents' semiosic flux. Diagram by Felipe Domingues.

The diagram above is also a try to bring into the discussion the role of the *semiotician design-researcher* in processes of product development and analysis; is also an attempt to confront Eco's statement on the role of the designer, which we do not believe is possible in case of most designers. Eco (1980) says that before thinking as a designer, the design professional should "think like a sociologist, an anthropologist, a psychologist, an ideologist, etc." (p. 48). Nevertheless, in this paper it was not possible to develop the diagram present in the Figure 8 due to, in our viewpoint, the need of empirical research and discussions on the theme. In addition, the contemporary literature, does not provide answers for the presented triadic relation. Consequently, at this moment we have no answer to the actual issue and the ones that may emerge from it. Consequently, the third and forth questions, which are interrelated and inquiry the correlation among individuals vs. contexts vs. interpretative answers vs. practical consequences, in our viewpoint, also require empirical and experimental research.

Lastly, the fifth question, is also related to the role of the semiotician design-researcher, that is, concerns in answering how the end-user's semiosic responses could be identified, analyzed and reported back to designers in early stages of design as well as in the design-logic phase as shown in Figure 8. It is to say that we have, at least three stages to be taken into account and evolve. In different levels of depth, these phases are under development[21], but herein we have no enough space to bring them into the discussion, keeping in mind that in this paper our focus was on the analytical aspect of the pragmatistic semiotic research in design.

4. Conclusion

Regarding to implications for theory, this paper adds knowledge to the discussions postulated by Deni (2015), on the need of the evolvement of systematic analyses on the predictive faculty of semiotics concerning specific circumstances. In addition, incorporates information at the dialogue with Boztepe (2007), regarding the establishment of research frameworks that take into account the analyses of cultural aspects for the development of global products.

With respect to implications on empirical and practical applications, the statements presented in the paper intends to allow the actors involved in the process of analysis and design of artifacts to better comprehend and frame what is behind the fruition act: the inferential logics of senses attribution. Moreover, it is believed that such comprehension may aid the processes of decision-making at the very early stages of design, adaptation and market positioning of goods (e.g., global products).

Through discussing and evolving the purpose of a method of framing the pragmatistic dimension of the artifacts purposed by Zingale and Domingues (2015), this paper may contribute to fields related to the design activity fostering interdisciplinarity. We believe that the better theoretical comprehension of the semiosic flux strengthen the analytical phases of design process, especially by placing the pragmatistic semiotics approach in processes of product development; keeping in mind that, in these processes experimental tests are crucial to validate the materialization of intended consequences.

Concluding, in further stages of the so-called broader investigation, the evolvement and application of such inferential examination, considering data retrieved from the living scene, may aid the analyses and introduction of symbolic features into artifacts in the very early stages of design. Consequently, providing scientific instruments to increase the understanding and validity of the intangible aspects of design by systematic analyses.

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Advanced design as a systemic practice for innovation on territory: Creative Digital City case, Guadalajara, México.

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Resumen

El Diseño Avanzado es una practica orientada a la busqueda y visualización de oportunidades de innovación futuras, una práctica que si se realiza sistemáticamente crea corredores de innovación para las empresas que trabajan bajo el concepto de innovación continua.

Estas prácticas han sido poco documentadas, en especial cuando se trata de su aplicación en la innovación territorial, de manera que se hace crucial para las regiones entender la complejidad implícita en estas dinámicas, así como el nuevo rol del diseñador, pues su labor, aparece en etapas tempranas en las cuales, la anticipación, el diseño estratégico y la sistémica aplicada, juegan un papel fundamental en la identificación de oportunidades de desarrollo y aporte del valor para el territorio. En tal sentido, el presente artículo tiene como objetivo, disertar sobre estos fundamentos a través de la exposición de un caso específico: Ciudad Creativa Digital, proyecto de ciudad inteligente que suma los objetivos de renovacion del entorno urbano de la ciudad de Guadalajara, con la creación e impulso de la industria creativa en México. La metodología utilizada para tal fin, se basa en el análisis sistémico de los diferentes actores y variables que intervienen en el caso. Los resultados obtenidos como producto de interrelación del sistema, son la configuración de mapas o rutas que muestran áreas de oportunidad para la innovación en una localidad determinada; situada dentro de una economía emergente que evoluciona de una estrategia de desarrollo económico basado en la manufactura, a una estrategia basada en el diseño y la innovación, con la creación de regiones del conocimiento y ciudades inteligentes.

Keywords: *Diseño Avanzado. Diseño estratégico. Sistémica aplicada. Territorio. México.*

Abstract

Advanced design practice focuses on search and visualization of innovation opportunities. While applying systematic, this practice creates innovation brokers for companies that work under continual innovation concept. These performs have not been widely *documented, particularly when they´re about its application on territorial innovation, reason why is crucial to regions understand the underlying complexity in these dynamics, as well as designer´s new roll. Designer task appears on the earlier phases on which anticipation, strategic design and applied systemic play a fundamental role to be able to identify development opportunities as well as value contribution to territory. In this regard, this paper aims to discourse about these statements through a specific case exposition: Digital Creative City, smart city project that sums renewal goals of urban environment of Guadalajara city, involving creation and promotion of the creative industry in Mexico. The methodology used for this purpose is based on systematic analysis of the different performers and variables involved in the case. Outcomes obtained as a result of interaction of the system are maps or routes configurations that show areas of opportunity for a specific local innovation; located within an emerging economy which evolves from an economic development strategy based on manufacturing, to a strategy based on design and innovation with the creation of regions of knowledge and smart cities.*

Keywords: *Advanced design. Strategic design. Systemic. Territory. México.*

1. Introducción

El desarrollo e impacto de la ciencia y la tecnológia han determinado la orienctación y desarrollo de las formas de comunicación y las dinámicas económicas y sociales de vida en el planeta. En este contexto, surgen en el trascurrir del tiempo nuevas y particulares necesidades que implican también una contínua renovación del rol estratégico del diseñador como creador focalizado en el campo de la vizualización del porvenir dentro de la configuración de formas de subsistencia estructuradas como sistemas interdependientes.

En tal sentido, el Diseño Avanzado se expone como una practica orientada a la busqueda y visualización de oportunidades de intervención futuras, en diferentes contextos de acción: empresas, entes gubernamentales, organismos, instituciones educativas, etc. Uno de los ejemplos mas resaltantes, puede encontrarse en el uso de sus fundamentos para la planificación, el diseño y el ordenamiento de las ciudades y sus componentes, dado que el tratar de anticipar las relaciones y formas de desarrollo del porvenir, juega un papel fundamental en las politicas de inversión e intervención a grandes escalas.

Al respecto, es esencial y definitorio para las regiones entender la complejidad implícita en las dinámicas antes mencionadas, así como el nuevo rol que el diseñador tiene dentro de las éstas, pues su labor, pasa a ser crucial en las etapas tempranas de investigación en las cuales, la anticipación, el diseño estratégico y la sistémica aplicada, se suponen elementales en la identificación de oportunidades de desarrollo y aporte del valor para el territorio.

Sobre esta consideración, el presente artículo tiene como objetivo, disertar sobre estos fundamentos a través de la exposición de un caso específico: Ciudad Creativa Digital, proyecto de ciudad inteligente que suma los objetivos de renovacion del entorno urbano de la ciudad de Guadalajara con el impulso de la industria creativa en México.

Visto como un sistema, este proyecto se visualiza para el centro histórico de la ciudad con la mirada puesta en la recuperación de la calidad de vida y la tradición de la zona y en la generación de nuevas oportunidades económicas, sociales y productivas para la comunidad que la habita. Como eje estratégico se marca un modelo urbano interconectado,sustentable y flexible que aborde temas como la movilidad, la infraestructura, la sustentabilidad y en general el diseño urbano.

En virtud de ser un proyecto estratégico multidisciplinar de carácter territorial, se considera idóneo para abordar temáticas en la formación de futuros diseñadores desde el punto de vista de ese nuevo rol demandado por la realidad. Igualmente lo es para ser tomado como referencia en el estudio y aplicación de fundamentos del diseño avanzado en la consideración de un caso específico. Al respecto, el planteamiento de investigación de este artículo, se llevó a cabo con la participación de tres sectores estratégicos: instituciones de educación superior, empresa y entes gubernamentales. (universidad,industria y gobierno).

Como hipótesis de apoyo se planteó que a partir de la práctica de proyectos de diseño avanzado desarrollados de manera sistémica, se pueden crear portafolios que funcionan a nivel estratégico para la industria o el desarrollo territorial.

Durante la investigación de tipo cualitativa se realizó con investigación documental y de campo. La metodología utilizada se basó en el aprendizaje basado-en-proyectos o Project-based learning, en el análisis sistémico de los diferentes actores y variables que intervienen en el caso y en la consideración de datos de entrada y de salida y de su interrelación para detectar énfasis y jerarquías que una vez analizadas, pudiesen contemplarse como áreas de oportunidad e innovación dentro de la propuesta general.

Los resultados obtenidos como producto, se plasman en mapas o rutas que muestran áreas de oportunidad para la innovación en una localidad determinada y en el marco del proyecto de ciudad creativa digital.

De todos los trabajos desarrollados, se exponen en este artículo sólo tres ejemplos, con el propósito de distinguir los factores que en cada caso, fueron determinantes para generar la propuesta y los énfasis de desarrollo de las mismas. Cabe resaltar como principal aporte, el valor que tiene la información generada desde y para cada una de las entidades participantes.

Particularmente en el ámbito docente, constituye un espacio de formación profesional que otorga la responsabilidad de visualizar a través de herramentas específicas, sistemas sostenibles abordando el proceso de diseño, mas allá de la conceptualización de productos y servicios, de manera interdisciplinar.

Para la empresa y la administración, la consideración objetiva de factores de innovación viables y/o futuribles, derivados del análisis conjunto de todas las variables de entrada presentes en cada problema a resolver, o la vision estratégica con escenarios o posibilidades de futuro.

2. Estado del Arte

En las últimas dos décadas diferentes autores han estudiado y planteado la dimensión estratégica del diseño y cómo la actividad del diseño cuando aparece a nivel de la estrategia empresarial, tiene la capacidad de crear oportunidades de innovación que transforman la cultura de la empresa; (Heskett, 2002) lo menciona como una de las culturas de diseño, dentro de la diversificación que historicamente ha vivido la disciplina, en sus diferentes prácticas y manifestaciones.

Esta dimension estratégica casi siempre es planteada por los autores como uno de los niveles superiores en que el diseño puede impactar en su actuar, es decir, como el estadío en las prácticas del diseño en que añade mas valor, por ejemplo (Celi, 2012) en su pirámide del valor del diseño, sitúa al diseño estratégico (o la aplicación del "design thinking"al nivel estratégico) en la punta, sugiriendo el diseño estratégico como la actividad del diseño que aporta el mayor valor en las empresas.

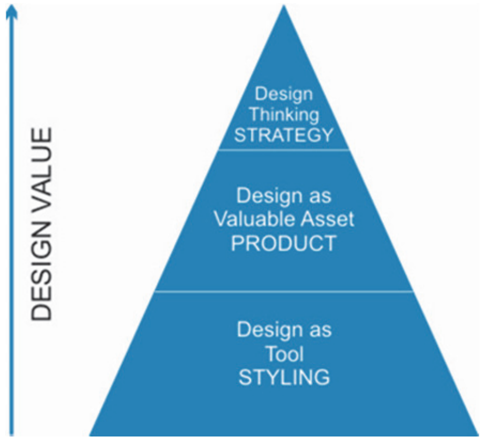

Fig. 1. Adaptado de Design Value. Fuente : Celi (2012)

Por otra parte, el valor del diseño de acuerdo a (Best, 2015) puede ser segmentado en tres actividades principales, la primera es la estratégica (la segunda son los procesos y la tercera es la implementación); dentro de la primer categoría la autora propone como una de las herramientas que las empresas pueden tener para encontrar oportunidades estratégicas la creación de escenarios, que ella misma llama "futuro imaginable" haciendo referencia a (Drucker, 2005) que menciona este mismo concepto cuando se refiere al desarrollo de un completamente nuevo producto o servicio: la creación de un futuro imaginable y de esa visión ir hacia atrás hasta el presente. En ambos planteamientos se sugiere el diseño estratégico como una actividad anticipatoria que conecta la vision estratégica de la empresa con escenarios o posibilidades de futuro.

A la actividad de diseño que tiene la particularidad de prefigurar el futuro algunos autores le refieren como Diseño Avanzado (Celi, Celaschi, Borja de Mozota, Iñiguez et al); de acuerdo a (Celi, 2010) la actividad del diseño avanzado aparecer el territorio pre-proyectual y ampliado, tratando principalmente con proyectos extensos: extendidos en tiempo, espacio, incertidumbre y complejidad; esta noción de proyecto extendido (sobre todo en el caso de tiempo), se refiere a la actividad de diseño que desarrolla proyectos en un horizonte temporal ampliado, mucho mayor al del proyecto tradicional (llamado tambien NPD), el horizonte puede ser de años, lustros y hasta décadas.

"Lo que el diseño denomina diseño avanzado o prospectivo se está convirtiendo en la actualidad en un modelo dominante, es decir, …se convertirá en la actualidad en un fenómeno de masas en la actividad del diseñador" (Mozota, 2006).

Una de las características principales del ADD en que los autores coinciden es el rol "visionario-estratégico" de la actividad, de acuerdo a (Desserti, 2010) en el ADD la actividad del diseño se aleja de su rol tradicional de resolución de problemas y se mueve hacia la búsqueda de posibilidades, y en dicho movimiento va de el mundo de las restricciones propias de un proyecto aplicativo, hacia el mundo de las oportunidades de innovación, así como también se mueve del rol técnico del diseño al rol visionario. (Fig. 2)

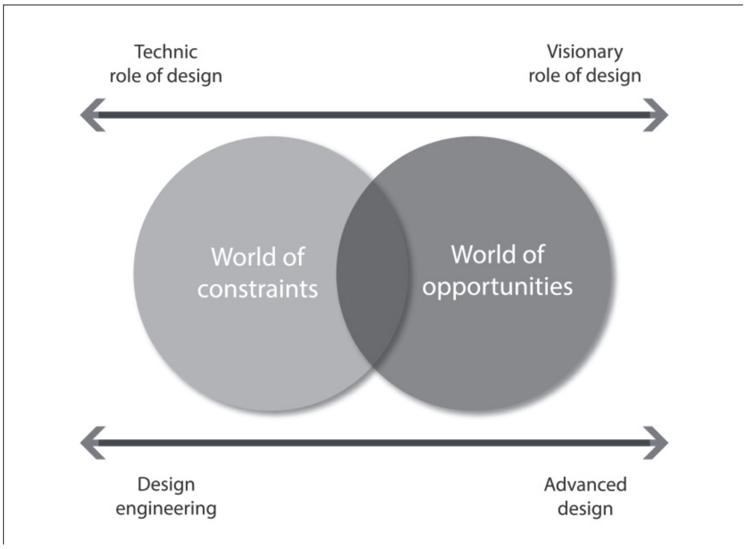

Fig. 2. Adaptado de Le tensioni del progetto. Fuente: Desserti (2010)

En el extremo izquierdo del gráfico se puede apreciar el contraste al rol visionario del ADD que de acuerdo a Desserti es el rol técnico del diseño, el diseño ingenieril.

En esta dimensión "visionaria", (Borja de Mozota, 2006) enfatiza la posición estratégica que el diseño ha tomado en la industria como creador de valor e introduce el concepto de el "Diseño como Transformador" (el cual lo menciona como un equivalente al diseño como visión) como uno de los "cuatro poderes del diseño" dentro de las organizaciones:

1. Diseño como Diferenciador
2. Diseño como Integrador
3. Diseño como Transformador
4. Diseño como Buen Negocio

Precisamente en el tercero de ellos describe como el diseño es capaz de generar visiones bajo el concepto de ADD como recurso para crear nuevas oportunidades de negocio; es el rol del diseño como transformador el que mejora las habilidades de una compañía para tratar con el cambio, y también, desarrolla la pericia para interpretar de mejor manera la compañía y el mercado y sus futuros.

En la perspectiva de Borja de Mozota el ADD juega un papel estratégico ya que ayuda dar "coherencia al sistema diseño y guía el futuro". En la siguiente gráfica se puede apreciar como por un lado lo sitúa en el nivel mas alto de los tres niveles en que una empresa puede usar el diseño y por otro lado como lo liga al "liderazgo en diseño" que la empresa puede tener. (Fig. 3)

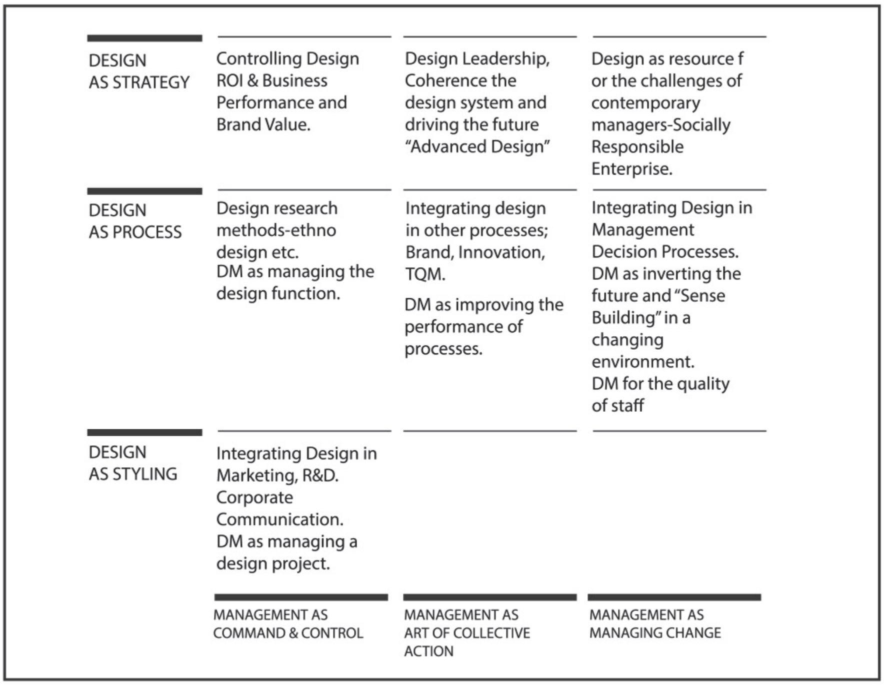

Fig 3. Adaptado de Design management is defined by what you think of design (vertical axis: the learning "ladder" of design), and by what you think of management (horizontal axis). Fuente: Borja de Mozota (2006)

En esta gráfica, se aclara como el ADD no es una herramienta estilística y tampoco esta en los procesos de diseño y métodos de innovación que la empresa desarrolla sino que se ubica en el tercer peldaño definido este nivel como el "Diseño como Estrategia"; donde el diseño se incorpora en las organizaciones a nivel de su estrategia empresarial y toma liderazgo para crear un sistema de innovación para la organización.

De acuerdo a la misma (Borja de Mozota, 2006) en su propuesta de el rol de el diseño como transformador, el ADD en su actuar suma a la capacidad innovadora de las empresas, en diferentes sentidos, tales como:

- Valor Estratégico
- Visión
- Prospectiva
- Gestión del Cambio
- Empoderamiento
- Proceso de aprendizaje de conocimientos
- Imaginación.

Todos ellos importantes para el planteamiento de el como una organización va a sostener a través del diseño la habilidad de cambiar y mejorar.

Esta perspectiva estratégica coincide con la de (DiBartolo, 2014), quien lo explica con la metáfora del "iceberg" (Fig. 4), DiBartolo coloca al diseño de producto como la parte mas visible de la organización o empresa, aquello que es visible para los consumidores y que es resultado de varias actividades mucho mas "profundas" de innovación, el ADD aparece en las actividades no visibles de la empresa, estrechamente ligado a las estrategias de diseño de la empresa y como el primer paso previo al desarrollo de conceptos de diseño que puedan culminar en productos.

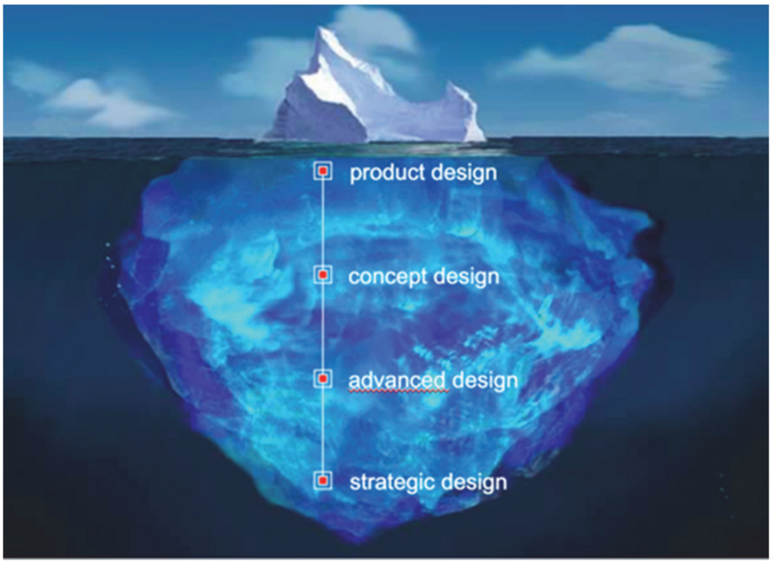

Fig. 4. Adaptado de El Diseño Avanzado. Fuente: DiBartolo (2014)

De acuerdo a DiBartolo es el ADD el que ayuda a conectar el largo plazo de la estrategia, con proyectos que permitan generar diseño conceptual para los plazos cortos que el mercado demanda, el ADD es una especie de interfaz que administra el corto y el largo plazo de la empresa.

En la caracterizacion desarrollada por (Iñiguez, 2016) sobre el ADD presenta doce atributos que como variables los definen y lo discriminan de entre las culturas del diseño, una de ellas coincide con los autores anteriores mencionados en que la actividad del ADD tiene una dimension estratégica (atributo 12 de la tabla).

Tabla 1. Atributos del Diseño Avanzado.

Número	***Concepto***	***Descripción***
1	*Complejo*	*Gestiona la complejidad*
2	*Meta-proyectual*	*Analiza de manera cualitativa los procesos*
3	*Sistémico-adaptativo*	*Utiliza metodologías adaptativas, no lineales y no convencionales*
4	*Multidimensional*	*Incorpora los axis del tiempo, espacio, experiencia y ética al proyecto*
5	*Horizontal*	*Es transversal a las áreas de una empresa*
6	*Prospectivo*	*Define escenarios futuros, futuribles*
7	*Process-oriented*	*Entiende el diseño como un proceso más que como un resultado*
8	*Innovation-driven*	*No da soluciones específicas, guía la innovación*
9	*Conceptual*	*Ligado al(os) concepto(s) más que a los productos*
10	*Visual/Verbal*	*Tiene un mayor grado de abstracción, se vale del lenguaje en sus procesos*
11	*Estratégico*	*Se orienta mas a la estrategia que a la aplicación*
12	*Multidisciplinar*	*Es desarrollado con la participación de diferentes áreas disciplinares*

Fuente: Iñiguez (2016)

En dicha actividad estratégica se sugiere como el proyecto que visualiza futuros y esta prefiguració,n funciona como un entorno de innovación continua en que se plantean posibilidades de innovación constantemente, catálogos de posibilidades que representan la estrategia de innovacion de la empresa en el mediano y largo plazo.

En este marco de acción, la sistémica juega un papel esencial, dado que el manejo de datos y las interrelaciones encontradas entre las variables de estudio, se constituyen en énfasis de desarrollo de nuevas oportunidades. Por otra parte, el atributo número 3 propuesto por Iñiguez,expone la utilización de metodologías adaptativas, no lineales y no convencionales, que de partida se emplean como sistemas abiertos.

Los procesos de innovación, han sido abordados desde múltiples perspectivas, a través de modelos de distinta naturaleza y desde campos diferenciados de acción al igual que los medios y métodos de trabajo para lograr resultados alineados a la idea, (León, 2009) pero al margen del modelo utilzado, los resultados siempre serán moldeados por causas exógenas y endógenas que rodean la situación de diseño.

Estas causas, contienen variables de entrada que deben relacionarse de manera integral con el propósito de entender y generar sistemas, en el caso del diseño avanzado, la visualización y tratamiento de datos como investigación, para generar escenarios futuribles y áreas de oportunidad, utiliza el pensamiento sistémico como parte de su ADN

3. Material y Método

La investigación conducida por los autores ha sido desarrollada en cuatro años, de Enero 2012 a Mayo 2016, donde el objeto de estudio han sido proyectos de diseño avanzado en que de manera intencionada y expedita se han planteado como ejercicios de deberían producir un catálogo de posibilidades de innovación que produzca una estrategia de innovación para el cliente. El cliente es la Ciudad Cretiva Digital que es un proyecto de innovacion territorial situado en Guadalajara, Jalisco, México; tiene como vision dos objetivos principales: el primero es el de crear un cluster empresarial de industrias creativas (en especifico: animación digital, multimedios, cine y música) y el segundo igual de importante, el crear un proyecto urbano de usos mixtos que rehabilite el centro de la ciudad. Dicho proyecto tiene como antecedentes el cluster de la industria de Tecnologías de Informacion y electronica que algunas décadas atrás se planteo como proyecto y que el día de hoy es una realidad (el 60% de la exportaciones del estado son productos de dico cluster y ha sido denominado como el “silicon valley” de México en diferentes medios).

Los proyectos de ADD para la Ciudad Cretiva Digital han incluído como actores la llamada “triple hélice” (universidad, industria y gobierno) ya que han sido desarrollados por estudiantes del Tecnológico de Monterrey Campus Guadalajara en coordinacion con los representantes de la industria de la Cámara Nacional de la Industria Electrónica, de Telecomunicaciones y Tecnologías de Información (CANIETI) y con supervision y apoyo del Gobierno del Estado.

En los cuatro años se han realizado un total de 40 proyectos de identificación de oportunidades, usando las herramientas del diseño y con la metodología de Aprendizaje Basado en Proyectos (PBL), con un proceso basado en el siguiente esquema:

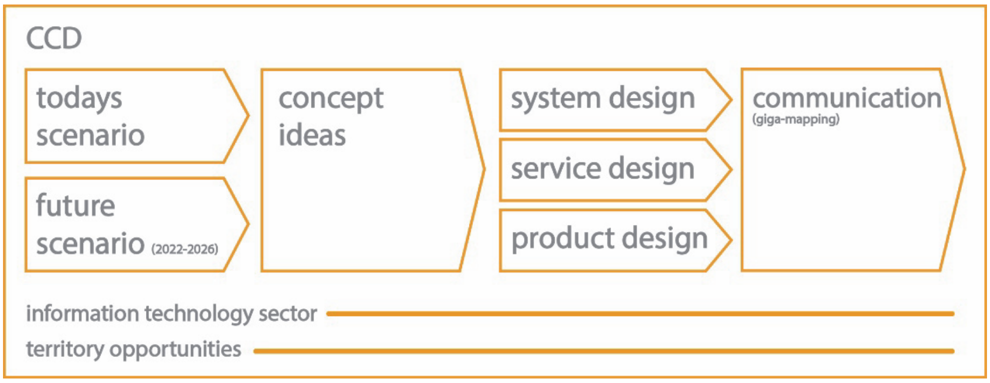

Fig. 5. Proceso de desarrollo de los proyectos. Fuente: Iñiguez (2016)

En cada fase del proyecto se usan difetentes herrmientas relativas al diseño, tales como scenario building, ideation, product design, prototyping and giga-mapping. El entregable final funciona como una descripcion del recorrido completo del proyecto, que trata de sitetizar los resultados de las diferentes etapas, expresa los resultados de las diferentes etapas y describe el resultado final bajo la herramienta del giga-mapping (Sevaldson,2011) que es una representación bidimensional que funciona como “nube de informacion” en que se abarca la complejidad del proyecto, intenta representar de manera visual la realidad no simplificada.

Las herramientas de investigación utlizadas en los proyectos incluye la investigación documental, investigación del campo, action research y la evaluación sistémica en que se analizan los proyectos para la determinacion de las variables que intervienen en ellos.

4. Resultados

La dimensión estratégica de los proyectos de diseño avanzado abordados sistemáticamente contienen cuatro variables principales, que son calificadas por los participantes en los proyectos como variables relevantes:

1. Complexity Management – Visualization
2. Opportunity Finding
3. Project Multiplicity
4. Organisational Transformation

A continuación se describe cada uno de ellos y se ejemplifica mediante proyectos particulares y su resultado (giga-map) como es que suceden:

4.1. Complexity managment - visualization

Los proyectos de diseño avanzado tienen como uno de sus atributos principales el que amplian la complejidad y variables participantes en los proyectos, por lo tanto funcionan como conductores que permiten navegar en la incertidumbre siempre presente en la innovación. La sistematicidad en los proyectos de diseño avanzado permite navegar en la incertidumbre, encontrar patrones y proponer posibilidades, al mismo tiempo que se visualizan, una suerte de administracion de datos complejos de manera no cuantitativa (como lo haria la “ciencia de datos” o el “big data”) sino mas bien cualitativa donde la informacion pasa de ser prospectiva, a ser anticipatioria o prefigurativa. El siguiente giga-mapping ejemplifica la gestió de información compleja de manera cualitativa, donde no se simplifica sino que se privilegia la densidad.

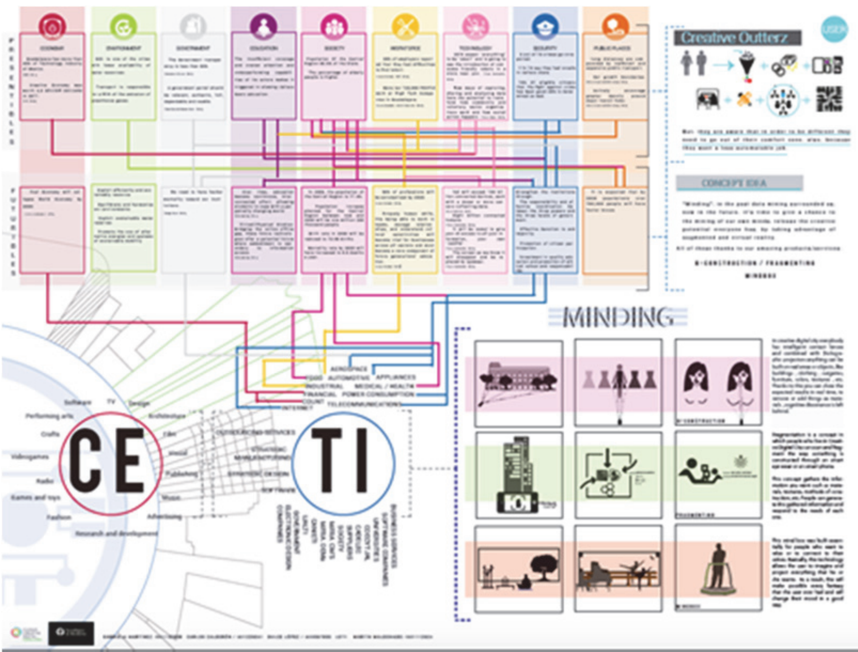

Fig.6. Ejemplo de Giga-map en Complexity Management – Visualization.

4.2. Opportunity Finding

La gestión de información compleja y la creacion de posibilidades funciona como una actividad de busqueda de oportunidades, oportunidades que se buscan en el FFEI, y que tienen un horizonte de aplicación futura. Ante la gran incertidumbre que viven las organizaciones actualemnte, el diseño avanzado brinda procesos que facilitan el encontrar posibilidades puntuales que pueden ser vistas a nivel estratégico como apuestas a futuro.

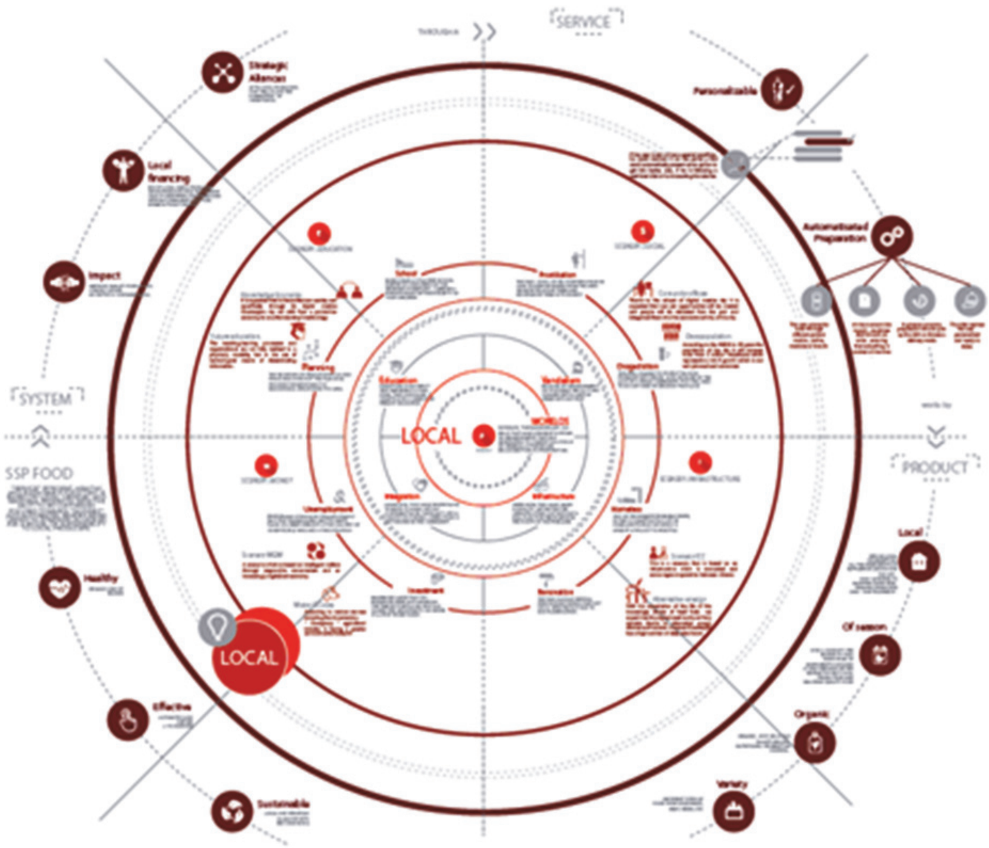

Fig.7. Ejemplo de Giga-map en Opportunity Finding

4.3. Project Multiplicity

Dado que los proyectos de Diseño Avanzado son prefiguraciones de posibilidades, los resultados sientan las bases para que otros proyectos puedan ser desarrollados a partir de ellos, ya sean otros proyectos de Diseño Avanzado como proyectos de NPD. El trabajo sistematico produce catalogos de posibilidades que en continuo se retroalimentan entre ellas y se multiplican, esto es percibido y valorado por los clientes como un potencial multiplicador de innovacion. Una nota importante es que no solo el resultado final (diseño de servicio-producto o sistema) es vista como base para ser un multiplicador de proyectos, sino todas las etapas del proyecto de diseño avanzado, dados los procesos de gestion de la complejidad y prefiguracion, cada una de sus etapas entrega posibilidades que pueden ser multiplicadas en diversos proyectos.

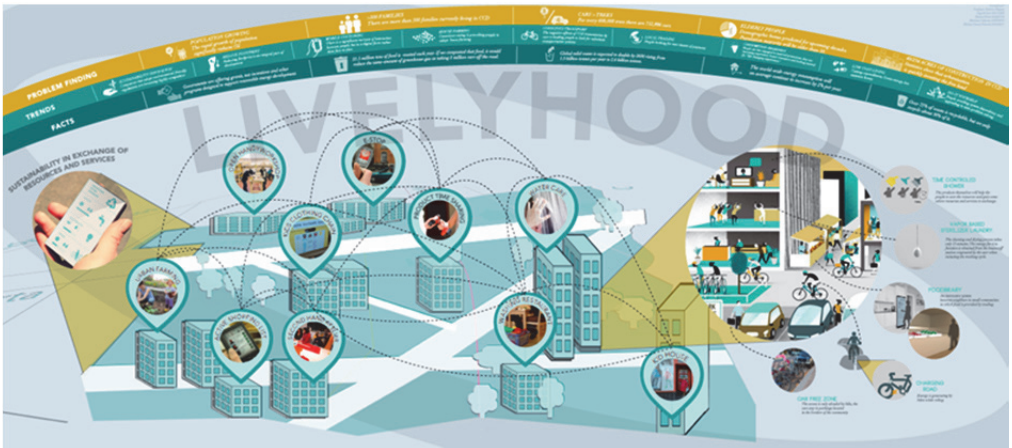

Fig. 8. Ejemplo de Giga-map Project Multiplicity

4.4. Organisational Transformation

Toda vez que los procesos de diseño habilitan a los participantes para gestionar la complejidad, encontrar oportunidades y producen una importante multiplicidad de posibilidades, la organización (entiendase como organización tanto el cliente directo como los diferentes participantes del proyecto) se ven transformados dado el conocimiento y competencias que generan los proyectos. Los nuevos conocimientos, oportunidades generadas y las plataformas multiplicadoras predisponen a los diferentes actores a la innovacion, asi que toda la organización sufre un cambio cultural.

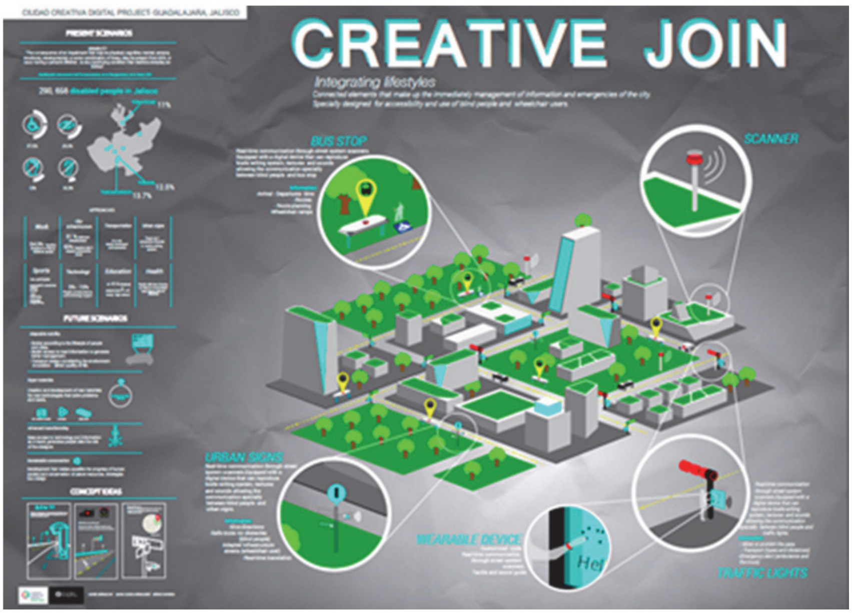

Fig. 9. Ejemplo de Giga-map en Organisational Transformation

4.5. La práctica Sistémica del Diseño Avanzado

Las variables de salida descritas anteriormente son producidas por la práctica sistemica de proyectos de diseño avanzado, son una suerte de innovación continua que incide en las posibilidades de innovacion de la empresa (o territorio); inciden desde luego como proyectos que generan innovacion per sé, pero también inciden a un nivel estratégico, ya que modifican el "catalogo" de innovacion de la empresa e inciden en la visión empresarial dada su capacidad de abordar el largo plazo. Las modificaciones que producen los proyectos pueden retroalimentar nuevos proyectos de diseño avanzado cerrando un circulo virtuoso en que de manera sistémica se conectala estrategia de innovacion (empresarial o territorial) con los procesos continuos.

Fig. 10. La práctica sistémica del diseño avanzado

5. Discusión y conclusiones

Los resultados de la presente investigación validan la hipótesis de partida, basada en el planteamiento de que a partir de la práctica de proyectos de diseño avanzado desarrollados de manera sistémica, se pueden gerenar portafolios que funcionan a nivel estratégico para la industria o el desarrollo territorial.

En tal sentido el aporte de conocimiento se concentra, por una parte, en el cómo la relación del diseño con contextos específicos, puede hacerse legible en términos de planteamientos concretos aplicables a futuras realidades. Por ejemplo, la generación de avenidas de innovación, que como ejercicios que desarrollan competencias puntuales, y que crean cultura innovadora, son productos concretos y utilizables, dado que han sido validados y analizados como sistema.

Por otra parte, la dimensión de aprendizaje del diseño a partir del PBL, la sistémica aplicada durante todo el proceso y los fundamentos o atributos de la actividad del ADD, demuestran que es viable generar esquemas de gestión y prácticas o formas de trabajo que apuntalen la formación de los diferentes actores, al momento de desarrollar proyectos de innovación guiada por diseño.

Finalmente, a los resultados dejan evidencia por un lado, de elementos clave que pueden ser utilizados para afrontar la gestión de la complejidad en este tipo de proyectos, a través de la colaboración interdisciplinar que crea lenguajes comunes de comunicación que sirven de plataforma para el diálogo entre diferentes agentes de conocimiento. Por otro, también cabe destacar como evidencia, el desarrollo de la capacidad prospectiva de las organizaciones y los individuos involucrados en el aprovechamiento de las ventajas proyectuales que representa el ADD.

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Systemic Education and Awareness. The role of project-based-learning in the systemic view

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Abstract

The paper investigates the role of Systemic design[22] in a well-structured social network as a tool to solve complex problems difficult to face by the application of a linear approach. It's necessary a change of paradigm: from an approach based on the competition and on the logic of continuous growth to a systemic vision, based on the collaboration, the awareness and the rediscovery of qualitative values. The ecological emergency demands more and more the development of sustainable and resilient communities. We have to change the way of thinking processes and relations, in other words we must be ecoliterate. Infact, ecoliteracy represents the starting point of innovative processes. It gives importance to the relations and to the multidisciplinary team-work. This cultural change begins at the level of the schooling system which now represents the official institution for growing conscious individuals. The current academic system has been defined by the same linear and competitive approach used to delineate our economic systems (social hierarchy, inequalities etc.). In practice, to achieve some important changes we need to act from students of primary school to college students and over. The paper investigates also the issues of the strict hierarchy between teacher and student and the support of collaborative behaviour. In this article we present different case studies (not only from the world of academia) and analyse the role of project-based-learning in order to inspire a new eco-competent generation of people.

Keywords: *Systemic view, Awareness, Sustainable communities, Ecoliteracy, Collaboration vs Competition*

[22] Bistagnino, L. (2011), Design Sistemico. Progettare la sostenibilità produttiva e ambientale. Slow Food Editor, 2nd Edition

1. Introduction

Through the critical analysis of some case studies, this paper intends to investigate different useful tools to the “ecological education”[23]. Moreover, it aims to analyse didactic activities which have more influence in the development of an individual and collective awareness to get closer students to the systemic approach. Observed institutions represent useful starting point to evaluate how it's necessary to rearrange also the school system, because actually it's the main organization designated to provide knowledge. In the next pages positive features of case studies will be underlined to define guidelines of systemic education.

2. Social, economic and product environment

Daily activities of human life are placed inside an huge context characterized by a systemic structure. Ecosystems, which are the setting of all human activities, are made up by interconnected subsystems, in which relations and networks represent the core that define their organizational schemes. However, if we look at our economic and product systems, we can easly prove that the way used to manage their processes is very far from natural ways. With the Cartesian revolution and the introduction of the scientific method, we witnessed a rapid change of vision and a dramatic change in the way to tackle complex issues. Moving away more and more from the holistic view, people think that the behaviour of living systems can be investigated like machinery.

Firstly, from the second industrial revolution, western societies have greatly modified the pace of own evolution, moving away more and more from natural cycles of development. Then, from the Second World War, the technological progress is increasing constantly and also it leads the economic, industrial and socio-cultural time. Greater is the speed of technological innovation and greater is the request of quicker production times and more efficient travels. The immediate impact of this uncontrolled acceleration, in all fields of industrial and post-industrial society, is the exponential evolution of its material culture (Thackara, 2005). The industrial society is following the principle “it is faster and it is better” and it achieve a pace not more supported by natural cycles.

The main need of people is the interaction with natural environment, modifying it according to own demand: so design is the essential source of human life, it's the foundamental action of all human being (Papanek, 1971). Nature designs constantly living systems and it rearranges structure and relations to adapt them to new conditions and to mantain them around a balanced equilibrium. Unlike living systems, our economy faces complex problems using a linear approach and “unsystemic” vision, typical of production systems of XIX and XX centuries. This kind of vision considers only one way to solve problems, it suggests preset solution, recommended like the only one able to recover an instability. A critical situation is considered like a breakdown of working machineries: we have to solve this breakdown as soon as possible, using all kind of instruments, but without looking into the real causes and behaviours that could have generate that situation. The main inclination is to reduce all complex systems in elementary parts, in order to modify working principles of each parts, without considering relations between different subsystems and between them and the context. The unavoidable consequence is the loss of worldwide vision and the importance of connections, which are essential requirments of systems. It seems to be progressively evident that frequently the real motivation of all problems is the exclusive application of linear approach in all field of everyday life, producing consequences on ecosystems, which are more and more visible and even less foreseeable.

[23] “Ecological education” refers to a trans-disciplinary approach used to increase in students the awareness around sustainable development (UNESCO, 2002).

Also the management of natural resources is designed along a linear model, in which raw materials are extracted more than enough, are transformed through unsustainable processes without cosidering their ecological footprint, are used and finally discared in the environment. But it's difficult to reintroduce them into the natural cycles without suffering damages more or less reversible. Like industrial production, also the consuption model is conceived and spreaded in linear way, in which the consuption of ephemeral goods is intensified. Since the 1970s people started to questioning the economy itself and the political behaviour in relation to the ecological issue, but only in recent times the environmental matter has started to get consequences on the industrial project and design culture (Tamborrini, 2009). If it is true that “the 80% of environmental effect of our goods, services and facilities is defined at the design step” (Thackara, 2006), the design world should become aware to the ecological issue and it should rethink processes to reduce their ecological footprint. We have to modify our behaviour before that the project is at the operative step, so it is necessary to develop a design culture that consider the ability of human systems to have an effect on other ecosystems.

3. School, university and cultural system

Culture is the main feature of human life that explains better than other all aspects of a specific historical period. Therefore we have to reflect about the ways to reproduce it and to impart it to other people. Nowadays culture is considered and leaded like an ordinary output of the industrial society. We are living in ages marked by a lot of changes and governaments of different countries consider the education like an instrument of competitiveness that distinguishes a nation from another. They want to educate a huge number of people using less as possibile amount of resources. So they set up a real education market inside which culture is exploited like goods able to enrich the governament. Schools and universities have the main purpose to spread culture in all classes of society, they must give to the people instruments useful to integrate them into the community. Education should set people in the condition to understand the features of the context and to be aware about the decision-making. For this reason education represents the instrument of people's freedom: educated people are free to uderstand what is going on around them, free to think and reflect and finally free to express their opinion about a common topic. Nowadays we often confuse education with a basic learning of technical concepts, which are useful in ordinary jobs but they don't help to develop a critical and holistic point of view. Formal education spreaded by schools and university often seems like blocked by the huge amount of subject: students have to learn a lot of disciplines in very brief time and this kind of learning doesn't give enough time to develop critical and “meta-cognitive” abilities (Illich, 1971).

Education is one of the most important moment in the human life, not only professionally, but also individually. The typical speed of our time, in which periods are strained to obtain the most profit, has some effects also in education. Like other aspects of human life, the education system is designed using the linear approach, so it draws a rigid and hierarchical structure that reproduces the same pattern of society, based on competitives and unyaldings classes (Bourdieu, 1970). The huge list of essential abilities represents a way to control students, because they have to learn them in schedule and it also contribute to increasing the stress of daily life. This stress is the consequence of an overloaded system, which very often seems like a “knowledge factory”. Inside this factory the productivity and the quantity are main topics and its first purpose is to obtain a number like merit: in this scenario the educational path loses its important sense. Especially in Bachelor degree, Masters and PhD we can notice that there is a tendency on focusing the attention on a single field of study, it asks that students have very detailed knowledge, but at the same time they lose the ability to connect topics of different disciplines.

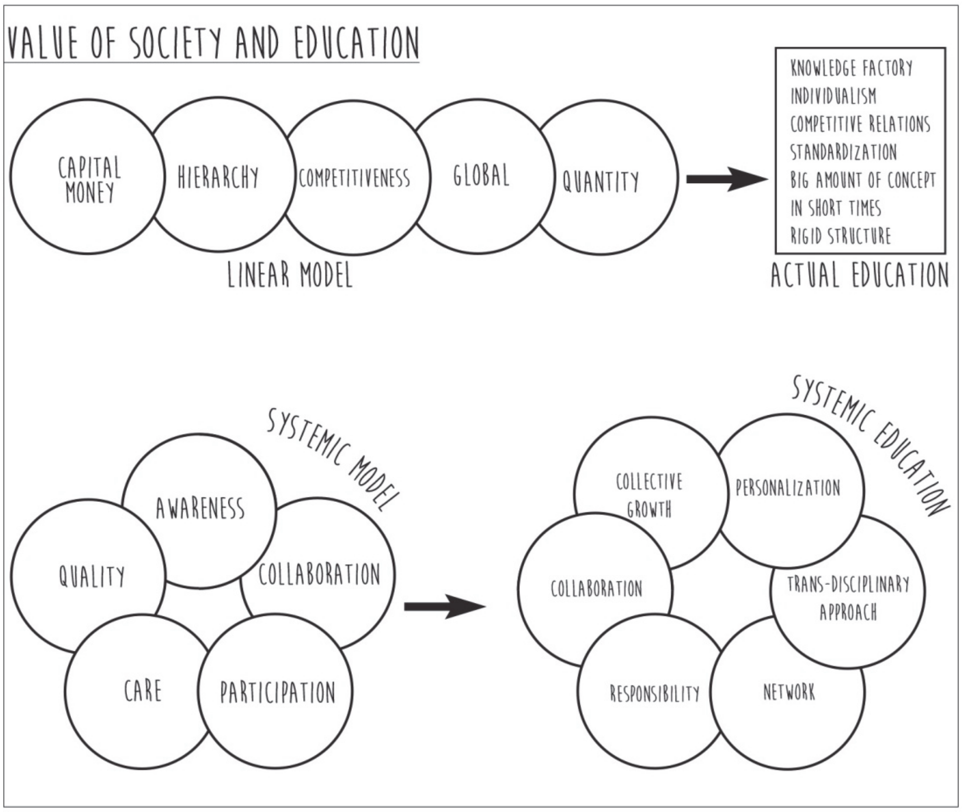

Fig. 1 Comparison between values of linear and systemic model and their consequences on education system.

4. Comparison between linear and systemic model

Looking at the ecosystem's organization, we can learn that all subsystems are interconnected and they are working in collaborative way. A very important role is represented by relations, because they set up the network in which the informal communication and sharing abilities take part between different components and also they contribute to the training of common knowledge. If we compare this mode of operation to the one of human activities, we can easily notice that they are not interconnected and they don't collaborate between them, namely they have a lot of trouble in creating a cooperative network. The main motivation of this gap between human and natural field is due to their opposite systems of values. Ecosystems follow the principles of systemic thinking to organize their structure, which is based on relations, on collaboration and on the quality of their trading and products. On the other hand human activities are the implementation of the linear paradigm and their fundamental values are very far from the systemic view. The linear society is marked by a strict hierarchical structure and competitive relations, used to achieve a dominant position on other people: the wealness of each person is not due to the wealth society, but it is the consequence of aggressive behaviour adopted to achive a position of economic power compared to other people. The only way to obtain the success is proving to be better than others, using own abilities to achieve an exclusive individual benefit without sharing them with the community. Often the only one aim of relations and tradings between people and companies is the accumulation of monetary capital, which is represent the driving force of the local and global economy. The same economy that imposes a pace following the illusion of an illimitate exponential growth (Capra, Handerson, 2009). To satisfy this constant request of growth by the marketplace, the product system reacts focalising the attention on the mass production and on the number of goods, at the expense of their qualitative values. In this way a standardized production model, which is based on the huge number of products, is adopted like the only one possible with the aim to preserve the perception of an ephemeral and material richness. Technological development is exploited like the main motivation to plan the obsolescence of industrial products, in such a way that industrial production always replies to superfuous needs of the marketplace. All of these things contribute to the creation of a “Kleenex Culture” (Papanek, 1971) and our ecosystems are not anymore able to support this kind of throwaway culture. The main aim of the hierarchical and pyramidal structure of our society is the accumulation of huge amount of money in hands of few people through the maximization of the profit in more and more brief times. The economy is mainly interested to cash flows and to financial transactions, without considering the real wealth and the capability of systems to react in front of a critical situation. Following this linear development model, our global society has led to a rigid and fragile economic system, which is not able to re-organize itself in an efficient way after a disruption which has changed its balance. At the same time the uncontrolled exploitation of resources and the overproduction of waste have an effect on the environment and they cause a reaction so much violent and unpredictable that escapes more and more often from the human control. The linear cultural paradigm gives us suggestions and interpretations of society which aren't anymore able to satisfy real needs and at the same time to give attention on the natural ecosystem's wellness. We can notice especially in the agriculture and energetic sectors how nature and society are following two different paces: the second one is consuming more resources than the first one can produce them (Thackara, 2006). Ecosystems send a very strong message to humankind in reaction to this exploitation: it's not possible to think and effect anymore on the basis of an hypothetical illumined growth, when available resources are limited. So, nature reacts reducing the amount of available resources and showing in a more emphatic way the consequences of human actions, which cause ecological impacts more and more devastating and that effect unavoidably the financial system (Heinberg, 2011). Just as psychological consequences are evident on people's health: more quickly the economy increases and expands itself and stronger is the perception of heaviness in daily life. The time acceleration in all daily activities (job, relax time, family time...) effects like a spinner on the exponential development of material culture, linking the human nature to the concept of heaviness (Calvino, 1988). For these reasons it's necessary to change the approach used to take on different aspects of human life, we need to change the prospective from whence we are looking at things of our society. In other words it is necessary a change of paradigm from linear to systemic. We are aware that the actual situation needs new tools to understand new conditions and to decide how intervening in the future. So we have to learn a new language that allows to read and to understand consciously the complexity. This implies a change in the culture and in values systems that lead the human behavior.

5. Sustainable communities like organizational model for the future

The ecological urgency encourages the transition from actual settlements into sustainable communities. Nowadays the real challenge is the creation of resilient communities based on the examination and comprehension of natural systems (Capra, 2014). So we have to redesign processes and relations depending on resilience, just like that systems are able to modify their structure to adapt them to new conditions defined by flows and new balances into a complex scenario. Community represents the best expression of “democracy”, inside which different part contribute to increase the decision-making power and the freedom of speech of its members. The attention is focusing in particular on some principal aspects of communities: the economic and decision-making autonomy, the ability to reproduce themselves without any external aid and the network like structure (Bookchin, 1989). The same concept of community suggests an important change of values: inside a community members establish relations based on trust, on awareness and on care for other members. Relationships and exchanges are directed to put in sharing material goods, knowledge and ability with the purpose to maintain the comfort of the same community. Collaboration is the most important features of all activities inside a community and it has the aim to support and keep a dynamic community. The success and the realization of each person is not based on individualism, but on cooperation and sharing. Therefore people have an active role in the context, they try to act in a sustainable way on the environment and also they try to establish a constant relationship with it. Another important features of the ecological systems is the preservation of the community itself, that finds a way to be self-sufficient through internal processes and exchanges of input-output. This is so different from economy that is based on the exploitation and consumption of external resources. The modification of the cultural background becomes therefore the starting point to define a new system of values.

5.1 Ecoliteracy

To live side by side in armony with ecosystems, we have to re-organize structures, flows and relations of human systems. To do that we need to own instruments to understand living systems and to learn from them, in other words we need to become ecoliterate (Capra, 2011). It's necessary that people learn a new language and that they pass down it to new generations of youngs, because this language can help to design a communicative and exchanging network between different systems. All this requires a big effort in changing our habits and in redesigning our daily processes. However nature can suggest us a lot of examples about how manage our processes in a sustainable way. The first step in this direction is becoming ecoliterate and ecoliteracy have to become an essential part of the cultural background not only of future generations but also of politicians, of managers and of those people who have the ability to modify the environment. To notice significative changes into the society, the systemic view of life must be spreaded to a huge group of people, starting from primary school until post-university education. Rethinking education in a systemic view involves also a reconsideration of the hierarchical relationship between teachers and students, of the study plan and of the way of teaching.

So purposes of ecoliteracy are:

- to build "eco-competent" people, that are be able to read dynamics of living systems, to re-elaborate what they have learned and finally to apply it in daily activities;
- the promotion of collaborative behaviours through multidisciplinary team-work learning;
- the development of individual and collective awareness about ecological and systemic issues through the practice to represent an active role into the community;
- sharing of goods and knowledge with all members of community;
- the re-organization of all activities on the basis of local community's wellness;
- the development of responsibility toward other members and the environment;
- the creation of a huge network of exchanges;
- the deep knowledge about local flows and dynamics and their preservation.

All of this contribute to modify the actual cultural paradigm marked by materialism, not only into communities, but also inside each person. The challenge is overstepping the individualist approach, based on consumption and material supremacy and look at relationships and collaboration like resources of individual and common wealth.

"We find spiritual fulfillment in nature or by helping others. None of these pleasures requires us to consume things from the Earth, yet each is deeply fulfilling. These are complex pleasures, and they bring

us much closer to real happiness than the simple ones, like a bottle of Coke or a new minivan." (Suzuki and Dressel,1999, pp. 263-4)

This quotation wants to note how our perception is impaired about what can really give us wealth: the capitalist society suggests us to search happiness in consumption and purchase of material goods, but people can reach the real satisfaction using their abilities for community. Systemic education involves training of listening and understanding skills about other needs and also finding solutions far from the restricted material satisfaction. So it's necessary to develop abilities to understand messages sent by other people and by environment. In ecoliteracy, ecological studies are the fundamental background for other disciplines, directly related like biology and natural sciences or less related like economy, but important because it deals with the flow of raw materials. Systemic education requires a significant transition in educational paradigm: we have to open education to an ecology of mind (Bateson, 1977), involving also spiritual features of human life. Another challenge is the re-connection of the academic world to the real world, reconsidering the experience like an important moment in the educational path.

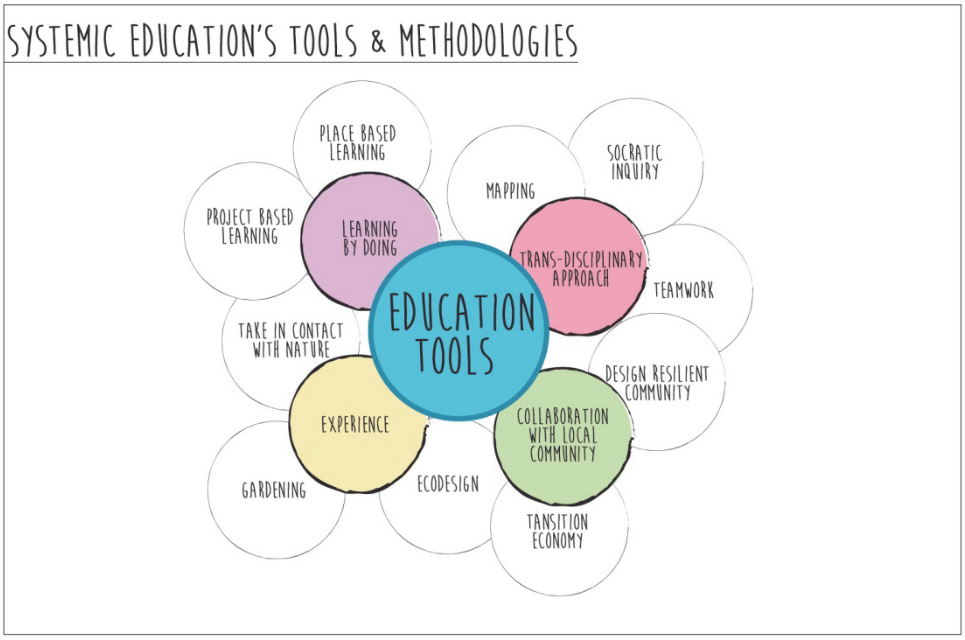

Fig. 2 Description systemic education's features

5.2 Case studies

Many projects around the world offer alternative choices to the traditional education and they consider ecology like the "fil rouge" that links all disciplines. Below some significant case studies will be analyzed, considering institutes and experts linked to ecological topics. The attention will be focused on those realities that handle the education about systemic design.

Fig. 3 Location of institutes and organization involved in sustainable field of study

We can underline a huge network of researchers and activists, involved in different project on global and local scale and moved by the intention to make people aware and to change the strict mechanistic approach in scientific studies. Between those it's important referring to the work of F. Capra, J. Thackara, V. Shiva, S. Kumar e G. Pauli. With their publications and their active role, they try to promote some changes in different fields of society. Fritjof Capra, in his books, disapproves the strict mechanistic approach in research projects and promotes the application of the holistic view in scientific fields. He also extends the network vision to all aspect of human life, from politics to social sciences. He is involved, like co-founder, in "CEL- Centre for Ecoliteracy", that promotes the ecological language in primary and secondary schools. The institution offers a systemic learning, based on the participation and on the educational power of experience. Students are led, during the learning, of principles of living system through the involvement in practical activities, like school gardening (Capra, 2014). Looking at university education, "Second Nature" (Boston, USA) promotes the ecological education working with a network of colleges in United States. They want to help college campuses into the transition to energetic sustainability. The main aim is to increase the amount of courses in ecological disciplines, to promote the foundation of new research centres, to improve their energy performance and to decrease their consumption.

Other two important exponents, linked to the ecological Indian activism, are Vandana Shiva e Satish Kumar. The first one is involved in conflicts related to the food sovereignty, the agriculture and the farmer's rights and the protection of biodiversity. She is working to make global public some problems that afflict the poorest parts of India. Important is her attention to women's marginalization and its relation with the western development model. Her position regards to the mechanicistic scientific research is highly critical, because it distances people from nature and ecological systems from human society. In India she established the "Bija Vidyapeeth – Earth University" into the "Navdanya Biodiversity Conservation Farm". It is a living and learning centre focused on democratic education, community living and protection of seed's biodiversity. The centre mainly offers courses about agroecology and organic food systems. Another exponent linked to the Earth University is Satish Kumar, activist and editor of

"Resurgence & Ecologist" magazine that give global information about ecology, philosophy, sustainable development and arts. The main purpose is to offer some alternative causes for reflection in comparison to mainstream discussions, acting on individual and collective awareness. Kumar's education is linked to Jain monks and non-violence and he represents for many people a spiritual guide. His activism is put into practice in the foundation of the "Small School" and the "Schumacher College".

Schumacher College is an international learning centre focused on environmental sustainability, trans-disciplinary and holistic learning. It works together with the Plymouth University and the Transition Network (Totnes, Devon, UK) and it proposes short and post-graduate courses, by accepting students from all parts of the world. So there is a multicultural place of study and teachers adopt community learning and "learning-by-doing" approach in educational activities. Students are divides in teamworks and they get in touch with complex theory, dynamic systems theory, biomimesis, permaculture, ecological design thinking and economy for transition. Practical experience, like gardening, and living community are considered like central moments in the learning path and in the development of ecological awareness. Educational activites include democratic involvement, sharing ideas, moments for individual reflection and practical works useful for the community.

Near to the Schumacher College is the "EDE- Ecovillage Design Education" (EDE), organized by GEN-Global Ecovillage Network and by Gaia Education, promoted for the first time in 2005 at Findhorn Ecovillage in Scotland. Every year a lot of different courses, about sustainability, are proposed in different places around the world, especially in South America. Educational activities take place into "living and learning centres "and they are organized in theoretical lessons, practical activities, workshops, project-based-learning and games, used to teach ecological principles. They propose flexible programs to adapt them to different scenarios like intentional urban and rural communities or colleges. They also apply an holistic view to sustainability, ecology, economy and social studies. Spiritual field is very important in EDE, so they propose to follow a healthy life style and to practice a daily exercise program (like meditation). All of these aspects can be useful to re-connect each person to other people and to the context.

Other two important exponents are the British theorist of design John Thackara and the Belgian economist Gunter Pauli. In different ways they get closer to sustainability and in particular to systemic design. Thackara in 2000 founded "The Doors of Perceptions", an international network of designers, innovators and students joined together in the research of solutions for a sustainable future. So the network is a real community of practice, in which ideas and knowledge are shared during meetings and workshops. They discuss about the role of technological innovation and which kind of benefit it can offer to future societies, they also talk about networks inside cities and local business. Thackara affirms that the cultural change have to start from the bottom part of the society, from common people that involve themselves in local business to promote the territory. It is very importan because "local realities compose the global one" (Thackara, 2012). He also suggests to focus our attention on relationships, because we can realize sustainability, that often is a more theoretical concept, in them.

"In nature, waste does not exist and there is no unemployment. Everything have a role into the system and outputs of an activity become inputs for another one". (trad. G. Pauli, 2010)24

As Thackara, Pauli suggests to focus our attention on relationships and to consider them like basis of the re-organization of our economic and industrial systems. Through the international network ZERI, composed by economists and other experts, Pauli proposes to reorganize our business in "open systems",

[24] "In natura non esistono disoccupati e neppure rifiuti. Tutti svolgono un compito e gli scarti degli uni diventano materia prima per gli altri". Pauli, G. (2010). Blue Economy. 10 anni, 100 innovazioni, 100 milioni di posti di lavoro. Edizioni Ambiente.

in which the output of an activity can become the input for the generation of other interconnected activities. Main instruments to realize this network are the biomimesis and the good knowledge of local features.

Near to the “Blue Economy” of Pauli, we can find the Master course in “Systemic Design”, which takes place at the Politecnico of Torino by the prof. L. Bistagnino. “Working on the territory” is the central activity of the educational path. The territory is described by a qualitative approach that underlines its features using flow maps of raw material and energy across local systems. The main purpose is to develop into student abilities of trans-disciplinary analysis and teamwork learning, that are useful to redesign our production model from linear to systemic. Educational activities are organized using the “boss-less” structure: theoretical lessons are replaces by the “learning by doing” method and by the “project based learning”. The professor plays the role of “mentor” and he gives the possibility to teamworks to self-organize their educational path.

5.3. Review

From the comparison of case studies we can notice some differences and similarities in education about environmental sustainability and systemic view. All of these examples show how community of practice, relations, territory and active involvement have an important role in education path.

Some projects are more focused on spiritual education like foundamental moment in the development of ecological awareness. These activities ask to the people to share their abilities, knowledges and ideas and at the same time they have to learn from others and work with them. Practical activities and learning have the aim to encourage collaborative and dynamics behaviours inside groups.

In many projects ecodesign and gardening are used like didactic instruments (ex. Centre for Ecoliteracy and Schumacher College), because they are practical activities that connect the group of student to the context. Often ecological dimension in education is dealt with the project based learning (ex. Gaia Education), because practical involvement can build a more established awareness.

6. Conclusions

The radical transformation of the current structure of societies involves a necessary re-organization of educational system. The organization of future societies in sustainable communities requires that also people and leaderships are appropriately educated. It's necessary to take place the quantitative approach, based on a large amount of concept, with the qualitative learning that suggests different ways to apply theoretical concepts to the real life. The systemic learning of scientific disciplines uses, like didactic instruments, principles of living systems like concepts of scheme (relations), structure and processes. Trans-disciplinary methodology is very important in systemic learning: to develop holistic view is necessary to make connections between different fields of study. For this reason workshop can help students to understand how to apply theoretical notions in realistic context and also it represents the moment in which people can develop awareness about their active role. Students take cooperative behaviours and democratic involvement and their work often have some positive consequences on local communities.

Education has to be rearranged to create a network of interactions that connects people to the context and also this network can be useful to create a learning community. The aim moves from the profesionalization of students for the employment to the social education of them, through conscious development and emancipation (Freire, 2004). Redesigning education like an open system, students get to know with concepts of exchange, relations, flows and collaboration, all features typical of living systems.

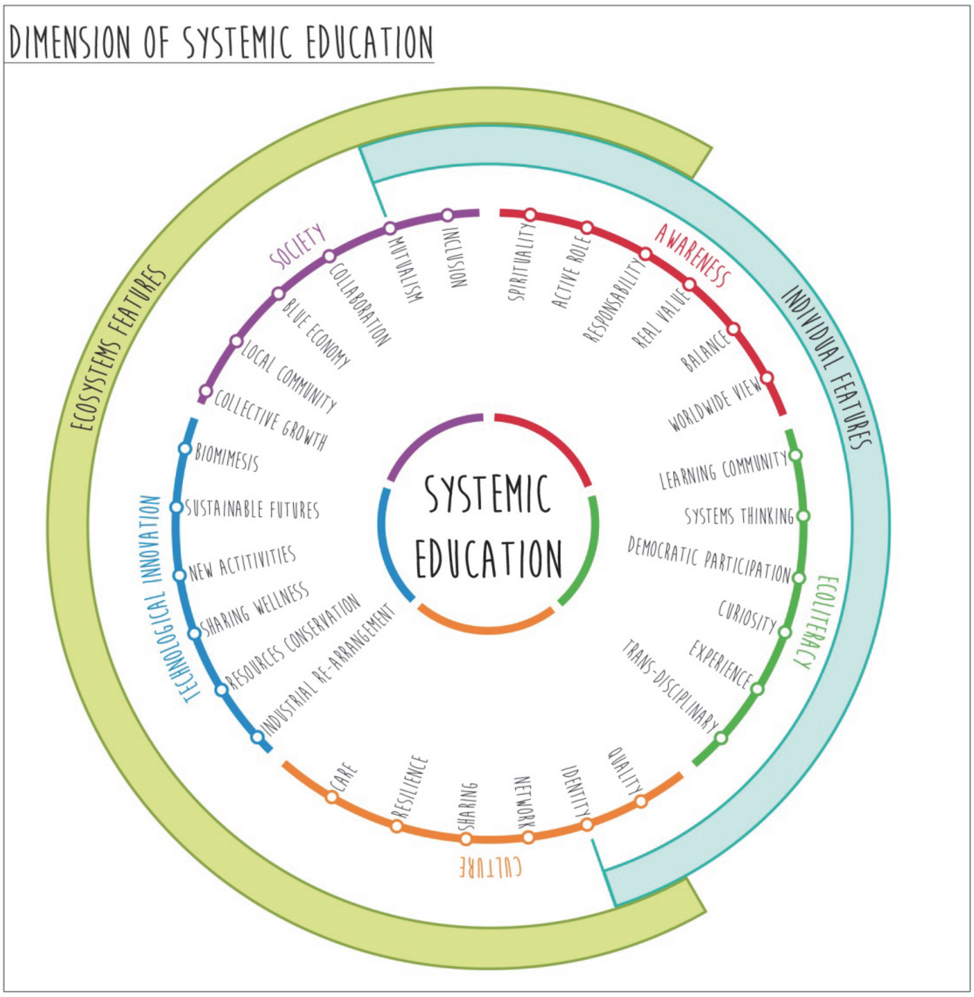

Fig. 4 Dimensions of systemic education

This analisys underlines that we are moving first steps toward a sustainable future and many of these steps are done by small realities which are working on local scale. But this transition requires that increasing ecological awareness effects more strongly on our society, through making a network between design and local economy, socio-cultural and spiritual dimensions of human life.

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Rural Development And Sustainable Innovation. How Systemic Design Approach can contribute to the growth of marginal regions

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Abstract

The objective of this project is to reach sustainable development in rural areas through Design Aapproaches. We intend here, as "sustainable", that matches the three dimensions of sustainability, that works for people, planet and profit - a 'triple P' challenge. Sustainable development consists of goals, strategies, and processes that together provide more socially, economically and ecologically alternative tracks to conventional development, offering improved livelihoods to the poor in ways that promote both their empowerment and the conservation or improvement of key natural resources so that the basis of productive activities can be maintained into the future (Lele 1991; Pretty 1998). The topic of rural development is very relevant becouse of the quantity of people, very often poor or extremely poor people, living in rural territories. More than 3 billion people live in rural areas. Design rarely deals with rural development and with the definition of a system that can facilitate the growth and the development of the territory. If it does, design usually focuses on products or services.

The most important futures, which globally all rural areas share in common, are remoteness and isolation. Many development specialists and rural sociologists argue that small structure and cooperation are important strengths that contribute to ethic and social identity. The central role that play territorial context and relationships in the Systemic Design Approach (SDA) makes it a very effective approach to support and encourage rural development in a sustainable way. Applying the SDA, it is possible to manage local resources and local products in a way that allows the economic strengthening of the farmers and communities that live in the territory.

The Systemic Design team of the Deparment of Architecture and Design (DAD) of Politecnico di Torino has been engaged for years into the develop of the approach of Systemic Design that can be summed up by five basic principles (Bistagnino 2011: 19):

Output > Input: the output (waste) of a system becomes the input (resource) for another one

Relationships that generate the system, each one contributes to the system

Auto-generation systems sustain themselves by reproducing automatically, thus allow them to define their own paths of action and jointly co-evolve

Act locally: context is fundamental because it values local resources (humans, cultures and materials) and it helps to modify local problems in new opportunities.

Man at the centre of the project: Man is connected to own environmental, social, cultural and ethic context.

It is essential to start from the current state of the art, that allows to define strengths and weaknesses, before to design the system, made of flows between actors.

Keywords: *systemic design, rural development, inclusive, cooperation*

1. Introduction

The purpose of this work is to understand how to reach rural development in a sustainable way (that works for people, planet and profit - a 'triple P' challenge) in marginal and complex areas, in particular, in rural areas. Sustainable development consists of goals, strategies, and processes that together provide more socially, economically and ecologically alternative tracks to conventional development, offering improved livelihoods to the poor in ways that promote both their empowerment and the conservation or improvement of key natural resources so that the basis of productive activities can be maintained into the future (Lele 1991; Pretty 1998). The work done has the objective to encourage social innovation processes for the improvement of the quality of life and the economic wellbeing of people in marginal areas. Achieving sustainability, in environmental, economic and social terms, on small rural areas is no longer a possibility but an imperative. Rural areas, all over the world, are fragile environment aggravated by stagnant economies, high unemployment, persistent poverty, deteriorated social well being, lower earnings and diminished health care. Social changes, such as large-scale migration, and climate change have major consequences for small-scale farmers in the developing rural areas of the world. Currently over 50% of the world population still directly depends on rural livelihoods that are highly vulnerable to climate change (McIntyre et al., 2009). Rural development is a very relevant topic because of the quantity of people that lives in this situation. More than 3 billion people live in rural areas and 1.4 billion people are extremely poor. Identification of innovative processes useful for the development of small-scale farmers, therefore, is crucial. Increased infrastructure, market access and information, and creative financial solutions are necessary for sustainable increases in productivity. To reduce poverty in rural areas is necessary to invest in agricultural and rural development.

The most important case study of the research work takes place in Mexico, State of Guerrero, Ahuacuotzingo. This region was chosen because of its particular features related to food, both the production and the consumption. Take action on these aspects means managing environmental, social, economic and health consequences. Approximately one quarter of Mexico's 100 million people live in rural areas, and depend primarily on agriculture. Farming is important for land use and for the management of natural resources. Thus farmers are fundamental social, cultural and economic actors in rural areas. Important are also the agro-food networks that are generated. Since the main part of the research is the project with the Cooperative Ahuehuetla in Mexico, we need to consider that agriculture in Mexico is not only a fundamental economic activity of the rural population involving about 37% of the total population, but has also deep social significance and cultural meaning.

The most important futures, which globally all rural areas share in common, are *remoteness* and *isolation*. Many development specialists and rural sociologists argue that small structure and cooperation are important strengths that contribute to ethic and social identity. Support and facilitate positive change for rural development must include the participation of small communities. Local people need to be encouraged to think about their futures and to put into practice their ideas, founded on their culture and traditions. Therefore, the goal of this research is to lean a process based on capacities and ability of local people.

The central role that play local resources and relationships in the Systemic Design Approach (SDA) makes it a very effective approach to support and encourage rural development in a sustainable way. Applying the SDA, it is possible to manage local resources and local products in a way that allows the economic strengthening of the farmers and communities that live in the territory.

Since farming is a mainstay of most rural economies, the research aims to promote economic diversification combining traditional agricultural skills and new technical and technological know-how. This mainly because rural areas are characterized by a strong and evident contrasting perception of the traditional and local culture. On one side a very strong sense of belonging to the territory, the local culture and the tradition. On the other side the perception, shared by the majority of the population, of what is linked to tradition and indigenous culture as poor, worthless. The answers to the problems of these complex territories, cannot be found only looking to the past. Solutions should be promoters of innovation, with the attention and sensitivity to the local culture. This is the reason why an important section of this work is focused on technologies.

2. State of the Art

2.1. Rural Development (RD) and Social Innovation (SI)

Since the most important objective and goal of the research is to generate rural development we need to define what rural development is, what it really means and what practical consequences might have on the territory and local communities. There is no universally accepted definition of rural development. It is the result of various physical, technological, economic, socio-cultural and institutional factors and it represents an intersection of agricultural, social, behavioural and management of sciences. Rural development can be defined as, helping rural people set the priorities in their own communities by providing the local capacity. According to Robert Chambers, rural development is a strategy to enable a specific group of people, poor rural women and men, to gain for themselves, and their children more of what they want and need. We can define rural development as a Process leading to sustainable improvement in the quality of life of rural people, specially the poor.

2.2. Social innovation

In public discussions and in policy, innovation is still almost exclusively treated and perceived as economic innovation focusing on technical efficiency as well as the commercialisation of science and technology (Adams and Hess 2008, pag 5).

The traditional technological or economic innovation is usually the result of internal research and development conducted in a company or institution that leads to the market introduction of a new product, service or technology. Social innovation, in contrast with technological and economic innovation is not teleological and may not necessarily have an economic impetus.

During this research we discuss social innovation from a rural development perspective. The classic formulas of process and product innovation are part of an economic paradigm, which often represents, itself, the cause of certain problems, especially for the environment. This is also the reason why, the topic of innovation, today, is differently declined, in his social meaning. Social innovation processes work especially where market fails and where public policies do not offer adequate solutions to the challenges. This especially where governance structures are weak to find solutions for complex problems and hesitate to generate answers to the needs in local systems. Social innovation processes are capable of mobilizing, openly and continuously, a large number of actors active in the local system searching useful solutions (Murray et all, 2010).

Brunori et al. (2008) write about the evolution of innovation studies in agriculture, showing the progressive shift from a 'linear' or so called 'exogenous' conception of innovation to a 'systemic' or 'endogenous' approach, defining innovation as a learning process. Brunori asserts that innovation occurs when the network of production changes its way of doing things. In this sense innovation is related to the resulting pattern of interaction between people, tools, natural resources. With this new vision, learning becomes the core of innovation processes.

Innovation thus is not only technological innovation. Is more related to a successful change in production, consumption and distribution systems. Indeed comprehend new practices, artefacts and/or combinations able to generate a process of production, a network, the integration of two different activities.

What I find very interesting and useful for this research is well described by Van der Ploeg et al. (2008). Social innovation must be strongly connected with locality and contextual knowledge. This means that innovation is linked to a specific context, many times to a specific region.

3. Description of the research work

The research work consists of several parts. The structure chosen to describe the research path does not follow the chronological order. The search path has been marked by several revisions and changes in direction.

The work is mainly structured in 3 parts. The first one is the analysis and the definition of the state of the art. The second one is the Systemic Design Project of flows and relationships in collaboration with the Cooperative Ahuehuetla of Ahuacuotzingo, State of Guerrero, Mexico. The last part is the implementation, or definition of the steps necessary to put this project into effect, and the framework that outcomes from the research.

3.1 Ahuacuotzingo, State of Guerrero, Mexico

The territory of the State of Guerrero, and in particular Ahuacuotzingo, has been investigated and analysed from several perspectives.

Named for Vicente Guerrero, a leader in Mexico's wars for independence, the region became a state in 1849. Guerrero is divided into local governmental units called municipios (municipalities), each of which is headquartered in a prominent city, town, or village. Much of the state's population consists of impoverished Indians and mestizos, a significant minority of whom speak an indigenous language as their primary language; more than two-fifths of the people live in rural areas. Considering the standard economic measures, it is easy to notice that Guerrero consistently ranks among Mexico's most impoverished states. The transportation infrastructure is poorly developed and maintained. The rural population lives dispersed among scattered and often very isolated villages; in 2010 just over fifty-eight per cent of the state’s population was spread among more than seven thousand communities with fewer than 2,500 residents.

For a substantial majority of the rural population, the subsistence agriculture with supplemental commodity production or seasonal wage employment remains a way of life.

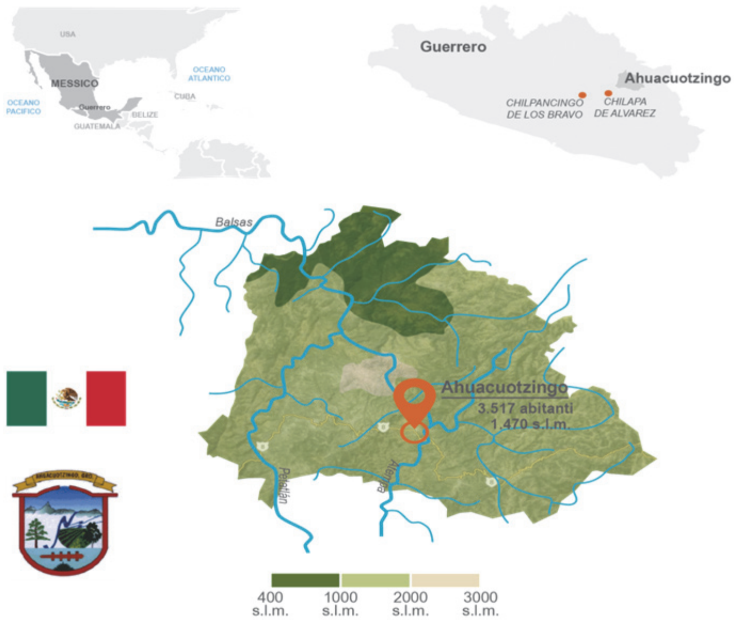

Fig. 1 Map of Ahuacuotzingo, State of Guerrero, Mexico

One of the 81 municipalities of the State of Guerrero is Ahuacuotzingo. Approximately 60 km from the capital Chilpancingo, its territorial extension is of 388,4 km ² and the population mainly dedicates to primary Sector. The subsistence agriculture is the most important activity for people of Ahuacuotzingo. Subsistence agriculture is self-sufficiency farming in which the farmers focus on growing enough food to feed themselves and their families. Tony Waters writes: "Subsistence peasants are people who grow what they eat, build their own houses, and live without regularly making purchases in the marketplace." However, despite the primacy of self-sufficiency in subsistence farming, today most subsistence farmers also participate in trade to some degree, though usually it is for goods that are not necessary for survival, and may include sugar, iron roofing sheets, bicycles, used clothing, and so forth.

As many rural areas are, the territory of Ahuacuotzingo is characterized by low population and enterprises density, high unemployment, economic decline associated to a trend of emigration to other states, mainly to United States, and cities far away, with the consequent abandonment of agricultural land and the deterioration of the natural habitat.

Since 1980, Mexicans have been the largest immigrant group in the United States. In 2013, approximately 11.6 million Mexican immigrants resided in the United States (up from 2.2 million in 1980) and they accounted for the 28% of the country’s foreign born (41.3 million). This situation generates a radical change in lifestyles, food consumption, and a loss in material culture, because people try to emulate other cultures losing totally their own local culture and traditional know-how. In recent years, few farmers seek to improve the quality of life and well-being returning to cultivate the land in their own hometown. The population of this rural area, rather isolated, reveals to be intimately and intensely linked to the territory and to have a strong sense of belonging and aggregation. In addition, the farmers of the cooperative

Ahuehuetla, with which we have been working, are very motivated for a substantial changing towards sustainable rural development.

The Ahuacuotzingo community was characterized by the production of panela, a sugarcane product obtained by boiling and evaporation the sugarcane juice unrefined. Land next to Ahuacuotzingo, now mostly abandoned or underutilized, was intended primarily for this crop and most of the people worked in this sector. With the advent of liberal market, a large quantity of white sugar produced in the United States and other countries, arrived in Mexico. This caused the sudden lowering of the price of white sugar and, consequently, a decrease in demand for panela that, by then, had become much more expensive.

Understand how the migration of humans out of rural areas affects those left behind is very important from a social and economic welfare point of view. At migrant destinations, immigrant labour enters into local production activities, complementing some factors while possibly competing with others (including some types of non-immigrant labour). It influences both the level and distribution of income in migrant-host economies. The micro impacts of migration on agricultural productivity are complex. Rozelle, Taylor and deBrauw (1999), using simultaneous-equation methods and a data set from China, found that the loss of labour to migration significantly reduced grain yields, reflecting an absence of on-farm labour markets. One of the most important factors that must be considerated in order to investigate the migration impacts, both at migrant origins and destinations, is remittance.

The phenomena of migration, which for decades has driven masses of people from Mexican rural areas to US metropolis, is very complex. It has impact and consequences in the short, medium and long term, and affects the economic, social, cultural as well as environmental. The most pessimistic studies on migration-development interactions in source areas appeared in the 1970s and 1980s. A more optimistic scenario comes out from the researches on this topic in the 1990s. If we want to find the true impact of migration we have to position ourselves in the middle, between these two ways of thinking. In recent years studies about migration suggest that the interaction between migration and key economic variables represents a complex combination of these two ideas. For example, recent studies find that migration has both negative "lost-labour" and positive remittance effects on source economies. In the United States, new research indicates that the impacts of immigration are complex, operating through indirect channels largely ignored by past research. New research methods generally are required to uncover interactions between migration and economic changes at migrant origins and destinations.

Furthermore, we have considered the issue of food security and climate change. Rural areas are characterized by a very strong specificity, social and environmental. It is necessary therefore to investigate these aspects to better understand the strengths and potential of the territory in order to promote the "revitalization".

3.2. A real “security crisis” in the State of Guerrero.

Insecurity and violence associated with organized criminal activity are pervasive in Mexico’s southern state of Guerrero. The state’s homicide rate is the highest in the country and extortion and kidnapping are commonplace. The state is divided into territories within which either drug trafficking organizations (DTOs) or community policing networks exercise control over local policing functions. What happens in rural areas is that competition between groups of traffickers over the state’s prodigious narcotics output creates violent no-man’s-lands in buffer zones between territories controlled by rival groups. The single most important source of DTO earnings are profits from the sale of heroin derived from poppy that is grown in the mountains throughout the state. An estimated sixty per cent of Mexico’s poppy crop is grown in Guerrero. State efforts to suppress the violence and the associated criminal activities have been disorganized and have not been successful. Part of the problem clearly involves the permeation of state institutions by DTOs. A substantial portion of the state's population depends on earnings derived from narcotics production and many others depend on revenue streams that involve DTO participation. Reducing the economic role of DTOs will cause substantial dislocation and hardship that the state and federal governments must be prepared to address.

In a communiqué published at the beginning of May 2015, the Tlachinollan Mountain Center for Human Rights warned that the *"violence has no limits, and the lack of capacity of the authorities to confront it is evident. The political class finds itself trapped within its own labyrinth. It fell into the same claws of the crow that gave birth to it, and it has had to submit itself to the very laws of barbarism which it has itself imposed. Guerrero is a territory mined by violence. There is no place there that escapes control by organized crime […]. "*

In 2014, the murder rate in the State of Guerrero was the highest in Mexico and eight times the national average. It was the year that 43 students from the Ayotzinapa rural teachers' college were taken into police custody in the town of Iguala and disappeared. A search expedition did not locate the missing students, but uncovered hundreds of hidden graves of unidentified human remains buried in the gloomy hills outside the town. The murder rate so far in 2015 is 29 percent higher compared to the same period a year ago.

3.3. The contrast place

The rural area of Ahuacuotzingo is characterised by strong and deeply rooted contrasts. This mainly caused by the fact that it is a territory in many ways underdeveloped but which suffered the consequences of globalization. Many inhabitants of Ahuacuotzingo have televisions, someone have mobile phones, few people the internet connection. This is substantially the cause of the larger part of the contrasts.

The analysis done through literature review on rural development and social innovation in rural development and the investigation on Ahuacuotzingo community reveals us the main territorial strengths and weaknesses.

The rural area is fragile and rich at the same time. Weak and strong at the same time. Stable, planted in the area, connected to the environment, aware depending upon it. It's an isolated and distant place from the rest of the world, but very strongly connected to the territory. The reason of contrasts, contradictions and paradoxes lies in the feeling of *mexicanidad* described by Octavio Paz and Carlos Fuentes in their literary work. This emotion is expressed primarily as a deep love for the roots which lives together with an ever-present sense of loss and regret mixed to a sense of pride for the cultural heritage. The portrait that emerges is of a population constantly looking for itself, or rather, for a clear identity. A people in whose veins run two legacies: the indigenous one and Spanish one. The Spanish heritage, for obvious reasons, is a baggage that is experienced by the Mexicans in a contradictory and indefinite way.

4. Systemic design project

The research provides an example of how to create well being and an important economic flow applying the SDA in Ahuacuotzingo context. From the focus on the product the attention moves to flows that generate different activities.

The system project begins with the definition of priorities: first define the actors, than their activities, al last design the material and energy flow. We initially identified the main actors, that is the members of the Cooperative Ahuehuetla, born thanks to this project. The main actors are: 5 farmers (Nacho, Tonio, Josè, Angel and the Cavideco-Centro de Apoyo para el Desarrollo y Vinculación Comunitario, Beto) holding a total of 43 hectares, but currently cultivating only 12 hectares, 1 group of women that cultivate a greenhouse for the production of organic vegetables, 1 group of women, sisters, who have recovered the activity of production of panela which had been abandoned by their father. The actors of the system work as if they were part of the same organism. Each farmer or actor becomes specialized in one activity in particular. The waste of each activity are used and returned in other productive activities. This allows the generation of new products, which do not exist at the moment. Nacho is the farmer who recently became part of the Ahuehuetla Cooperative. His role in the project is important as a producer of fish. For his breeding he uses worms arising from the production of Tonio. Tonio, which is at the moment the farmer better organized and with the best production, in the project produces sugar cane, which is useful for the feeding of animals but, above all, is brought to the group of women for the production of panela and derivatives. Thanks to the biodigester he produces biogas used in his tortilleria. In this activity he uses the corn that he produces on his field. His other productions are butter, cheese and yogurt, worms, compost, agave. The main activity of Beto is instead the dairy where he produces cheese, butter and yogurt. These products can be partially sold and partially used at the Cavideco. Jose produces sugar cane, corn and nopales. It has a small breeding whose products sells directly on the production site. Angel is the operator of the Cavideco that was founded in 2009. This centre was founded with the objective of developing the skills of men and women respecting environmental sustainability, promoting a natural tourism project and volunteering using local resources for the community development. This centre is one of the key locations for the project. It's a meeting point for cooperative members, here there is the restaurant and the natural swimming pool for the whole community, there are laboratories for the transformation of the food produced by the farmers of the cooperative. Furthermore it's the place where workshops and seminars will be are. An important part of the project provides that the Cavideco will become an essential place to develop the potential of the community. Here indeed practical workshops will be organized for the farmers and for the whole community of Ahuacuotzingo. Seminars and workshops will be organized primarily to support the farmers and other workers of the community in its activities. This part of the project relating to the education and organization of these courses is a practical outcome that we have already achieved. Inside the event Verano Intercultural courses were held to educate farmers in relation to self-construction of micro bio digesters and greenhouses for vermicomposting. Essential activities in the system project. Cavideco will also be the point of contact, the link between the Ahuahuetla Cooperative and the rest of the community. Here indeed it will be possible to purchase the products of the cooperative that will become the main results of a virtuous production system that uses in the best way possible the resources of the area and considers the output of the system, not as waste, but as an important input for other productive activities. New producs outcome from the Systemic Design project applied to Ahuehuetla Cooperative.

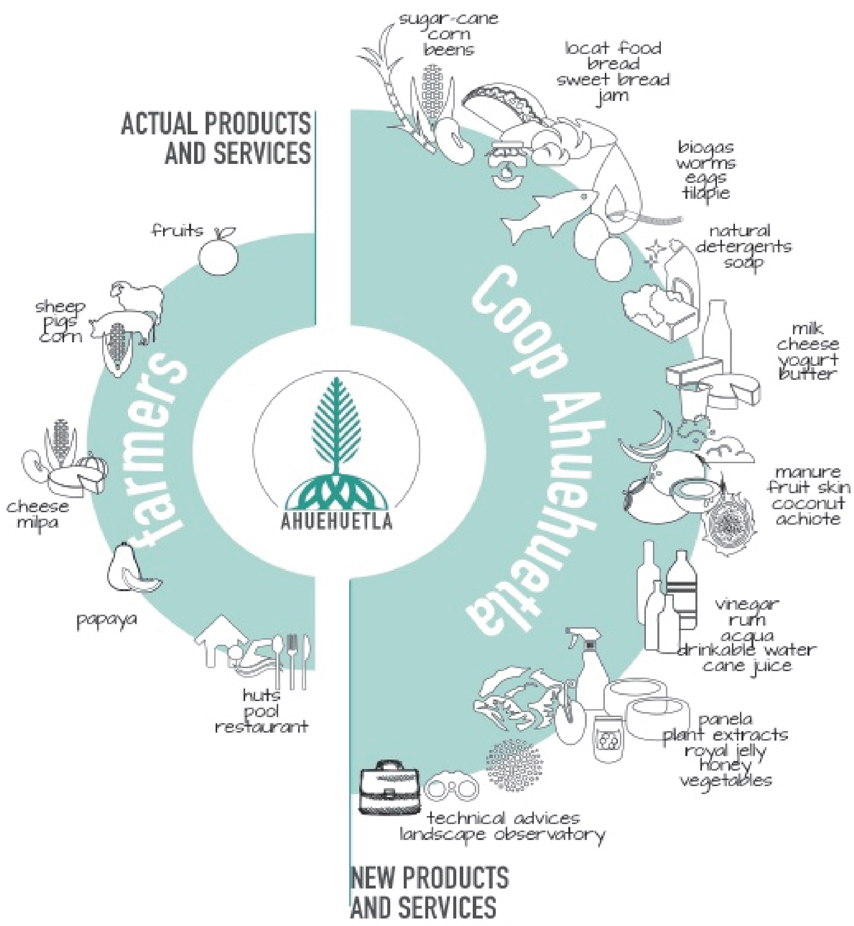

Fig. 2 New products by the Cooperative Ahuehuetla throwth the application of Design Systemic Approach

5. Main results

The conversion of the waste of the area into resources generates many new products and related production activities, such as fish farming, compost and worm compost, worm farming, seeds self-production, natural filtering of water, biogas, bio detergents and natural soaps, panela (which was the typical and most important production of this area until it has been replaced by the refined white sugar), honey. We have divided the main results in *Preliminary Results* and *Outcomes*.

Preliminary Results are practical results, already achieved during these years of research. First of all the creation of the Ahuehuetla Cooperative, which is the first step of the project, to involve people in the research. Within the project of Ahuehuetla Cooperative, we also dealt with the design of the logo, which is the central visual element that helps to identify and remember the brand. As happen in every company, this icon is a real symbol: the main purpose of it is to summarize and underline shared concepts and values from farmers. It is not only a graphic action, a graphic sign but it is a way to define and promote a strong and precisely identity for the farmers and the entire community. Other fundamental preliminary results are the improvements made in 2015 at the Cavideco. Two biodigesters were built, in which is disposed organic waste and that generates biogas that is used in the kitchen restaurant. Kitchens chimneys were equipped, a small improvement but very important considering the diffusion of respiratory diseases caused by the production of smoke in the kitchens. Further more we have planted at the Cavideco 40 fruit trees, for the production of oranges, lemons, mangoes, bananas that are used directly in the restaurant or processed in the laboratory. It was built with discarded materials, an entertainment area for children who attend the centre. The sheet metal on the roof has been replaced with a structure waterproofed using a fabric covered with a natural substance derived from the viscous liquid which is obtained from nopal, a typical and widely present plant in the territory. Furthermore, a greenhouse for the production of vermicomposting has been built.

Outcomes are above all regarding the implementation of the project. The Outcomes are the key research results, in line with the objectives set at the beginning of the project. First of all the *framework*, useful for other rural development projects in similar contexts, than the definition of the steps for the *implementation* of the project, the definition of active *actors team* in all phases of the Approach of DS application process.

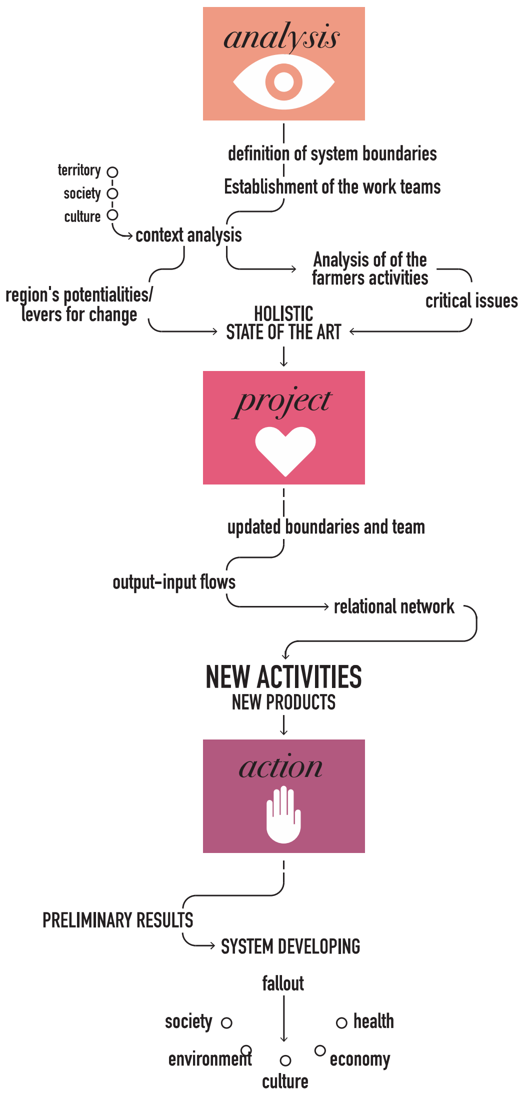

Fig.3 Framework for rural development applying Design Systemic Approach

6. Conclusion

Expected results regard social, economic, environmental and health aspects. The farmers of the cooperative Ahuehuetla can become not only self-sufficient in terms of energy and food production, improving the quality of life, but also increasing the supply of food products, both unprocessed and processed.

During the Field research some important needs from the farmers came up: for example, they need to have counseling and contacts with experts and technicians in the field of organic farming and appropriate technology. This is why we designed and managed also the educational part of the project, mainly divided into two parts. On one side, some practical courses held by technicians and addressed to farmers already have been organised in Ahuacuotzingo at Cavideco. On the other side, Systemic Design seminars addressed primarily to university students can be organized, with the purpose of developing the competences in designing and organizing flows in a system. This is the reason why we are working together with Nuria Costa Leonardo, one of the 1000 women proposed for the Nobel Peace Price 2005, involved in different projects with the Red Mexicana de Mujeres (rememur) on socially responsible business related to rural development. This also helps us to relate to a distant reality from ours, though often so similar to many other rural areas all around the world. A very important result is the definition of pathways and frameworks that lies under the systemic project. This is what makes it scalable and replicable. The starting data, defined during the preliminary phases of analysis of the Holistic State of the Art, are subject to different variations. It depends on many factors, especially as the impossibility of farmers themselves to quantify their own inputs and outputs. This limit turns out to be insignificant precisely because the main objective is not the quantitative result, but the identification of a framework that can be reused and exported to other rural realities in order to foster sustainable development.

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Products as communication platforms. Investigating and designing the evolution of retail services in the digital era.

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Abstract

In the lifecycle of material products, information and communication have always played a prominent part that, in the digital era, is growing and is expected to grow further, also enabling the blooming of grass root and bottom-up changes in the galaxy of design-production-retail systems. Retail services are not just a way to obtain goods: they provide opportunities for social relationship and cultural growth, and can be considered as a field for social innovation. Our research aims to investigate the systemic changes that are occurring in the realm of information and communication services for the retail of material products, and their consequences on design, production and distribution processes. Our goal is to outline strategic approaches to the design of innovative service/systems and, presently, we mainly focus on two key issues:

- - understanding and modelling the tangle of factors that determine the user experience in traditional and digital shopping processes;

- - develop design methodologies for the creation of new meaningful services, so to support the customers in the understanding of value and in the search of quality in shopping processes.

The paper investigates new social behaviors related to shopping, such as show-rooming and web-rooming, and we demonstrate that the pervasive use of mobile devices produces new social phenomena in retail processes and enables new opportunities to create value in retail services. From the investigation of online and off-line markets, it emerges the importance of social dynamics and human interactions belonging to physical world: relational dynamics and knowledge acquisition processes play a very important role in the elicitation of senses and emotions, in cultural upgrading, value understanding, quality awareness, trust building. The analysis of these phenomena and the presentations of some design experiences bring us to the definition of some strategic directions guiding the generation of new paradigms of services in the retail field.

Keywords: *Intangible Value, Customer Experience, Behavior Design, Technology Based Service Design, Ethics.*

1. Investigating and modeling the changes induced by ICTs in retail systems

In this paper we present some results obtained within a wide-range research project aimed to investigate the realm of new social and professional phenomena in retail, and to experiment innovative ICT-based services to support commerce and shopping. . The research is carried on through the collaboration between the Interaction&Experience Design Research Lab at the Dipartimento del Design of Politecnico di Milano, and the Joint Open Lab S-Cub created by TIM at Politecnico.

Commerce and retail have been playing a very important role in societies since the dawn of history: search and sale of goods promoted, in the course of time, the exploration of new lands out of the known territories, motivated the construction of road networks and of new cities; commerce represented a strategic asset for entire populations in different eras and location of the world, and the social exchanges that always accompany sales have been also diffused opportunities for information exchange and cultural growth. Nowadays, commerce is one of the main axis of human consortiums and of industrial systems: not only it is the main way for the distribution of goods and one main leverage of economies. Beyond that, the availability of retail services influences several aspects of life quality and can significantly affect the appearance and the social dynamics of local environments.

In the last decades, the pervasive diffusion of ICT-Information and Communication Technologies, of Internet and of online services produced substantial changes in the sale systems through the creation of e-commerce opportunities, and, in some cases, deeply affected the entire product/service system, as in the case of musical and publishing products for which the de-materialization of goods has been accompanied by a revolution of the whole distribution system.

Still, the present situation seems to be a transitory one, far from achieving a steady order, and we are witnessing a tangle of different trends and contradictory phenomena.

Online service providers are getting ubiquitous and all-comprehensive; they increase their effectiveness offering real-time delivery of goods of any kind: from fresh foods to furniture, medicals, books and so on; they host industrial products but also offer e-commerce facilities to little-scale producers, artisans and manufacturers. Amazon and other companies refined the usability of their digital services so to make “natural” the online shopping processes, reducing the complexity of procedures for selection, data filling and payment, and making them almost automatic. New websites and mobile services appear everyday to support online sales, to allow product personalization, and promoting information and social activities related to the shopping experiences.

Most of the existing ecommerce services produce very poor information about products and little or none opportunities of social interaction between customers and producers or sellers. On the other hand, due to the diffusion of smart phones, consumers enact personal strategies to ensure to themselves the desired conditions of good purchasing, to obtain information about the products of interest, and engage themselves in forms of entertainment related to shopping. In the whole, the introduction of ICTs in the realm of retail is enacting some disruptive changes, involves new stakeholders, and produces new service paradigms based on different systems of mediation and disintermediation. It is quite evident that, on a long term perspective, these changes will also influence industrial processes and organizations, and will have effects on the quality of material goods, on the perception of quality and on the evaluation criteria that guide customer choices and preferences. While the fast growing of online sale services is impressive and can actually endanger the future of little and local shops and sale-business, in countries such as Italy, the opportunities to create new services and new forms of value in retail are still underexploited and several stakeholders of the shopping system still seem unable to face the change.

In this context, there are a number of different topics that it is worth to investigate in a design research. The research reported in this paper focuses on hybrid processes, involving customers both online and in stores; our final aim is the design of innovative services for retail, capable to provide new forms of value to customers in the fruition of retail services. Physical stores represent important economical and social resources for local environment, and we believe that ICTs can be employed to empower the quality of their business; furthermore, as customers are already vastly employing digital devices with respect to their shopping activities, little shops with local business should embrace the opportunities offered by technology so to better respond to users needs.

In the design tradition, designers act on material attributes of products to provide new value in terms of form, sensorial engagement, symbolic significances, and aesthetic qualities. Furthermore, interior designers act on the appearance of retail spaces and on their organization so to create meaningful contexts where material products can be better offered to customers and where the shopping experience can become more interesting and appealing. The characteristics of physical stores influence the customer experience, and their perception of quality of products, so affecting the final satisfaction; the design of interiors can provide a suitable frame for presenting and interpreting forms and functions of products, they can envision scenarios, values and inspiring storytelling, and produce experiences that are worth on themselves. In our approach, the role of experience and service designers is quite similar to role played by interior designers in the project of a new store: our goal is the experimentation of services capable to create value in terms of meaningful engagement of customers during the shopping process, both online and in store. We refer more to the dialogic and dynamic dimensions of the experience rather than to the physical appearance of stores and digital services, and our references are in the field of the aesthetics of interaction (Pillan 2015).

"Designing such products and systems requires an aesthetic that goes beyond traditional static form aspects. It requires a new language of form that incorporates the dynamics of behavior. We argue that once we start designing the aesthetics of interactive behavior, a social and ethical dimension is introduced as well." (Ross and Wensveen 2010)

In the existing services of e-commerce, ICTs support the accessibility of products making them available from everywhere, for everyone, at any time; furthermore, they offer limitless opportunities of information and social exchange about goods. For these reasons, the discussion about digital services for retail is often focused on factors related to process effectiveness and on market opportunities, such as on the use of data and big data to orient production, on new forms of advertising, on production systems allowing product personalization and more.

In our research, the focus is mainly on the quality of the customers experience related to the shopping process. In order to design new digital services for retail, we are now investigating the conceptual meaning of value in retail; furthermore, we study new social behaviors related to shopping, such as those indicated as showrooming and web-rooming, demonstrating that the pervasive use of mobile devices produce new social phenomena in retail processes and actually creates hybrid physical/digital experiences. The study of these new trends provides some interesting insights with respect to the new needs and expectations of customers. In our research, the shopping experience is framed not just in terms of efficiency of purchase, but we also investigate the opportunities in terms of knowledge, awareness, social exchange, and value proposition that can be generated by the use of digital technologies to support information and decision processes in stores and online. To investigate the point of view of retailers, we are also conducting some design experiments and in this paper we report some outcomes of a workshop performed in Milan in via Canonica, an area rich of little stores that still have a very limited use of ICTs in their business.

In order to produce new value for physical shops and stores, design should focus on two different aspects that make the off-line experience unique, valuable and difficult to be replaced by online services, at least in their present organization. From our research, two directions seems to offer promising design directions. The first one is the hedonistic and practical exploration of the qualities of goods; the second one is the social engagement between sellers and customers. As a result of our research, the presence of qualified persons in store change the perception of the quality of products and also the shopping experience that, in turn, influences the perception of the product quality.

2. A discussion about value in retail services

In the very beginning of their book, P. Newbery and. K. Farnham state that "Value is a predicated on asymmetry" since, if we define value as "a fair return or equivalent in goods, services, money for something exchanged", the value produced in business depends on the fact that "one side has a something that the other desired". In the design of product/service systems, the "value comes in different flavors" and the intangible value related to services or, in a wider sense, to the quality of experience, is still hard to evaluate as a number of different needs and factors influence it, such as security, novelty, excitement, habit, knowledge, practical and hedonic motivation and more (Newbery and Farnham 2013).

The design of innovative retail services should provide new forms of intangible value to customers; on the other hand, the quality of retail services is often tightly intertwined to the quality of goods or, at least of the perceived quality of sold products. So, in order to investigate the factors that mostly influence the customer experience in a shopping process, we need to identify the different ways in which the quality of goods influence the quality of retail services. Apparently, the quality of material products can be easily defined in terms of objective attributes such as materials, production processes, durability, economical and environmental sustainability, and so on. Actually, this definition is not trivial at all, since the different aspects that we can consider are not simply inter-related and, in some cases, they conflict. Every act of shopping begins long time before the moment when the actual purchase is accomplished: even when we buy a simple product such as a box of spaghetti in a supermarket, our mind performs complex decision activities, most of which are very quick and not conscious; all of them, anyway, refer to past experience, memories, evaluation criteria that are the construct of our emotional and cognitive attitudes. Furthermore, different cultures assign different importance to some factors such as authenticity (with respect to the brand, place of origin, materials, etc.) in the evaluation of quality. (Carroll 2015) For each customer, the quality of a purchased product is almost never absolute: each human being is subjected to anchoring and priming effects, and is therefore influenced by context factors; as a rational evaluation of the quality of a product is a very complex task, customers employ approximation strategies during shopping to satisfy their need of making some sense in the decisions (Kahneman 2011). Actually, the perceived quality strongly depends on the personal motivation of customers, on the desire of obtaining an item, on the availability to pay for prestige, appearance, aesthetics; on judicial, religious or moral issues, or any combination of these reasons. (Neap and Celik 1999).

To better understand activities, needs, and expectation of customers with respect to shopping activities, we are observing behaviors of customers online and in store, and there is a number of interesting and innovative phenomena that is worth to investigate.

It is important to point out that, very often, the criteria adopted to evaluate a product employed by the producer can differ from those adopted by customers; sellers and sale services play an important role to understand and fill the gap between the different perspective driving the evaluation of quality. To this purpose, we can refer to the important distinction between "value creation" and "value capture" (Bowman and Ambrosini 2000) value is created by organizational members, value capture is determined by the perceived power relationships between various stakeholders. In other words, customers assess the overall value of a product on the perceptions of what is given and what is received (Zeithaml 1991).

3. Evolution of shopping behaviors and services

The arrival of internet increased the number of channels through which people can buy a product, actually offering an alternative to market places and giving to consumers the access to an almost unlimited variety of products, so enabling the diversification of the purchase processes (Arnold and Reynolds 2003) (Morales et al. 2005). Nowadays the shopping process is a complex and sophisticated experience involving customers in a number of different processes such as getting information, understanding values, comparing solutions, framing needs, managing social activities related to goods, influencing trends and so on. Due to the diffusion of mobile technologies, these processes involve both physical locations (retail stores), the virtual market in the web and social networks.

In the past, internet-based shopping experience used to take place in private environments, such as domestic or office spaces. People purchasing products through their laptop or desktop had wider choice of products and sellers but, at the same time, all social were substantially absent (Schaefer and VanTine 2010). This isolationism can be identified as one of the main causes of the ROPO, Research Online Purchase Offline, phenomenon; indeed, people found a way to use the potentialities of the online shopping - by using the web as a giant catalogue of products – but they decided to purchase offline, in traditional stores, the products selected online. This phenomenon, named *web-rooming*, can be related to the will of people access both the advantages of the web, together with those of the physical world such as social dynamics and material interaction with products.

With the spreading of smart mobile devices, the shopping experience changed again, because we are no longer tight to desktop computers, and we can access to information everywhere at anytime. The mobile technologies modify the boundaries between the physical world and the web, and actually create overlapping and hybrid experiences. As a consequence, the online shopping processes moves from indoor to possibly any locations, and this opportunity gave birth to *showrooming*, i.e. Try Offline, Purchase Online (IBM 2014). The physical stores become a showroom where products can be watched, touched, tested, selected; they are a physical catalogue while the shopping experience is then completed online (Burke 2002). Smart devices are tools to access digital media inside the shop in order to memorize and to catalogue goods in order to facilitate the subsequent purchase online. Furthermore, they allow social interaction within the shopping activity. Between others, we report here an interesting case study documenting the emerging of new spontaneous retail phenomena supported by mobile devices. It refers to the activity of some Chinese buyers in Milan, Italy. The commercial offer of fashion product in Italy and in China is quite different and some Italian brands, selling their products in both countries, offer pieces of clothes that differ from the point of view of tissue (materials, pattern, colors), shape and style. Some Chinese buyers developed a service of "buying at a distance" based on the following actions: they enter a luxury store, choose some suits and wear them in the dressing room; as they do so, they use mobile devices to share on the web their fitting test in the dressing room, snapping selfies, or making videos. They also photograph labels and tags with prices and details, and send these data via WeChat (Weixin) to customers in China. When the remote customer is satisfied, the local buyer receives a real time payment trough WeChat or via Alipay, concludes the purchase and payment in the shop and ships the products via couriers. These phenomena and others document the ferment of new activities related to commerce and supported by mobile digital services. These phenomena can be convenient for customers but also for producers since they represent a way to broad the market potentialities; they are much convenient for brands that have their own shops and evaluate the growth of markets in a global vision, while could produce problems to local shops, if not adequately managed. On the other hand, these new forms of intermediation will have some consequences on styling visions and fashion design strategies, since it appears as evident that buyers at a distance consider as a value the opportunity to buy products that are available only in a market different from their domestic one. The above reported system is an opportunity of income for young Chinese students in Italy. In China, these buyers are named wēi shāng – people that have a mini business - a type of business that make us to reflect on how social needs, global markets and major platforms can be used by people to create grass-roots entrepreneurship (Serra 2016).

Fig. 1 Screenshot from the site TaoBao

4. Digital services for retail and opportunities of social innovation in local environments

The creation of services for selling online products that the user needs to feel, touch, try (such as clothing but not only), poses research questions related to the understanding of how we can support people so they can explore and perceive the quality and establish a physical relationship with the product itself (Burke 2002). In the interaction with goods, a number of different cognitive and emotional processes take place simultaneously, some of which are conscious while most are performed through rapid and automatic exploration and non conscious strategies of evaluation. Each physical interaction – with a product or with the surrounding environment - is a source of sensorial stimuli, an opportunity of experiential knowledge and of valuable active engagement for customers. On the other hand, when customers physically interact with material goods, sellers have the opportunity to show and bring to evidence some quality characteristics of products that cannot be easily described in terms of words or images. This is true for any kind of product, from books to clothes, from cars to photo-cameras.

In this paper, we focus our attention on little local shops, and on those selling artisanal products. Artisanal products have characteristics that depend on materials and on fabrication processes; the visual appearances and performances of these products are often variable in time and from a specimen to the other. In our investigation in Milan, we observed that in artisanal shops, i.e. in those shops that sells unique specimen often handcrafted and sometimes produced in place, the perceived quality of the products (crafts) strongly depends on their “artisanal” nature and the perception of its value significantly depends on the social dynamics within the store itself. We investigated this through observations in stores and interviews with sellers. In artisanal stores, direct social relationships between customers and sellers influence the sense of authenticity with respect to people and products. This is related to a diffused value:

"The demand for authenticity—the honest or the real—is one of the most powerful movements in contemporary life, influencing our moral outlook, political views, and consumer behavior."

(Potter A 2010)

The artisanal products are produced by artisans, either completely by hand or with the help of hand-tools and even mechanical means, as long as the direct manual contribution of the artisan remains the most substantial component of the finished product; even when artisans make quantities of the same design, no two pieces are ever exactly alike. An artisanal product is something made by a person who makes artsy things that are 'beyond a craft' that they create an 'economic moment' where that thing can be rare/unique/limited. Their special nature derives from their distinctive features, which can be utilitarian, aesthetic, artistic, creative, culturally attached, decorative, functional, traditional, and religiously and socially symbolic and significant. So the artisanal product it's very full of value that came from: the craftsman that create the product, the material that he used to realize the product and also from the context in witch the craftsman operates. Through the direct interaction with the producer or seller, a customer can build a system of trust and shared values based on the quality of human empathy, that is translated into trust and appreciation with respect to material qualities of the product itself.

"In advanced consumer economies, consumers are buying on the basis of their interpretation of the product and its story" (Glenn R. Carroll, Balázs Kovács 2013)

So artisanal products have a story to tell that represent the value itself and quality, intended as in the above, becomes the prevailing purchasing criterion.

5. Preparing the ground for co-design of new service paradigms

Every retail process is the outcome of a complex system involving a number of different stakeholders: from producers of raw to manufactures, from distributors to traders, from city planners to local inhabitants. In some cases, little shops are also the production space of the artisan/vendors and in Milan a growing number of these activities are appearing in several areas of the town, revealing a renewed vibrancy of the social and economic small scale entrepreneurship that should be sustained and promoted. In our ethnographic research, we learned that in traditional retail system, vendors play a very important role enabling the information flow from the final consumers to the producers and therefore they can have a very valuable role inspiring innovation. The design of new retail services should consider all the variable and stakeholders of the system in order to investigate the opportunities to generate value in the amplest sense.

In the following of this paper, we will describe some results obtained in a design workshop aimed to the design of digital services for little shops in Milan. The workshop was organized at the School of Design at Politecnico di Milano with the students of the first level master degree in Communication Design and it involved around 40 students.

The design context was via Canonica in Milan. Via Canonica in a street in a central area of the town hosting several little stores and boutiques, some of which owned by artisans working in place. From the architectural point of view, the area is quite a hybrid district, with a number of new buildings and some popular old condos still maintaining the pre-war appearance. On the other hand, Via Canonica can also be considered as a "place in between" since it is located between other more famous and glamorous areas, and is not a touristic place. In the past, some initiatives aimed to build some sort of local brand identity or a common communication strategy failed and did not rally the participation of retailers and other stakeholders. For these reasons, the Canonica district seems to be an interesting lab where we can investigate social local phenomena that are related to traditional retail services, and where we can experiment innovative services. During the workshop, all design activities were accompanied by ethnographic analysis to investigate needs, motivation factors, wishes and values of buyers in different retail fields, collecting interviews with manufactures and traders.

The involvement of Design university students in the generation of innovative concepts of products and services has a long tradition: educational labs taken as a base of speculation in design theories have been the object of controversial discussions. In our case, the involvement of students born in the digital world (Reisenwitz and Iyer 2009) is indeed more relevant as we need a new generation of designers capable to include the technical solutions in their proposals. In the studio lab, the brief demanded a visual project for the district identity, a mobile application or a web-based service aimed to support the exchange of value between the local stakeholders and to create a different kind of cultural relationship between customers and the retailers. We also required video-scenarios to sustain effective communication of the service concepts and enable co-design in multicultural environments (Pillan, Spadafora, and Vitali 2014). The design strategy aims to create services based on the integration of physical and virtual spaces, acting on the borders of the online and the off-line experiences. This approach focuses on both digital and analogue factors of experience as a continuous, so to create a multichannel communication path between the stakeholders and merge different flows of value exchange; from the traditional paradigms business-to-business and business-to-consumer, we move toward a full range of possibilities involving manufacturers, vendors and final customers also considered as a source of value. The outcomes of the workshop provided the tools to enable some further design activities aimed to discuss scenarios with some representative stakeholders of the environment and social system revolving around via Canonica. It is important to point out that in our approach, technology based services should be produced in a co-design process involving stakeholders and the new paradigm of services generated in the workshop are considered just a preliminary step aimed to prepare the ground for co-design activities, and to provide concrete examples to discuss, also building a common language shared by stakeholders and designers.

Through the analysis of the outcomes of the workshop, we could extract a number of insights useful in our research, part of which are summarized here in the following. Via Canonica is really a “place in between”, i.e. a place where various typologies of stores and very different people (in cultural, economical, ethnic senses) coexist, and it can be considered as representative of a number of urban environments that are experiencing changes without a development plan. It is an interstice between more visible realities, and a “border line” between old and new, (old retail and new branded stores), a place where novel phenomena coexist and have the room to grow. It emerged that variety is perceived as a value and an opportunity to live and work adopting a favorite personal lifestyle.

The existence of a variety of shops, each one with a specific identity, some referring to tradition and some new, play an important role in defining the collective identity of the area, offering a character of authenticity and uniqueness to the whole environment, so contributing to generate a sense of belonging and a pride of being and working there.

On the other hand, the real value of the district is in the sum of individual local identities that mainly manifest themselves also through the presence of the variety of shops and other professional initiatives. In most cases, the external appearance of shops is not noticeable or glamorous, and most buildings appear just as “normal” urban residences. This “normality” is perceived as a value by inhabitants and vendors. For most of the interviewed people, the main goal is the maintenance of the existing state, and the opportunity to continue a business mostly based on a reputation based on quality of products and processes.

Probably, a proposal of collective communication and local brand doesn't meet the consensus of the local stakeholders since local stakeholders seems to be more interested in maintaining their individual identity rather then in being part of an organized system.

With respect to digital services to communicate the existence of shops (and of local products, business activities and artisanal production locations) and improve the service offered to customers, our workshop demonstrated that it is possible to design a wide variety of services capable to give new value to the local offer through the organization of events, and through the use of multimedia solutions to document and explain the local and diffuses cultural heritage. As we had previously deducted from research based on case study analysis, in Via Canonica the quality of social interaction is a basic and important factor influencing the customer experience. Digital communication can enable new and richer dialog between local stakeholders and between them and the other players of the production/distribution system, but new services should be developed with a "soft hand", without perturbing the individual needs in terms of independence and identity.

The most promising direction toward which address future efforts in the design of digital services to support local retail seems to hinge on the dialogue between inhabitants around quality of products/quality of life issues. This result will drive our future efforts.

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Intangibles para el proceso de diseño en el marco de la sociedad del conocimiento

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Resumen

Hoy vivimos en la llamada "sociedad del conocimiento", la cual ha generado grandes trasformaciones en el quehacer empresarial. Las empresas han pasado de un sistema productivo, basado en factores materiales, a un sistema económico constituido por factores cognitivos, creativos e informativos que contribuyen cada vez más a la riqueza de las empresas. En este contexto, el objetivo del artículo es identificar las nuevas formas de conocimiento que transforman, específicamente, la dimensión empresarial y su vinculación con los componentes intangibles, cuyo tratamiento se convierte en insumos del proceso de diseño. Para su desarrollo, se optó por una investigación descriptiva de la literatura existente, que permita crear un estado del arte para conocer qué aspectos se han investigado y cuales permanecen ignorados. En este sentido, se pudo evidenciar que el mayor reto para las empresas es la gestión apropiada del conocimiento, con el que se alcance un posicionamiento competitivo y asegure su supervivencia. La disciplina de diseño desempeña un papel estrategico en la consecución de este objetivo, pues, bajo una visión sistémica, realiza la función transformadora de buscar nuevas estrategias, que le permitan identificar y mejorar la gestión de los intangibles empresariales, con la clara intención de innovar y optimizar el diseño de lo tangible.

Palabras clave: *sociedad del conocimiento; intangibles empresariales; proceso de diseño; diseño estrategico, innovación.*

Abstract

Nowadays we live in what is called the "knowledge society" which has generated great transformations in business activity. Companies have gone from a material based production system, to a knowledge based productive system, where creative and information related factors are contributing increasingly to the wealth building of businesses. In this context, the objective of this article is to identify new forms of knowledge that can transform this business dimension and its relationship to the intangible components, such treatment becomes an important input in the design process. For its development, we chose a descriptive research of existing literature, allowing to create a state of the art in order to know what aspects have been investigated and which remain unknown. It became evident that the biggest challenge for companies is proper knowledge *management, thereby achieve a competitive position and ensure its survival. The design discipline plays a starring role in achieving this objective, therefore, under a systemic, performs the transformative role of new strategies, allowing him to identify and improve management of business intangibles, with the clear intention to innovate and optimize the design of the tangible.*

Keywords: *knowledge society; business intangibles; design process; innovation.*

1. Introducción

El paso del tiempo, ha marcado históricamente transformaciones que han afectado a todo tipo de empresas, sean estas pequeñas, medianas o grandes. Los historiadores han agrupados estas transformaciones en tres sociedades: la Agrícola, la Industrial y la del Conocimiento, también identificada con los términos: "Sociedad Post-industrial"(Bell,1991), "Sociedad de la Información", "Sociedad Red" o "Los Flujos" (Castells, 1999). Por lo que resulta necesario realizar una rápida mirada del pasado, para visualizar el hoy.

La sociedad agrícola. Es la más larga de la historia, fue una etapa dominante a través de la cual el ser humano lograba su subsistencia y desarrollo, se cuenta sus inicios desde que el hombre está en la tierra, hasta finales del siglo XIX. (Giner de la Fuente & Gil Estallo, 2014).

La Sociedad industrial.- Surgió a mediados del siglo XVIII como consecuencia de la revolución Industrial iniciada en Inglaterra, se extendió por Europa y en o corto plazo al resto del mundo. La productividad fue el valor más deseado, cada individuo era considerado un engranaje del sistema que producía la mayor cantidad de mercancía posible en el menor tiempo posible. Esto represento grande movimientos migratorios, del campo a la ciudad que es dónde se concentraron las fábricas, el sociólogo Marx enfoca el trabajo del obrero como "El trabajo externo, el trabajo en que el hombre se enajena, es un trabajo de auto sacrificio, de ascetismo" (Marx, 1844).

La sociedad de conocimiento, tiene sus orígenes en los años noventa cuando se analizaron los cambios en las sociedades industriales, surgió el término sociedad post-industrial, introducido por el sociólogo Daniel Bell(1973; 2001), "este tipo de sociedad está orientado hacia el progreso tecnológico y la evaluación de la tecnología y se caracteriza por la creación de una nueva tecnología intelectual como base de los procesos de decisión" (Bell, 1991, pág. 53). Esta es la sociedad de la globalización y las Tics, y en ella nos encontramos hoy.

El sociólogo Manuel Castells, centra sus estudios en analizar las afectaciones de esta nueva sociedad desde varias ópticas: los movimientos sociales urbanos, el surgimiento de la sociedad en red, y el rol de las ciudades en la economía basada en información. Sostiene que "debido a que la materialidad de nuestra existencia está hecha de flujos y/o de resistencias a estos flujos basados en la comunidad, la representación de los valores e intereses en nuestras sociedades ya no se estructura sobre la base del trabajo, sino que se expresa en términos de un mensaje simbólico, los flujos no son sólo un elemento de la organización social, son la expresión de los procesos que dominan nuestra vida económica, política y simbólica" (Castells, 1999). Estas afirmaciones, permiten visualizar claramente que la sociedad se transforma a través de sus diversas dimensiones: cultural, económico/empresarial, la planificación espacial y la tecnológica, proporcionando modelos globales con múltiples interconexiones. El presente artículo tiene como contexto específicamente las transformaciones ocurridas en la dimensión empresarial, a lo que surge los cuestionamientos : ¿qué cambios experimentan las empresas?, ¿qué relación tiene estos cambios con la presencia o generación de activos intangibles? y ¿en que contribuye la inminente presencia de los intangibles, con el trabajo de los profesionales del área de diseño?

La presente investigación pretende dar contestación a cada una de las preguntas planteadas, para lo cual su objetivo es identificar las nuevas formas de conocimiento que transforman, específicamente, la dimensión empresarial y su vinculación con los componentes intangibles, cuyo tratamiento se convierte en insumos del proceso de diseño.

2. Antecedentes teóricos.

2.1 La sociedad del conocimiento y su impacto en las empresas.

Drucker en su libro "La era de la discontinuidad" da origen al término "la sociedad del conocimiento", es reconocido como padre y mentor conjunto con Fritz Machlup (Drucker, 1969). El ganador del premio Nobel de Economía en 1987, Robert Solow, fue uno de los primeros en señalar la importancia del conocimiento en el crecimiento económico, expresando que este es una función de capital, trabajo y conocimiento, sus estudios sobre esta temática, fueron la base para otorgarle el Premio Nobel. Sus estudios incluían análisis numéricos sobre el crecimiento económico de Estados Unidos en la primera mitad del siglo XX, en la que se evidenciaba un residuo inexplicable, que no es el resultado del incremento de los factores de capital y trabajo. La parte no explicada se denominó "residual de Solow", que correspondía a algo más, al progreso técnico, como lo llamó Solow, o simplemente conocimiento. (Corrado, Hulten, & Sichel, 2004).

Este conocimiento, está transformando radicalmente las economías, los mercados y la estructura de la industria, los productos y servicios, los puestos de trabajo y los mercados laborales (Drucker, 1969). Las antiguas tradiciones a nivel empresarial se han visto gravemente afectadas, Idris Moote menciona que "las empresas están sufriendo una gran turbulencia cultural constante con afectación directa sobre reputación, crecimiento y rentabilidad" (Mootee, 2014, pág. 3). Calleja (2001), señala que "las empresas como organizaciones humanas con objetivos de creación de riqueza y bienestar, están afectadas por el crecimiento de la complejidad y deben establecer mecanismos para tenerla en cuenta y moverse con éxito en un entorno más interdependiente". Por otra parte Morán y Brightman afirman que las empresas deben "renovar continuamente de dirección, estructura y capacidades de la organización para servir a las necesidades siempre cambiantes de los clientes externos e internos" (Moran & Brigthtman, 2001, pág. 115), lo que lleva a pensar que las empresas se enfrentan a una gran incertidumbre.

Estos acontecimientos, han originado numerosas investigaciones a nivel mundial, bajo el enfoque de identificar las causas y posibles soluciones a las transformaciones empresariales. Aguilá y Monguet desarrollaron una metodología para guiar la evolución desde modelos de negocio obsoletos a modelos propios del siglo XXI, ellos exponen un esquema analítico para la reconstruir la oferta del producto y servicio (Aguilá & Monguet, 2010). Los autores Giner de la Fuente & Gil Estallo, en cambio se enfocan en "estudiar como las TIC están cambiando de forma radical la división de trabajo dentro de las empresas y con ello enviando a la basura los paradigmas de la gestión de la empresa" (Giner de la Fuente & Gil Estallo, 2014). Moote, propone una metodología sobre como insertar en la empresa moderna un nuevo conjunto de instrumentos basados en el Design Thinking, que permita una nueva oleada de colaboración, visión y aprendizaje , destinados a mejorar la toma de decisiones (Mootee, 2014). Los autores Anargyros & Loeb,en su obra ¿Y si ponemos los relojes de nuevo a cero?, ofrecen una visión particular desde el Diseño de las transformaciones empresariales: "repensar el presente desde diferentes puntos de vista ofreciendo estímulos para darse cuenta de futuros posibles, el futuro no existe, pero con el fin de desarrollar hipótesis del futuro, hay que mirar más de cerca la actualidad, la zona cero" (Anargyros & Loeb, 1998). La mayoría de estos estudios tienen como punto de partida, que la empresa tome conciencia de la situación, a través de la identificación de las fuerzas externas a las que están sometidas actualmente. El presente articulo ha tomado de base las fuerzas externas analizadas por los autores Aguilá y Monguet, a saber:

- Globalización, partiendo de un mercado local o regional, se ha evoluciona a los internacionales y a mundiales, alcanzables gracias a la presencia de la tecnología, la internet rompió todos las barreras físicas y territoriales. Tanto las ventas como, las tareas deben realizarse bajo una visión planetaria. Los ciclos económicos están fuertemente caracterizados por la mundialización.

- La sostenibilidad del planeta, la crisis de los recursos naturales, es más urgente que la económica y empeora cada vez más a medida que aumenta la población, y no hay que olvidar el reconocimiento de los derechos de las minorías.
- La innovación tecnológica, no solo la informática y las comunicaciones, la bioingeniería, los nuevos materiales, la nanotecnología están provocando continuamente revoluciones en los mercados.
- Demografía, grandes migraciones procedentes principalmente de países en desarrollo, hacia países desarrollados, generan cambios en la cultura y costumbres occidentales, los cuales poseen en su mayoría bajas tasas de natalidad.
- La saturación de oferta de productos , la eminente necesidad de reformular la oferta de los mercados, considerando una diferenciación que asegure la supervivencia en el mercado.
- La necesidad cambiante de los usuarios, lo que fomenta la co-creación con los clientes, esto generá elementos de confianza mutuos.

2.2 Los intangibles empresariales.

La intangibilidad[25] se manifiesta en las dificultades de medir, tocar y manipular, el término “activos intangibles”, es definido por distintos organismos internacionales como la FASB (Financial Accounting Standards Board) en los Estados Unidos o el ASB (Accounting Standards Board) en el Reino Unido , y por la Norma Internacional de Contabilidad NIC 38[26], en forma similar (Cañibano & Gisbert , 2005) como:“ identificable, de carácter no monetario y sin apariencia física” (NIC 38, 2004, párrafo 8). La importancia de medir los activos intangibles dentro de las organizaciones modernas radica en que estos representan un recurso crucial para la sostenibilidad de los beneficios económicos en el largo plazo.

Desde la década de 1990 viene creciendo la inquietud sobre la necesidad de analizar y medir los diferentes tipos de activos intangibles para incluirlos en los estados financieros de las empresas. Este ha sido el propósito de numerosas investigaciones, desde variadas perspectivas: la contable, el capital intelectual, medida de desempeño y la valoración financiera. Para citar solo un ejemplo, el artículo “Study on the measurement of intangible assets and associated reporting practices”, detalla 23 métodos de medición de activos intangibles. (European Commission, 2003). Por otra parte, la empresa Ocean Tomo con sede en Chicago, Estados Unidos, realizo un estudio que media el peso de los componentes tangibles e intangibles en el valor de mercado, a una muestra de 500 empresas que componen el índice S&P500. El período de observación fue de 35 años, en él se evidenció un cambio drástico en la proporción de los componentes que soportan el valor de mercado de las empresas, al pasar del 83% tangible vs. el 17% intangible en el año 1975, a una inversión de la proporción, con un 20% tangible vs. un 80% intangible en 2010 (Torres, 2014).

Otra contribución influyente sobre el crecimiento y valoración de activos intangibles lo dan Carol Corrado, Charles Hulten y Daniel Sichel (en su momento investigadores del Federal Reserve Board y de la University of Maryland), identificada como CHS, la que se ha convertido en la metodología estándar en la literatura económica actual. Esta considera que los gastos que se realizan las empresas en diseño, marketing, formación del personal o mejoras organizativas, son tan importantes como los gastos en I+D (Corrado, Hulten, & Sichel, 2004). Esta metodología ha sido utilizada por otros centros de investigación, tal como el proyecto INTAN-Invest [www.intan-invest.net], aplicada para calcular la inversión en intangible de un grupo de países europeos. Los autores han continuado con sus investigaciones y sus trabajos propiciaron la creación de organizaciones como Innodrive,

[25] Intangible: adj. Que no debe o no puede tocarse. Diccionario de la Lengua Española. Real Academia Española. vigésima primera edición, 1992

[26] El objetivo de esta Norma es prescribir el tratamiento contable de los activos intangibles, especifica los criterios que permiten reconocer un activo intangible y también especifica cómo determinar el importe en libros de los activos intangibles

establecida bajo los auspicios de la Comunidad Europea, quien ha financiado numerosos estudios para entender cabalmente la importancia de los activos intangibles en la sociedad del conocimiento.

La metodología CHS, identifico y clasifico en tres grupos a los activos intangibles, que le permiten realizar su respectiva cuantificación: **Información computarizada** (software y bases de datos); **Propiedad científica y creativa** (I&D, exploración minera, derechos de autor y costos de licencia, desarrollo de productos, diseño y otros gastos de investigación); **Competencias económicas** (valor de marca, capital humano, estructura organizativa, modelo de negocios) (Corrado, Hulten, & Sichel, 2004, pág. 40).

3. Metodología.

La metodología aplicada en este artículo, fue realizar una revisión descriptiva de la literatura existente sobre la afectación del conocimiento en el quehacer empresarial y su vinculación con los intangibles empresariales. Para la localización de los documentos bibliográficos se utilizaron varias fuentes documentales. La búsqueda se realizó utilizando los descriptores: sociedad del conocimiento, intangibles empresariales y proceso de diseño. Otro criterio de validación fue considerar publicaciones en español o inglés, en las que se hayan obtenidos resultados debidamente respaldados, con información obtenida de un proceso meticuloso de investigación.

4. Resultados.

Luego del análisis de la bibliografía recogida, sobre el nivel de afectación que realiza la presente sociedad del conocimiento, a la dimensión empresarial. Se evidencio que esta, trastorna principalmente el modelo de negocio de la empresa, lo que conlleva a una redefinición de su estructura organizacional y ocupacional, y por ende un cambio radical en sus procesos. Entre las fuerzas externas que originan el cambio en el modelo de negocio se encuentran: la globalización, la innovación tecnológica, la sostenibilidad del planeta, la demografía, saturación de oferta de productos y servicios y la necesidad cambiante de los usuarios.

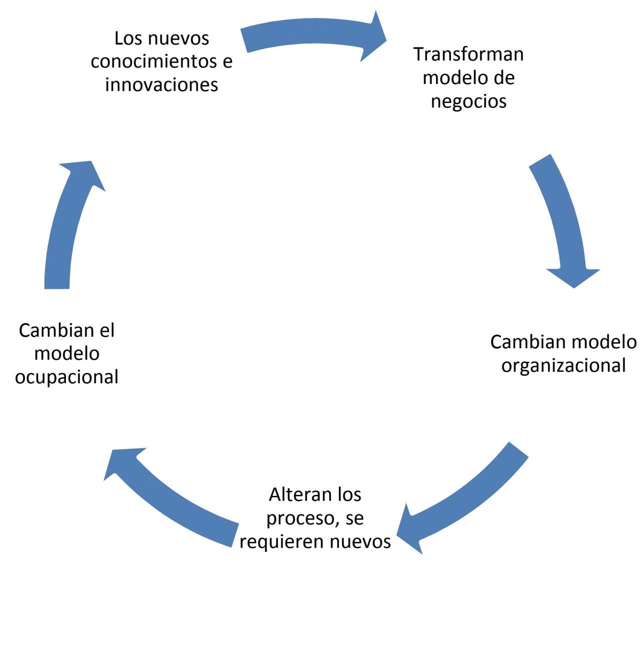

Fig 1. El ciclo de afectación en la dimensión empresarial, causada por la sociedad del conocimiento. Fuente : Los autores.

Estos elementos externos impactan sobre la empresa, obligandola a reemplantearse su oferta desde una visión interna, esto ha dado origen al crecimiento y valoración de los activos intangibles, Drucker considerado el mayor filósofo de la administración del siglo XXI, menciona que "la empresa debe enfocarse específicamente en la complejidad de los activos intangibles, pues es aquí donde está su mayor crecimiento, para lograr una ventaja competitiva sostenible, y en esencia un conocimiento productivo" (Drucker, El management del siglo XXI, 2000). La identificación de cuáles son los intangibles empresariales, resultantes de la gestión del conocimiento ha tenido muchas opiniones, también numerosas metodologías que permiten su medición e incorporación en los estados financieros (explicación detallada en antecedentes téoricos). El presente articulo ha tomado de base la metodologia CHS, la que clasifica en tres grupos a los activos intangibles: Información computarizada, Propiedad científica y creativa y Competencias económicas (Corrado, Hulten, & Sichel, 2004, pág. 40). Para efectos de medición, esta se descompone en 9 indicadores.

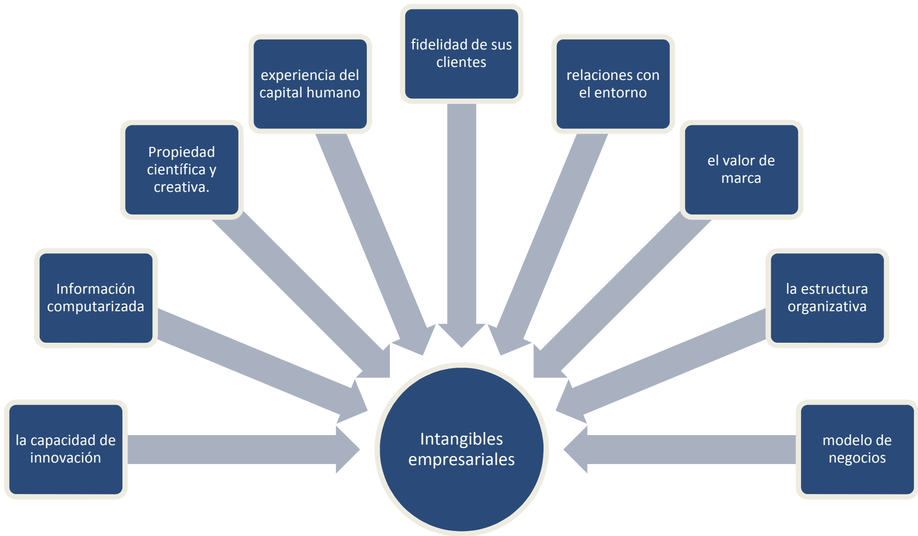

Fig. 2. Los intangibles empresariales. Fuente : Los autores.

Potenciar estos intangibles es la nueva estrategia empresarial, a la que deben estar alineados todos los procesos, incluyendo el de Diseño. El Diseño desde la optica de proceso, esta presente desde las fases de detección de portunidades y analisis de las necesidades del Mercado, hasta las fases de comercialización del producto. En este intervalo confluyen campos de actividad tan diversos como marketing, ingeniería, sistemas de información, etc. Este proceso desde una óptica sistémica, tal como lo describe el Modelo de Diseño Concurrente de Hernandis, específica que "las Variables de Entrada (VE) dadas desde el sistema exterior influencian los aspectos a considerar en el diseño, aportando valores cualitativos o cuantitativos que actúan sobre el Sistema" (Hernandis, 2010). Sería necesario entonces que estas VE, contemplen las variables internas de los intangibles empresariales. Esto nos coloca en un nuevo escenario, la inminente necesidad de observar y estudiar desde la perspectiva de Sistemas, los intangibles empresariales en el proceso de diseño, tal como lo menciona Evers "mientras los conocimientos aumentan con gran rapidez, el saber de lo que no sabemos aumenta con velocidad aún más vertiginosa". (H. D. Evers 2000. p. 8). En este contexto, se ha encontrado algunos esfuerzos desarrollados por investigadores que buscan optimizar el proceso de diseño como función transformadora, captando la intangibilidad empresarial: Donald Norman y Roberto Verganti; Alessandro Deserti y Francesca Rizzo; Francesco Zurlo y Cabirio Cautela y David Aaker.

4.1. Capacidad de Innovación

Donald A. Norman[27], uno de los originadores del diseño centrado en el usuario -HCD (por sus siglas en inglés human-centered design)" y Roberto Verganti un estudioso de la gestión de la innovación tecnológica. Utilizan de base a las teorías establecidas en el campo de la innovación y la investigación científica / tecnológica, que distinguen la innovación radical e incremental, básica y la investigación aplicada, analizan muchos casos en las que el diseño impulsa a la innovación, llegando a una conclusión. "Una innovación radical surge sin ningún tipo de investigación de diseño o análisis formal de las necesidades de una sociedad o sector en particular, surgen impulsado por los cambios tecnológicos" (Norman & Verganti, 2014, pág. 84), citan un ejemplo reciente tales como Facebook, twitter y las redes sociales, surgieron simplemente porque sus inventores pensaron que eran cosas interesantes para probar. Generalmente una innovación radical genera una disrupción. Norman no pudo encontrar ningún ejemplo de innovación radical que resultó del proceso diseño centrado en el usuario. Una vez que la innovación radical se había desarrollado, sin embargo, el diseño centrado en el usuario (HCD) fue invaluable como una manera de mejorar el producto. La mejora de sus ejemplos es que Google, Facebook y Twitter se han modificado a sí mismos desde su introducción inicial (Norman & Verganti, 2014, pág. 79).

4.2. Estructura Organizativa

Alessandro Deserti[28], investigador en el área de gestión del diseño, e innovación a través del diseño. Francesca Rizzo[29,] investigador en el área de diseño de servicios y diseño participativo, realizan una investigación, que se centra en explorar la idea de que el diseño de nuevos productos podría traer cambios inesperados en la cultura de una empresa, ya que su desarrollo puede generar contradicciones entre la cultura actual y la que se necesita para poner en práctica la innovación. Los autores proponen una perspectiva de abajo hacia arriba en el cambio organizacional, vinculándola a la observación de casos reales y la situacionalidad de la práctica del diseño y la cultura como un valor posible, en contraste con la idea de modelos y técnicas que supuestamente pueden ser aplicado en cualquier contexto y situación. Por esta razón, los autores critican el cambio de arriba hacia abajo desde el punto de vista de gestión y pensamiento de diseño; como inadecuados para hacer frente a los cambios e innovación. Esta investigación también realiza un aportación sobre el tema que el producto o servicio, a ser desarrollado no debe únicamente considerar en su fase inicial las necesidades externas de los clientes, sino este debe poder transmitir la cultura de la empresa (Deserti & Rizzo, 2014, pág. 37).

4.3. Técnología

Francesco Zurlo[30] y Cabirio Cautela[31], proponen que el diseñador debe saber escuchar las narrativas empresariales en el rol de intérprete-lector, para luego poner en acción una contra-narración animada por la forma y la lógica del proceso creativo, cuyos resultados se expresan como conceptos y prototipos, proceso que cambiaría de acuerdo a los diversos contextos productivos. Dan una amplia explicación

[27] Donald Norman cofundó el Nielsen Norman Group, consultoría dedicada a la usabilidad, profesor emérito de la Universidad de California, San Diego (UCSD), tanto en Ciencia Cognitiva y Psicología. Asesor empresarial y organizaciones como el Instituto de Diseño de Chicago y ex Vicepresidente de Tecnología Avanzada de Apple. Sus últimos estudios están enfocados en cómo se conjugan las emociones y diseño en el uso de los productos, tema desarrollado en su libro "emotional design".

[28] Alessandro Deserti ,profesor del Politécnico de Milano, departamento de Diseño, Investigó las nuevas funciones de diseño dentro de las empresas, instituciones y entornos sociales, ha publicado libros, ensayos, artículos en revistas y actas de congresos internacionales.

[29] Francesca Rizzo, profesora adjunto en la Universidad de Bolonia, Departamento de Arquitectura, imparte clases de Diseño Industrial. Ella trabajó en diferentes proyectos de investigación europeos y nacionales en el campo de Diseño de Interacción y Diseño del Servicio. Es autor de numerosos artículos publicados en las actas de congresos (DPPI , HCI , IASDR , PD ; DRS) y revistas (Codesign , Tecnología y Cognición , Comunicación de la ACM).

[30] Francesco Zurlo, catedrático en el Politécnico de Milán, Director del Master en Diseño Estratégico .Ha sido el director general de Polidesign - 2004-2008. Fue galardonado con el 'Golden Compass 2001 (el premio de diseño más prestigiosos de Italia). Ha publicado más de 40 artículos, entre ellos seis artículos en revistas internacionales sobre cuestiones de diseño e innovación y publicado seis libros.

[31] Cabirio Cautela, profesor asistente del Politécnico de Milán, Phd en Business Management. Ha sido visitante invitado en Stanford University – CDR (Center for Design Research) en el 2012. Sus Investigaciones giran sobre el rol estratégico del Diseño, el manejo de procesos de diseño. Es co-director del master en Strategic Design.

teórica documentada acerca de lo significa "las narrativas[32] del negocio" creadas por las empresas, según (Czarniawska, 1997), que demuestran que pueden ser usadas en sus relaciones con los diseñadores. En su metodología propuesta establecen que existen dos variantes: el mercado y la tecnología, con sus respectivas opciones de elección, viejo y lo nuevo, crea cuatro campos narrativos diferentes, como se muestra en la Figura 3: la narrativa de explotación, la tecno-narrativa, el relato centrado en el usuario y el exploratorio. Los autores quieren llegar a determinar y principalmente a dotar a los diseñadores, el camino a seguir dependiendo de lo que trasmita la narrativa empresarial, viéndole desde una óptica sistémica, se podría indicar que identifica claramente variables, que servirán para alimentar la primera etapa del proceso de diseño (ver tabla 1) (Zurlo & Cautela, 2014).

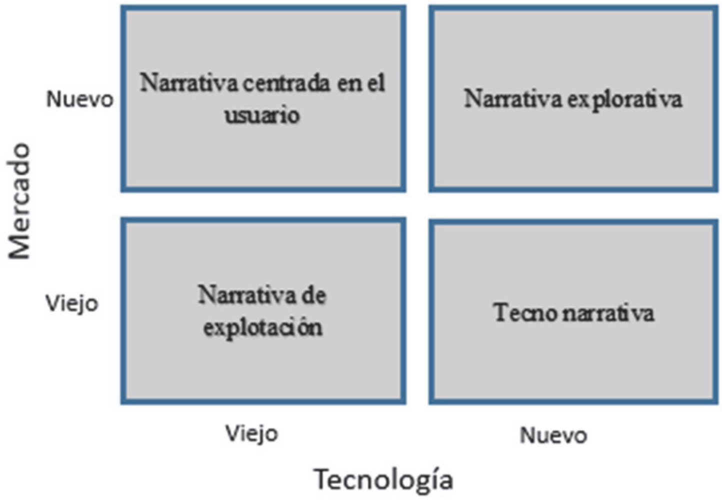

Fig. 3 Las narrativas empresariales. Fuente : DesignIssues: Volume 30, Number 1 Winter (2014).

Tabla 1. Las Narrativas empresariales versus los factores que promueven el proceso de diseño.

Narrativas empresariales versus estrategias de diseño				
	Narrativa de explotación	**Tecno-narrativa**	**Narrativa centrado en el usuario**	**Narrativa explorativa**
Orientación del Diseño.	Reconfiguración de estilos	Búsqueda de nuevas aplicaciones	1.1.1. Explotación de tecnología en nuevos mercados	1.1.2. Innovación del modelo del sistema/negocios.
Fuentes de creatividad	Tendencias extra-sectoriales /estímulo	1.1.3. Futurología 1.1.4. Patrones cognitivos de los usuarios	1.1.5. Evolución de signos relacionados a productos, espacios y contenidos	1.1.6. Perspectivas del sistema de las partes interesadas

Fuente : DesignIssues: Volume 30, Number 1 Winter (2014)

[32] Narrativa, se considera una parcela de eventos secuenciales e interconectados con un comienzo, una conclusión y una estructura básica (Fisher, 1935, pág. 74)

Valor de Marca, David Aaker[33], se ha destacado en el mundo del Branding por estudiar y analizar en profundidad la marca y todos los aspectos relacionados con ella, desde la óptica disciplinar del marketing. Aaker considera "el valor de marca como una combinación de conocimiento, lealtad y asociaciones de marca, que se suman para proporcionar valor a un producto o servicio" (Aaker D. , 1996). El autor afirma que el primer paso que hay dar, para iniciar la gestión de la marca, es desarrollar una *identidad de marca*, que es un conjunto único de asociaciones que se vinculan a lo que la marca pretende representar. La identidad de marca, para Aaker según su modelo es un conjunto de 12 elementos que caen bajo cuatro perspectivas: Marca como producto, Marca como organización, Marca como persona y Marca como símbolo. Su aportación genera alteración en el campo investigativo, lo que da inicio a numerales estudios relacionados, es así que su hija Jennifer Aaker identifica que para construir una identidad hay que considerar tres dimensiones: "la *Personalidad* que construye la marca al comunicar, el discurso de todo lo que tiene que decir y las expresiones que deberá utilizar para que puedan ser captados" (Aaker J. , 1997).

La personalidad de marca se constituye en un componente intangible de la marca, y es definido por su autora "como el conjunto de características humanas asociadas a una marca" (Aaker J. , 1997), bajo este contexto se crea un modelo que permite medir la personalidad de la marca. En el proceso de creación se utilizó 37 marcas en diversas categorías, lo que le permitió detectar 114 rasgos que las describen. El resultado final de este estudio desarrollado en Estados Unidos, presenta un instrumento para medir la personalidad de marca que consta de quince rasgos y cinco dimensiones: sinceridad (práctico, honesto, sano, alegre); emocionante (atrevido, animado, imaginativo, actualizado); competencia (confiable, inteligente, exitoso); sofisticado (clase superior, encantador); rudeza (abierto, resistente). La personalidad de la marca es un componente indispensable a ser considerado en el proceso de diseño, si se visualiza este proceso desde una óptica sistémica, se da la fase de análisis, en la que se debe llegar a la conceptualización del tangible resultante, el mismo que debe tener impregnado la esencia de la marca empresarial.

5. Conclusiones

Como protagonistas de la sociedad del conocimiento, se puede apreciar la evolución de las dinámicas sociales, empresariales y culturales que surgen ante la inminente influencia de las innovaciones tecnológicas. El área de diseño no está alejado de esta influencia, muy por el contrario el diseño ha sido movido progresivamente desde los objetos tangibles (donde su enfoque central era su valor de uso), hacia los aspectos vinculados a la intangibilidad: la experiencia de compra, la dinámica de acceso del producto, su disponibilidad y su nivel de nnovación, los que a más del uso, se han constituido en los elementos diferenciadores que crean valor para los usuarios. La integración entre los componentes tangibles e intangibles se ha convertido en un área importante de estudio para él diseño.

Al realizar un recorrido bibliográfico sobre la inclusión de los intangibles empresariales en el proceso de diseño, se pudo evidenciar que es realmente escasa la información, la mayoría de los resultados se concentran en estudiar necesidades, preferencias e intereses del consumidor , reconocidas como variables externas a la empresa, sin considerar las variables internas originadas por los intangibles empresariales. Se ha podido identificar un total de 9 intangibles empresariales, que pueden ser medidos y registrados en los estados financieros por el área contable.

La integración de estos componentes intangibles en el proceso de diseño bajo una visión sistémica, hace necesario que el diseñador adquiera nuevas destrezas. En el rol de intérprete de las narrativas empresariales requerirá necesariamente conocer términos y conceptos administrativos. En el rol de interlocutor de la cultura organizacional, conformada por valores, normas y creencias, visualizada como personalidad de marca, deberá tener nociones de psicología. El desarrollo de la capacidad de Innovación, un intangible de gran potencial en la empresa, pone al diseñador en otro rol, debe ser un futurólogo, que explote al máximo su capacidad creativa. La sostenibilidad del planeta, exigirá que el diseñador comprenda su compromiso por el medio ambiente, por lo que deberá tener nociones de esto también. Hay más variables a considerar dentro del proceso y mucho que investigar aún, este análisis es solo un

[33] David Aaker, es profesor emérito de ET Grether de Estrategia de Marketing de la Escuela de Negocios Haas. Es consultor de marketing y autor de más de 100 artículos y unos 15 libros sobre marca. Es considerado uno de los líderes mundiales en su especialidad asesorando empresas de Estados Unidos, Japón y Europa. Es Vicepresidente de la consultora Prophet Management Team.

pequeño aporte al estado del arte de los intangibles empresariales en la sociedad del conocimiento y su implicación en el proceso del diseño.

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Caso Garittea, del campo al campus: Creación del diseño de la identidad visual de una organización a través del trabajo colaborativo entre comunidades campesinas y la academia.

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Resumen

Se presenta la experiencia de articulación entre academia, ONG y asociaciones campesinas, alrededor del desarrollo de capacidades para la comercialización de productos de café, en el marco del diseño colaborativo y participativo, que permite avanzar en la construcción de canales de economía solidaria y comercio justo. Garittea *es una empresa social que disminuye la intermediación comercial, defiende los ingresos de los pequeños caficultores y genera procesos de empoderamiento en las comunidades campesinas; es una marca creada para el fortalecimiento de las relaciones campo-ciudad, el desarrollo sostenible, el impulso del trabajo interdisciplinario y colaborativo, elementos esenciales en la creación de la identidad y el diseño de comunicación visual de una organización. Villafañe (2008) afirma que la identidad corporativa es el "ser" de la empresa, su esencia, concepto que se toma como referencia y pone de manifiesto la importancia del trabajo colectivo en la creación de la identidad en las organizaciones.*

Este estudio deja ver los modos de participación e intervención de los distintos actores y áreas del conocimiento en los procesos de diseño y gestión de una organización, generando el posicionamiento y la visibilización del carácter de una comunidad productiva. La identidad de Garittea parte de una visión integradora articulada con perspectiva de la triple hélice (Etzkowitz et al. 2000) donde empresas, universidades y otras organizaciones se encuentran para trabajar con un compromiso colaborativo.

Los actores del proceso se definen a través de una triada, compuesta por la empresa, (socios de Garittea): la Asociación de Pequeños Caficultores de La Marina, la Asociación de Caficultores Orgánicos de Colombia y el Instituto Mayor Campesino, quienes han aportado su know–how y la experiencia de sus procesos de creación de nuevos productos; un equipo de I+D+i (profesores y gestores), quienes han incorporado sus metodologías y herramientas a través de la interdisciplinariedad en saberes como el mercadeo, la ingeniería, la economía, la psicología y el diseño, aplicando entre otros recursos, modelos *sistémicos de formulación por objetivos para apoyar los procesos creativos y la gestión del diseño; los diseñadores (estudiantes), quienes han trabajado en la creación de la identidad de Garittea a través de un equipo integral, dando como resultado la creación de la identidad corporativa e identidad visual de Garittea.*

Palabras clave: *Identidad visual corporativa, entornos colaborativos, diseño participativo campo – ciudad, sistémica.*

Abstract

This paper presents the joint work experience between academics, ONGs, and farmer´s associations, about the development of capabilities for the marketing of coffee products, in the framework of colaborative and participative design, that allows the progress in the construction of solidary economic chanels and fair trade. Garittea is a social entrepreneurship that lowers commercial intermediation, defends the income of small coffee producers, and creates empowerment processes in the rural comunities; Garittea is a brand created for strengthtening rural-urban relations, sustainable development, the promotion of interdisciplinary and colaborative work, esential elements in the creation of business identity and the design of an organization visual comunication. Villafañe (2008) states that corporative identity is the "being" of a company, its essence, a concept that is taken as a reference and highlights the importance of collective work in the creation of identity of organizations.

This study reveals the several ways of participation and involvement of different actors and areas of knowledge in the processes of design and management of an organization, that creates positioning and visibility of the character of a productive community. The identity of Garittea departs from an integrated vision, articulated with triple helix perspective (Etzkowitz et al. 2000) where companies, universities, and other organizations are willing to work jointly with a colaborative commitment.

The actors in the process are defined by a triad, the firm (Garittea shareholders): the Association of Small Coffee Growers of La Marina, the Association of Colombian Organic Coffee Growers and the Instituto Mayor Campesino, who have contributed with their know-how and experience in the processes of creating new products; a team of I+D + i (teachers and administrators), who have incorporated their methodologies and tools through interdisciplinary knowledge in areas such as marketing, engineering, economics, psychology, and design, using among other resources, systemic models of formulation by objectives to support the creative process and the design management; and, finally, the designers (the students), who have worked on creating Garittea´s identity through an integrated team, resulting in the creation of corporate identity and visual identity of Garittea.

Keywords: *corporate visual identity, colaborative environments, rural-urban participative design, sistemic.*

1. La experiencia. Actores y tensiones

"Profesor , no nos interesan sus planteamientos de un negocio que se fundamenta en la lógica del mercado, para nosotros la vida se mueve en la construcción de posibilidades de encuentro y cooperación…" Líder campesino (2014)

Ubicar el contexto de la experiencia creativa asociada al proyecto del café, implica re-leer un proceso construido conjuntamente, entre académicos, funcionarios de una ONG y líderes campesinos. Volver una y otra vez sobre la experiencia de encuentro que hemos construido, ha permitido constatar las distintas tensiones sobre las que se ha establecido la construcción de un proyecto denominado *Garittea, del campo al campus*. Tensiones que bien vale la pena explicitar cuando abordamos el encuentro desde dos lógicas: el valor de los emprendimientos medido por las ganancias, el empleo que genera, la acumulación y la aplicación de modelos previamente establecidos, que marcan resultados "éxitosos" en el mercado; y la concepción de los proyectos productivos generadores de encuentros, posibilidades, recreación de la cultura, cuidado de la naturaleza y compromiso con la vida. En palabras de Albarracin (2009, p. 19) "quizás ese es el punto más conflictivo de una aproximación de este tipo de iniciativas, ya que su correcta lectura precisa el deslizamiento de un terreno claramente definido por la materialidad del dinero, las mercancías, la acumulación, a otro, fangoso e inhóspito y acechado por el fantasma de un concepto tan vago como el del capital cultural"

Pareciera que esta dinámica social que se establece entre los saberes hegemónicos y los saberes populares, no termina de transformarse; García Canclini (1990, p. 221) lo ha señalado desde hace más de dos décadas, cuando menciona: "el avance económico moderno no implica eliminar las fuerzas productivas que no sirven directamente a su expansión si esas fuerzas cohesionan a un sector numeroso, aún satisfacen necesidades sectoriales o las de una reproducción equilibrada del sistema. A la inversa y complementariamente, la reproducción de las tradiciones no exige cerrarse a la modernización".

De igual manera, García-Canclini hace referencia a una serie de estudios en América Latina (México y Ecuador), que ponen en evidencia que las dinámicas económicas, políticas y sociales perpetúan la discriminación y desigualdad de oportunidades para los grupos étnicos y campesinos para acceder a bienes económicos, a educación media y superior pertinente y de calidad, y a nuevas tecnologías; entonces, ¿cuáles son los caminos que deben recorrer comunidades indígenas, afro, campesinas para mantener las tradiciones, participar de la vida urbana y de las reglas comerciales modernas?

En esta perspectiva, la integración de algunos grupos tradicionales con la modernidad ha implicado, como lo menciona García-Canclini (1990, Págs 222-223), una consolidación del sujeto político y social. Es evidente que existen múltiples maneras de construcción de vínculos entre lo tradicional y lo moderno, lo popular y lo culto, lo local y lo extranjero; así como las clases hegemónicas ajustan sus saberes, al mismo tiempo, "las clases populares adoptan sus saberes y hábitos tradicionales". Sin mayor conflicto, entonces plantea García Canclini, la importancia de los cruces culturales y la reestructuración de los vínculos, especialmente, en las nuevas generaciones, más expuestas al mundo globalizado. Allí, el diseño tiene la oportunidad de jugar un papel de gran importancia en este tipo de procesos.

Si bien los planteamientos de García Canclini se realizan en función del arte versus las artesanías, para el caso que nos ocupa nos enfrenta a reflexiones similares aunque más adaptadas a las lógicas y saberes de los habitantes de las urbes versus los habitantes de la zona rural, específicamente, de los campesinos con sus cosmovisiones, luchas y resistencias. Precisamente estos saberes que provienen de la memoria común y cotidiana, y brotan de la dimensión social sensible, se configuran como proyectos estéticos pues proponen modos de hacer, maneras de habitar o circular, formas de interacción que invitan a la elaboración conjunta de sentido.

Ya Michel De Certeau (2006) , lo señala: “la práctica cotidiana es relativa a las relaciones de fuerza que estructuran el campo social como el campo del conocimiento”. De igual manera, De Certeau propone abordar la cultura, en función de objetivos y relaciones, apropiando informaciones, selecccionado y ordenando, bajo la consideración de tres aspectos: estético, polémico y ético.

En efecto, De Certeau, (2006. p. 263) afirma:

“En sí misma, la cultura no es la información, sino su tratamiento mediante una serie de operaciones en función de objetivos y relaciones sociales. Un primer aspecto de estas operaciones es estético: una práctica cotidiana abre un espacio propio en un orden impuesto, como lo hace la acción poética que pliega a su deseo al uso de la lengua común, en un nuevo uso transformador. Un segundo aspecto es polémico: la práctica cotidiana es relativa a las relaciones de fuerza que estructuran el campo social como el campo del conocimiento. Apropiarse informaciones, ponerlas en serie, editarlas a su gusto, es cobrar poder sobre un conocimiento y dar vuelta, de esa forma, a la puesta de imposición de lo ya hecho y ya organizado. Equivale a trazar, con estas operaciones apenas decibles, apenas nombrables, su propio camino en la resistencia del sistema social. Un último aspecto es el ético: la práctica cotidiana restaura con paciencia y tenacidad un espacio de juego, un intervalo de libertad, una resistencia a la imposición (de un modelo, de un sistema o de un orden): poder hacer es tomar distancias, defender la autonomía de algo propio”.

En el mismo sentido, el geógrafo Milton Santos, explica cómo la globalización es espacio de flujos diversos: hegemónicos, hegemonizados, rápidos y lentos; los flujos conforman verticalidades y horizontalidades que se entretejen en distintas direcciones. Las horizontalidades se componen de las acciones cotidianas de individuos o instituciones, que responden al ejercicio de existencias solidarias, son lugares que propician relaciones sociales y que fundan lazos solidarios de ciudadanía; las verticalidades son acciones hegemónicas, son elementos perturbadores que intentan traspasar las lógicas de aquellas horizontalidades que se construyen a sí mismas, desde la confianza, desde los afectos, desde la la posibilidad de erigirse como actores sociales colectivos, que se empoderan a partir de sus relaciones. Para Santos (2000), entonces, los cambios vendrán de abajo, desde el territorio, el trabajo y lo cotidiano, a partir de una toma de conciencia de los efectos excluyentes y la retoma de la solidaridad como fundamento de las relaciones sociales. Así, la horizontalidad que se teje desde el espacio-tiempo, desde lo rural y lo urbano, permite el surgimiento de lo político que se fortalece en la dimensión social y sensible de la multiplicidad de actores.

En este contexto, el desarrollo del proyecto *Garittea* ha estado dinamizado por la interacción de tres actores: el Instituto Mayor Campesino- IMCA-, la Universidad Javeriana Cali y las asociaciones de campesinos- la Asociación de Pequeños Caficultores de La Marina ASOPECAM, la Asociación de Caficultores Orgánicos de Colombia ACOC; todos estos sectores, han intercambiado perspectivas, lo mismo que intereses y afectos, para definir el alcance del proyecto y los modos de su realización, que suponen procesos de construcción y deconstrucción, continuos, como lo hemos mencionado anteriormente.

Ahora bien, esta iniciativa se enmarca en varias plataformas de articulación:

1. La más evidente está referida al trabajo colectivo entre comunidades campesinas, funcionarios de la ONG y académicos. Perspectiva que evidencia el intercambio, interdisciplinar (ingenieros, administradores, diseñadores de la comunicación visual, arquitectos, abogados), y de saberes populares y académicos, “facilitando el aprovechamiento de recursos y promoviendo la interrelación con otras disciplinas actores y saberes”(Gil, J. 2009, p.31).
2. Otra lectura podría ampliarse a las diferentes redes donde cada uno de estos actores participa y genera procesos colectivos, pues “las redes no remiten solamente a una forma de operar, sino

que suponen nexos conceptuales y espacios de complicidad que trascienden la mera mecánica administrativa" (Gil, J., 2009, pág.31). Situación que nutre el proceso emprendido, como bien lo plantea Yudice (Citado por Javier Gil, (2009) p. 31) "las redes aportan un minucioso trabajo de articulación del cual no son capaces las instituciones modernas. Entra además en espacios a donde no llegan las instituciones…se permitiría que el protagonismo de la acción cultural provenga de la sociedad civil misma". [34]

3. Por su parte la Universidad, identifica en esta alianza la posibilidad de crear un "laboratorio vivo", que impacte directamente el compromiso de docentes y la formación de estudiantes en la perspectiva de su compromiso social, tal como reza su Misión: "la creación y el desarrollo de conocimiento y de cultura en una perspectiva crítica e innovadora, para el logro de una sociedad justa, sostenible, incluyente, democrática, solidaria y respetuosa de la dignidad humana."[35]

El derrotero que se ha establecido está en función de integrar dos ejes: la perspectiva campo-ciudad alrededor de un proyecto de economía solidaria y comercio justo en el campus universitario, y explicitar las diferentes formas del trabajo articulado academia, ONG, en este caso el IMCA, y comunidades campesinas. Y además, la perspectiva de la construcción sostenible, en tanto el espacio donde funcionará la tienda de café corresponde a la Casa Alero, casa que obtuvo varios premios, entre ellos el primer lugar en la categoria en Ingeniería y Construcción y Balance Energético, en la competencia mundial del Solar Decathlon Latin American and Caribbean 2015. Esta edificación completa el ciclo del laboratorio vivo que se quiere crear, facilitando mayor apropiación de una propuesta económica de construcción sostenible, éticamente responsable, portadora de solidaridad conjunta y por tanto, promotora de esperanzas.

De esta manera, la Asociación de Pequeños Caficultores de La Marina ASOPECAM, la Asociación de Caficultores Orgánicos de Colombia ACOC, el Instituto Mayor Campesino IMCA y la Universidad Javeriana Cali, vienen trabajando en la construcción de una empresa social que bajo los principios de la economía solidaria, contribuye a eliminar la intermediación comercial, a defender los ingresos de los pequeños productores de café, para potenciar capacidades en las comunidades campesinas, a través de la comercialización directa al consumidor final y la compra de café a un precio justo, impactando el proceso formativo de los estudiantes javerianos, potenciando, además, la construcción de un modelo de consumo ético y sostenible, en la comunidad educativa.

El canal que permitirá que estos objetivos sociales y formativos puedan cumplirse, se materializará en la tienda especializada de café en el campus universitario denominada *Garittea del campo al campus*, la cual generará un espacio de creación de posibilidades y de gestión de productos propios del mundo campesino y del encuentro híbrido entre las culturas rurales y urbanas.

La comercialización del café, está dada en la creación de posibles y nuevas formas de encuentro entre la ciudad y el mundo rural, entre los jóvenes universitarios y los campesinos, entre los modelos de gestión y la creación, alrededor del fortalecimiento de valores. En palabras de Javier Gil, este espacio de la tienda *Garittea* puede ser una invitación " a producir lo nuevo, a generar nuevas relaciones con la economía, la

[34] A manera de ejemplo, el Instituto Mayor Campesino junto con otros Centros Sociales orientados por la Compañía de Jesús en Iberoamérica, comparten la misión de acompañar a las personas empobrecidas en su articulación social, política y económica, para que recuperen el control sobre los procesos de desarrollo y mejoren sus condiciones de vida, se han unido y han creado la **comunidad de aprendizaje COMPARTE**. Con la orientación de la Comunidad COMPARTE y bajo la metodología participativa de lectura estratégica del territorio se ha identificado la producción y comercialización directa de cafés especiales como un proyecto económico-productivo, que de acuerdo con las potencialidades y retos de la región centro del Valle del Cauca, puede generar una remuneración justa e incrementar los ingresos de las familias campesinas de esta zona del Valle.

[35] Consejo Directivo Universitario. Acuerdo N° 576. Abril 26 de 2013.

política, la educación, la vivencia del tiempo y del trabajo, la relación con las comunicaciones; tal vez implica nuevas maneras de estar juntos y de construir comunidades" (pág. 28)

En su fase inicial, este proyecto favorece la condición social de 61 familias campesinas ubicadas en la zona centro del Valle del Cauca, Colombia, con la visión de integrar en el mediano plazo otras organizaciones campesinas e indígenas para que circulen sus productos de origen a través de este canal de comercialización solidario. Al mismo tiempo, el proyecto genera impacto académico con la oferta de espacios curriculares, como trabajos de grado e investigaciones que continúen desarrollándose alrededor de los ejes articuladores siguientes: consumo responsable, economía solidaria y comercio justo en la perspectiva del fortalecimiento de relaciones culturales campo-ciudad.

2. Requerimientos de diseño

El proyecto *Garittea del campo al campus,* tuvo hacia 2014 su primera intervención por parte de estudiantes de la Carrera de Diseño de Comunicación Visual de la Pontificia Universidad Javeriana Cali, y la necesidad se centró principalmente en la definición de un nombre (*naming*) y el desarrollo de un logotipo que identificara esta iniciativa de trabajo ya que hasta mediados de 2014 ésta era conocida como *el proyecto del café*, y no evidenciaba las particularidades y valores de un planteamiento de estas características. Lo anterior se enmarcó en la necesidad de lograr un nivel de identificación del proyecto dentro de la comunidad académica de la Universidad, así como dentro de las comunidades campesinas, las ONG vinculadas a esta iniciativa y el público objetivo al cual se quería llegar en el futuro.

A partir de ello, se inició un proceso de formulación de estrategias de identificación que fuera de la mano con los criterios fundamentales del proyecto con el objetivo de comunicar (poner en común) una propuesta de trabajo colaborativo y participativo con criterios de sostenibilidad, justicia, economía solidaria, autonomía, naturaleza, diálogo de saberes, respeto al medio ambiente, comunidad, entre otros. De esta manera, los diseñadores en formación pusieron en juego sus competencias profesionales, las cuales, se asumieron desde el conocimiento y las capacidades enmarcadas en un saber hacer, un saber analizar, un saber actuar y un saber decidir en contexto.

El ejercicio se llevó a cabo inicialmente en la clase de *Diseño de Comunicación Visual*, aunque posteriormente participaron otras asignaturas, como *Identidad de la Marca en los Empaques*. Se partió de la estructuración de un brief que sirviera para conocer y estudiar todos los componentes iniciales necesarios para llevar a cabo el proyecto de diseño, tomando como base la definición de los siguientes puntos a partir de la metodología propuesta por Phillips (2004):

a. Descripción general del proyecto
b. Objetivos del proyecto
c. Campo de intervención
d. Contexto y antecedentes
e. Audiencia objetivo
f. Requerimientos de diseño
g. Alcance de la propuesta
h. Entregables

Antes de abordar la definición del brief, los estudiantes iniciaron sus indagaciones sobre el proyecto del café estudiando las cuatro dimensiones de la identificación institucional: *Realidad*, *Comunicación*, *Identidad* e *Imagen* (Chaves, 2001). El objetivo se centró en el conocimiento a detalle de las características y componentes básicos que defieran el proyecto, en el cual se pudieran observar las dimensiones de este ente social cuya representación manifiesta el discurso de identidad de un sujeto diseñado.

Al aproximarse a la ***Realidad*** del proyecto (conjunto de rasgos y condiciones objetivas del ente social), se intentó dar respuesta a la pregunta *quién es el ente social*. Allí se estudiaron la modalidad organizativa del proyecto del café*,* su historia, su definición jurídica, sus componentes administrativos, su infraestructura de funcionamiento, entre otras. Los hallazgos permitieron observar un proyecto con una tendencia evolutiva, en el que se configuró un proceso en su dimensión operativa y en sus objetivos de trabajo a futuro.

Posteriormente se analizó la ***Identidad*** del proyecto*,* la cual está determinada como un fenómeno de la conciencia en respuesta a la pregunta de quién quiere ser el ente social. Este aspecto asumido como una forma de autorepresentación, se manifiesta por medio del conjunto de atributos asumidos como propios por el proyecto del café donde se hace evidente la filosofía del proyecto, sus principios de personalidad, sus ideales y sus valores como sujeto social.

A continuación, los estudiantes realizaron un estudio sobre la ***Comunicación***, dimensión semiótica del proyecto (conjunto de mensajes efectivamente emitidos de manera consciente e inconsciente por parte del ente social). Allí, se analizaron los tipos de mensajes que el proyecto del café debe emitir con el fin de dar respuesta a las necesidades de comunicación de un proyecto de estas características (qué se quiere decir fue la pregunta orientadora). A partir de lo anterior, los estudiantes pensaron en los discursos a presentar, los medios a utilizar, así como en las múltiples audiencias que el proyecto debía considerar en la construcción de su identidad corporativa.

Finalmente, se trabajó en la ***Imagen***, última dimensión dentro del esquema propuesto por Chaves (2001) en la construcción del registro público de los atributos identificatorios del proyecto del café*.* Así, se determinó la lectura y la interpretación que de ella hace la audiencia de modo intencional o espontáneo. Este punto definió lo que los diseñadores desean dejar en la mente del público objetivo del proyecto, aspecto vital y esencia en todo proyecto de identidad visual corporativa.

Teniendo como fundamento principal la información recopilada y construida sobre los cuatro dimensiones anteriores, se dio inicio al trabajo de construcción del brief, en el que fue esencial la participación de todos los actores del proyecto del café (comunidades de caficultores, ONG y academia). Las particularidades de cada una de las partes integrantes de este proyecto, se hicieron evidentes en las reuniones de trabajo del proyecto, expresando la manera en como cada grupo interpretaba las necesidades que debía dar respuesta el ejercicio de diseño. Los campesinos manifestaron su interés para que el proyecto de identidad corporativa acogiera el saber tradicional campesino, sus expresiones cotidianas, la riqueza natural de su entorno y diera cuenta además del proceso de producción del café. Por su parte, el Instituto Mayor Campesino abogó por un discurso de identidad que tuviera fortaleza desde el punto de vista comercial, sin dejar a un lado la representación del trabajo comunitario que caracteriza a esta iniciativa*.* La Universidad, manifestó su interés para que el proyecto diera cuenta del diálogo de saberes, así como de los múltiples públicos objetivos que se verían involucrados en una iniciativa como ésta.

Los objetivos del proyecto de diseño se enmarcaron en una primera fase, en la articulación de un nombre para esta experiencia de trabajo, bajo los requerimientos anotados anteriormente. Posteriormente, se debía desarrollar un logotipo que representara la diversidad y multiplicidad del proyecto del café, bajo criterios de recordación, claridad, legibilidad, autenticidad y versatilidad en su aplicación. De esta manera, la propuesta debía ser de fácil implementación en múltiples soportes, sustratos, tamaños y plataformas, ya fuera impresa o digital, ya que el proyecto implicaba múltiples necesidades comunicativas de acuerdo a sus intereses de proyección social y comercialización.

En lo atinente al campo de la intervención, la tarea a desarrollar se centró en el diseño de identidad corporativa, ya que el ejercicio en una primera fase se enmarcaría principalmente en este campo, aunque después se integraron otras áreas como envase y etiquetado, diseño publicitario, diseño de interacción, diseño de producto y diseño editorial, entre otros.

Posteriormente, se analizaron las características contextuales del proyecto con el fin de establecer de manera muy precisa el escenario de acción donde se llevaría a cabo el ejercicio. Se estudiaron en detalle las particularidades de cada una de las partes involucradas en el proyecto del café, sus principales características, sus aportes y nivel de participación en esta iniciativa, aspectos tratados con amplitud en el punto “La experiencia: actores y tensiones”.

Los estudiantes en este proceso de briefing realizaron un estudio detallado de referentes y proyectos similares, tanto a nivel nacional como internacional, construyendo un Benchmarking muy completo que sirvió para identificar fortalezas, debilidades y oportunidades de diseño que pudieran ser tenidas en cuenta al momento de llevar a cabo la intervención.

Uno de los aspectos fundamentales en el desarrollo del brief, fue el referido a la audiencia a la cual iría dirigida la propuesta. Este proyecto, al ser una iniciativa que se configurará y materializará a través de una cafetería en el campus universitario de la Pontificia Universidad Javeriana Cali, involucra a diversos públicos que circulan día a día por ella. Este punto pone en evidencia la diversidad de personas que deben ser tenidas en cuenta para el desarrollo del diseño de identidad para el proyecto del café, siendo éste uno de los mayores retos para la definición de requerimientos alrededor del *naming* y el posterior ejercicio de logotipia, así como de arquitectura de marca por parte de los estudiantes.

3. Modelo de encuentro de trabajo colaborativo y participativo para la creación de la identidad de Garittea.

En términos del sustento epistemológico del proyecto, destacan tres premisas fundamentales: la visión de trabajo en entornos colaborativos y principios de diseño participativo bajo un enfoque sistémico. Roncancio (2011) afirma que “un entorno colaborativo universidad – empresa es no sólo deseable sino una estrategia prometedora para promover el desarrollo humano, ambiental, económico y social para facilitar el desarrollo científico y la innovación y, especialmente, para asegurar mínimos de convivencia y cohesión social” (pág. 304). En términos de *Garittea*, en esta fase del proyecto se definieron los actores implicados y sus roles a través de una triada de participación, en la que cada uno de ellos aportó un valor significativo para el crecimiento y desarrollo del proyecto. La Universidad mediante el equipo de I+D+i (gestores y profesores) y los diseñadores (los estudiantes); y por su parte la organización con su *know-how* y una constante comunicación en torno a saberes necesarios para la creación de la identidad.

Fig. 1 Triada de trabajo colaborativo para la creación de la marca Garittea (Fuente: elaboración propia)

La perspectiva del trabajo en entornos colaborativos se basa en la propuesta de Leydesdorff (2000) y (Etzkowitz & Leydesdorff, 2000). La primera hélice de la triada reflejada en *la empresa/organización* (socios de Garittea), está conformada por la asociación de pequeños Agricultores de la Marina –ASOPECAM-, la Asociación de Caficultores Orgánicos de Colombia –ACOC- y el Instituto Mayor Campesino –IMCA-, los cuales han aportado el *know–how* y la experiencia en detalle en cuanto a sus procesos y el desarrollo de nuevos productos. Su figura como demandante del servicio en la creación de la identidad organizacional ha sido clave en la formulación del briefing y los requerimientos de diseño.

La segunda hélice estructurada por un equipo de I+D+i (profesores y gestores), todos pertenecientes a la Pontificia Universidad Javeriana Cali, los cuales y según la definición de Etzkowitz & Leydesdorff (2000), han sido puente creador del conocimiento con un papel estratégico fundamental para generar la relación de la empresa con el diseño, articulando el conocimiento de las personas involucradas y sus relaciones, apoyando la innovación en los procesos de creación de valor, e incorporando al propio tiempo sus metodologías y herramientas bajo un enfoque multidisciplinar. Saberes como el mercadeo, la ingeniería, la economía, la psicología, la arquitectura y el diseño, han sido recogidos en modelos sistémicos de formulación por objetivos para apoyar los procesos creativos y la gestión del diseño (de la información y el conocimiento, de responsabilidades y desarrollo de las actividades en el proceso).

Por último, la tercera hélice está representada en los diseñadores (estudiantes), de varias carreras de la Pontifica Universidad Javeriana Cali, aportando insumos conceptuales clave para un resultado obtenido, incluyendo los aspectos normativos y legislativos inherentes a los productos de la marca.

En términos del diseño participativo, destacan tres cualidades esenciales señaladas por autores como Kang *et. al*. (2015), relacionadas con la inclusión de los actores involucrados en todas las fases del proceso, el fomento del sentido de pertenencia y el *prototipado cooperativo*.

Los beneficios de este ejercicio participativo y colaborativo para la universidad se ven representados en la generación de conocimiento que luego podrá ser trasmitido a generaciones siguientes de actores bajo unas estructuras dinámicas que centran el proceso en las personas.

4. Modelo sistémico de formulación por objetivos como herramienta para la creación y gestión de la Identidad de la marca Garittea

La compleja participación de los actores de Garittea en el proyecto de creación de identidad, requirió de un modelo para organizar y gestionar la información, variables y requerimientos, de tal forma que se pudiesen además evidenciar y trazar las rutas de toma de decisiones a través del proceso. Para ello se recurrió al modelo *"IdThink"* desarrollado por Demarchi *et al*. (2014), que se centra en la gestión del conocimiento inherente a los productos, servicios y procesos de las organizaciones. El *"IdThink"* a su vez, se asienta en el modelo sistémico de formulación por objetivos propuesto por Hernandis (1999). Se trabajaron los dos componentes marco del modelo: sistema de estudio (del modelo de producto) y sistema exterior, con sus respectivas variables de entrada y salida. El análisis del sistema exterior se llevó a cabo bajo el enfoque propuesto por Rosales, E. *et al*. (2015), a través de un mirador conceptual y seis componentes clave: la empresa/organización, conocer el contexto (análisis DAFO), conocer las personas, la competencia-referentes, explorando conceptos (perfil del consumidor ideal), benchmarking interno-externo y un panel semántico conceptual (moodboard). Este enfoque permite la externalización del conocimiento, y posteriormente hacerlo explícito, para favorecer el planteamiento y la formulación de los objetivos en el sistema de estudio.

Volviendo permanentemente sobre esta información, se permite el análisis, la descripción y la resolución de problemas, a los fines de realizar posteriores correcciones a desviaciones en la gestión del diseño. De igual forma, se facilitan los procesos de iteración y de validación durante las diferentes fases de *prototipado cooperativo*.

En el caso de Garittea, el primer paso fue determinar entre todos los actores, las claves asociadas a la creación de la identidad de una marca que permitiera mostrar la consolidación de un proyecto humano, honesto, justo, orgánico y solidario. Para los productores de café del Valle de Cauca el principal desafío que la marca debía transmitir, era el de darle valor a las riquezas que poseen en lo agroecológico y en lo cultural, además de hacer reconocimiento a la necesidad de fortalecer la cadena productiva, de manera que se pudiera llegar al consumidor final, aportando a su educación a través de la valoración del consumo de productos agroecológicos y la apreciación de la calidad del café producido bajo este modelo.

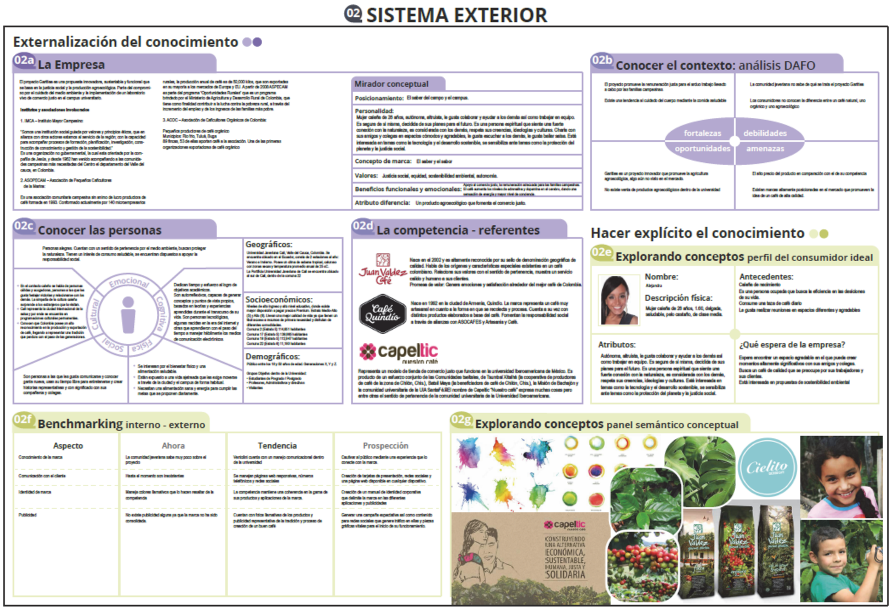

Fig 2: Análisis del sistema exterior proyecto Garittea.

En el primer componente del modelo, el sistema exterior fig 2, se recogió toda la información que afectaría al sistema de producto y en el caso de *Garittea*, toda la información necesaria para tomar decisiones en la creación de su identidad, los puntos fuertes que debían ser investigados así como los datos pertinentes para la empresa desde el mirador conceptual: posicionamiento, personalidad, concepto de marca, valores, beneficios funcionales y emocionales y atributos diferenciales. Se estudiaron igualmente la competencia y los referentes, incluyendo sus estrategias e identidad visual (imagen, tipografía, color y forma). Por otra parte, se estudió al usuario/consumidor desde un análisis de los factores humanos a través de las cinco dimensiones propuesta de Kumar (2013) y se analizó el contexto a través de un análisis DAFO. Por último se recurrió a un explorador de conceptos a través de un panel semántico conceptual que se emplea para descubrir asociaciones y percepciones construidas por los actores participantes del proyecto, a través de un moodboard de imágenes propias para inspirarse y dar personalidad al proceso creativo.

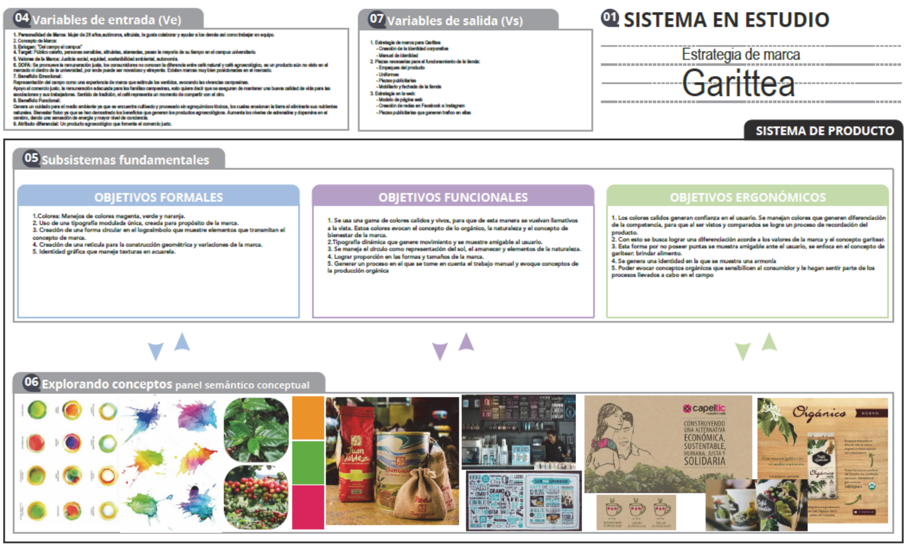

Fig 3: Análisis del sistema de producto proyecto Garittea.

En el segundo componente del modelo y con apoyo del ejercicio realizado en el sistema exterior, se realizó el análisis del sistema de estudio y del sistema de producto, en el que se establecieron las variables de entrada y de salida. Se volvió sobre el panel semántico conceptual y se definieron los objetivos *formales*, *funcionales* y *ergonómicos* de acuerdo a los criterios de Hernandis (1999) y Rosales *et al.* (2015). Los objetivos formales están relacionados con la satisfacción de los requerimientos estéticos de un producto (semiótica, forma, colores, texturas, tendencia, acabados, armonía, originalidad), los objetivos funcionales están asociados con proporcionar al producto la tecnología, adaptabilidad, transformación, conservación, uso, co-creación/configuración, y por su parte, los objetivos ergonómicos, se ocupan de la adecuación de los aspectos formales y funcionales al usuario (antropometría, percepción visual, aspectos cognitivos, afectivos y conductuales). Ver fig 3.

Como resultado de este proceso de creación fue una marca que refleja los valores, beneficios, misión y visión de la organización; su tipografía, simbolo visual, colores, slogan y el sistema gráfico rememora la labor diaria de las familias campesinas, el bienestar humano y la frescura de los rostros trabajadores, usando este último como elemento en el lenguaje gráfico de la marca. Para el distintivo el concepto manejado fue la agroecología evocando lo orgánico reflejado en una tipografía única e irreproducible (logotipo) y exaltando en el isotipo el propio nombre “garitear” que significa transportar alimento a la plantación para los recolectores de café. Ver fig 4.

Fig 4. Diseño de la Identidad Visual de Garittea.

5. Algunas reflexiones para seguir abordando

El desarrollo de un proyecto con las características que hemos enunciado, nos ubica en diferentes lugares que es necesario abordar desde la formación de diseñadores y profesionales en general. No queremos dejar pasar este ejercicio reflexivo sin compartir algunas ideas que nos han suscitado el encuentro e intercambio entre académicos, comunidades campesinas y funcionarios de una ONG.

» El acto productivo del diseño implica la creación de nuevos actores, en tanto se hace obligatoria la lectura crítica del contexto que ayude a orientar la propuesta creativa y a capturar el sentido de lo no dicho, de lo profundo, de lo fundante. Surgen algunos interrogantes: ¿Cómo lograr esta perspectiva sociocultural y política en la formación de los profesionales y superar la mediación instrumental que lleva a la materialización de la demanda del cliente?, en esa lógica globalizada del cliente tiene la razón.

» El lugar del usuario o consumidor. ¿Cómo lograr una interacción continua con el usuario para garantizar dinamismo y pertinencia en la creación de la marca? Esta y otras preguntas similares nos llevan a plantearnos la forma de cristalizar la promesa de valor del producto, seguramente la definición de la experiencia de marca exige una interacción permanente con el usuario, el consumidor final.

» Entonces, se requiere diseñar estrategias que sean flexibles, que logren capturar la identidad de la marca como una constante de sentido, pero al mismo tiempo introduzcan elementos nuevos, frescos, que den cuenta de ese mundo circular en interdependencia que obedece a lo rural. Aquí el uso del espacio, sus formas de habitarlo, hacerlo propio tiene una connotación claramente articulada a la marca, a Garittea, donde el campo, la vida silvestre llega al campus universitario, a la ciudad.

» La creación de la identidad de marca corresponde a concretar lo intangible, aquello que se fundamenta en los valores de la propuesta de negocio , de ahí que el valor del trabajo interdisciplinario y el intercambio de perspectivas y saberes se convierte en un detonador de colores, imágenes, formas y trazos, que logran dar cuenta del encuentro humano y territorial.

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Emotional Branding: emotions and feelings aroused by the design of the olfactory experience of consumption according to the ecosystem approach to communication.

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Abstract

This article discusses the recognition of semiotics experience and olfactory experienced by consumers in FARM brand's physical store environment, so that it can be achieved the goal of conceptualizing the consumer olfactory design experience within the environment aroma of the brand from the semiotic point of view and the ecosystem approach to communication. In this sense, the theoretical background involves studying and researching of languages, representations and aesthetic communication from an ecosystem perspective, according to authors Monteiro (2011) and Pereira (2012), Peirce's semiotics and the semiotics of culture, theory the affordances Gibson (1979) and Morin's complex thought (2008). The developed research is qualitative, empirical and exploratory nature, it has having been used in its methodology techniques by Moraes and Mont'Alvão (2010) as a basis for modeling FARM brand's communication ecosystem, as well as systematic observation Gil (2010) to collect data on the environment selected as analysis system target. The development of the research took place in the physical store of FARM brand, located in Shopping Manauara, placed in Manaus city, within the Graduate Program in Communication Sciences - PPGCCOM, from Federal University of Amazonas - UFAM. The main results can be mentioned the presentation of communication complexity of the brand studied through systematic analysis of their contact points and the subsequent location of the physical store environment and the aroma within this ecosystem, so that they can understand the process of management of intangible presence in the consumer experience organized with the aim and achieve the emotional and sensory consumer's memory.

Keywords: Communicative ecosystems, Emotional Branding, Olfactory Experience, Semiotics Experience.

1. Introducion

This article presents partial results of a research that aims to investigate the use of flavorings in physical stores and its relationship with the consumer experience presented by FARM brand and experienced by consumers. This strategy, which has been increasingly adopted by the market, is part of the work of the emotional branding, which aims to manage to touch points of a brand aimed at the communication of their identity to the consumer, arousing sensations and positive emotions leading to loyalty.

The adoption of this type of communication approach by brands was established as the traditional media such as advertisings and billboards have become cold elements that can no longer connect with the public. To meet the new needs of this group, companies had to propose to go beyond the production of goods, also producing pleasure, desires, emotions and new loves.

In order to communicate this new humanized, dynamic and emotional profile, you need to subtly achieve the perception of each individual and one of the means found to achieve the production of these intangible assets was adding to brand communication strategies that encourage all the sensory system of individuals. When entering the physical store of a brand, the consumer is not achieved only with low prices and quality, but also with colors, aromas, textures and flavors that communicate the brand style and invite you to let yourself be seduced by this world.

It is this complexity that arises behind the use of a flavored environment which this article aims to explore, as well as the feelings and emotions that technical and programmed process aims to awaken in individuals who participate in this interaction. Therefore, it has aimed to conceptualize the design of semiotics experience and consumer touchable with the brand environment of aroma from the semiotic point of view and the ecosystem approach to communication. Therefore, we will take the process of emotional branding as a communicational complex and hierarchical phenomenon, composed of various organized systems to work semiosis brand (sign) with your consumers (interpretant), and where the design appears as intangible manager and as a model agent of the brand identity.

Thus, it can be said that the problem addressed in this article is if the flavoring used by emotional traits in their physical stores, as a potentiator of the consumer experience, can be seen as a sign of its participant communication ecosystem. In order to find ways to understand the various layers in which this scent is involved, this project will take as object of study the Brazilian brand FARM and the environment of its physical store, located in the city of Manaus.

2. The brand according to the semiotic point of view and the ecosystem approach to communication.

For Charles S. Pierce, a sign is "anything that leads to something else (its interpretant) to refer to an object to which itself refers (its object) in the same way", which turns out to check the this imperfect and incomplete condition, being unable to be the object itself because of its representation of condition. (PIERCE, 2012, p. 74)

According to Lucy Niemeyer (2007), it is important to pay attention to the character of representation of signs, as well as to the fact of this being present, being in the place of something without being something itself. For the author, they are such features that allow the sign to assume mediation between a missing object and an interpreter who is present. It is from these characteristics of the sign that FARM brand will be understood, chosen as case study of this research.

According to Joan Costa (2011), a brand is a sign composed of smaller signs, organized in favor of a form of a containing picture a message to people with certain behavioral profiles. There is thus a semiotic system, composed of linguistic signs (brand name) and visual (symbol, colors, shapes, lines, icons).

According to Clotilde Perez, "brand is a symbolic connection between an organization, an offer and the world's consumption." (Perez, 2004, p. 10). Thus, it is understood that brand is mediation device, which establishes a relationship between the production system of a company and the consumer system through the production of meaning of their smaller signs, the management process that fits the design.

It is clear, therefore, the existence of different systems and processes of meaning that mediation established between the brand and the consumer. It is to understand this complexity that seeks aid in the ecosystem perspective of communication, which according to Pereira (2012), has to do with a new way of looking at communicative practices. Rather than isolating and simplifying the phenomena, the proposal challenges the researcher to seek an understanding of its objects that takes into account the complexity of the system of human and environmental relationships in which it is inserted.

Another important concept to understanding the studied brand semiotic communication process is the semiosis, which according to Irene Machado (2008), is the time where there is the transformation of information into a sign, and the generation and circulation of meaning, the construction of meaning fields and the creation of answerability circuits.

For Lopes and Pereira (2014), semiosis also helps understanding the communicational ecosystems by giving value to the movement that allows sign systems to establish a relationship. According to the authors, "semiosis is a process that involves cooperation between signs, which enables us to talk about the relationship and interaction between these signs in growth processes." (LOPES E PEREIRA, 2014, p. 154)

Returning to the effects caused by the sign, Niemeyer (2007) Santaella (2012) affirm that the nature of this effect is quite varied and may be a feeling, action or representation. For a long time, marketing, advertising, design and branding used the signs to lead the consumer to perform the purchase action, and despite the success for a long time, now, it was realized that the generation of feelings can be more beneficial, leading to a loyalty able to make the purchase action a routine.

Such sentimental loyalty has been explored and developed by various companies through two brand management processes called sensory branding and emotional branding, aimed at building a more emotional and sentimental relationship, and therefore less rational and impersonal, between the marks and consumers. Regarding the olfactory branding, this has received great support with quantitative research to ensure its efficiency. According to research carried out and presented by Lindstrom, "of all the senses, smell is by far the most persuasive" (LINDSTROM, p. 86, 2012). The author further states that, because of the visual and auditory stimuli to which we are subject, smell has become much more efficient with regards to capture memories.

However, despite its apparent effectiveness, only one olfactory branding action is not enough to cause the differentiation effect on the market, pursued by the brands that apply. You must create a rich system of consistent signs around the olfactory sign, so that it can stand out and fulfill its function through the relationship established with others. It is from this process, where the performance of design can be seen in most cases, you can achieve the construction of an identity through the consumption experience.

In this development process the consumer experience a brand aims to offer the desires and consumer wishes are taken into account at all stages. Therefore, there is the need to analyze not only the environment that is offered, as well as the effect of this on the perception of the individual to whom it is intended. The concept of *affordance*, developed by James J. Gibson is a strengthening of the idea that individual and the environment are interconnected and cannot be analyzed separately, defended by the author throughout the development of his theory of perception ecology.

For Gibson, *affordances* are everything the environment offers the perception of an animal can serve their objectives and needs of beneficial or malevolent way, so that "the possibilities of the environment and the way of life of the animals go together inseparably" (GIBSON, 1986, p. 15).

Gibson draws attention to the fact that, with the technological development of all areas of our society, the man began to modify the environment so that it is able to provide *affordances* to facilitate his experience (paving streets, under surfaces safer and more efficient, electricity, heating, etc.). Thus, the human being is surrounded by artificial environments, often built to suit specific purposes. (Gibson, 1986)

Santos (2012) uses the theory of *affordances* together with Lotman's modeling concept to address environment processing space as a result of the design of action. According to the author, you can see that, through its management action, the design develops environments composed of a series relationship between different languages.

As for Irene Machado (2010), the concept of modeling used by Lotman in his studies on the understanding of semiotics of culture, is the expansion of sign systems in interaction. According to the author, through its interconnected actions these systems transform the space into an information environment, signic and complex, ready to be realized, appropriate and modified by individual contact.

Returning to Santos (2012), it can be seen that the spaces chosen to use the shops has shown a lot of *affordances* increasingly specified, thus modeled according to the communication needs of each brand, becoming in a separate and unique atmosphere in which with regard to brand communication purposes, but can often result in unexpected effects such as discomfort and repulsion.

In short, what was intended by the gathering of these concepts is to create a conceptual field that enables understanding the dynamics present in these artificial environment and modeled through the ecosystem approach, for this is available to study the resulting communication complexity of the individual's interaction with the environment that presents itself.

3. Methodology: the way to get to the understanding of this phenomenon.

Aiming to apply theoretical concepts previously presented so to build a methodology capable of supporting the study of semiotics experience established between the consumer and the FARM brand, selected methods and techniques will be described below.

3.1. Systemic modeling of the brand and the location of the physical store environment as the analysis target system

According to Moraes and Mont'Alvão (2010), the use of models in the analysis of a system is so to facilitate the study and, although the authors use such models as a guide towards the display of machines, it is noted that the intention of recognizing the characteristics of a system through these models shown appropriate for understanding planned to be reached about the communication ecosystem of the studied brand. Thus, it was made use of hierarchical ordering model operating system (Figure 1), according to the authors, seeking to position the target system according to their inclusion in other hierarchically superior systems is explicit even those contained systems within this target system.

In an effort to adapt the hierarchical ordering model operating system to study the contact points that make up the communication ecosystem of the brand, it also became based on the model developed by

Delano Rodrigues (2013), where the points are expressed by contacting which can be used by a tag to communicate their identity and establish a communication process with the consumer, as can be seen in figure 2.

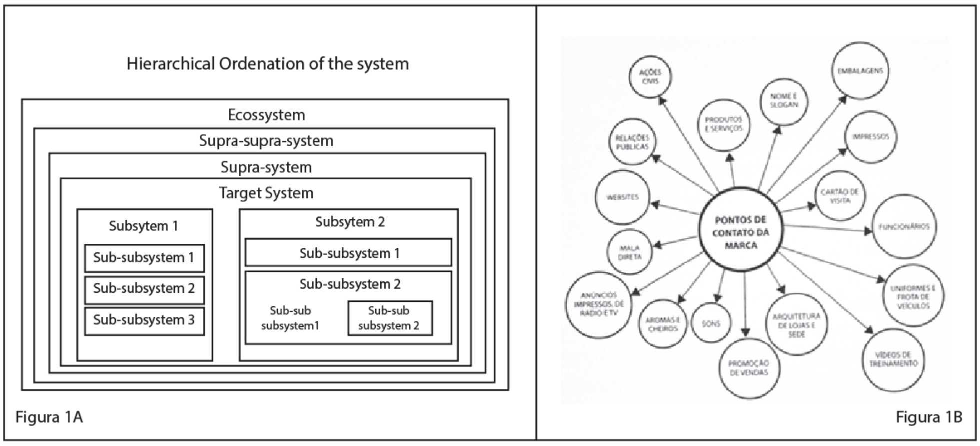

Fig. 1 1A - : hierarchical ordering model of operating system. Source: Moraes and Mont'Alvão 2010/

Fig. 1B Representation model of the contact points for communicating the identity of a brand. Source: Rodriges, (2013)

With the combination of these two models, was expected to enable a deeper approach on each of these contact points, from de Moraes and Mont'Alvão model (2010), will be seen as supra-systems and systems that make up the ecosystem communicational brand.

3.2. Semiotic analysis of the target system

To compose the semiotic methodology of the analysis, it was proceeded with a systematic observation, assisted by photographic record, of FARM's physical store environment that is located in Manauara Shopping, in Manaus, state of Amazonas. According to Marconi and Lakatos (2010), this technique is so to use the perception from the sensory system to obtain certain aspects of reality through the examination of the facts or phenomena under study. For systematization of the collected data, it elaborated a table that was made the record of the present signs in accordance with the sense that it affects the environment.

We will continue now with the presentation of the communication ecosystem of the studied brand, to further proceed with the presentation of semiotic analysis developed on the physical store environment. However, it was first made an explanation of the characteristics that led to the choice of the FARM brand as the case of study.

4. FARM's communication ecosystem and analysis of the physical store environment as a target system

FARM was chosen as a case of study of this research for several reasons. Mainly because their emotional and sensory positioning to the consumer as well as the fact that they find themselves installed in Manaus just over a year, which put it in the new position, and at that time the most desired brand among the female audience, young and city leader of opinion. However, there were still other factors indicating that this would be the best choice for the goals of the research, which will be discussed below, along with the presentation of the brand profile.

FARM was born in Rio de Janeiro and began selling its products in 1997 in Babylon Feira Hype, street fair where many other Brazilian brands came from. In the beginning, production was handmade with hand-painted fabrics and many colorful *bodies*, a characteristic that has become a differentiator in a period of fashion prized by the industrial and the cold and dark tones. With the growing success within the show, it was noted that the colorful, sensual and printed Brazilian style in the brand products had a strong appeal for consumers. Thus, production was once spontaneous and departed the personal desires of the designer, began to set the main objective of the brand: to portray the style of Rio's life. In proposing to adopt this Rio and Brazilian identity, both in its textile production, as the lifestyle that seeks to sell the brand to win the domestic market and also draw the attention of the international market.

Regarding the image search pf brand communication, we can start by saying that, as well as in Rio de Janeiro, there is no winter. Although the temperature drops, there is room for a light dress and a little skin showing. Its pieces value the use of natural and fresh fabrics with bright and colorful prints and details in a handmade way, which matches perfectly with the college girl that goes to school in the morning and later passes on the beach before returning home, dresses up and leave again to meet friends in the bohemian neighborhood of Lapa.

Currently, to provide this customer experience and strengthening its Carioca identity, Brazilian, natural and colorful, FARM makes use of various touching points, from the concept stores of architecture, to the attention to online sales service and the use of a unique aroma, which is the focus of this work and that was the main element of motivation for the development of this research with the inclusion of a case study. Next, we will present the systemic modeling that exposes the operation of each of the points of contact identified in the communication ecosystem FARM brand.

4.1. Systemic modeling the brand and the location of the scent application

As it can be seen in the developed representation model (Picture 4), it was identified that the communicational ecosystem FARM brand consists of the following supra-system: the social networks, the product, the sale, the packaging, the actions and the employee. Among these, there is the sales supra-system, which is composed of two smaller systems, the E-farm, wich regards to online sales, and the physical store, which regards to points of physical sale which are spread throughout Brazil.

The functions that were observed by the researcher in the studied ecosystem were to: communicate the brand identity (its values, aesthetics and lifestyle that it brings), popularize the brand (strengthening and communication of your image to the public) , loyal customer (offering a positive shopping experience and leading consumers to buy other times), sales (organization and implementation of sales and actions aimed at increasing the number of sales) and product selling (offering spaces for the marketing of products).

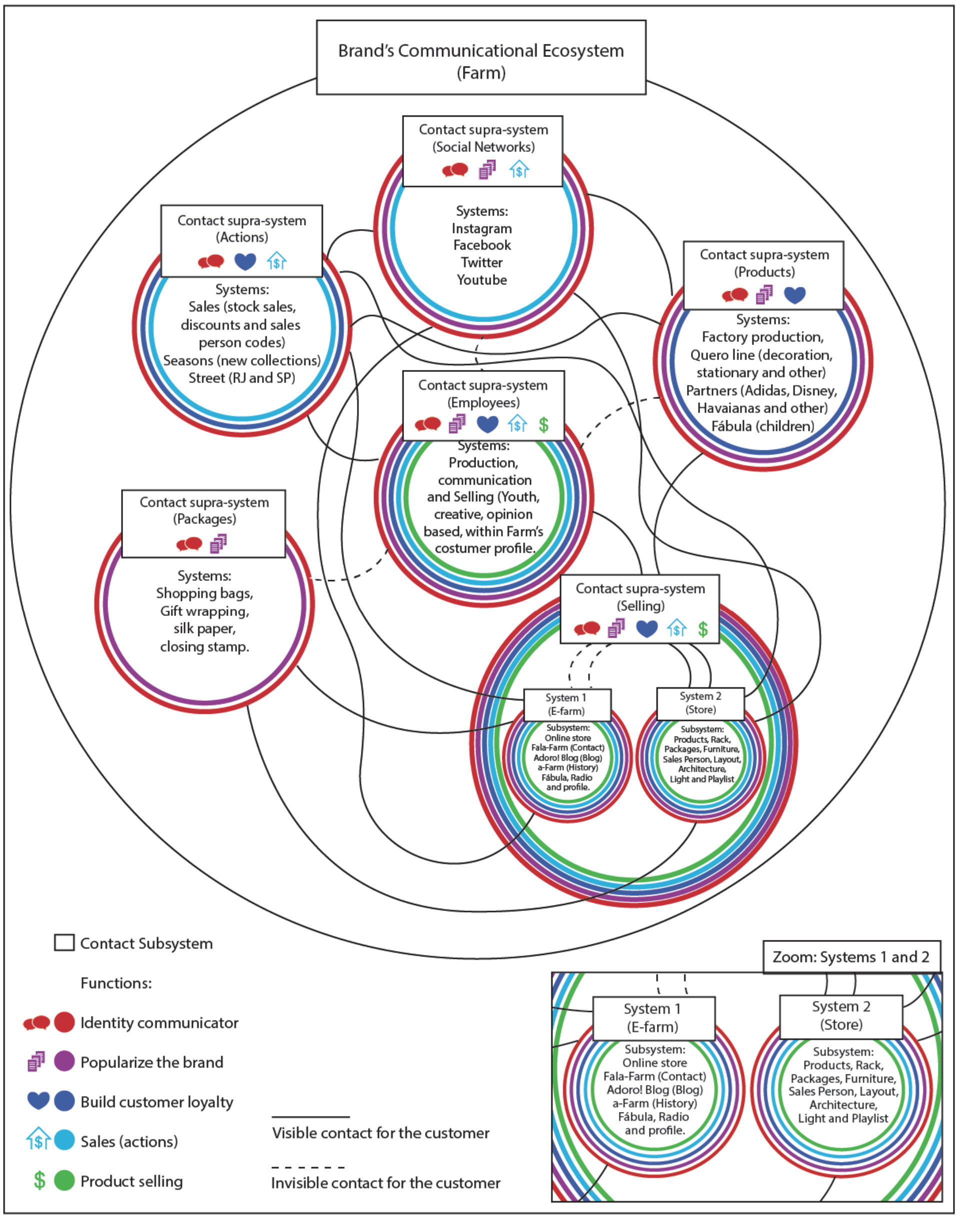

Fig. 2 FARM's ecosystem representation model communicational. Source: From the author's own production.

From the development of this model, it was possible to go into analysis of how the brand proceeds in each of these contact more systematic and objective way supra-systems. However, for this article, will only present the most important supra-systems to the understanding of the brand's performance mode, they are the products, employees and sales.

Starting with supra-systems contact product that meets the functions to communicate brand identity, popularize the brand and loyalty. It was also noted that its production is divided into products from the factory (clothing, footwear, accessories and lingerie), partnerships with other brands (Disney, Havaianas, Adidas, among others), the I-line (furniture, decoration, sports items, stationery, etc.) and Fábula (children's line).

These FARM's products, still in its beginning in Babylon Feira Hype, exerted a direct influence on the definition of identity that the brand would seek to convey in all its productive and commercial complex, so now is your strongest point of contact. The models and prints follow a standard aesthetic, strengthens the brand identity and serves as a basis for the development of activities of other points of contact. The use of signs that convey a style linked to nature as fish, flowers, fruits and animals typical of Brazil to reinforce the association of the brand with the carioca girl who loves to be close to nature. Thus, loose dresses and cotton gowns covered with embroidery and lace come to further strengthen the artisanal and natural image, as well as accessories that use wood, bone, rope and leather.

Regarding partnerships that FARM incorporated into its production over the years, there is the use of *Zé Carioca*, a Disney character, Havaianas are sold in the shop and on the site, and the international partnership established with sporting goods Adidas brand. Taking for example the case of Disney, it is interesting to note the exclusive use of the character *Zé Carioca*, a Brazilian parrot created by Disney in 1940 as a picture of Rio trickster, as an appeal childhood memory of consumers who had contact with the comic book character. This effort to occupy the daily life of his audience was already being contemplated by its line of furniture, stationery, decoration and sundries, called Quero. Along these lines, FARM print your prints on cushions, chairs, notebooks, mobile phone cases and even surfboards, skate and bike.

I emphasize, finally, sensory contact process that is through the brand's products. Attention should be paid to the fact that the materials described above can bring own peculiarities. The cotton fabrics such as rayon, and linen, have a more natural texture, which absorbs the touch and imparts a greater comfort than other synthetics. The same goes with leather and wood used. The colors of the prints also behave differently in each material, which stimulates the consumer point of view to make it recognize that certain style of stamping combined with a certain type of tissue, likely belonging to the FARM. Finally, you can also notice these olfactory stimuli in each piece of clothing sold by the brand. By applying this flavor in their products, even after leaving the store, or without even having gone there to shop, as in virtual consumer experience, the consumer is informed by the aroma that is applied to the piece, that the product really belongs to FARM.

Moving on to the analysis of supra-systems to one that involves the employees hired by the brand, it must meet the functions of communicating identity, popularize the brand image, build customer loyalty, promote increase in sales number to inform the customer of the ongoing actions, as well to sell the products. The constituents of these supra-systems systems are the production, communication and sale, the latter being engaged in consumer experience developed by the brand at the point of selling.

As specified in the representation of the communication ecosystem of the brand model, hiring its team prioritizes young people who fit the profile of consumption objectified by FARM, with fashion knowledge, design, architecture and self-respecting for comfort and a more natural style and alternative. Among the employees of the factory and communication, this approach creates a team that works with more motivation and pleasure to be producing something that really believe and identify. Regarding sales staff, the effect is similar: they have vendors that not only sell products but also use them inside and outside the workplace. This reveals that the sales team feel a desire to consume the items sold by brand similar to its consumers.

Another aspect to be noted in the saleswomen is an informal appearance, where the hair is always loose and natural, without the intervention of flat iron, brush or curling iron. The makeup is also little or no. Clothing and used as uniform shoes are the same as the collection is in progress, however, are not standardized and each seller chooses you prefer to use. Thus, it has been enhanced once again, the image of the girl who values the comfort and believes in its natural beauty, which ultimately creates an empathy between the consumer and the vendor during the time of consumption experience.

Finally, we have the sales supra-systems, which is composed of the E-farm systems, intended for online sales, and the Physical Stores, which takes the consumer experience and the primary contact with the scent used by the brand. Through these supra-systems caters to the functions to disclose the identity of the FARM, popularize their image with the public, customer loyalty, promote increase in sales and provide a space for the marketing of their products.

Regarding the E-farm system, this includes not only the subsystem's online store also subsystems a-Farm (History), adoro! (Blog), fala-Farm (a platform to send questions, suggestions, etc.), Radio and Fábula (Children's Line). It is noteworthy that the website design follows the same line of appeal to nature and handmade, so that we see the use of earth and warm tones such as beige and burnt brown, and embroidery and applied flowers pictures in the background.

Among the subsystems, I present adoro!, a blog maintained by the brand, which posts news of all kinds from programming tips for the weekend to interviews with Brazilian artists. In it there are also disclosed the actions promoted, launches and promotions planned for the coming days, also serving as registration platform all that the brand has done over the years. In this space, it is interesting to note how they are brought to the universe of the brand outside interests to the dynamics of consumption. Art, sport and music are placed with the intention to entertain, inform and add value to the brand image in its audience.

Regarding the system of physical store, this will be reviewed following further, so will reserve this space to introduce the objectives that the brand hopes to achieve through the consumption experience that has developed to the point of sale environment.

The environment of the physical store of a brand basic and primary objective is to offer the consumer a place to which he can go whenever you want to buy a particular product, a particular brand. Thus, the more a brand stores have, the more customers she will meet. However, currently, the success of a brand and the increase in sales also depends on the power of seduction that the space intended for consumption exerts on a given target audience. With this, the physical store should provide the consumer is a memorable consumer experience where it offers over the perception of these individuals is an environment to communicate and seduce to the lifestyle that the brand fold.

This system, as could be observed in other supra-systems also seek to promote an emotional and sensory appeal to the consumer. Textures, colors, patterns, sounds and unique aroma invite the body that there comes to get going the way and allow the brand to occupy a space in your memory. Thus, it is understood that more than a space intended for consumption, the environment of physical stores FARM brand provides well-being and pleasure to those who attend, either through the decoration, lighting, music or service, and the role of each of these subsystems selling point inside the consumer experience offered, which we will analyze below with the assistance of a semiotic methodology.

4.2. Target system analysis: physical store environment and modeling signs of the brand

From this moment on, we will start the target system semiotic analysis of this research: the environment of physical Store FARM brand. We will focus on the following point for the description of the main signs that operate in this environment modeling process, which aims to portray the brand identity and the lifestyle sold by it.

As is described in the model representation of the store environment (Picture 5), systematic observation was observed that the consumer becomes stimulated by four of his five senses: smell, hearing, touch and sight. This takes place initially through the aroma that is applied to both the clothes and the environment as a whole.

Regarding the visual stimulus, this is what is done by the greater amount of signs, beginning with the facade, where the visual identity and the adhesive with a standard that refers to a braided straw is-applied, and the organization of products on display. When entering the store, we have clothes, racks, mannequins, tables, benches and even an artificial tree.

Moving on to the signs for the auditory stimulus, which first caught the attention of the observer was standard playlist. However, from the second visit, it was noted that other sounds were also part of that environment, such as the speech of the sellers, the spontaneous conversations that leave both the consumers, as their own sales team and sounds from the drive the hangers on the metal structures of the racks.

Following to the stimulus exerted on the touch, as was observed by the researcher, this is mainly mediated by the textures of different fabrics used in the manufacture of clothing. Then it is noticed the textures of other natural materials, gifts in bags, shoes, accessories, hangers and shopping bag that is delivered to the consumer at the exit of the store.

Turning to complex functions that the environment includes through these stimuli, there is the mission of communicating the brand identity, given that this is the process that will be explored below, through the description of the meanings that these signs carry, which enable physical space that acts as a significant and surrounding environment.

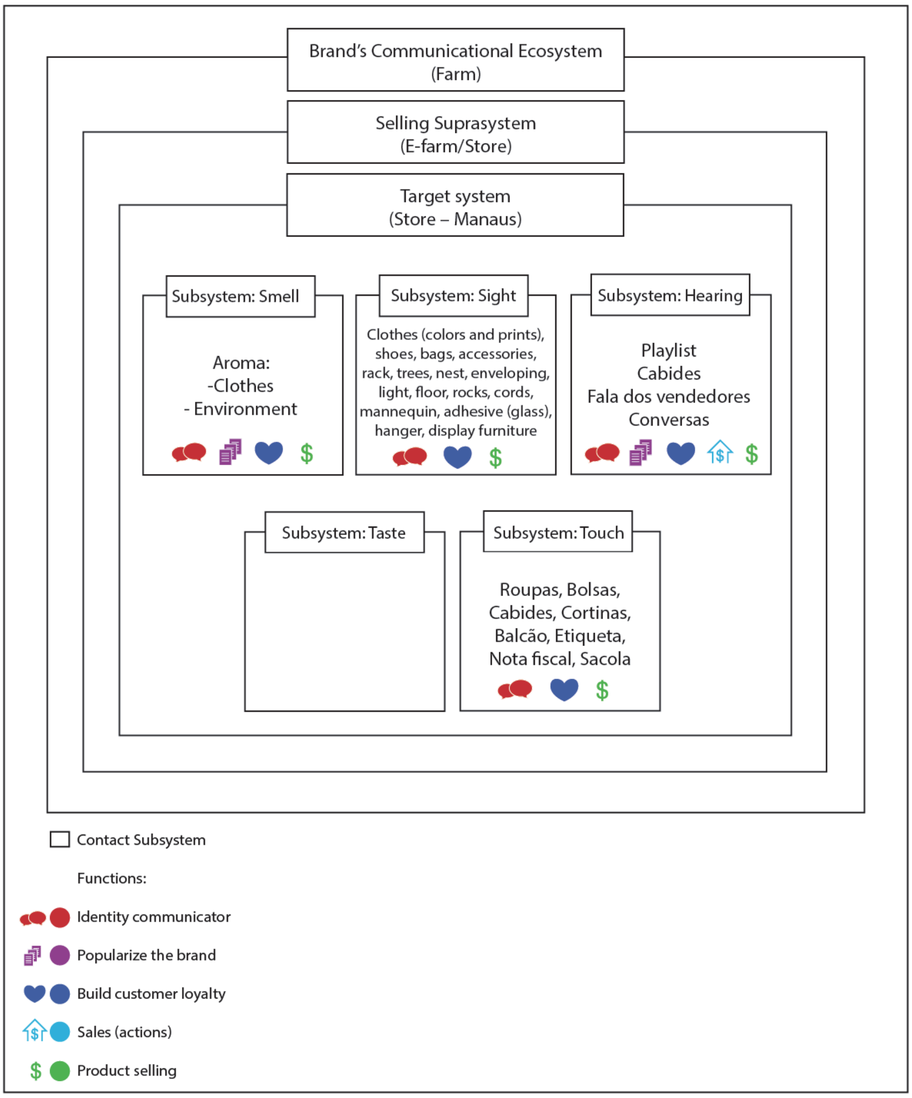

Fig. 3 Data representation model collected by systematic observation of FARM brand's store physical environment. Source: From the author's own production.

Moreover, now that the signs are already known are installed in the store environment, from this moment we will continue with the description of how this group of signs operates in the modeling of a significant environment, which is modeled by the identity and style life the FARM brand aims to communicate.

As discussed earlier, the FARM seeks to convey to the consumer, through the purchase experience, the summer feeling, beach, daylight, contact with nature and rest. Many other concepts could be related to carioca lifestyle that the brand sells, however, he followed up with them to make it possible to maintain certain objectivity. In Picture 6 we have a selection of some photographic records of signs that act on the consumers during consumer experience and will be analyzed below.

We will start the semiotic analysis of the photo 1 of the shop environment (Picture 6) of the front of the store, which highlight the adhesive applied on the glass, a sign that is twisted the straw chairs, which can also be observed at the background on photo 4. This braided, which initially was made with straw and therefore also carries the character of use of a natural material, in the 90s has become quite popular to be applied also on plastic materials, so it was common to find them both in homes and in work environments. Thus, it notes that this is configured as a sign that turns to the concept of "contact with nature" and also stirs the memory of the consumer to recover the memories of childhood carries.

Moving on to the signs recorded in photo 2 of Picture 6, in it we see the presence of two floor finishes, the laminated wood and concrete gravel, as well as a pair of shoes and a purse. Regarding the concrete gravel, it is understood that this sign search mean the concepts of "beach" and "contact with nature" and, by association, also end up meaning the concepts of "summer" and "rest". It is important to pay attention to the fact that this relationship with nature only established because, when presenting in association with wood floors, concrete gravel out of industrial conceptual field to act creating the sand idea of the beach, stone waterfall and mountain views, garden and nature.

Following the analysis, on photos 3 of 6 is possible to verify the presence of several signs, among which highlight the adhesive applied on the wall of the mezzanine, with a green print sheets, the product displays furniture that resembles a tent fair and lighting design.

Starting with the adhesive, it is noted that this sign seeks to communicate the concept of "contact with nature", so that it reinforces the idea that nature is present in that environment. This idea is reinforced by the lighting project, which aims mainly to represent the concept of "daylight", but also reinforces the "contact with nature". Through photo 3 (Picture 6), you can see that the light sources attached to the iron structure lying on the shop ceiling were organized in different directions, with the intention of creating a more natural lighting and to imitate the spontaneity that the sunlight passes through the leaves of a tree, as you can see the reflection of the focus on the floor.

Regarding the furniture that seeks to mean the fair booth, we note that the intention in this case is to create an association between the store environment to the environment of the fairs where it is customary to find small entrepreneurs, differentiated products and small-scale of production. Redeems Thus, the shopping experience that occurred when the FARM was still a display of these fairs, through the idea that the exclusivity of yesteryear still exists. we should also pay attention to the fact that this type of furniture reinforces the concept of "rest" with a view to visiting these fairs is usually done on weekends and is seen as a time of leisure.

In photo number 4 of Picture 6, having already addressed the lighting project and the proposal of the adhesive applied on the glass, my description will focus on the action of the tree as a sign. This, which acts in the meaning of the concept of "contact with nature", as well as the adhesive described above, brings the feeling that nature is present in that environment, even by artificial means. Interestingly, the tree used is of no extraordinary realism, however, by allying with the other environmental signs, this sign is not enough to cause any estrangement by artificiality. This is mainly because the interest and judgment of the consumer not be returned to him but to the products displayed.

Reaching the mannequins description, registered in photo number 5 of Picture 6, it is interesting to note that, unlike light beige on mannequins we see in many stores, FARM's ones appear in a darker beige, as if sunburned, so as a girl who goes to the beach. Thus, it is understood that this sign has the function of communicating the concepts of "beach" and "summer" in the store environment through this different coloring, but also reinforces the connection of the brand with the Rio de Janeiro and with image one has of Rio's ever going to the beach and that is always with tanned body.

In photo number 6 (Picture 6), highlight the space record for parts that appears between the sequence of exposed clothing on the racks. In this case, highlight the shades applied to furniture. Always beiges and browns, furniture create a neutral space, which allows the color of the prints and the small details of each piece stand out. It is an opposition work and support: to bring elements with neutral colors and rustic materials, which is in the center of the consumer's attention is clothing, its color and the delicacy of applied details. Moreover, the characteristics of the materials used, such as concrete chippings, wood, rope and the green of tree and adhesives, reinforce concepts mark search bring themselves and not are applied to all the parts which produces and sells.

Finally, we bring in photos 7 and 8 (Picture 6) some records of the dressing room. This presents simple and functional, with white walls, large mirror, front light and hooks to hang clothes. The connection to the store environment and the brand is established only by the curtain fabric and the wooden cube, which serves to support the clothes or as a seat. The white and empty space act as a background that highlights the part of the qualities of the body of the consumer who tries it on.

Fig. 4: Data representation model collected through photographic record of FARM brand's store physical environment. Source: From the author's own production.

Regarding the action of sound and olfactory signs observed during the visits, note that you cannot make photographic record of both, therefore I can only describe what I observed and recorded through notes in a field diary.

Starting with the sound signs, as it was mentioned earlier, the playlist varies according to the collection. Between visits, it was displayed the collection focused on the new years' festivities and holidays, with many white pieces and fluoride, from the more formal and elegant for the night, to shorts, body stockings and casual tops, representing summer and the beach. Thus, what could be heard was Brazilian music, artists like Caetano, Gilberto Gil and Alceu Valenca. Although there were other less-known songs in the sequence of songs, it was noticed a clear link with the Brazilian northeast and the beach view and holiday.

Regarding other audible signs, from the second visit it was observed that these stimuli, such as speech of the attendants, the conversations among the other consumers who were in the store and the sound of hangers passing the racks, these have proved more spontaneous and less programmed than the playlist. These signs, it is interesting to note that although these sounds are the result of an interaction with the other signs, and are not as controlled by the process of systematization and standardization of consumer experience developed by the brand, they are extremely important for the process identification as a time of purchase.

Finally, to complete this analysis of the physical store of the studied brand environment, we will describe the action of the aroma as a sign. Starting with the question of visual and sonority of the scent: they do not exist. This is a sign that only acts on the sense of smell, and cannot be seen or heard. However, the main advantage of application of this sign is that it extrapolates the spatiality of the store, acting on the perception of the consumer still outside the store. Serving as a store near the flag, the aroma also has the task of seducing the consumer. Upon awakening the memories of other pleasant moments of consumption where the scent was involved, there is a mobilization of the purchase desire.

Just as the physical store environment must communicate the concepts of "beach", "summer", "daylight", "contact with nature" and "rest" and the brand seeks to portray the lifestyle of Rio's girl, the aromatic bouquet developed to synthesize these conceptual fields, to show up the other cohesive contact supra-systems. At this point, it is emphasized that the knowledge of notes, chords and aromatic bases limits the description of this smell by the researcher. However, general considerations can also be woven, particularly as regards the overall impression that the aroma passes and concepts that the brand seeks to add to your image.

In striking projection and woody notes, the scent developed to communicate the identity objectified by FARM remembers the smell of natural elements and earth, like weeds, wood and cotton, also resembling the smell of jeans. Thus, the aroma of FARM communicates ownership ratio and retraction of the aesthetic present in nature that it provides, particularly through its textile production.

It is important to pay attention to the fact that the aroma developed for the brand is unique and therefore has no prior association with another object. Although try to recognize the essences that make up its aromatic bouquet, this process is much more difficult. It's not like the smell of chocolate, lavender or talc, it is simply FARM’s scent. It is understood, therefore, that the other signs present in the store environment also act in the role to strengthen this association.

5. Recognition of FARM’s aroma and the emotions aroused in the consumer experience

Considering what was describe, it can be concluded that the research presented involves issues of difficult treatment and evidence, to involve an investigation into the aroused feelings and emotions a sign that accesses a sense of the human sensory system still little explored in relation to stimulation aimed to promote sales and customer loyalty. However, in this sense, the adoption of a semiotic methodology probed to be able to direct the search not for the quantitative effort and common evidence of classical science, but for a presentation of the phenomenon from the researcher's point of view, the result of their own semiotic experience with the brand of choice for study.

Regarding the adoption of the ecosystem approach of communication, defended and used by researchers of the Graduate Program in Communication Sciences - PPGCCOM, from Federal University of Amazonas - UFAM, this proves to be interesting for this research also by proposing to add knowledge several areas for greater completeness in understanding the object of study, which will allow the researcher to grasp concepts and techniques of the different areas. Another point is its connection with the theory of complexity, which aims to examine the relations between the different organizational systems.

It is also believed that the use of semiotics of culture as a basis for the analysis of these relations, made it possible to understand the complex hierarchy that is established in the system of a brand, where systems larger model the order of smaller systems to a communicational goal common is reached. At this point, the sign of concepts, semiosis, culture systems and modeling will serve as a guide to the understanding of the elements to be studied, and the results from the design of action in the management of intangibles that motivated the development of this research.

Finally, there is the need to proceed with an interview with the group of consumers that is achieved by the brand in Manaus, so that the recognition of the aroused feelings and emotions in the consumer as a result of semiosis of the sign-brand and sign-flavor can be better understood from the survey descriptions about the expected and unexpected facts that face a modeled reality which is the selling environment designed for the FARM brand.

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Termografia: ferramenta auxiliar na pesquisa de materiais e no design de produtos

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Resumo

Termografia é um procedimento de medição passiva e sem contato, que registra a distribuição de temperatura na superfície de um material, constituindo-se como um aporte para análises de condutividade térmica, além de contribuir para os estudos a respeito da percepção tátil. Este equipamento possibilita ao designer reunir recursos adicionais ao procedimento de mapeamento da relação de percepção, permitindo uma prospecção aprofundada e interior da matéria em estudo. O equipamento gera imagens a partir de um espectro de cores, exprimindo variações de temperatura, destacando detalhes que não são perceptíveis a olho nu e permitindo a visualização de áreas e variações de emissão de calor da superfície do objeto. Tais dados se tornam diferenciais e indutivos para o processo de projeto. Considerando a importância da termografia, este artigo direciona seus estudos para validar esse instrumento auxiliar de coleta de dados, que permite compreender a percepção a partir da interação do usuário com polímeros, identificando qualidades inerentes a cada tipo de material e indicando novas possibilidades e alternativas de uso. Plásticos ou polímeros não são em si uma entidade única de material, mas muitas categorias com qualidades e propriedades específicas, representando uma classe a parte entre as modalidades de materiais. Usuários utilizam-se da interação tátil para avaliar essas qualidades. Mapear essa interação por meio da termografia pode fornecer dados relevantes para designers no desenvolvimento de produtos. Para a coleta de dados foi utilizada a termo-câmera Flir Ex6 com detector de matriz de plano focal (FPA), microbolómetro não refrigerado, com gama espectral 7,5-13 µm. Para o corpo de amostras foram selecionados os polímeros: PP, PMMA, Poliestireno, PU, PVC expandido e rigido, PA e PC em tamanho de 80 x 80mm e espessuras variando entre 3 e 5mm. A variação de espessuras se deve ao padrão de mercado. Participaram do estudo 10 pessoas, homens e mulheres, de idades variadas, em amostra não estratificada. Pretendeu-se com o estudo confirmar a termografia como uma ferramenta auxiliar de investigação para melhor interpretação das variáveis térmicas dos polímeros e averiguar tanto a sensibilidade de contato como a condutividade de cada material e se o fator de condutividade térmica altera a percepção de suas qualidades pelos usuários.

Palavras-chaves: *termografia, termograma, percepção de materiais, design, polímeros.*

Abstract

Thermography is a passive and contactless measuring procedure, which registers the temperature distribution along the surface of a material, constituting as a standing to thermal conductivity analysis, as well as a contribution to studies of the tactile perception. This equipment enables the designer to gather additional resources to the mapping procedure concerning the relation of perception, allowing an in-depth and inner exploration of the studied material. The device generates images from a color spectrum, expressing variations in temperature, and highlighting details that are not visible to the naked eye, allowing also the viewing of heat areas and the variations of heat emission along the surface of the object. Such data become differential and inductive to the design process. Considering the importance of thermography, this article focuses its studies to validate this instrument of data collection, which allows us to understand the perception from the user's interaction with polymers, identifying qualities inherent in each type of material and indicating new possibilities and usage alternatives. Plastics or polymers are not in themselves a single material entity, but they comprise many categories with specific qualities and properties, representing a peculiar class among the modalities of materials. Users resort the tactile interaction to assess these qualities. The mapping of this interaction through thermography can provide relevant data to designers in the development of products. For data collection was used a thermal camera Flir EX6 with focal plane array detector (FPA) and uncooled microbolometer with spectral range from 7.5 to 13 micrometers. For body samples were selected polymers PP, PMMA, polystyrene, PU, PVC and expanded rigid, PA and PC in size of 80 x 80mm and thicknesses ranging between 3 and 5mm. The variation in thickness is due to the industry standard. The study included 10 people, men and women, of several ages, in not-stratified sample. With this study, it is intended to confirm the thermography as an assistant tool for research, for better interpretation of thermal variables of polymers, and to determine both: the contact sensitivity to the conductivity of each material, and if the thermal conductivity factor alters the perception of its qualities by users.

Keywords: *thermography, thermogram, perception of materials, design, polymers.*

1. Introdução

Devido à evolução dos processos de representação e de comunicação de resultados de projeto, torna-se necessário ampliar e incorporar diversas outras possibilidades tecnológicas, principalmente aquelas que carregam inovações para o processo de produção de objeto. Assim, a ferramenta termográfica possibilita ao designer reunir recursos adicionais aos procedimentos de mapeamento da relação de percepção, permitindo uma prospecção aprofundada e interior da matéria.

As aplicações da termografia em processos e procedimentos de projeto de produtos tem-se mostrado crescente em decorrência do "barateamento" da tecnologia empregada nas termocâmeras existentes no mercado. Em suas diversas aplicações, atualmente, intensificou-se sua aplicação na geração de informações a respeito do corpo humano; na interface de contato com os objetos por transferência de calor; na avaliação das propriedades de um material; para identificação de pontos de atrito a partir da geração de calor de cada material empregado no objeto; na avaliação de materiais a partir do interior dos produtos, onde é imprescindível a qualidade técnica de produção, objetivando sanar ou minimizar riscos.

Considerando a importância da termografia, este artigo direciona esforços para validar esse instrumento de coleta auxiliar de dados, que permite compreender a percepção a partir da interação e de estímulos do usuário com polímeros. Averiguando, assim, tanto a sensibilidade de contato, como a condutividade de cada material, além de determinar se o fator de condutividade térmica altera a percepção de qualidade do material pelos usuários. E, desse modo, através do processo de mapeamento, identificar qualidades inerentes a cada tipo de material e indicar novas possibilidades e alternativas de seu uso.

Neste sentido, a ferramenta apresenta-se como um recurso relevante para captação de dados térmicos, auxiliando na captura de dados, os quais poderão se tornar diferenciais e indutivos para o processo de projeto. É uma ferramenta de diagnóstico rápido, habilitado a gerar termogramas que auxiliam na interpretação de variáveis térmicas através de software específico. Constitui-se em um equipamento de verificação *in loco* do comportamento dos materiais, promovendo a detecção da condutividade térmica. Também, poderá auxiliar na análise da percepção tátil do usuário, identificando qualidades inerentes a cada tipo de material, além de indicar novas possibilidades e alternativas de aplicação, devido à composição de fabricação do polímero, que é modificado de fabricante para fabricante.

Essa ferramenta também gera informações a partir do contato e interação do corpo humano com os objetos, por meio do mapeamento das transferências de calor emanadas dessas relações. A termografia apresenta-se como ferramenta auxiliar em uma investigação que busque melhor interpretação das variáveis térmicas dos polímeros. Dessa maneira, busca averiguar tanto a sensibilidade de contato, como a condutividade de cada material e, se, esse fator de condutividade térmica altera a percepção de suas qualidades pelos usuários.

O objetivo do estudo é avaliar por meio do uso da termografia se o nível de transferência de calor realizada pelo usuário em interação com o material plástico, associado a produtos, compromete a percepção das qualidades do produto, interferindo no seu conforto e usabilidade. Propõe-se responder à questão central da pesquisa - como as mudanças térmicas, ocorridas a partir da interação do usuário com o material plástico, aplicado a produtos, podem afetar a percepção das qualidades do material?

2. Utilização do termograma em projetos de produto

A termografia é um procedimento de medição passivo e sem contato, que apresenta a distribuição de temperatura na superfície de um objeto. É uma ferramenta que se apresenta como aporte para análises de condutividade térmica e percepção tátil, dentre tantas possibilidades. Destacam-se as informações geradas a partir do contato e interação do corpo com o objeto, através do mapeamento da transferência de calor. Permite, assim, obter estudos criteriosos de materiais e dos acabamentos dos objetos, contribuindo, também, para os estudos a respeito da percepção das qualidades dos materiais na relação usuário-produto.

O objeto em estudo representa um espectro de cores que exprime variações de temperatura do material, detalhes imperceptíveis visualmente. Para os designers, esta ferramenta possibilita ampliar a visão perante os objetos e mapear a relação de percepção, permitindo, assim, uma prospecção mais aprofundada da matéria em estudo. O processo realizado pela ferramenta é constituído pela captura da radiação térmica infravermelha emitida pelo movimento vibratório das moléculas que compõem os materiais. Converte a energia do comprimento de onda infravermelha em imagens de luz visível, onde os objetos, acima do zero absoluto, emitem energia infravermelha térmica.

Desta forma, a criação da imagem térmica (termograma - em escala policromática, em escala monocromática, ou entre tantas outras possibilidades hoje presentes através do software de tratamento) proporciona, através de uma imagem gerada pela ferramenta, a visualização de áreas e variações de emissão de calor da superfície do objeto. Esta emissão de calor conhecida como emissividade ou poder emissivo, segundo Pereira (2013), é a capacidade de envio de energia por radiação da superfície, relação existente entre a energia irradiada por um corpo real em relação a um corpo negro (objeto ideal que absorve, em qualquer comprimento de onda, toda a radiação incidente sobre ele) sob a mesma temperatura.

As informações obtidas pelo termograma contribuem para uma melhor interpretação das variáveis térmicas dos materiais e ainda colaboram para verificar a sensibilidade de contato realizado. Ainda, o termograma permite a manipulação da imagem, executada por meio de softwares que geram diversas informações gráficas e dados para um mapeamento preciso. A compreensão da emissividade de polímeros é muito relevante para as pesquisas na área, devido à exatidão proporcionada pela captura dos termogramas, pois corpos com altas taxas de emissividade irradiam mais energia que aqueles com baixas taxas, sendo que a quantidade total de radiação depende de sua temperatura e de sua emissividade.

Assim, para este estudo, será necessário o cálculo preciso da emissividade de cada material utilizado na análise de cada amostra. Objetiva-se a construção de uma tabela com os dados de emissividade de cada material coletado, a fim de servir de orientação no ajuste da emissividade da termocâmera. Tal tabela, que será imprescindível, servirá ao processo de captura ao obter exatidão nas imagens térmicas. Desse modo, a criação de tal tabela faz-se necessário para futuros estudos, variando devido à composição de cada polímero.

Para que a termocâmera realize o cálculo da temperatura, outros fatores devem ser considerados, além da emissividade. Fatores que também influenciam na medição, como a transferência de calor, que é dividida em três principais modos - condução, convecção e radiação. Esses processos indicam o estado e a direção da energia transferida. A condutividade igualmente é outro fator de transferência de calor, por meio do qual ele é transferido de um corpo sólido ou pelo fluido em repouso.

Outros fatores atuantes são a reflexão do objeto e ascondições metereológicas durante a captura. Também, os sistemas de calefação e ventilação, sendo que outros aspectos fazem parte da linguagem fotográfica: a nitidez da imagem, a distância focal com relação ao objeto, medições de exposição correta, entre outros detalhes específicos que serão investigados em razão da utilização da termocâmera específica para a coleta de dados (SILVA; TARRALI E MELZ, 2015).

3. Percepção das qualidades do material plástico pelos usuários

Entender como pensam os indivíduos que utilizam objetos plásticos em seu contexto de uso e práticas é importante para compreender como se processa a experiência do usuário, sendo que essa compreensão pode se tornar fonte de possíveis inovações e melhorias na experiência com os produtos e materiais.

Os significados de materiais atribuídos pelos usuários, em um contexto particular, são consequência da interação entre usuário-produto e material. Os materiais de que são feitos os produtos afetam a atribuição de significados aos mesmos, conforme relatado por diversos estudiosos afetos a esse campo: Krippendorff e Butter (2007); Ashby e Johnson (2011); Schiffeirstein e Hekkert (2008); Karana e Hekkert (2010); Karana, 2010 (*apud* MIRA, 2015).

Os significados conferidos aos materiais pelos seus usuários só são compreensíveis quando da interação com produtos em sua vida diária. Esses significados podem ocorrer em contextos distintos, e variar entre diferentes indivíduos e culturas. Além disso, significados variam com o tempo e de acordo com a memória de experiências anteriores ou associações (GIBSON, *apud* HOCHBERG, 1994). Dependendo do contexto de uso, as funções práticas dos objetos podem conter mais de um significado e variar em diferentes contextos.

Durante o processo de interação, os indivíduos utilizam-se de todos os sentidos. Ficou evidenciado na pesquisa referenciada (MIRA, 2015) que a aparência estética, notada pelo usuário, cria a expectativa inicial, que leva a um segundo momento de avaliação - a interação táctil**.** Isto porque a estética de um produto trabalha criando a expectativa, os atributos visuais operam estimulando os sentidos da visão e emoção; ao passo que é por meio dos outros sentidos, principalmente o táctil, que o usuário avalia o material, experimenta produto e material e elabora seus significados. Logo, este nível de percepção é decisivo para a decisão do usuário.

A percepção estética dos materiais significa os atributos que relacionamos por meio dos sentidos – visão, tato, audição, olfato e paladar. "A estética desperta o interesse, estimula e atrai os sentidos; materiais plásticos podem ser tão macios ao toque quanto tecidos e resistentes como o metal, mas são quentes ao tato", na visão de Ashby e Johnson (2011). A estética é também entendida pelo usuário como sendo belo ou não; pode ser a aparência da forma, as cores da moda ou uma textura que confere à superfície um toque agradável; pode ser ainda uma maneira de expressar uma mensagem sociocultural, um estilo por meio da expressão da forma e do material, de acordo com Muller, citado por Ross e Wensveen (2010).

Certas características, que podem ser avaliadas por meio do sentido da visão, podem ser confirmadas ou não através do toque. Utiliza-se a percepção táctil para a avaliação de formas, qualidades de materiais, texturas, suavidade, temperatura, flexibilidade, resistência, peso, dentre as muitas características de um produto, além de fornecer referência e permitir os acionamentos, tais como montagem e desmontagem, limpeza e manutenção de produtos (FAUCHEAU et al, 2015, p. 1-2).

Plásticos representam uma categoria de materiais à parte. São versáteis, possuem propriedades demandadas e ajustadas a muitos segmentos de mercado, e a milhares de produtos estão associados. Para cada tipo específico de produto é possível encontrar um polímero adequado àquela aplicação. Quando designers e produtores necessitam de um esforço ampliado, objetivando melhoria de desempenho, ou uma característica que se associe à funcionalidade de um produto, é possível alterá-lo modificando sua composição, adicionando compostos ou cargas ou combinando-o com outros polímeros (blendas poliméricas), que reforçam uma determinada propriedade, a qual se pretende ampliar e representam um universo de possibilidades, pois mimetizam outros materiais.

A fim de aprofundar conhecimentos acerca das variáveis que interferem na experiência com materiais, os dados coletados por meio desta investigação - a emissividade e a condutividade térmica dos materiais, poderão ser de relevância para entender como se processa a percepção e os estímulos ou não desta variável e como a composição dos polímeros altera esses dados. Sendo assim, há a necessidade de aferir procedimentos, criar parâmetros por meio de tratamento e organização dos dados, que servirão para obtenção de informação de qualidade e contribuirá para o campo do design, como recurso para o desenvolvimento e melhoria de produtos e da interação de usuários com eles. Desse modo dando ênfase à necessidade de detalhar os processos e/ou procedimentos adotados para a coleta de dados.

4. Método

4.1. Considerações a respeito do método

Objetivando aprofundar os conhecimentos a respeito da percepção dos usuários, relacionada aos materiais plásticos; tendo como base os resultados obtidos a partir da pesquisa referenciada (MIRA, 2015) e, também, objetivando testar um instrumento de coleta de dados quantitativo - a termografia, passa-se a descrever os procedimentos do método aplicado.

Foram convidados a participar do estudo dez participantes, entre homens e mulheres, em amostra não estratificada. Explicou-se a cada um dos participantes os procedimentos que ocorrem no ambiente preparado para o experimento, detalhando, primeiramente, o uso do equipamento, o ambiente preparado e o modo do procedimento de contato com as amostras (primeira, segunda e terceira etapas). Após todas as considerações, mediu-se a temperatura da amostra no ambiente, a qual foi anotada na ficha de análise de cada participante, ficha essa formulada pelos pesquisadores. Na etapa seguinte, mediu-se a temperatura das mãos de cada participante, em estado de repouso, e realizado o segundo termograma.

Em seguida, cada participante foi orientado a tocar, apenas com o dedo indicador, o corpo de prova, em uma inspeção cega, durante dez segundos (amostra delimitada pelo tamanho de 80x80 mm). Realizou-se o terceiro termograma, onde o participante não teve contato visual com a amostra. Ato contínuo, foi solicitado ao participante que interagisse mais com a amostra, momento em que foi aferida a transferência térmica. Nessa etapa foi possível identificar a quantidade de calor emitido pela superfície da mão após a manipulação da amostra. Assim, para esta análise, o participante interagiu com o corpo de prova por 10 segundos, a fim de atingir um equilíbrio térmico com o ambiente. Após este período, procedeu-se à captura térmica.

4.2. Diretivas para a captura termográfica e uso do equipamento

Os dados discriminados abaixo servem como orientação e parâmetro, os quais foram mantidos durante cada coleta e verificados constantemente para uma obtenção precisa dos termogramas, seguindo as orientações do manual da ferramenta Flir (2015).

Antes de realizar a captura com a termocâmera, procedeu-se à limpeza da lente infravermelha, a fim de obter um resultado preciso durante as etapas de coleta de dados, sem interferências. Também foi realizado uma limpeza do corpo de prova após cada coleta realizada e mantendo um intervalo para cada coletada para não interferer na temperatura da amostra. Para se obter resultados precisos, o fabricante recomenda que se aguarde cinco minutos após ter iniciado a câmera para realização da captura, o que foi realizado. Outro ponto é a mudança da paleta de cor (ferro), selecionada pelo sistema da termocâmera, que será necessária para facilitar a análise da imagem durante o processo de captura.

Por se tratar de análise de imagem, foi necessário verificar os seguintes parâmetros: a quantidade de energia infravermelha emitida, transmitida e refletida pelo objeto; o sistema previamente selecionado; a imagem dinâmica multiespectral (MSX), onde a termocâmera apresenta uma imagem infravermelha em que os contornos da amostra ficam mais definidos. Esse procedimento possibilitou definir a distância de alinhamento entre a termocâmera e a amostra. Procedeu-se à realização de imagens de forma tradicional para registro de comunicação dos dados e documentação de todas as etapas de coleta.

A distância entre a câmera e corpo de prova é um fator importante para obtenção de maior confiabilidade dos dados e precisão do registro. Requer que sejam definidos previamente e que seja utilizado o mesmo critério de valor para todas as capturas realizadas, ainda que com mudança das amostras. Assim, a termocâmera permaneceu fixa para que a seleção dos medidores de ponto fossem travados de forma a não ocorrer mudanças. Tal parâmetro foi utilizado para compensar a radiação que é absorvida pela atmosfera e a radiação da própria atmosfera.

Outro aspecto que foi levado em consideração foi a compensação da umidade relativa presente na atmosfera, sendo imprescindível definir a umidade relativa para o valor apropriado. Para distâncias de captura reduzidas, como a estipulada no estudo, adotou-se as recomendações técnicas do manual do equipamento (FLIR, 2015, p.58), definindo-se um valor de 50% - Neste modelo utilizado, já é definido automaticamente essa taxa para a umidade. A ferramenta também permitiu compensar o parâmetro de temperatura atmosférica entre a câmera e o objeto – alvo para 24°C, temperatura mantida no ambiente climatizado.

É importante frisar que a precisão da termocâmera utilizada neste trabalho gerou um erro de captura, considerado um fator de variação na coleta de dados desta pesquisa, característica comum a outras análises que utilizam essa ferramenta. O erro de precisão do equipamento Flir Ex6 pode variar de ±2°C (±3,6 °F) ou ±2%. Assim, a cada coleta é necessário ligar e desligar o equipamento, aguardando o tempo de repouso recomendado pelo fabricante, como mencionado anteriormente, para obtenção de melhores resultados.

4.3. Definindo o grau de emissividade de materiais personalizados

Segundo o manual (FLIR, 2015) do equipamento utilizado, a "emissividade" é uma propriedade que indica a quantidade de radiação gerada por um objeto comparada com a quantidade refletida pelo mesmo. Para uma medição térmica precisa, definiu-se o grau de emissividade para cada amostra, determinando padrões para inserção da ferramenta. O modelo de termocâmera utilizado neste estudo foi a Flir Ex6, que possibilita variáveis de 0,1 a 1,0ε. Considerou-se que há emissividade da planta das mãos em repouso e durante o experimento foi fixado um valor de 0.98ε, conforme tabela fornecida em forma de aplicativo (Infrared Emissivity table for android) pelo fabricante do equipamento.

A termocâmera utilizada, bem como outros registros documentais sobre o uso da ferramenta, não registra a emissividade de polímeros. Logo, foi necessário identificar um valor personalizado para cada material analisado, a fim de obter medições mais precisas. Sendo assim, antes da realização da coleta de dados, foi imprescindível realizar o cálculo de emissividade para cada amostra, seguindo orientações do fabricante.

A radiação refletida pelo objeto foi compensado quando necessário. Havendo baixa emissividade e temperatura do objeto significativamente diferente da temperatura aparente refletida, definiu-se a compensação, ajustando corretamente a temperatura aparente refletida no polímero. Neste caso, a interface do equipamento utilizado - Flir Ex6 permitiu ser ajustado automaticamente, com base na entrada da temperatura refletida.

4.4. Variáveis consideradas

Foram considerados como amostras de materiais polímeros laminados encontrados no mercado, que também coincidem com os materiais aplicados ao design de produtos. Para definição dessas amostras, foram considerados critérios de seleção de materiais coincidentes com o aplicado ao design de produtos de uso pessoal e/ou doméstico. Em algumas categorias de produtos, o material aplicado não foi encontrado na forma laminada e por essa razão não fez parte das amostras para o experimento, como por exemplo o polímero melamina. Assim, considerou-se variáveis importantes, observadas na medição das amostras e descritas a seguir: amostra plana sem textura, amostra com textura e com brilho, amostra com textura e sem brilho, geometria do material, diferentes materiais plásticos e temperatura em repouso e após o contato.

4.5. Seleção dos materiais

Foram selecionados para esse estudo polímeros que são encontrados no mercado sob a forma de chapas planas. Em sua maioria commodities, pois são esses utilizados com maior frequência nos produtos, sendo eles: PMMA, termoplástico com alto índice de transparência; Poliestireno, termoplástico commoditie de uso geral; PP, termoplástico commoditie; PS, termoplástico/poliolefinas; PVC rígido; PA ou Nylon 6.6, polímero de engenharia; PVC expandido. Todas as amostras eram planas e possuíam o mesmo tamanho (80x80mm), variando apenas na espessura (3 a 6mm). Apenas o nylon apresentava textura diversa, que é inerente à própria característica do material.

Cada polímero, de acordo com suas propriedades e características, decorrentes de suas composições, mantém condutividade térmica diferente e que será possível de identificar atráves do estudo. As análises identificaram variáveis de retenção de calor resultante do contato, revelando quais amostras reteram maior quantidade de calor e se possuíam menor condutividade térmica.

4.6. Procedimentos para a coleta de dados

Para realizar a coleta de dados de forma precisa foi necessário adotar os procedimentos e recomendações disponibilizados no manual da ferramenta - FLIR. Manual do utilizador série Flir Ex (2015).

Delimitou-se realizar aferições relacionadas à condutividade térmica, a fim de correlacionar esses valores aos resultados obtidos na pesquisa de Mira (2015) sobre a qualidade dos materiais, na visão dos usuários. Por ser a condutividade térmica uma variável, era possível sua interferência nos resultados, tendo em vista que alguns grupos de polímeros possuem um alto nível de emissividade térmica. Logo, para controlar o ambiente onde foram realizadas as capturas, foi desenvolvido um aparato para o estudo. a fim de facilitar o mapeamento junto aos dez participantes. Fixou-se a termocâmera neste aparato a fim de manter a mesma distância durante o registro de cada coleta, conforme apresentado nas figuras 1 e 2.

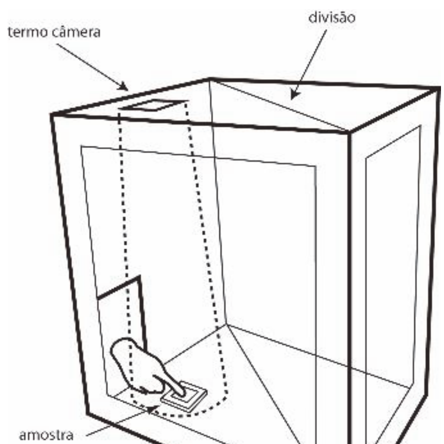

Fig. 1 Diagrama do aparado desenvolvido para a coleta de dados

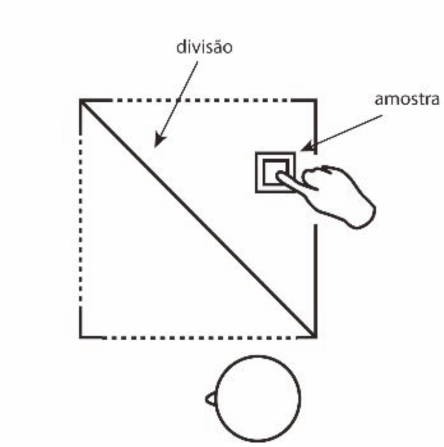

Fig. 2 Diagrama do aparado desenvolvido para a coleta de dados

O aparato possibilitou a troca de amostras, e posicionando-o corretamente, foi possível também que o participante do estudo não visualize o objeto alvo da captura. Procedeu-se dessa maneira para que o estímulo visual não interferisse no resultado da coleta, bem como para garantir o emprego do método proposto. Conforme demonstra imagem a seguir figuras 3 e 4.

Fig. 3 Coleta de dados no Laboratório de Ergonomia e Interfaces (LEI). Foto: Ana Paula Maldonado

Fig. 4 Coleta de dados no Laboratório de Ergonomia e Interfaces (LEI). Foto: Ana Paula Maldonado

Inicialmente, mapeou-se a amostra em repouso no ambiente, considerando a umidade e a temperatura, dados esses que foram registrados. Após esse procedimento, aferiu-se a temperatura da planta da mão do participante, sem contato com a amostra. A partir da realização desses procedimentos, que antecedem o contato com a amostra do material, é que foi realizado o mapeamento do contato do participante em ambiente controlado para obtenção da condutividade térmica. O contato foi mantido por dez segundos, cronometrados em todas as coletas, para todas as amostras.

A condutividade térmica é uma propriedade física dos materiais, motivo pelo qual todos os materiais possuem a capacidade de conduzirem calor (CALLISTER, 2002). O fluxo de calor ocorre por condução, convecção ou radiação, conforme mencionado nas diretivas para a captura termográfica. Segundo Dischinger (2009) um material será percebido como frio ao toque se ele conduzir rapidamente o calor recebido pelo dedo. Para identificar a disbribuição de temperatura das amostras foi necessário realizar a coleta de dados em um ambiente climatizado e com temperatura ambiente controlada.

Solicitou-se, também, que os participantes registrassem suas impressões em um formulário pré-formatado, no qual constava um código de identificação para cada amostra. Nessa parte do registro de impressões o usuário poderia manipular o corpo de prova ampliando o contato. Não se estimulou a resposta dos participantes por meio de atributos pré-definidos, tendo em vista a busca por uma descrição mais espontânea.

4.7. Tratamento dos dados coletados

Como forma de representação, essa ferramenta visa facilitar a interpretação de dados invisíveis à primeira vista, pois a olho nu eles não são perceptíveis. O uso desse instrumento de representação visual facilita, também, o desenvolvimento e análise de materiais, podendo contribuir para a concepção e escolha de materiais mais adequados à produção de objetos**.**

Para tratamento dos dados, depois de coletados, foram indexados e realizados procedimentos de análise considerando a emissividade do material e a transferência de temperatura do participante para a amostra de material plástico. Considerou-se as variáveis importantes já descritas anteriormente (item 3.4).

A termocâmera (figura 5) utilizada pertence ao Laboratório Didático de Conforto Ambiental (LADICA), do Departamento de Arquitetura, Urbanismo e Paisagismo da FAAC/UNESP e a análise das termografias foi enpreendida com o uso do software Flir Tools. A coleta de dados foi realizada no Laboratório de Ergonomia e Interfaces (LEI) do mesmo departamento da Universidade Estadual Paulista (UNESP), em sala climatizada, cujo termômetro indicava a temperatura de 24°C.

Fig. 5 Termocamera Flir EX6. Foto: Ana Paula Maldonado

5. Resultados

Em cada termograma obtido foi realizada uma leitura pelo software mencionado, por meio do qual foi possível visualizar a temperatura exata de cada ponto da amostra, através de um ponto de medição preciso. Outra ferramenta associada ao software permitiu traçar uma faixa de medição, que possibilitou identificar as temperaturas máxima, mínima e média de cada amostra, assim como a função delta do ponto de contato. Assim foi possível observar a variação de temperaturas, através da condutividade de cada material, conforme pode ser observado nas figuras 6, 7, 8, 9 e 10 do participante p1t. Identificando diferenças da difisuidade do calor em amostras com alto e baixo índice de condutividade térmica.

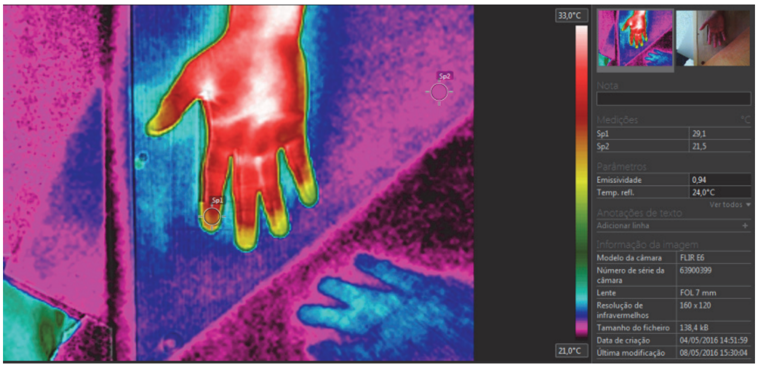

Fig. 6 – Termograma da temperatura da mão em repouso – 29,1°C

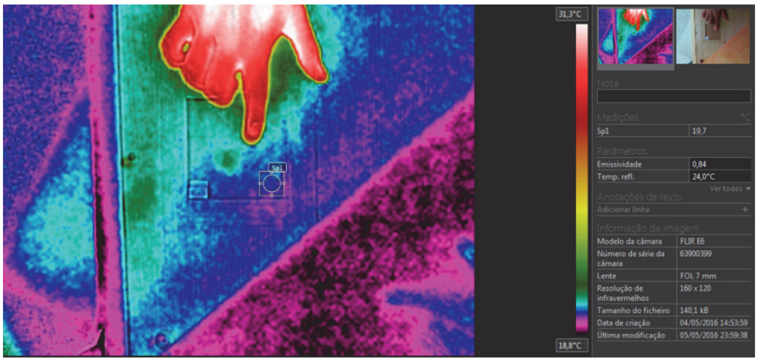

*Fig. 7 Termograma da temperatura da amostra com o contato inicial do polegar com a amostra PMMA – 19,7°*C

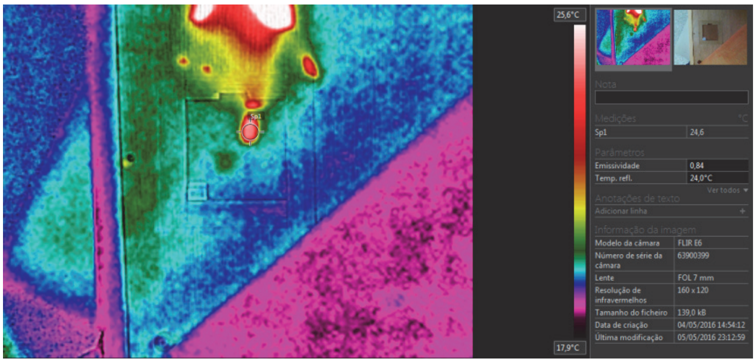

*Fig. 8 Termograma apos 10 segundos de contato do polegar com a amostra PMMA – 24,6°*C

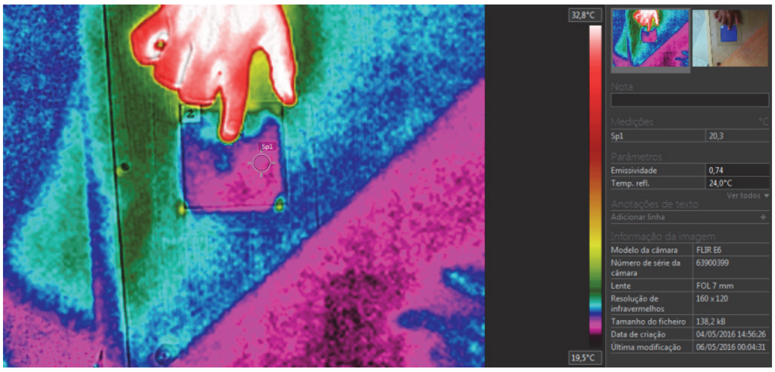

*Fig. 9 Termograma da temperatura da amostra com o contato inicial do polegar com a amostra Poliestireno – 20,3°*C

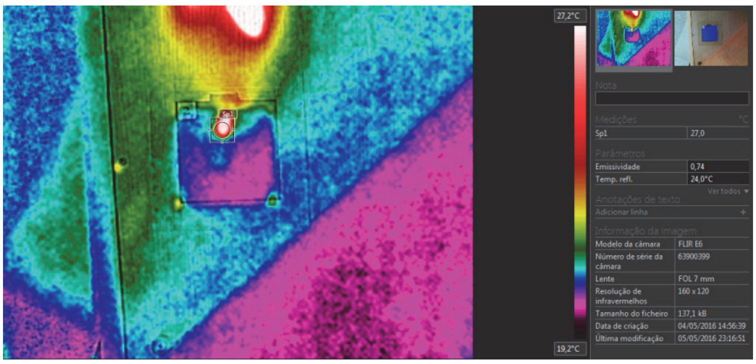

*Fig. 10 Termograma após 10 segundos de contato do polegar com a amostra Poliestireno – 27,0°*C

Por meio da leitura das imagens termográficas de forma ampla, com ênfase na analise de toda a coleta, foi possível verificar que a temperatura obtida de cada participante (ponto de leitura no dedo indicador) manteve-se, em média, aproximadamente em torno dos 4,5°C de diferença da temperatura ambiente (24°C). No aparato, durante todo o experimento, manteve-se a temperatura de 0,55°C de diferença em relação ao ambiente (24°C), preservando uma média de temperatura em torno dos 23,45 °C. Os pesquisadores não verificaram que essa pequena alteração de temperatura do aparato tenha interferido nos resultados obtidos ao logo do experimento.

Houve variações com relação às amostras, conforme tabela 1 abaixo:

Tabela 1. Estratificação dos dados do participante p1t

P1t	Polímeros	ambiente	temp. mãos	temp. amostra s/c	no. captura inicial	no. captura final	tempo contato	difusividade	condutividade térmica
	PMMA	24°C	29,1	20°C	19,7	24,6	10s	4,9	0,08 - 0,25 W/m*K
	Poliestireno			20,7°C	20,3	27,0	10s	6,7	0,12 - 0,13 W/m*K
	PP			21,9°C	22	27,2	10s	5,2	0,11 - 0,17 W/m*K
	PA			22,1°C	22,3	27,8	10s	5,5	0,18 - 0,35 W/m*K
	PVCex			22,4°C	22,6	30,9	10s	8,3	0,15 - 0,29 W/m*K
	PVCrig			22,0°C	22	29,6	10s	7,6	0,15 - 0,29 W/m*K
	PC			22,5°C	22,5	29,1	10s	6,6	0,19 - 0,22 W/m*K

Observou-se, através dos dados obtidos por meio dos termogramas, que as amostras PMMA (Resarbrás / Unigel), PA (Plastireal), PC (Bayer) e PP (Durplastic) não concentraram tanto calor através do toque quanto as amostras PVCrig e PVCex (Rochling) e o Poliestireno (Golden Signs). Percebeu-se que entre todas as amostras mapeadas, aquelas com maior retenção de calor também apresentaram menor condutividade térmica, haja vista que o calor aplicado sobre elas não se dissipou rapidamente.

Outro aspecto a ser esclarecido é que as medidas indicadas pela termocâmera, conforme mencionadas nas diretivas da coleta, não sao absolutas e que em estudos mais aprofundados se faz necessário a utilização de uma termocâmera que possua melhor qualidade de captura. Da mesma forma, se faz necessário ressaltar que para estudos futuros é imperioso mapear a interação com os produtos, a fim de verificar alguns tópicos relevantes, como por exemplo se a condutividade térmica do material afeta a percepção de qualidade do produto.

Fica evidente que a composição do polímero tem influência na condutividade do material, motivo pelo qual é possível compreender a razão pela qual a literatura existente sobre a condutividade térmica fornece apenas dados variáveis, tendo em vista que não levam em conta as características de cada fabricante. Para que o designer obtenha melhores resultados, com diferentes tipos de polímeros, é necessário que o fornecedor apresente tais dados.

5.1. Considerações finais sobre os resultados obtidos

Considerando a importância da termografia, este artigo direciona seus estudos para validar esse instrumento auxiliar de coleta de dados, que permite compreender a percepção a partir da interação do usuário com polímeros, identificando qualidades inerentes a cada tipo de material e indicando novas possibilidades e alternativas de uso.

Tem em conta que dados mais precisos de condutividade e emissividade térmica são relevantes para a aplicação do material e para os aspectos que se associam à percepção dos usuários, sugere-se a ampliação desse estudo. Concluiu-se que os materiais plásticos podem ser quentes ou frios, razão porque seu índice de condutividade térmica é determinante em muitas de suas aplicações, sendo que a capacidade de conduzir calor, sem dúvidas, pode afetar a experiência com o produto e com os materiais. Como exemplo pode-se citar os polímeros associados a produtos eletrônicos, que necessitam possuir isolantes térmicos e acústicos. Ainda, é possível mencionar os polímeros associados aos eletrodomésticos que precisam produzir calor ao processar alimentos, sem que isso represente perigo aos usuários. Em síntese, esse estudo não esgota resultados, fazendo-se, ainda, necessário empreender estudos complementares que possam ir além dos resultados aqui apresentados.

6. Agradecimentos

Os autores agradecem ao CNPq, pela concessão da bolsa de doutorado (ao primeiro autor); aos professores Prof. Dr. João Roberto Gomes de Farias, por fornecer a termocâmera pertencente ao Laboratório Didático de Conforto Ambiental (LADICA), do Departamento de Arquitetura, Urbanismo e Paisagismo da FAAC/UNESP e ao Prof. Dr. Luis Carlos Paschoarelli, por permitir o uso do espaço climatizado do Laboratório de Ergonomia e Interfaces (LEI) do mesmo departamento da Universidade Estadual Paulista (UNESP), para realização da coleta de dados.

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TRANSFORMATION FUNCTION

University/Research/Business: case study of Spinoff Innoarea Design Consulting S.L.

Gabriel Songel
Chair Professor Universitat Politècnica de València, Spain.
Keynote Speaker

Abstract

A review of the system that connects Research and businesses will introduce intangible perceptual models of the new social and economic reality going beyond of Research services from the University to businesses. It is presented how they are converted into tangible realities in new business centered in advanced services of Design through the so-called Strategic Design that brings new methods and tools for the development of new business models, new products and services.

From an innovative attitude, renewal vocation and as a demonstrative sample, it was created in 2008 the spinoff Innoarea Design Consulting, a design consultancy company that year after year until now settles a systemic vision of design and their connections with Research and Higher education.

A review of the social and economic situation of the recent crisis required to assume new challenges. On one side, from the educational environment, university degrees offer syllabus that were designed more than fifteen years ago for the different industrial and service sectors than have been transformed deeply, either they not exist anymore, putting in evidence the lacks of the educational system and an urgent demand of adaptation to new reality. On the other side, a paradigmatic swift in the social, economic and technological dimensions in Spain and in the European Union, have allowed to create one of the first University TBE based on knowledge in the creative industries in Spain. In fact, new legal disposals for the university staff, the social demand for a new productive model, the evolution of design services market, and the technological availability of mobile devices for leisure and communications allowed the creation of a new business model that shows a new sample of the university system to transfer Research to companies. In particular this paper explains how from techniques of new products and services opportunities analysis in different industrial sectors, through the methodology of Trend Matrix, was the base knowledge transferred from the UPV to the spinoff. Its implementation and development have achieved milestones like the launch of new products in international markets, exhibition editions centered in Design and Innovation and the creation on Technological Events in the national panorama.

Keywords: *Entrepreneurship, Design, Knowledge, enterprise*

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Projetar a Forma: uma proposta de ferramenta metodológica para o direcionamento da sintaxe visual no design de moda

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Resumo

O artigo apresenta o recorte de uma pesquisa de doutoramento desenvolvida em parceria entre Universidade de São Paulo, Universitat Politècnica de València and Universidade Estadual de Londrina. Aborda o âmbito do ensino de projeto em graduações de design de moda, com ênfase na investigação de metodologias para gerir o processo projetual, propondo estratégias facilitadoras da sintaxe visual para a configuração de artefatos de vestuário de moda. Para isso, parte de uma pesquisa exploratória, de base bibliográfica e documental, em que se analisa o sistema de interações construído entre vestimenta e usuário, para demonstrar que as relações estabelecidas no sistema corpo-artefato-ambiente se distribuem em fatores de adaptação física, expressão individual e representação social. Deste modo, situa o vestuário de moda como um espaço de vivências sensoriais que produz significações e enfatiza a dimensão estético-simbólica como quesito essencial no planejamento da experiência de uso deste tipo de produto. Tal perspectiva corrobora a relevância de ferramentas metodológicas que propiciem a síntese de códigos expressivos para guiar a composição formal, com vistas à articulação entre as dimensões material e informacional do artefato projetado, uma vez que a informação (conteúdo) é transmitida pela sintaxe dos elementos da configuração (forma). Sobre esta plataforma, o artigo relata as bases teóricas, a proposição e a aplicação de uma ferramenta destinada à geração de conceitos formais na prática projetual do design de moda. A explanação integra fundamentos acerca do design de moda, do pensamento visual e das técnicas de síntese imagética, para examinar apreciações em campo e discutir a efetividade da referida ferramenta. Os resultados reforçam a hipótese de que a combinação de métodos que exploram o pensamento visual pode auxiliar os estudantes na percepção das diversas variáveis que influenciam a composição formal de um produto e, por conseguinte, na síntese de relações sintático-semânticas para impulsionar a geração formal.

Palavras-chave: *design de moda, projeto, metodologia, ensino, síntese visual.*

Abstract

This article presents a part of a PhD research developed in partnership between the Universidade de São Paulo, Universitat Politècnica de València and Universidade Estadual de Londrina. It approaches the sphere of project teaching in undergraduate fashion design courses, with an emphasis on research of methodologies developed to manage the design process, proposing facilitating strategies of visual syntax for the configuration of fashion clothing artifacts. To achieve this, It was applied a part of the exploratory bibliographical and documental research, which examines the interaction system built between clothing and user to demonstrate that the relations established in the body-artifact-environment system are distributed on factors of physical adaptation, individual expression and social representation. Thus, it situates the fashion clothing as a field of sensory experiences that produces meanings and emphasizes the aesthetic and symbolic dimension as an essential requirement in the planning of user experience in this type of product. Such perspective reinforces the relevance of methodological tools which propitiate the synthesis of expressive codes in order to guide the formal composition with regard to the links between the materials and informational dimensions of the designed artifact once the information (content) is transmitted by the syntax of the elements of configuration (form). Upon this platform, this article reports the theoretical basis, the proposition and application of a tool aimed to generate formal concepts in the project practices of fashion design. The explanation integrates fundaments of fashion design, visual thinking and imagery synthesis techniques to examine field assessments and discuss the effectiveness of this tool. The results reinforce the hypothesis that the combination of methods that explore the visual thinking can help students in the perception of the different variables that influence the formal composition of a product and therefore the synthesis of syntactic-semantic relations to boost the formal generation.

Keywords: *fashion design, design, methodology, teaching, visual synthesis.*

1. Introdução

Todo projeto de design se vincula às solicitações do contexto sociocultural, propondo interfaces (tangíveis ou intangíveis) que mediam a integração humana com esse entorno. Por isso, a definição de referenciais simbólicos para a configuração de um artefato depende do estudo dos códigos comunicativos que permeiam o contexto, já que tal objeto deve fazer parte do sistema de sinais sociais presentes no universo do usuário.

Para projetar o vestuário de moda é preciso entendê-lo como um espaço dinâmico e interativo, no qual os elementos que compõe sua forma mediam um enunciado não verbal que se integra às mensagens do meio onde se insere, promovendo um processo de identificação e comunicação. Assim, ao abordar o projeto de design na área de moda, é essencial analisar a articulação de valores simbólicos como um ponto crucial entre as diretrizes do ensino de projeto. Por conseguinte, o desenvolvimento de ferramentas para auxiliar o desenvolvimento da capacidade expressiva é fundamental para a formação de um designer de moda, uma vez que o refinamento desta habilidade o ajudará na decodificação e transposição de códigos estético-simbólicas para a configuração de produtos de moda.

Nesta direção, este artigo relata os resultados parciais de uma investigação de doutoramento que aborda o instrumental metodológico para o o ensino de projeto. No presente estudo, foi realizado uma investigação em campo para verificar o desempenho de estratégias metodológicas para a síntese de conceitos de linguagem visual no projeto de vestuário de moda. As interações em campo foram efetuadas com estudantes do curso de Design de Moda da Universidade Estadual de Londrina (UEL), por meio da observação participante em oficinas de projeto.

A argumentação pontua a importância da síntese visual como facilitadora do pensamento projetual. Desta maneira, sintetiza as bases teóricas que, agregadas às análises da observação participante em campo, guiaram a proposição de um instrumental metodológico que auxilia a síntese de conceitos expressivos para a sintaxe da forma no design de moda.

Cabe observar que no universo pedagógico estudado a expressão utilizada para referir-se ao campo da gestão do projeto de artefatos de vestuário de moda foi convencionada como “design de moda”, por isso adotou-se a mesma nomenclatura para a presente reflexão. Destaca-se também que algumas análises contidas no texto já foram publicadas em trabalho anterior, no entanto, como integram a trajetória de uma pesquisa mais ampla, são fundamentais para o entendimento da proposta aqui tratada.

2. Bases Teóricas

O valor de um artefato está intimamente ligado à avaliação subjetiva do seu desempenho na relação de uso, ou seja, um produto será considerado bom à medida que estabeleça algum significado no cotidiano de seu usuário. “Algo deve ter forma para ser visto, mas deve fazer sentido para ser compreendido e utilizado” (Krippendorff, 1989, p.14). Para tanto, se presume que os enunciados visuais transmitidos através da configuração de um artefato podem gerar percepções de natureza diversificada, evidências sobre a operacionalidade, o uso, referências culturais, etc. Tais percepções, quando sobrepostas pelo usuário em seu contexto sociocultural, são assimiladas e interpretadas, derivando decodificações que compõem o conteúdo simbólico do artefato. Assim, a ordenação configurativa é suporte da informação e essencial na semântica do produto.

A configuração (forma) do vestuário de moda é concretizada e refinada ao longo do processo projetual, a partir da análise e experimentação integrada de aspectos perceptivos, materiais e técnicos, todavia essa efetivação depende da delimitação de critérios norteadores para impulsionar a sua geração. Neste sentido, as bases teóricas, resumidas a seguir, assinalam os aspectos comunicativos do vestuário de moda e a importância deste quesito no seu processo projetual.

2.1. O Vestuário de Moda como Enunciado Visual

O vestuário de moda participa ativamente das vivencias humanas com o entorno físico e sociocultural. Como veículos de adaptação física, expressão individual e representação social, as vestes se convertem em instrumentos para a construção de significações e registros móveis das relações de tempo-espaço incorporadas à cultura material.

A vestimenta, conforme Montemezzo e Santos (2002), pode ser considerada como “Interface Global Primária”, visto que se faz presente na maior parte do tempo cotidiano, incorpora-se ao meio físico/material do homem e interage com o organismo de maneira generalizada e direta, intervindo na realização das ações humanas e no relacionamento do corpo com quaisquer espaços. Seguindo por esta direção, destaca-se Saltzman (2008) e Souza (2008) que exploram os conceitos de habitat, interioridade e exterioridade, espaço público e privado, para explicar que a superfície têxtil, ao delimitar forma, volume e silhueta, simultaneamente, transforma a anatomia corpórea, promove interfaces com o espaço circundante e configura um espaço particular de sensações e percepções que se antepõe às relações com outros espaços e outros corpos. Deste modo, pode-se visualizar o vestuário como segunda pele, integrando um conjunto de camadas espaciais sucessivas, em que interagem espaço corpóreo, espaço da veste e os espaços por onde este corpo vestido transita e habita.

Consequentemente, corpo e artefato entrelaçados se acoplam a outros espaços, onde outros corpos vestidos transitam e se integram (mesmo que temporariamente), criando uma malha comunicativa que manifesta um ininterrupto e recíproco movimento de transformação do cenário social. No contexto complexo atual, marcado pela realidade multifacetada, híbrida e dinâmica, as significações geradas nessa malha de percepções são transitórias, por isso, cada corpo habitante transforma o espaço habitado, mas também é constantemente transformado neste fluxo rizomático de conexões.

Desta perspectiva, o vestuário de moda é um importante veículo de processos comunicativos, uma linguagem, como sancionam Castilho (2004) e Oliveira (2007), sobretudo pelo canal visual não verbal. Isso conduz, naturalmente, a presente explanação pelos caminhos da comunicação visual, inferida no presente contexto como o processo de interação entre signos não linguísticos, especificamente os que se pronunciam na composição plástica da forma visual de artefatos. Coelho (2008) recomenda que este tipo de comunicação, quando estudado em função do projeto de um artefato, deve ser considerado como um dos propósitos inerentes ao design, definindo que projetar a comunicação visual significa "estabelecer qual a melhor maneira de transmitir visualmente um determinado conteúdo" (Coelho, 2008, p.142). Contudo, o autor enfatiza os elementos culturais como determinantes dos significados possíveis para as diversas formas visuais de comunicação.

Para analisar a vestimenta como veículo comunicativo, retoma-se os componentes de uma mensagem visual não verbal definidos por Munari (2006): informação e suporte visual, sendo a informação o conteúdo a ser comunicado e o suporte visual a forma. Nesta linha de raciocínio, o conteúdo semântico do artefato se faz perceptível através do conjunto de elementos e relações compositivas que constituem sua forma.

No campo do design, Cardoso (2012) argumenta que o termo forma abrange três aspectos inter-relacionados inseparáveis: a) aparência, aspecto perceptivo por um olhar; b) configuração, no sentido composicional, de arranjo das partes; c) estrutura, referente à dimensão construtiva. Neste sentido, atribui-se à forma de um objeto uma qualidade sensorial ampliada, que não se percebe em um único plano de visualização. Para percebê-la há uma confluência de aspectos de superfície, volumetria, contorno, espaço e ponto de vista. Como entidade de dimensões múltiplas e interdependentes, o autor destaca o papel expressivo e informacional da forma, produzido especialmente pela percepção visual.

Sob este prisma, encontra-se pertinência com o que Couto, Farbiarz e Novaes (2014) denomina figura, definida pelo autor como o resultado do processo de configurar um objeto, sendo o conjunto de aspectos do objeto que se pode perceber sensorialmente, imaginar e representar.

Assim, o termo forma, neste estudo, é entendido como um composto material/estético /informacional. Compreende o conjunto de relacionamentos entre os componentes configurativos de um artefato, experimentado sensorialmente em múltiplas dimensões e percebido como expressão de informação visual. Logo, forma e configuração, quando usados como atributo de artefato (produto) no decorrer do texto, têm o mesmo sentido.

Entretanto, para estabelecer um canal de comunicação, através da forma do vestuário de moda, é fundamental projetar de modo coerente a ordenação (sintaxe) dos elementos configurativos, para que esta se integre ao fluxo de códigos vigentes no contexto do usuário e, por conseguinte, sejam reconhecidos, assimilados e, finalmente construídos como valores simbólicos. É certo que, para isso, é necessário codificar o artefato em sistemas de signos reconhecíveis, pelo que se prevê que é imperativo antes identificá-los entre as unidades culturais presentes no contexto em que o produto será inserido.

Niemeyer (2003) explica que esse processo de comunicação envolve dois elementos ativos: gerador (designer/empresa) e interpretador (usuários e sujeitos que não são usuários finais, mas estão implicados no trajeto da mensagem, na comercialização e difusão). Para a autora, gerador e interpretador alternam suas posições, pois com sua reação, "o interpretador passa a produzir mensagens, que por sua vez são processadas (ou não) pelo gerador" (Niemeyer, 2003, p.23). Desta maneira, o designer absorbe grande parte da responsabilidade pela a escolha das estratégias comunicacionais do projeto.

Toda a arguição anterior demonstra a estreita relação entre as dimensões sintática e semântica de um produto. No entanto, para a efetiva transposição de conteúdo (informação) para a forma, é essencial compreender os conceitos de sintaxe e semântica entre as dimensões atuantes na configuração de um produto. Estas dimensões foram explicadas por Niemeyer (2003), juntamente com as dimensões material e pragmática, conforme resumido a seguir.

A) Dimensão material: se constitui pelas propriedades materiais do artefato, a sua materialidade em si. Niemeyer não a explora isoladamente, salientando que o aspecto hílico será melhor entendido como elemento comunicativo quando articulado com as outras dimensões.

B) Dimensão sintática: referente à estrutura e ao funcionamento técnico do artefato. A estrutura consiste na parte do produto e o modo como se conectam, incluindo construção técnica e detalhes visuais, os quais também são descritos como aspectos da composição formal, que abrange elementos visuais compositivos e procedimentos relacionais. Gomes (2006) também elucida esta dimensão sob o mesmo princípio de ordenação dos elementos que se articulam para formar e informar.

C) Dimensão pragmática: versa sobre o uso prático (utilidade) do produto, considerando todo o seu ciclo de vida, apreende o conjunto de relações que o produto estabelece com o usuário no campo ergonômico ou sociológico (quem usa e em que situação é usado). Gomes (2006) destaca que envolve a relação entre os signos (produto) e seus intérpretes (usuários).

D) Dimensão semântica: concentra as qualidades expressivas e representacionais, é a dimensão que agrega aspectos de referência à dimensão sintática e material, seus descritores. Trata de como o produto sugere, através da composição formal, as suas qualidades de uso.

É primordial advertir que, tais dimensões foram isoladas para fins didáticos, mas Niemeyer (2003) alerta que as dimensões se constituem simultaneamente e articulam qualidades representacionais em conjunto, uma vez que os significados são cunhados por meio da percepção conjugada de tais dimensões, mediante a experiência vivenciada com o produto em um determinado contexto. Por consequência, ainda que esta pesquisa esteja centralizada no recorte que trata da dimensão sintática e de sua influência na dimensão semântica, a composição da forma do vestuário é resultante da coordenação das propriedades da matéria, dos requisitos de uso, dos referenciais estético-simbólicos e dos parâmetros de adaptação para o conforto corporal. Somente por meio da interação desses fatores é que se expressa alguma informação coerente.

Portanto, o sucesso da comunicação está diretamente ligado à habilidade do gerador (designer/empresa) do enunciado formal/visual em manipular os elementos sintáticos na configuração dos produtos. Sanches (2012) confirma que a competência para manejar a linguagem visual é indispensável aos designers que pretendem articular códigos simbólicos no planejamento das interfaces que projetam, proporcionando experiências cognitivas a partir do uso de tais artefatos.

Para que a forma seja mediadora de significações, o processo projetual se encarrega de antever relações semânticas que possam ser atribuídas ao artefato nos contextos a que se destinam. No entanto, essa tarefa só obterá êxito se for auxiliada pelo conhecimento de diretrizes para organizar e harmonizar os elementos formais, extraindo-os do entorno e transpondo-os para o planejamento do partido comunicacional do artefato. Com o intuito de proporcionar meios para estabelecer tais diretrizes, examina-se o processo de delimitação projetual no design de moda.

2.2. O Projeto do Vestuário de Moda

Segundo Niemeyer (2003) o modo como um produto é sentido decorre do julgamento de percepção que é submetido. Então, face a sua estrutura mental, o indivíduo pode reagir ao produto. No projeto de design de moda, analisando a relação entre usuário e produto, infere-se que a percepção da informação depende de uma sintaxe que relaciona elementos compositivos em códigos reconhecíveis, dando forma ao conteúdo. Logo, como já comentado, a definição de um referencial simbólico (códigos reconhecíveis) depende do estudo do contexto sociocultural, já que deve fazer parte do sistema de sinais sociais presentes no universo do usuário.

Sanches, Hernandis e Martins (2015) ressaltam que o vestuário de moda traz intrínseco um propósito de uso social, para o qual a experiência sensória é o veículo. Por isso, ao planejar esta interface vestível, é premente considerar que a experiência do corpo usuário unifica percepções em nível físico, psicológico e social. O sistema de interações entre usuário, vestimenta e ambiente, vincula-se à adaptação do corpo ao entorno, atribuindo-lhe proteção e, especialmente, uma aparência propícia para a aceitação e integração no contexto sociocultural.

Dos argumentos supracitados se extrai dois princípios básicos para a delimitação da forma no design de moda: a) cada elemento configurativo é um enunciado visual e, concomitantemente, meio de adaptação física ao ambiente material; b) o enunciado visual da forma é altamente influenciado por conteúdos culturais.

Deste modo, o processo projetual emerge das solicitações do contexto e finaliza submergindo outra vez na mesma realidade que o definiu, transformando-a e, possivelmente, influenciando novas solicitações. Então, é essencial conhecer que tipo de informações definem as variáveis projetuais e também as interações geradas pelo artefato projetado.

Para maior entendimento dos fatores que influenciam a delimitação de um conceito de linguagem no design de moda, destaca-se os pontos cruciais do desenvolvimento projetual e o fluxo de variáveis envolvidas neste setor. Nesta direção, Sanches (2011) e Sanches et al. (2016) resumem as principais categorias de informação que direcionam o projeto do vestuário de moda, mostrando a relevância da inserção do projeto no seu contexto gerador e destinatário, para a efetiva integração das demandas humanas, sistemas produtivos e gestão empresarial. Os autores definem o fluxo de informações entre os universos usuário e corporativo, elencando as variáveis fundamentais para a delimitação projetual no design de moda (Fig.1).

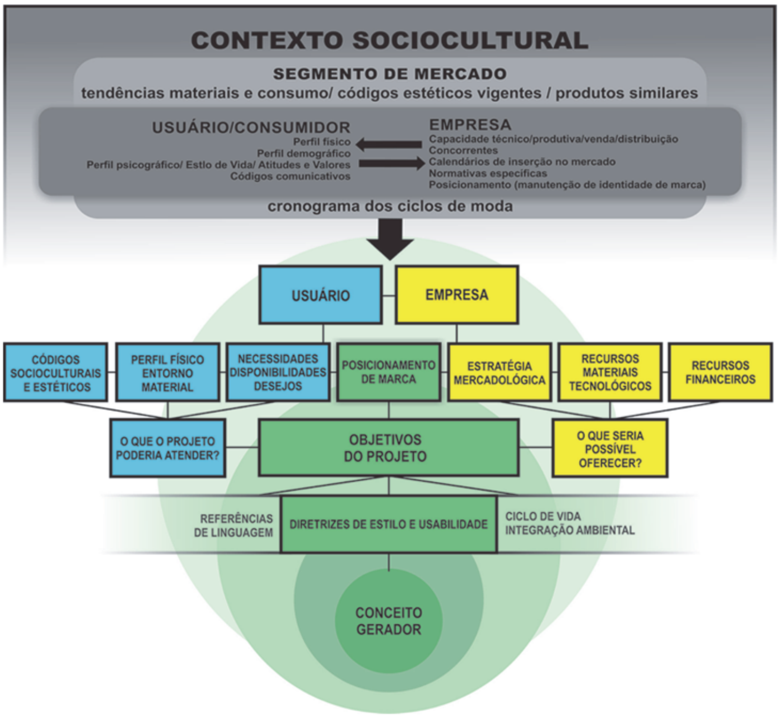

Fig.1 - Fluxo de informações na delimitação projetual do Design de Moda. Fonte: Elaborado pela autora, com base em Sanches (2011) Sanches et al. (2016)

Sanches (2011) exalta que esta organização não é uma cadeia linear de procedimentos, mas sim uma estrutura dinâmica que se entrelaça, se retroalimenta e absorve novas informações que a transformam. “Contudo, o ponto de partida é sempre o reconhecimento do cenário que envolve o usuário, das nuances deste contexto, para a identificação das suas necessidades e desejos. “ (Sanches, 2011, p.2). Por consequência a delimitação projetual parte da interpretação e decodificação do contexto para sintetizar as diretrizes do projeto e o conceito gerador.

Esclarecendo, para Lessa (2009), o conceito do artefato refere-se a uma síntese dos traços e características do artefato que mais fundamentalmente o determinam, sua essência de atuação no cotidiano humano. Neste sentido, adotou-se o termo “conceito gerador”, à semelhança de Montemezzo (2003) e Sanches (2012), destacando que projetos de vestuário de moda geralmente englobam a concepção de vários artefatos em concomitância, vinculados por uma mesma ideia central. Essa essência partilhada guia os princípios funcionais/formal/visual do conjunto de artefatos projetados, respeitando a imagem da marca e as metas comerciais da empresa que propõe os novos produtos e/ou serviços. A diretriz expressa pelo conceito gerador é decodificada em elementos configurativos, guiando todo o processo projetual e ajudando a manutenção da coerência de linguagem.

Com base nestes estudos, torna-se claro que a diretriz para a sintaxe da forma é construída em um sistema de relações, em que estão incluídos: as possibilidades (ou restrições) oferecidas pelos materiais, tecnologia e mercado; a estrutura corpórea do usuário, bem como seus signos de representação social e códigos específicos de expressão estética.

Vale ressaltar, contudo, que, conforme Sanches et al. (2016), o projeto de design constitui um sistema permeável que se transforma constantemente na interação com o entorno sociocultural. Neste processo, as decisões se conectam umas às outras a partir de uma rede dinâmica que vai assimilando novas informações e se modificando até delinear uma trajetória viável. No trajeto é essencial identificar estratégias que facilitem a gestão das variáveis projetuais, promovendo a conexão das informações e auxiliando a síntese de conceitos.

Considerando tais aspectos no universo acadêmico estudado, os procedimentos pedagógicos costumam canalizar muitas ações didáticas em prol da edificação da competência expressiva dos estudantes, com o objetivo de prepará-los para esta articulação semântica na sintaxe visual dos artefatos projetados. Para isso, as ferramentas de síntese imagética se mostram como ótimas aliadas na gestão do sistema projetual, ampliando a análise de aspectos subjetivos na experiência de uso do vestuário de moda.

Sanches e Martins (2015) ratificam que a síntese visual, por meio do emprego de imagens, auxilia a organização sistêmica do pensamento sobre a dimensão estético-simbólica do projeto e, ao mesmo tempo, é uma importante ferramenta de comunicação entre os profissionais que participam do processo de desenvolvimento de produtos, já que facilitam a visão panorâmica e a discussão sobre o processo, estimulando cada sujeito a coordenar seu domínio de ação sob o mesmo foco.

2.3. O Pensamento Visual como Estratégia Projetual no Design de Moda

No âmbito do design de moda, a comunicação por meio de imagens, incluindo desenhos de representação do produto e pesquisas fotográficas, pode ser utilizada em várias etapas do projeto. Sanches (2012) reforça que as ferramentas de síntese visual são essenciais ao fluxo de interações entre os elementos do sistema projetual e funcionam como meio de organização cognitiva para concretizar abstrações, facilitar a síntese de conceitos e comunicar ideias no trabalho em equipe

Motta (2010) enfatiza que as representações imagéticas são responsáveis por grande parte da viabilização do raciocínio humano. Elas consistem no principal conteúdo do pensamento, independente da “modalidade sensorial” que a gerou e de se referirem à uma coisa ou a um processo. (Damasio, 1996, p.36 apud Motta, 2010, p.120). Nesta direção, Dondis (1997) menciona uma “inteligência visual” e a capacidade humana de se comunicar em um plano não verbal. Em vista desse papel determinante da visualidade, esta autora defende a relevância de inserir, no percurso educativo profissional, a formação de um repertório para manejar a linguagem visual.

No contexto estudado, as imagens são usadas para delinear os parâmetros de sintaxe visual e indicadores de qualidades expressivas que são identificadas nas pesquisas de contextualização do universo do usuário, o qual também pode ser mapeado com a ajuda da síntese visual. Sendo assim, Sanches e Martins (2015) mapearam ferramentas que já demonstraram seu valor nas práticas didáticas do design de moda. Entre as principais ferramentas, destaca-se os painéis de síntese do cenário de inserção do produto, como o Painel de Estilo de Vida e o *Mood Board* de conceito de marca, assim como os de expressão emocional, como o Painel Semântico e o Painel de Tema Visual.

Por outro lado, Eppler e Burkhard (2004) investigam os benefícios do uso de representações visuais para transferência e produção de conhecimento, afirmando que a maioria das atividades cerebrais lida com o processamento e análise de imagens visuais. Conforme os autores, muitos estudos empíricos já mostraram que as representações visuais são mais eficazes que as verbais em diferentes tarefas, uma vez que a capacidade do canal de entrada de estímulos é maior quando são usadas as habilidades visuais.

Neste rumo, a utilização de mapas mentais tem sido amplamente adotada nas esferas do ensino/aprendizagem de projeto. De acordo com Buzan e Buzan (1996), esse tipo de ferramenta integra diversas estruturas cognitivas, encadeando o pensamento irradiante, o imaginativo e o estruturado, simultaneamente. Desta forma, promove a irradiação de uma ideia central em uma rede de relações, as quais são impulsionadas por estímulos associados (palavras, Imagens, esquemas gráficos, etc.) e sintetizadas em um espaço multidimensional que facilita uma apreensão totalizante e unificante das informações.

Pelo exposto, o uso do pensamento visual, por meio de representações gráficas, favorece a percepção de conexões simultâneas, imprimindo mais agilidade na compreensão das relações do "sistema projetual" e na associação de informações. À luz destes preceitos, sobressaem duas aplicações relevantes da síntese visual na delimitação projetual do design de moda: a gestão de informações e a expressão de referências estético-simbólicas. Estes direcionamentos serviram como plataforma da ferramenta apresentada nesta explanação.

3. Abordagem Metodológica

Com o intuito de estudar estratégias para a sintaxe da forma no ensino/aprendizagem de projeto diretamente no universo acadêmico do design de moda, a investigação de doutoramento tomou a forma de projeto de pesquisa na Universidade Estadual de Londrina (UEL), nomeado Incubadora de Novas Ideias: laboratório de estudo de metodologias para a sintaxe visual. A partir de análises fundamentadas em pesquisa bibliográfica, pesquisa documental e experimentações qualitativas em sala de aula, identificou-se um instrumental metodológico que demonstrou bons resultados em situações projetuais diversificadas. Com base nestas constatações, foi elaborado um conjunto de ferramentas inovadoras que se destinam à gestão de informação e à expressão de conceitos de linguagem visual, das quais será detalhada apenas a que se refere à síntese expressiva, denominada Mapa de Categorias Expressivas.

Para validação das ferramentas foram realizadas interações com estudantes do Curso de Design de Moda da UEL. Sob a abordagem qualitativa da investigação etnográfica, empregou-se a observação participante em oficinas/aulas de projeto. Tendo em vista que a observação participante presume seus desdobramentos conforme realiza a aproximação com o universo pesquisado, os contatos em campo foram empregados em mais de uma etapa da pesquisa de doutoramento, uma vez que as elaborações iniciais das ferramentas exigiram a identificação de pontos críticos, a partir da observação das condutas espontâneas entre os estudantes.

As observações foram documentadas por meio de imagens fotográficas, vídeos e protocolos de observação, com registro simultâneo de observações descritivas e reflexivas, sendo distribuídas em três momentos (com grupos distintos), contando com a colaboração de 65 alunos (total) e 8 professores colaboradores.

4. Resultados e Discussão

O projeto *Incubadora de Novas Ideias: laboratório de estudo de metodologias para a sintaxe visual* realizou análises dos documentos de registro de projeto, efetuados pelos próprios alunos. Os resultados destas análises exploratórias indicaram que, no universo estudado, o uso de sínteses imagéticas como painel semântico e *mood board* já eram bastante valorizadas, assim como os diagramas gráficos, principalmente os mapas mentais, que têm sido cada vez mais frequentes entre as ferramentas escolhidas pelos estudantes.

Outra estratégia a ressaltar no ambiente estudado é a utilização de verbos de ação como ponto de partida para a experimentação da forma. Nas práticas criativas com a modelagem tridimensional (*moulage*), um verbo é tomado como impulsionador para a manipulação de possibilidades formais, estimulando a transformação de ideias. Assim, o verbo acolher, por exemplo, poderia dar impulso à várias maneiras de movimentar o plano têxtil sobre o corpo e gerar diversas interpretações volumétricas, ou derivar outros verbos para experimentação, como proteger, abrigar, aconchegar, etc.

Sobre este alicerce detectou-se que algumas ferramentas metodológicas poderiam ser coordenadas, otimizando o emprego do pensamento visual na síntese de referencias para a sintaxe da forma no design de moda. Considerando os conhecimentos prévios dos estudantes, as bases teóricas da pesquisa bibliográfica e as constatações da observação participante, construiu-se os parâmetros para proposta do Mapa de Categorias Expressivas.

A referida ferramenta se aplica à síntese e comunicação de conceitos de configuração. Com ele pode-se organizar, reunir e filtrar referenciais estético-simbólicos, sintetizando uma estrutura de conexões para o enunciado visual do artefato projetado, na qual se evidencia possibilidades configurativas. Foi concebido a partir de uma combinação de técnicas, incluindo *mood board*, escala de diferencial semântico, verbos de ação e mapa mental.

A partir do uso de estratégias para a exploração do contexto sociocultural, os estudantes identificam códigos simbólicos que permeiam o universo usuário e são capazes de sintetizar o conceito gerador (Sanches, 2011; Sanches et al., 2016) por meio de palavras-chave que definem o verbo de ação inicial. Para impulsionar a geração de ideias é efetuada uma coleta subjetiva de imagens, quando os participantes do projeto recolhem imagens que representam a ação sugerida pelo verbo. De posse destas imagens, o próximo passo é a elaboração de um mapa mental imagético, em que se conectam representações similares e são identificadas possíveis categorias expressivas.

Para extrair elementos configurativos desta ferramenta, uma escala de diferencial semântico é aplicada para analisar as percepções sensórias (luz, temperatura, toque e gesto) de cada categoria expressiva. Para esclarecimento, uma escala de diferencial semântico mensura as reações emocionais que acompanham uma palavra, um objeto ou uma imagem. Sua utilização pode ser resumida do seguinte modo: a partir de dois descritores (adjetivos) opostos, situados nos extremos de uma escala em que se apresenta um intervalo de valores, qualifica-se as sensações provocados pelo objeto (palavra ou imagem) conforme se aproximam mais de um extremo ou outro (Osgood, Suci e Tannenbaum, 1957; Martins e Theóphilo, 2008).

Finalmente, as mensurações das percepções sensórias, resultantes do diferencial semântico, são interpretadas em cores (luz e temperatura), texturas (toque) e estruturas formais (gesto). Para melhor entendimento, as Fig.2 e Fig.3 mostram exemplos de aplicação.

Fig. 2 Exemplo de Mapa de Categorias Expressivas. Fonte: acervo da autora (2013)

Fig. 3 Oficina de Projeto com Aplicação do Mapa de Categorias Expressivas. Fonte: acervo da autora (2013)

5. Considerações Finais

De acordo com Cardoso (2012), os conceitos simbólicos que são atribuídos à um objeto, em realidade não são qualidades fixas e tampouco derivam diretamente da sua configuração física, mas de um repertório cultural e de pressupostos, ou seja, o significado é construído pela integração da percepção humana, com o tempo, o espaço, a cultura e a memória. Não obstante, mesmo que a interpretação esteja circunstanciada por repertórios individuais e o contexto, as percepções de sentido provocadas pelo artefato se efetivarão apenas se o suporte formal/visual estiver organizado de modo a estimular associações peculiares aos universos em que transitam os usuários interpretadores.

Neste rumo, o Mapa de Categorias Expressivas possibilita o direcionamento dos elementos sintáticos de modo integrado e pertinente. Igualmente, promove a comunicação entre os participantes do projeto e facilita as iniciativas de design colaborativo, uma vez que o usuário pode ser incluído na elaboração do mapa mental imagético.

Ainda que os resultados se refiram às aplicações no universo acadêmico do design de moda, as mesmas estratégias poderiam ser estendidas a outras experimentações, visto que as ferramentas de síntese visual favorecem a percepção de conexões simultâneas e, como meio de organização cognitiva, facilitam a expressão de abstrações e a síntese de conceitos.

Ressalta-se que o Mapa de Categorias Expressivas foi adotado no ambiente pesquisado, depois das validações efetuadas por intermédio de análises comparativas, auto avaliações dos estudantes e avaliações dos professores colaboradores que participaram do estudo. Entretanto, percebe-se que para a evolução destas novas abordagens, a organização curricular do curso em questão pode ser fator de influência, já que o seu projeto pedagógico promove a flexibilidade de planejamento e a integração das unidades curriculares na prática projetual. Finalmente, sob o rumo da gestão sistêmica do projeto e do pensamento visual, espera-se avançar na busca por melhores práticas educacionais para o desenvolvimento do raciocínio projetual entre estudantes de design de moda.

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Farmácia hospitalar como oportunidade para a gestão de design no trabalho de prevenção do erro de medicação: estudo em uma realidade brasileira

Hospital pharmacy department as an opportunity to design management for medicine error prevention: a study of a brazilian reality

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Resumo

O erro de medicação é um problema do qual nenhum hospital está imune. O trabalho para a prevenção do erro deve, portanto, ser uma constante que visa, em última análise, a segurança do paciente. Um antecedente importante para reduzir a probabilidade da ocorrência do erro é criação de uma cultura de segurança em todo o sistema de medicação. (Werner, Nelson e Boehm-Davis, 2012; Anvisa, 2010; Otero López et al., 2008b; Schneider, 2007; entre outros). A gestão de design pode agir, assim, contribuindo com a resolução de problemas de forma ordenada e lógica (Borja de Mozota, Klöpsch e Xavier da Costa, 2011) e cooperando para a eficiência estratégica das inter-relações (Best, 2012). Neste sentido, deu-se a questão de pesquisa: em que setor do hospital pode-se iniciar um trabalho de gestão de design que venha a contribuir para a prevenção do erro de medicação? O objetivo traçado pela pesquisa foi de identificar um setor do hospital onde ações de design possam ser implantadas para, de forma estratégica, prevenir o erro de medicação. Para tanto, foi realizada uma pesquisa sistemática, com foco em um levantamento bibliográfico exploratório, de natureza básica. Primeiramente foram abarcados dados qualitativos sobre as características do erros de medicação e a sua classificação segundo a literatura. Posteriormente houve o mapeamento dos setores envolvidos no sistema de medicação e o apontamento de ações onde a gestão de design pode atuar como apoio à prevenção do erro. O resultado indicou a farmácia hospitalar como um setor estratégico e de oportunidade para a atuação da gestão de design. Ficou evidenciado que, ali, o trabalho de prevenção tem sido efetivado essencialmente por profissionais da área da saúde que tem o domínio sobre as formas nas quais o erro de medicação pode ser evitado, porém desconhecem o campo do design em sua abrangência e, portanto, não utilizam as possibilidades dessa área. Outros resultados concentram-se no apontamento, ainda inicial, de possibilidades nos níveis operacional, tático e estratégico do design que cooperam para a prevenção do erro de medicação. Entre elas, citam-se melhorias nas identificações de produtos fracionados e armazenados, organização do espaço e otimização do trabalho. Esta pesquisa foi parte embasadora de um projeto que *está em prática em um laboratório de design de uma universidade brasileira. Ocorre a partir do trabalho de uma equipe multidisciplinar, que conta com pesquisadores designers, em parceria com profissionais da área da saúde atuantes em um hospital público psiquiátrico.*

Palavras-chave: *design, gestão, sistema, hospital, medicação.*

Abstract

Medication error is a potential risk in any hospital. Preventing medication error must therefore be a continuous work, aiming the safety of the patients. The creation of a safety culture throughout all the hospital medication system is an important step to reduce probability of error. (Werner, Nelson e Boehm-Davis, 2012; Anvisa, 2010; Otero López et al., 2008b; Schneider, 2007; among others). Thus, design management may act in order to contribute solving problems in an ordered and logic way (Borja de Mozota, Klöpsch and Xavier da Costa, 2011) and to collaborate with the strategic efficiency of interrelations (Best, 2012). This research aims to identify a department in the hospital where design actions might take place to prevent medication errors in a strategic way. Therefore, a systematic research was conducted, focusing on basic exploratory bibliographic survey. At first, qualitative data about the characteristics of medication errors were gathered and classified, based on literature. Then the departments evolved on the medication system were charted to point where design management might act to support error prevention. The results indicated the hospital pharmacy as an opportune and strategic department for the actions of design management. It was evidenced that at the hospital pharmacy, prevention work has been essentially performed by health professionals who are proficient at the ways to avoid errors, but disregard the field of design in all its range, and therefore, they do not use the possibilities of it. Other results focus on pointing, still early, possibilities on operational, tactical, and strategic levels of design that cooperate to medication error prevention. Among them, better identification on fractionated and stocked products, space organization, and optimization of work processes were reported. This research was the basis of a project that is being conducted on a design laboratory in a Brazilian university. It occurs from a multidisciplinary team, counting with design researchers in partnership with health professionals of a public psychiatric hospital.

Keywords: *design, management, system, hospital, medication.*

1. Introdução

Os erros de medicação, segundo Mendes et al. (2014), são importantes causas de morbidade e mortalidade. Os autores apontam que tais erros causam a morte de 1 (um) a cada 131 (cento e trinta e um) pacientes ambulatoriais e 1 (um) a cada 854 (oitocentos e cinquenta e quatro) pacientes internados, o que consiste numa taxa de erros de medicação que varia entre 4,8% e 5,3%. Pesquisadores que estudaram o tema em hospitais públicos brasileiros, chegaram a identificar problemas na administração de 30% dos casos (Moreira Reis et al., 2010).

Os erros estão ligados a diversos fatores relacionados ao paciente, aos profissionais de saúde e ao medicamento, como a semelhança de embalagem e dos nomes dos produtos e a maneira de identificá-los nos processos intrínsecos ao sistema de medicação. Podem ser ocasionados por problemas de prescrição, por omissão, por dispensação equivocada, por administração de dose errada ou dose farmacêutica imprópria, por preparação inadequada, entre outros. (MENDES et al., 2014; Almeida Lopes et al., 2012; Moreira Reis et al., 2010; Azevedo Anacleto et al., 2010)

Nesse contexto e, ainda, considerando relatos trazidos pela mídia brasileira onde chamaram a atenção a presença de erros como armazenamento de medicamentos em local equivocado, relatos de sobrecarga de trabalho vivida pelo professional da saúde e trocas decorrentes de extrema semelhança de embalagens e rótulos de medicamentos (TEIXEIRA, 2011; G1, 2010; CAVALLARI, 2010), apresenta-se a pesquisa concentrada na seguinte questão: em que setor do hospital pode-se iniciar um trabalho de gestão de design que venha a contribuir para a prevenção do erro de medicação?

A pesquisa partiu do princípio de que o erro de medicação é um aspecto que nenhum hospital está imune (Werner, Nelson e Boehm-Davis, 2012, entre outros) e que existem protocolos indicando caminhos para a prevenção desse tipo de erro (Anvisa, 2010; Otero López et al., 2008b). Também considerou que a gestão de design, enquanto processo sistemático, ou seja, de resolução de problemas de forma ordenada e lógica (MOZOTA; KLÖPSCH; COSTA, 2011), pode contribuir para a questão da prevenção do erro de medicação. Isso porque o contexto do sistema de medicação hospitalar tem características que demandam um trabalho orientado a uma abordagem global que, ao mesmo tempo, considera partes individualizadas. A gestão de design, justamente, apresenta-se sob a perspectiva de uma visão do todo unificado, conectado a partir da eficiência das inter-relações e interdependências das partes individuais que o compõem (Best, 2012).

Neste sentido, o artigo apresenta a pesquisa que delineou-se no objetivo geral de identificar um setor do hospital onde ações de design possam ser implantadas para, de forma estratégica, prevenir o erro de medicação. Como objetivos específicos, visou-se realizar um levantamento sistemático para verificar os indicativos da literatura neste contexto e compreender como se dá o sistema de medicação na realidade brasileira.

Para tanto, foi realizada uma pesquisa sistemática, com foco em um levantamento bibliográfico exploratório, de natureza básica. Primeiramente foram abarcados dados qualitativos sobre as características do erros de medicação e a sua classificação segundo a literatura. Posteriormente houve o mapeamento dos setores envolvidos no sistema de medicação, a visita para conhecimento da realidade de um hospital e o apontamento de ações onde a gestão de design pode atuar como apoio à prevenção do erro.

2. Procedimentos metodológicos

O levantamento bibliográfico exploratório ocorreu em duas etapas. A primeira, deu-se por meio da pesquisa sistemática que abrangeu, especialmente, artigos de periódicos científicos disponibilizados nas bases *Ebsco Host* (Ebsco-Publishing, 2015), *Scielo* (Fapesp et al., 2015), *Science Direct* (Elsevier, 2015a), *Scopus* (Elsevier, 2015b) e *Web of Science* (Thomson Reuters, 2015). Também houveram levantamentos nas bases *BDTD* (Ibict, 2015) e *ProQuest* (2015) a fim de identificar possíveis teses nesta área de interesse. A partir desta pesquisa sistemática, que utilizou procedimentos baseados no Processo de Mineração de Dados (Blum, Merino - Díaz e Merino - Schmidt, 2015), também se chegou a outras fontes sobre o tema – como registros em literatura, artigos de evento e apontamentos de estudos e de diretrizes. Algumas delas eram parte das referências trazidas pelos artigos verificados em tal revisão.

A segunda etapa do levantamento bibliográfico ocorreu após a primeira fase evidenciar um setor do hospital – a farmácia. Para a constatação de que este, de fato, se enquadrava como ponto estratégico para a gestão de design, a revisão sistemática foi ampliada. Um novo levantamento incluiu especificidades deste setor, por meio do uso de descritores e operadores booleanos (Figura 1).

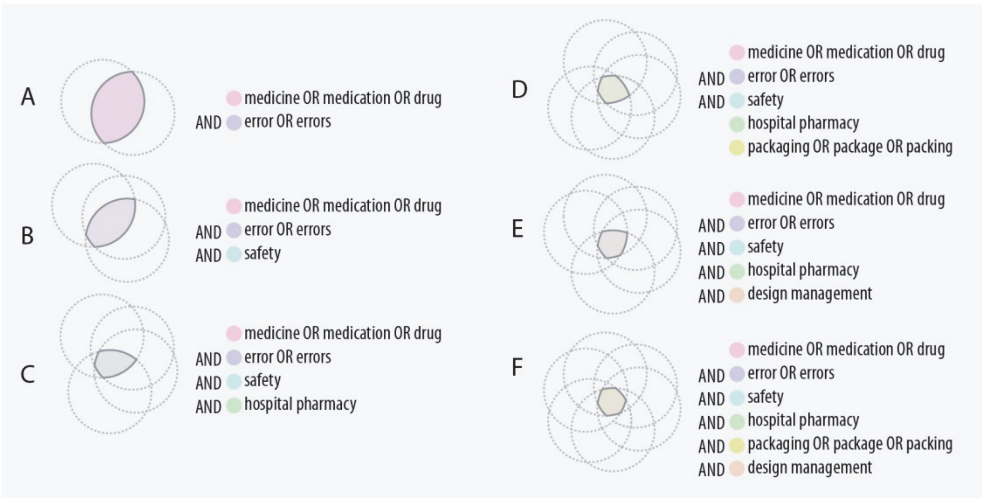

Fig.1 - Tópicos da revisão sistemática realizada na segunda etapa do levantamento bibliográfico. Fonte: os autores.

O processo baseado na Mineração de Dados é adaptado dos passos apresentados por Oliveira Rezende et al. (2005): (i) Conhecimento do domínio; (ii) Pré-processamento; (iii) Extração de padrões; (iv) Pós-processamento; (v) Utilização do conhecimento. Na etapa (i) Conhecimento do domínio foram selecionadas as bases de dados que apresentavam um conjunto de informações relevantes, em termos de quantidade, frente ao interesse da pesquisa. Em (ii) Pré-processamento, os termos descritores foram estabelecidos, bem como selecionados os limitadores de pesquisa disponibilizados em cada base de dados.

A (iii) Extração de padrões ocorreu utilizando combinações expressas por meio de operadores booleanos. O (iv) Pós-processamento envolveu a leitura e avaliação dos dados levantados e a seleção final que considerou, especialmente, a afinidade do dado no contexto da pesquisa – particularmente relevando o título, as palavras-chave e o resumo da publicação. Para (v) Utilização do conhecimento, procedeu-se à leitura dos textos selecionados e seu uso, tanto na construção da fundamentação teórica quanto como meio de se chegar a outros dados não contemplados nesta mineração.

3. O erro de medicação no contexto hospitalar

O National Coordinating Council for Medication Error Reporting and Prevention (Ncc Merp, 2015, tradução nossa) define que um erro de medicação é “qualquer evento evitável que pode causar ou levar ao uso inapropriado de medicamentos ou a danos ao paciente, enquanto o medicamento está sob controle do profissional de saúde, paciente ou consumidor”. Esclarece ainda que tais eventos “podem estar relacionados a práticas profissionais, produtos de saúde, procedimentos e sistemas; incluindo prescrições e ordens, rótulo, embalagem, nomenclatura, composição, dispensação, distribuição, administração, educação, monitoramento e uso”.

De forma similar, o órgão regulador ligado ao Ministério da Saúde brasileiro, a Agência Nacional de Vigilância Sanitária – Anvisa (2010), coloca que erro de medicação é “qualquer evento evitável que, de fato ou potencialmente, pode levar ao uso inadequado de medicamento”. Explica que “o uso inadequado pode ou não lesar o paciente, e não importa se o medicamento se encontra sob o controle de profissionais de saúde, do paciente ou do consumidor”. Ainda, indica que o erro pode estar relacionado “à prática profissional, produtos usados na área da Saúde, procedimentos, problemas de comunicação”, incluindo-se, portanto, questões como “prescrição, rótulos, embalagens, nomes, preparação, dispensação, distribuição, administração, educação, monitoramento e uso de medicamentos”.

A abordagem do erro pode se dar de forma pessoal ou sistêmica (Reason, 1990). Azevedo Anacleto et al. (2010) comentam que, em geral, o sistema de saúde brasileiro adota a abordagem pessoal, quando o erro é considerado um fato ocasionado por um indivíduo que deve, portanto, ser punido com medidas disciplinares, tais como reprimendas orais ou escritas. Por outro lado, é ideal considerar a abordagem sistêmica, pois esta compreende o todo onde o erro está inserido. Os autores esclarecem que o erro é uma consequência e não uma causa, que o ser humano e os sistemas são falíveis e que mudar a condição humana está aquém de mudar o sistema e torná-lo mais seguro.

Neste sentido, a compreensão do sistema hospitalar é inerente ao entendimento do erro de medicação. No ambiente do hospital é preciso considerar que existem dinâmicas próprias afetadas por: imprevistos e emergências que exigem complexas tomadas de decisão; atividades desenvolvidas em coletivo e divididas em turnos de trabalho e numa série de locais ou setores; intervenções diretamente sobre o ser humano, com implicações psíquicas e sociais. O erro, desta forma, é parte integrante de um conjunto de fatores que caracterizam o hospital como “ao mesmo tempo o lugar de um futuro cada vez mais eficiente e eficaz e o local de atendimento do sofrimento humano”. (Martin, Gadbois, 2007, p. 512)

Embora nem todos os erros possam ser classificados como sistêmicos – já que há comportamentos individuais que levam ao estado de risco (Azevedo Anacleto et al., 2010), a abordagem no sentido mais global favorece que falhas no processo sejam identificadas e que, desta forma, melhorias sejam implantadas para diminuir a ocorrência desses eventos (Borges Rosa e Perini, 2003). A abordagem recomendada pela Anvisa (2010) expõe a necessidade de “uma revisão de todas as etapas do ciclo do medicamento para a identificação da cadeia de falhas, quando da investigação de um erro”, já que “os erros de medicação são eventos complexos, envolvendo múltiplas etapas, procedimentos e pessoas”.

O erro é passível de ocorrência em qualquer ponto do sistema de medicação. Entende-se por sistema de medicação a série de procedimentos que ocorre desde a prescrição do medicamento pelo médico até o momento da administração da medicação no paciente (Monteschi Souta, 2015; Grou Volpe, 2014; Mcleod et al., 2014; Otero López et al., 2008b e 2008b; Perufo Opitz, 2006). Neste processo, os erros mais comuns, conforme explica Maiques Juliani (2014, p. 111-112), podem ser classificados em três tipos: de prescrição, de dispensação e de administração. O erro de prescrição é “um erro de decisão ou de redação, não intencional, que pode reduzir a probabilidade de o tratamento ser efetivo ou aumentar o risco de lesão ao paciente". O erro de dispensação considera aqueles relacionados aos equívocos de conteúdo, de rotulagem ou de documentação. O erro de administração é aquele ocorrido no preparo e na administração do medicamento.

Para compreender as circunstâncias do erro de medicação em um sistema que perpassa por diversos processos, ações de detecção do erro podem ser estabelecidas. Otero López et al. (2008a) apontam uma classificação estruturada, que visou padronizar a detecção, análise e registro dos erros de medicação na Espanha. Este modo de classificação do erro apoiou-se na taxonomia desenvolvida pelo Ncc Merp (1998). Consiste de uma série de tópicos que envolvem, desde a caracterização do paciente e das informações gerais sobre o contexto do erro e as consequências, até pontos que precisam ser considerados para detalhá-lo, tais como características específicas do processo em que houve a ocorrência e os fatores contribuintes para tanto (Quadro 1).

Quadro 1. Tipos, causas e fatores associados ao erro de medicação

Tipos de erro de medicação	Causas do erro de medicação	Fatores associados ao trabalho que contribuem para o erro
(1) Medicamento errado (2) Omissão de dose ou do medicamento (3) Dose errada (4) Frequência de administração errada (5) Forma farmacêutica errada (6) Erro de armazenamento (7) Erro de preparo, manipulação e/ou acondicionamento (8) Técnica de administração errada (9) Via de administração errada (10) Velocidade de administração errada (11) Horário errado de administração (12) Paciente errado (13) Duração do tratamento errada (14) Monitorização insuficiente do tratamento (15) Medicamento deteriorado (16) Falta de adesão do paciente (17) Outros tipos	(1) Problemas de comunicação / interpretação (2) Confusão entre nome/sobrenome de pacientes (3) Confusão entre nomes de medicamentos (nomes comerciais e princípios ativos) (4) Problemas na rotulagem / embalagem ou informações do produto (5) Problemas nos equipamentos e dispositivos de dispensação / preparação / administração (6) Fatores individuais (7) Outras causas	(1) Ausência ou insuficiente cumprimento de práticas prioritárias de segurança (2) Ausência de padronização de procedimentos ou práticas assistenciais (3) Ausência de protocolos ou guias clínicos atualizados de tratamento ou uso de medicamentos (4) Ausência ou obsolescência de fontes de informação sobre medicamentos (5) Ausência de sistemas de identificação do paciente (pulseira identificadora, etc) (6) Sistemas de comunicação / informação deficientes (7) Falta ou falha no processo de reconciliação (8) Medicamento não disponível (9) Condições de armazenamento inadequadas (falta de espaço, etc) (10) Sistemas deficientes de preparação / dispensação de medicamentos (11) Falta de informação, aos pacientes, sobre os medicamentos (12) Falta de programas ou protocolos de acompanhamento aos pacientes (13) Falta de programas de assistência para pacientes ambulatoriais (geriátricos, etc) (14) Pessoal (15) Fatores ambientais (16) Situação de emergência (17) Inércia do sistema (18) Outros fatores

Fonte: adaptado de Otero López et al. (2008a)

Em síntese, o erro pode ser classificado dentre, pelo menos, 16 (dezesseis) diferentes tipos que não somente consideram a troca equivocada de medicamentos, mas também aspectos como a administração de dose ou via erradas e problemas relacionados ao armazenamento, à identificação do paciente e à monitorização do tratamento. Entre as causas do erro, as confusões na comunicação e na interpretação de informações são as mais recorrentes, assim como problemas na dispensação, no preparo e na administração de medicamentos. Também questões de ordem individual relativas, por exemplo, às condições de trabalho dos profissionais atuantes no sistema.

O erro de medicação é um fato do qual nenhum hospital está imune (Werner, Nelson e Boehm-Davis, 2012). Neste sentido, a criação de uma cultura de segurança é um antecedente importante para reduzir a probabilidade da ocorrência do erro (Schneider, 2007). É preciso considerar que erros acontecem, em geral, em consequência de fatores decorridos em série, resultantes de ações partes de um sistema. Especialmente em ambiente hospitalar, onde múltiplas questões estão envolvidas para que ocorra o procedimento de administração do medicamento, uma ação equivocada pode vir de uma parte e afetar o todo, assim como a falta de estratégia no todo pode desencadear problemas aparentemente pontuais (Moreira Reis et al., 2010; Almeida Lopes et al., 2012).

Assim, o trabalho de prevenção do erro aplicado em pontos específicos do hospital tende a contribuir para a segurança do paciente e, portanto, deve ser uma constante. Para tanto, no Brasil, o Ministério da Saúde (Brasil, 2013) sugere que haja a "aplicação sistêmica e contínua de políticas, procedimentos, condutas e recursos" visando a "identificação, análise, avaliação, comunicação e controle de riscos e eventos adversos que afetam a segurança, a saúde humana, a integridade profissional", assim como "o meio ambiente e a imagem institucional". Tais focos voltam-se para a cultura da segurança, sendo esta o "conjunto de valores, atitudes, competências e comportamentos que determinam o comprometimento com a gestão da saúde e da segurança". O preceito é substituir "a culpa e a punição pela oportunidade de aprender com as falhas e melhorar a atenção à saúde".

4. Identificação de setor para trabalho de prevenção

A compreensão do sistema de medicação foi o primeiro passo para identificação de um setor do hospital onde, por meio da gestão de design, um projeto pudesse ser implantado, corroborando para o trabalho de prevenção. O sistema de medicação se refere a uma série de procedimentos que configuram o ciclo do medicamento no hospital (Monteschi Souta, 2015; Grou Volpe, 2014; Mcleod et al., 2014; Otero López et al., 2008a e 2008b; Perufo Opitz, 2006). A prescrição, a dispensação, o preparo e a administração de medicamentos são alguns dos principais processos constituintes desse sistema.

Em cada um dos processos do sistema de medicação, atuam profissionais – entre eles médicos, enfermeiros e farmacêuticos – que envolvem-se em atividades específicas para que a medicação chegue até o paciente. Neste contexto, "a escolha de um sistema de dispensação adequado contribuirá para a segurança e cumprimento da terapia medicamentosa prescrita ao paciente" (Ferreira Braga, 2014, p. 83). A dispensação é o processo de distribuição do medicamento, "a maneira pela qual a farmácia envia os medicamentos aos pacientes, mediante análise prévia das prescrições médicas" (Andrade dos Santos, 2006, p. 149), fazendo com que estes cheguem até a enfermaria para que seja administrado no paciente.

O fluxo de dispensação pode variar de hospital para hospital. No Brasil, destacam-se especialmente três: o sistema coletivo de dispensação, o individualizado e o de dispensação em dose unitária (Ferreira Braga, 2014; Maiques Juliani, 2014; Andrade dos Santos, 2006). O que varia entre eles é o curso de trabalho entre os setores, ou seja, as atividades desempenhadas pelos profissionais envolvidos – médicos, farmacêuticos, enfermeiros, entre outros – para que a medicação chegue até o paciente (Figura 2).

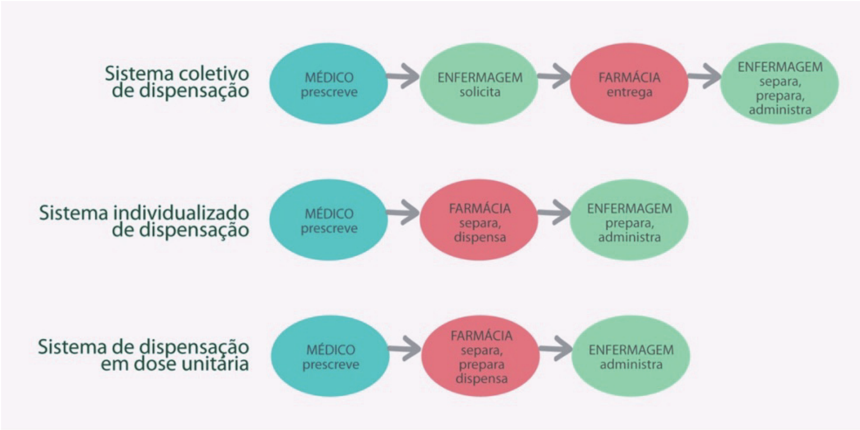

Fig. 2 – Fluxos do sistema de medicação hospital. Fonte: os autores

A prescrição é a indicação do medicamento que configurará o tratamento do paciente e é realizada pela equipe médica. Por meio de receituários, os medicamentos são requeridos à farmácia diretamente pelo médico ou com solicitação realizada via enfermagem. A farmácia entrega os medicamentos passando pelo processo de separação, que engloba a leitura da prescrição e a dispensação de medicamentos fracionados – a "subdivisão de um medicamento em frações individualizadas" (Brasil, 2006, p. 4). No sistema coletivo de dispensação, a enfermagem fica responsável, também, pela separação do medicamento que irá administrar. O processo de preparação do medicamento é, em geral, uma tarefa da enfermagem – exceto no sistema de dispensação em dose unitária, quando a própria farmácia realiza o preparo – sendo, os enfermeiros, os responsáveis pela administração do medicamento no paciente.

Analisados os fluxos que configuram os sistemas de medicação na realidade brasileira, levantou-se, ainda, os pontos do processo a serem considerados para a prevenção do erro de medicação. Nesse sentido, identificou-se que a Anvisa (2010) ressalta ações que perpassam pelos processos de prescrição, de dispensação, de administração, de monitorização e de sistemas e gerenciamento do controle (Quadro 2).

Quadro 2. Prevenção nos processos intrínsecos ao sistema de medicação

Pontos dos processos para prevenção do erro	
Prescrição	Avaliação da necessidade e seleção do medicamento correto; Individualização do regime terapêutico; Estabelecimento da resposta terapêutica desejada.
Dispensação	Revisão da prescrição; Processamento da prescrição; Mistura e preparo dos medicamentos; Dispensação dos medicamentos de maneira adequada e oportuna.
Administração	Administração do medicamento correto para o paciente correto; Administração do medicamento quando indicado; Informação ao paciente sobre a medicação; Inclusão do paciente no processo de administração.
Monitorização	Monitorização e documentação da resposta do paciente; Identificação e notificação de eventos adversos aos medicamentos; Reavaliação da seleção do medicamento, regime, frequência e duração do tratamento.
Sistemas e gerenciamento do controle	Colaboração e comunicação entre os responsáveis pelos cuidados de saúde; Revisão e gerenciamento do regime farmacoterapêutico do paciente.

Fonte: adaptado de Anvisa (2010)

Com levantamento dos pontos em que a prevenção do erro de medicação pode ser aplicada no sistema e com o cruzamento dessas informações junto às características de trabalho dos setores do hospital, a farmácia ficou evidenciada como mote estratégico. Dentre os processos de prescrição, dispensação, administração, monitorização e gerenciamento do controle, a farmácia revelou-se como setor-chave para início de um trabalho de prevenção via gestão de design, especialmente porque o profissional que atua na farmácia tem posição estratégica para supervisionar a qualidade do processo de medicação, desde a prescrição até a distribuição (Guchelaar et al., 2005).

Tamuz, Thomas e Franchois (2004) esclarecem que o fluxo de dados que levam ao erro de medicação pode ser reduzido por meio de rotinas de aprendizagem organizacional implantadas na farmácia hospitalar. A farmácia é um ponto importante na prevenção do erro no hospital, visto que o potencial de erro de medicação existe em diferentes setores, mas problemas nos procedimentos da farmácia podem estender-se para as demais fases do sistema de medicação (Almeida Lope et al., 2012).

Pela amplitude dos serviços que são de responsabilidade da farmácia hospitalar, é entendido que ela se caracteriza como uma unidade técnico-administrativa dentro do hospital, sendo que suas funções a relacionam com outros setores (Figura 3) do hospital (Andrade dos Santos, 2006). Dentre as funções da farmácia hospitalar, estão os processos de gerenciamento, de seleção de medicamentos, de programação, de aquisição, armazenamento, distribuição e de informação e a responsabilidade sobre a farmacotécnica – no qual se inserem os procedimentos de fracionamento – o ensino e a pesquisa (Cavalcante Dantas, 2011).

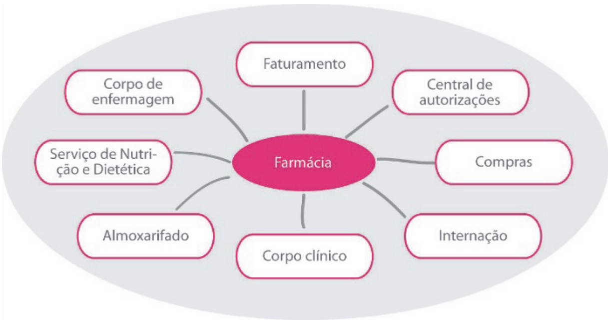

Fig. 3 – Relações da farmácia no context hospitalar. Fonte: adaptado de Andrade dos Santos (2006, p. 53)

Dentre os citados, o armazenamento, o fracionamento e a distribuição ou dispensação são procedimentos rotineiros de uma farmácia hospitalar. E, conforme destaca Almeida Lopes et al. (2012), embora exista risco de erro nos demais setores do hospital, a farmácia é o setor de dispensação responsável pelo quantitativo de medicamentos. Portanto, erros ocorridos na farmácia fazem com que o risco se estenda para as demais fases do sistema de medicação, o que pode ser agravado mediante o quantitativo de pacientes sob os cuidados da equipe multidisciplinar.

Azevedo Anacleto et al. (2010, p. 9) enfatiza que, como a principal função da farmácia é a dispensação nas quantidades e especificações solicitadas e nos prazos requeridos, ela promove o uso seguro e correto de medicamentos. Destaca que "a organização e sua prática devem prevenir que erros de dispensação aconteçam e por criarem oportunidades de erros de administração, possam atingir os pacientes". Neste sentido, a farmácia é, estrategicamente, um setor do hospital cuja prevenção do erro impacta em todo o sistema de medicação.

Visando a prevenção do erro, a aplicação da gestão de design na farmácia hospitalar pode, contudo, se dar a partir de ações diversas. A pesquisa demonstrou que, dentre os principais enfoques do erro na farmácia dos hospitais, estão o erro de conteúdo, o erro de rotulagem e o erro de documentação. Observando as características de cada um e os exemplos e, ainda, visitando a realidade de um hospital brasileiro, foi também possível apontar algumas ações de design para corroboração na prevenção (Quadro 3).

Quadro 3. Características, exemplos e apontamentos de possíveis ações de design

Tipos de erro de erro dispensação	Exemplos a partir da farmácia hospitalar	Possíveis ações de design para prevenção
Erro de conteúdo *Erro relativo aos medicamentos prescritos que foram erroneamente dispensados.*	Exemplos de erro de conteúdo Dispensação de medicamento diferente do prescrito; Dispensação de medicamento não prescrito; Dispensação de medicamento com outra forma farmacêutica ou outra concentração; Excesso ou omissão de dose ao dispensar; Medicamentos dispensados mesmo que visivelmente com desvio de qualidade; Medicamentos dispensados sem que constem todos os dados obrigatórios na prescrição;	Prevenção do erro de conteúdo Layout das tabelas e fichas de requisição e dispensação; Sinalização dos diferentes produtos em prateleira; Layout de etiqueta para identificação e diferenciação de produtos; Identificação de pacientes e/ou enfermarias; Diferenciação de indicativos de dose; Estocagem com controle otimizado de validade; Sistemas integrados entre os setores desde a prescrição.
Erro de rotulagem *Erro provindo de dados informacionais no rótulo do medicamento, seja pela incorreta identificação, seja por erros de grafia ou por ilegibilidade no próprio produto ou nas etiquetas utilizadas pela farmácia.*	Exemplos de erro de rotulagem Nome errado do medicamento; Concentração ou forma farmacêutica apresentada erroneamente; Data incorreta; Orientações erradas quanto ao uso ou armazenamento;	Prevenção do erro de rotulagem Cor das etiquetas e rótulos; Tamanho das etiquetas e rótulos; Modos de escrita voltados para legibilidade e leiturabilidade; Sistemas que integrem todo o processo da farmácia; Processos que facilitem a identificação e checagem; Distinção de produtos fracionados e não fracionados; Sinalizações orientadas à validade do produto estocado; Indicativos claros sobre a forma de armazenamento do produto; Layout das orientações de uso.
Erro de documentação *Relacionados com o registro de dados incorretos na documentação de dispensação.*	Exemplos de erro de documentação Ausência ou erro no registro de medicamentos controlados; Ausência de data ou de assinatura do prescritor ou do dispensador.	Prevenção do erro de documentação Identificação de áreas exclusivas para medicamentos controlados; Sinalizações específicas nas fichas de requisição; Sistema de comunicação entre os funcionários; Layout que facilite a identificação, o controle, a checagem e o arquivamento de documentos.

Fonte: adaptado de Azevedo Anacleto et al. (2010) – erros e exemplos. Os autores – apontamentos de ações.

As ações apontadas são práticas de design que se encontram associadas aos níveis da gestão de design. Esses níveis são o operacional, o tático e o estratégico, nos quais o design influencia, respectivamente, na oferta, nas pessoas e na organização (MOZOTA; KLÖPSCH; COSTA, 2011). Na gestão de design operacional, o grau de aplicação se dá nas atividades primárias, como ações de melhoria no layout das etiquetas aplicadas nos medicamentos fracionados. Na gestão de design tático, como competência administrativa, o design muda atividades de apoio, tais como integrações dos sistemas que venham a permitir a comunicação plena entre os setores envolvidos no sistema de medicação. Na gestão de design estratégico, o design pode transformar a cadeia de valor do setor. Neste último, as ações de design aplicadas à farmácia podem ser, futuramente, os meios que venham a operar para novos modelos de gestão na área e, inclusive, para a revisão e melhoria de protocolos e outros aspectos da legislação que regula o sistema de medicação brasileiro.

5. Conclusão

Considerando que o erro de medicação é um fator que nenhum hospital está imune e, portanto, as ações de prevenção visando a segurança são requeridas entre todas as atividades hospitalares, este estudo evidenciou que a gestão de design tem atributos que permitem subsidiar este meio. O contexto investigado revela que a taxa de erros de medicação na realidade brasileira requer atenção. Juntamente, os registros da literatura e dos órgãos competentes no país mencionam ações para a segurança do sistema de medicação. A pesquisa mostrou que o Design pode contribuir para tanto, especialmente porque as algumas das ações de prevenção estão adequadas ao escopo da gestão de design.

Respondendo ao questionamento sobre qual setor do hospital iniciar um trabalho de gestão de design que venha a contribuir para a prevenção do erro de medicação, a pesquisa apontou para a farmácia hospitalar. Por meio do levantamento sistemático, ficou evidenciado que este setor é estratégico no contexto do sistema de medicação. Dentre as principais formas de dispensação de medicamentos na realidade dos hospitais brasileiros, a farmácia hospitalar tem função central no sistema, pois é ela que controla o estoque e o armazenamento, o registro, a separação e a distribuição dos medicamentos.

É na farmácia hospitalar que o sistema de medicação é gerenciado nos seus aspectos técnicos e administrativos. Torna-se fundamental que ações para prevenção do erro de medicação sejam aplicadas diretamente no contexto da farmácia e em todos os níveis de suas atividades. Erros de conteúdo, de rotulagem e de documentação são alguns dos tipos que podem partir da farmácia hospitalar e atingir o sistema como um todo, chegando a equívocos que impliquem no paciente.

Por meio de um trabalho que englobe a gestão de design na farmácia hospitalar, ações que apoiem o trabalho de prevenção podem ser implantadas a curto, médio e longo prazo. Atividades que, hoje, são em geral desenvolvidas por farmacêuticos – tais como layout para identificação de medicamentos fracionados e layout de controle de estoque e checagem – e que fazem parte das habilidades de Design, podem ser melhoradas, otimizadas e, com isso, mais adequadas à prevenção do erro.

Dentre os apontamentos de ações a serem implantadas pela gestão de design visando a prevenção do erro de medicação, estão possibilidades nos níveis operacional, tático e estratégico. A identificação dos produtos pela melhoria da legibilidade e leiturabilidade, a indicação de aspectos que promovam a adequada comunicação entre os profissionais envolvidos no sistema de medicação e, por consequência, a manifestação de modelos de gestão voltados especificamente à farmácia hospitalar são, respectivamente, exemplos da aplicação da gestão de design neste meio.

Esta pesquisa é parte de trabalhos ligados ao projeto “Design e Saúde: da saúde do paciente às questões de saúde do trabalhador”, em prática no Núcleo de Gestão de Design e Laboratório de Design e Usabilidade da Universidade Federal de Santa Catarina. Trata-se da primeira parte de um estudo sobre a medicação em hospitais, tendo se limitado especialmente ao contexto revelado pelo levantamento sistemático focado em literatura. No entanto, a partir desta pesquisa, projetos aplicados já estão em prática em uma farmácia hospitalar, contando com o apoio de uma equipe multidisciplinar, que conta com pesquisadores designers, em parceria com profissionais da área da saúde atuantes em um hospital público psiquiátrico. Futuros estudos focam em demonstrar os resultados dos projetos aplicados e os ganhos da prevenção do erro de medicação por meio da gestão de design.

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Programming Visual Representations. Evolutions of Visual Identities between Tangible and Intangible

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Abstract

The communication design field it is considerably changed in the last 20 years and more as well as the role of the designer. Technology has modified the daily work tools, and new possible relations between the designer, the commitment, and the final user can be underlined.

Observing some of the most experimental practices, new visual languages have drawn the attention, affected by innovative approaches and mixed competencies. The area of visual identities is especially of interest, not excluding other areas of experimentations.

The phenomenon of the so-called dynamic or post-logo identities underlined the possibilities of using more fluid and expressive, variable, context related, processual, performative, non-linear, consistent visual languages instead of the usual and static repetition of a logo or an imposed series of rules (Felsing, 2010). However, also their contradictions in making recognizable an organization and in the visual identity daily management.

An interesting evolution to be underlined is in the use of the digital tools, not anymore in a passive way but in an active way. Visual designers can build their digital tools basing them on design and esthetic needs. The designer is not anymore just the user of ready-made digital tools, becoming himself programmer of customized digital toolboxes by using open source codes or hardware like Arduino. Not just a DIY attitude but something that it is changing the control knobs of a design system in all its process and development.

As far as technology support is relevant, technical matters are relegated in the background on behalf of abstraction and data parametrization that means on behalf of a meta-design level. The use of programming in creative and visual communication design processes "empowers the designer, freeing he from the constraints of predefined computational tools, and promoting creative freedom in the construction of visual metaphors" (Duro, Machado, Rebelo, 2012). The aim of this paper is to argue this recent evolution in the field of visual identities and the wider area of communication design practices.

Keywords: *Communication design, visual identity, brand identity, post-logo.*

1. Visual Identities: from static to dynamic systems

In the broad context of visual communication design disciplines, talking about “identity” usually refers to the field of the image. It refers to the representation of an organization, of a subject (the “personality”), through the use of a particular visual code organized on the basis of a predefined grammar that establishes the rules of operation and combination of primary (symbol or/and logotype), subsidiaries elements (typeface, colors, any other visual elements to be used as coordination elements) and applications (the so-called “points of contact”). Hence the definition of corporate identity, whose normative expression is the “manual”, the “rulebook”, useful to avoid dispersion and weakening of the communication; a typical phenomenon of entities with different interests and characterized by significant fragmentation.

By the use of the term “image”, we may refer to something intangible that marks and allows to identify a subject, making it tangible, so that it can coincide with the term “identity”. The expressions of “visual identity” and “corporate identity” thus tend to coincide. It is necessary to specify that “corporate identity” can allude to something wider than just the visual identity plan. Something that today we call “brand identity”, implying multi-dimensional and multi-channel scales.

Henrion and Parkin (1967) define “corporate image” as “the totality of pictures or ideas or reputations” of a “personality” (single entity or organization that is) in the mind of the people who interact with such “personality”. This idea is formed over time through a series of “points of contact”, such as buildings, products, packaging, printing, vehicles, publications, uniforms, promotional activities, etc. In other words through all that complex of actions, channels, and tools that enable users or clients to get in touch with an organization.

The points of contact - at least those who need a “visual interface” - is precisely the object of visual communication projects, while also involving other design skills depending on the application, the scale, the size that they will have to take. The use of the “manual”, initially utilized in the supra-national dimension organizations (prototypical case, among many, is that of Shell) and then adopted in all areas in which it was requested a project of visual identity, it resulted in the production of corporate images frequently monolithic, based on the logo and its replication on the various applications, without significant variations. However, according to this model, firmly based on an atomistic and structuralistic approach, an “image” is not able to exhaust all the dimensions of a “personality”. In the sixties had already spread the idea, inspired by systemic thinking, that “[...] for the receiver, image rests on a substrate consisting of an assemblage of objects. These objects, in the perception function like the constitutive features of a unitary complex of signs” (Anceschi, 1988). This “unitary complex of signs” is, in fact, the system of points of contact outlining the traits of this “artificial person” (e.g., an organization).

In the culture of “corporate image”, “corporate personality” (or “artificial person”) is a figure (or person) that “consists of objects” and corporate image is communication through a juxtaposition of objects, or rather narration through objects. The corporate image then produces an “image”, the portrait of the organization's artificial person, through the control of the appearance of individual objects. Where control is employed through a legislative system of implementation and combination of rules (the “Manual”), that organizes grammar and syntax of visual communication, with the limitations that bureaucratic or technocratic application of the rule may have.

The systemic approach to corporate image project is clearly manifested when switching from application of the rule to the program, or if you agree to the combinations of the elements, “meetings between formula and circumstance”, able to surprise beyond normative forecasts, passing by the size of appearance (image) to the behavior. Henrion and Parkin (1967) about it spoke of “design coordination”, to emphasize the importance of designers directing role in defining an identity.

In the latest twenty years, the idea that an identity centered on a logo could be the only and most effective possibility has been discussed in various practices and some specialized literature. A "post-logo" concept has emerged emphasizing the possibility to express effectively a "personality" using criteria which underline differences, or inconsistencies, according to a most dynamic and flexible logic. Visual identity tends to represent the varieties of a "personality", giving greater importance to the previously considered subsidiary elements and their combination on the basis of criteria that always allow the recognition of the communicating subject using a system of rules that takes account of its complexity, its inherent differences, the variety of possible expressions (Felsing, 2010; Van Nes, 2013).

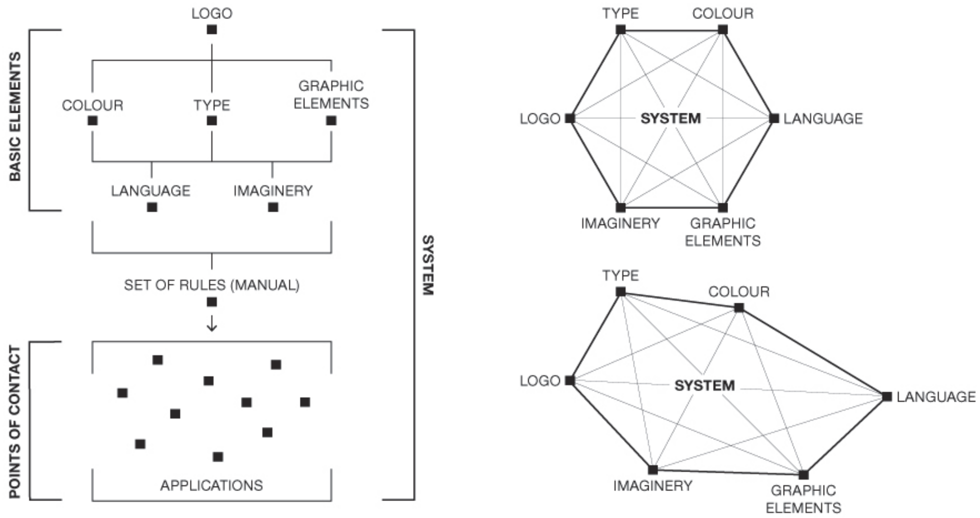

Fig. 1 Left, a representation of the typical visual identity structure (made by the authors). On the right it is represented how dynamic or flexible visual identities work. Source: Van Nes, (2013).

The definition of "identity" it is extremely interesting itself: it is possible to define it as a "fundamental unity that is achieved through the multiplicity of aspects." So at the base there is a unit, equality between different elements, however, belonging to the same set, to the same context. The identity of a subject, its unity, it is reinforced by the differences of its attributes and its modes of expression.

While there are the organization's needs to set up new relationships with its stakeholders in new ways, on the other hand, there are trends of design thinking and approach that similarly tend to innovation: "a brand is no longer simply a nice, clean logo that is attached in the same place every time. A brand is a platform, a brand is flexible, a brand is a place for exchange, it is not fixed, and therefore there is no such thing as a single brand. Methods exist which allow a shape to form, which allow communication and recognizable behavior, but this is no longer about something inflexible and permanent" (Shaughnessy, 2008).

This attitude has resulted in a direction in which the project of "corporate branding" (evolution of the culture linked to the one of "corporate identity" of the sixties) waives the imposition of trivial rules (or trivializing) and dictates the long sweltering, tending more towards fluid and expressive languages. Some organizations developing structures and communication tools have understood that it could be more efficient to modulate the tone of their communication, adapting to the variety of the target, rather than fall from a single, monotonous voice. If a personality in general terms is not possible to define it as a mono-dimensional subject, it surely can not be an organization and its resulting communication strategy, which moreover is aimed at markets that are definitely multi-dimensional (Dorrestejin, 2007).

One of the factors that contributed to this new scenario it is certainly the growth of the digital environment. In the last 20 years, the system of visual identities has been revitalized by the adoption of formal building tools and processes nearer to meta-design matrices. That is a change from closed (e.g. logo-centered) to open systems. Particularly of interest is the use of programming codes to generate and manage visual artifacts on a parametric basis.

2. The use of programming in visual design

The use of programming in visual design it is not something peculiar only to the so-called Generation Y (those born between 1980 and 1996) designers, for which the use of technology is natural if not obvious (Wicht, 2011). In visual and graphic design there is a particular field that emerged in the last 30 years as extremely suitable to experimentations in this direction. Type designers are used to comparing their designs both to formal and technical meanings. Moreover, because of this inner nature of the design of types, when digital technology arrived in the 1980s, "type designers made the accidental a starting point for new ideas. Some, as they became more adept with the new technology, began to intervene in the underlying computer code" (Crow, 2008).

Experiments like the ones promoted by Fuse or Emigre magazines (that became a type-foundry too) opened to commercial practices new perspectives in the use of computer and enhanced several critical considerations. The most evident result of those conditions it can be found in the Dutch group called Letterror, which enthusiastically pioneered the adoption of coding as a design tool, with their typeface Beowolf in 1991. They were the first designers to use code to randomize typography and their aesthetic undoubtedly celebrated the handmade and the physical. In a certain way, Letterror harnessing digital technology to create letterforms by art-directing the multiple possibilities programmed into their bespoke software engines (Crow, 2008), anticipated most recent formal and procedural issues. Issues that were already experimented by computer scientist and mathematician Donald Knuth in the 70s. Knoth developed Metafont, a program that worked with the idea of parametrical fonts and would allow designing an infinite number of typefaces (Knoth, 2011).

If type design appears to be a suitable field of experimentation, in many other areas of visual design, such visual identity, it is possible to find interesting evolutions. Also, it is useful to mention just a few cases acquired from the professional practice.

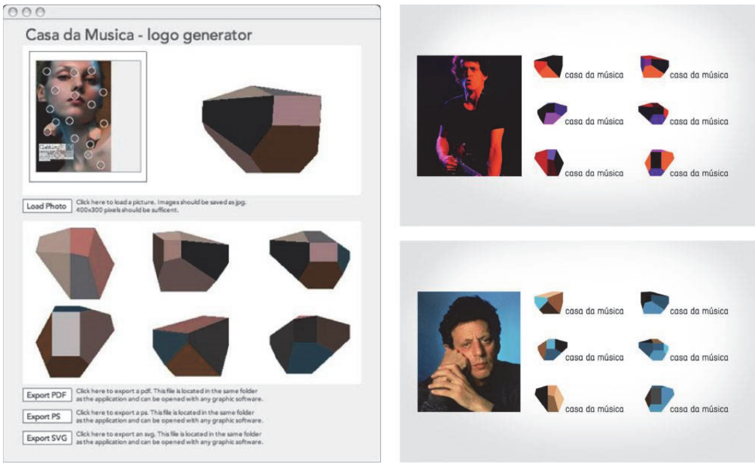

Fig. 2 Logo generator – developed using Processing – for the Casa da Musica. Oporto (Portugal), design Stefan Sagmeister, (2007).

Chronologically the logo-generator for the Casa da Musica (Sagmeister, 2007; fig. 2) is ones of the very first. It works on six versions of a basic sign, necessarily inspired by the Rem Koolhaas's design of the building, showed from different perspectives. Through the different views of the building, 17 facets are defined – from those a 17-point color-picking mechanism is created as customized software. That allows to select from images the colors of the sign to be used in the various communication matter for particular events or the staff (e.g. business cards). The logo changes in every application and media and the colors change too. The software offers an endless variety of solutions both for the audience and for those who have to manage the identity every day.

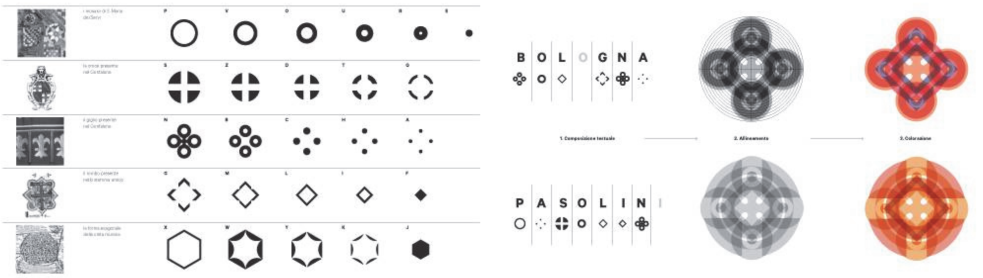

Fig. 3 Basic elements of the visual alphabet and set of rules for logo arrangement, "è Bologna" city brand, design Matteo Bartoli and Michele Pastore, (2013).

Another case study to mention is the one of the place brand for Bologna, adopted in 2013. The visual system (designed by Matteo Bartoli and Michele Pastore; fig. 3) is based on a visual alphabet in which the single letters are replaced by geometric abstract signs inspired to a typical Italian historical imaginary. In this way, the richness of elements and tangible and intangible values –that can be typically referred to an Italian town– are translated. The forms freely take up again some figurative archetypes of the Italian city and more precisely of Bologna (Vit, 2014), such as walls, brick mosaic, the lily and the heraldic cross. Through a customized online software (available at http://ebologna.it/) it is possible for everyone to write what "Bologna is" ("è Bologna"). This is not just an adaptive and flexible visual system, but participatory too (Vit, 2014). Another point that emerges is that of a brand as a platform and of a logo conceived as a people's heritage, which belongs effectively to everybody.

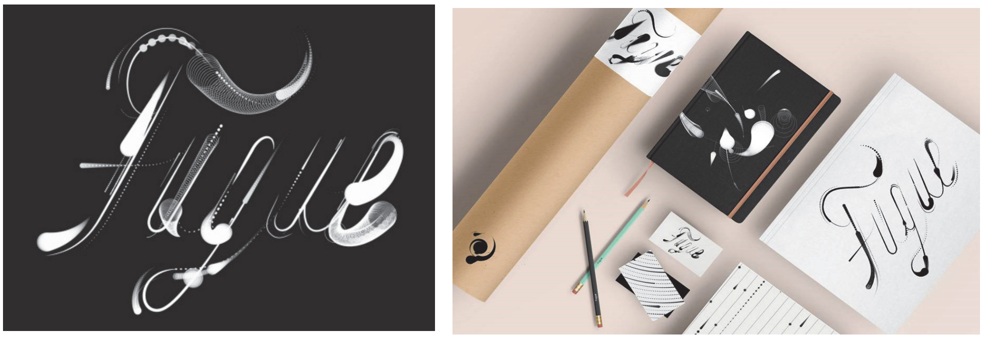

Fig. 4 Fugue identity, logo detail and some applications, design Stefan Sagmeister and Jessica Walsh, (2015).

The last example to mention is the one of Fugue (Sagmeister and Walsh, 2015; fig 4), a company specialized in the automation of the creation, operations, and regeneration of cloud infrastructure. The brand concept visualizes the ephemerality and embodied core attributes of lineage and elegance. The logo works like the software does: it constantly regenerates itself while data moves from one point to another. Since the company is about constant regeneration and evolution, the design agency developed an application that allows them to import any SVG file so to easily create new patterns and illustrations over time as needed. The user can then alter the size, speed and density with the application to increase clarity or create specific styles of animations based on their need and export .tifs or .mov files. The logo application also has a drawing function so that you can draw abstract visuals in the Fugue language using a tablet device.

What emerges is the use of code to program devices to produce and generate visual artifacts. Traditionally, when graphic designers have to design a logo or a visual identity system, they reduce contents and values of an organization through signs by using professional tools. In the past those were pencils, photos, scissors and so on, then the very first photo and layout software. The use of code opens to the possibility to create devices (toolboxes, like logo-generators are) to produce and generate visual artifacts able to manage variations. Visual designers have to define still the set of rules and a framework to shape a visual identity. So the designer part becomes the one who sets parameters to generate forms not losing sight of a visual identity system main task that is to identify and to make recognizable an organization (Téllez Bohórquez, 2011).

3. The designer-developer

The use of proprietary software (or closed source software) that limit the possibilities to the ones provided by package developers did not result until today in significant innovations in terms of visual language. Those limitations have been effectively underlined by the expression "form follows software" (Serriano, 2003), which make evidence to the need, by the creative world people, to experiment all open source programming codes possibilities. Reas et al. (2010) expressed well this way of thinking: "Proprietary software products are general tools designed for the production of specific types of forms (…). To go beyond these limitations, it is necessary to customize existing applications through programming or to write your own software". A direction that Galanter (2003) already summarized, therefore: "It was seemingly inevitable that soon after the adoption of the computer by designers as a manual tool for CAD, there would follow the adoption of genetically inspired algorithms for the creation and selection of variations".

The use of codes makes possible to manage and – according to Manovich (2001) – generate multiple formal solutions, to set up automation, repetition, scalability and variation processes. Those systems can be considered as facilitation tools of a creative act, as they allow to spend more time in experimentation, research, production; and the final result can be more satisfying for the designer as well as consistent with the design ambitions and requests (Reas et al., 2010).

The visual designer knowledge, way of thinking and workflow are changing because of the new possibilities offered by programming (Lehni, 2011). Moreover, a new practitioner is emerging: the designer-programmer or the designer-developer. A practitioner who has no fear in using the daily work tools, as computers are, in a more consistent way. Computational design usually requires the designer to write programs and because of that, it is possible to mistake the practice of computational design as a technical skill rather than a way of thinking. Learning to program and engage the computer more directly with code, opens the possibility of not only creating tools, but also systems, environments, and entirely new modes of expression. It is here that, using McLuhan metaphor, the computer ceases to be a tool and instead becomes a medium (Reas et al., 2010).

Moreover, it is to consider, accessibility to instructions and information related to codes, allowed by the global open source culture, as a critical component in this evolutionary process (Lehni, 2011). This culture allows sharing knowledge, results as well as codes, making possible a constant upgrade. A knowledge available for all, blurring the borders of a merely professional disciplinary field.

4. Experimental outputs

Consistently to those critical issues and practices, a series of experimental projects have been developed in the Visual Communication Design Final Synthesis Studio of the Communication Design Bachelor at Politecnico di Milano over the last three years.

The brief was to design visual identities programming and using open source codes and, when possible, hardware like Arduino or Genuino so to experience a multidisciplinary approach and test more contemporary design methods and processes.

Unreal organizations were assumed as subjects of the design, this to allow students to work deeper on the conceptual side and to look for case-histories (to be assumed as inspirations) not necessarily referred to the assigned organization. As well as to get students used to cross disciplinary borders and to criticize fixed fields. Triggs (2003) expression on experimentation as a way to find solutions, even in areas that we (as teachers and/or practitioners) or students do not precisely know, it is incredibly fitting. A "learning by doing" approach, aimed to result in prototypes, is the main methodological framework. During projects development, students experienced something close to the definition of "thinkering" (think + tinkering) given by Paola Antonelli (2011) in which a final result it is possible through progressive collective refinements.

The applied methodology can be summarized as in the following schema (fig. 5), inspired to the spiral model of software development by Barry Boehm (Dubberly, 2005). This model perfectly representes repeating cycles of design with a spiral path moving away from a center starting point. In each of the 4 main phases (Objective setting; Risk assessment and reduction; Development and validation; Planning the next phases) students experienced different design steps approaching gradually and practicaly their final solutions. The model seems to fit well to the adopted laboratorial design process.

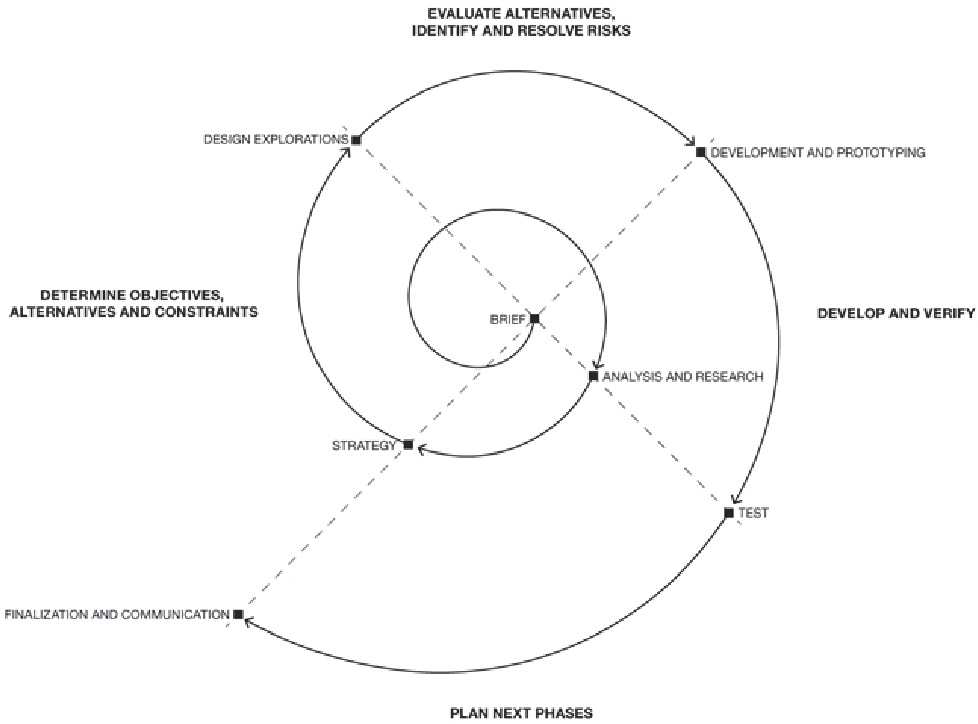

Fig. 5 The spiral model of the methodology applied among years in the experimental Design Studio at Politecnico di Milano.

Every year the class was organized in groups of 4 or 5 students each. First, each group has to define the whole concept and the organization of the assigned subject, his aims, his values through targeted research (intangible issues); then to design the visual system, defining appropriate communication channels, tools and applications (tangible issues).

During the first year of this experimental Design Studio (2013-14) each group had a specific subject to work on (e.g. nation branding, sports event, currency system, political party, and so on). Each group had to develop his project defining parameters and rules of the visual identity variations to be programmed by using the code VVVV. The following example it is to be assumed as peculiar of this design experimentation.

The visual identity for an invented hacker micronation located in the Westman Islands – a series of small islands sited south of Iceland –, is mainly based on two elements: the Vegvisir (the ancient Icelandic magical stave intended to help the bearer find their way through rough weather) inspired an alphabet; the glitch (the bitmap images failure) inspired the graphic elements of coordination. The Vegvisir-inspired elements are used to arrange the primary symbol of the nation and to write customized codes to use as customized fiscal codes.

Fig. 6 On-screen writer and printer for the Westman Islands nation's brand identity.. Design by Mariagloria Posani, (2014).

A particular toolbox has been designed and prototyped to write and print the visual code (fig. 6). The toolbox is composed of an on-screen writer called Muninn and of a printer named Huginn (the two ravens that fly all over the world and bring information to the god Odin). The glitch inspired elements are used in two ways. First, to arrange the visuals of printed and digital applications. Also, as a digital nation's flag that is shaped through a particular sound-reactive generator: two central rectangles change on sound volume and

tone variations; a series of disturbing pixels increase and arrange themselves following the ground noise. The overall elements give a visual representation of participatory democracy.

Fig. 7 Yangcu Identity points of contact and the cross-stitch printer. Design by Daniela Arienti, Nicolas Attolico, Andrea Benedetti and Clelia Codella.

The following year (2014-15) the class worked on visual identities referred to unrecognized nations inscribed in the list of the UNPO (the Unrepresented Nations and People Organization). The aim was to stimulate considerations on cultural expressions to be used as soft-power elements and objects of communicational pression to be recognized.

One of those results was referred to the people of Degar-Montagnard (fig. 7), located in the Vietnamese region, in South East Asia. They are called “mountain people”. Starting from textile compositions, the group developed a texture based visual identity and a typographic system as basic elements of a communication system called Yangcu. To empower the communication, a toolbox has been realized. This allows to print textures as cross-stitch masks and, at the same time, to easily share cultural elements by the customization of a daily object.

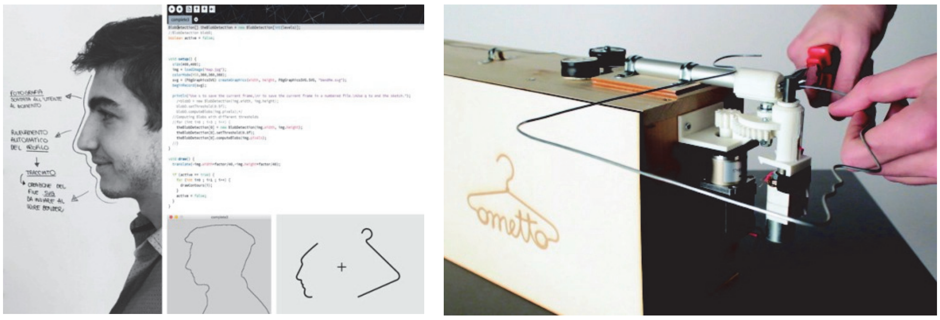

Fig. 8 Ometto identity: the contour tracking schema and the Wire Bender. Design by Martina Bonanomi, Gianluca Bruno, Luana Caiazzo, Tommaso Diena, Valeria Esposti.

During last year (2015-16) the class worked on visual identities referred to unreal companies producing everyday objects like umbrellas, light-bulbs, buttons or hangers. Each group has to design visual identity in both two and three dimensions. Furthermore, studends had to work on the design of an experience to be contextualized in a fixed area of 4 x 4 meters, by realizing devices ("communication machines") that interpreted companies' values making those accessible to users. In the case of a hangers producer (called Ometto, that is an italian name for clothes hangers; fig. 8), a clean and minimalist brand identity was developed as well as a cutomized device. The device has two main sections: a contour tracking of the user's profile (programmed in Processing) and a wire bender (a revised version of DiWire Bender by PensaLab basicly developed with Arduino). The contour tracking program reads the .svg file (of the user's), set the size of the product and sends the exact coordinates to the Wire Bender, which personalize a hanger with the user's profile.

5. Conclusions

The examples as mentioned above (both case studies and experimental outputs obtained with research through teaching) allow making some final considerations.

The real evolution that emerged in the field of visual identity design is in the use of the digital tools, not anymore in a passive way but in an active way. Visual and graphic designers can build their digital tools basing them on design and aesthetic needs. Interpretation of intangible issues (the ones of an organization to communicate as a brand) can be empowered by the use of intangible (codes) and tangible (hardware) tools. Results are still points of contact and experiences (tangible items), but innovation is in the creative process, instead of in the final result (Galanter, 2003), is in the "way to live our own creativeness" (Soddu, 1998). The above mentioned new approach to brand identity design is "open, unpredictable, functioning like an organism that modifies and adjusts itself to suit different contexts. Now, the designers are not aiming to make the audiences' mind to be imprinted with a logo, but aiming to create live dialogues with them" (Graphic, 2010).

However, the full potential of the computer as a programmable device to be used in the representation of organizations and the managing of a visual identity system remains still to be entirely explored. Applying programming in the creation of visual identity systems should make possible to redefine the idea of the manual (to be intended as the rulebook of a visual identity system) and the way the visual governance of a brand could work. Digital codes allow managing in a more flexible and practical way how a visual identity works in his everyday life.

It is clear that the role of the visual designer itself is changed. The line between “designer” and “developer” is apparently blurred, and this is not limited to screen or projected image (Reas et al., 2010). It also affects the design of physical spaces and experiencial spheres.

Finally, introducing those issues in a didactic context, emerged that programming environments and languages are never static, just like spoken languages that evolve during time. Programming evolves and is becoming more and more part of the designer toolset and open source is a key component in this evolutionary process. This way of working and designing should be encouraged, especially during students education so to make possible the use of digital tools in a more consistent and suitable way (Lehni, 2011).

6. Acknowkedgements

The authors would like to thanks the teachers and colleagues who worked during the last three years at the Communication Design Studio, Design School of Politecnico di Milano: Andrea Braccaloni, Pietro Buffa, Alessandro Masserdotti and the assistants Ambhika Samsen, Andrea Novali, Francesca Bozzia and Dario Verrengia. With them it has been possible to launch and share an actual, not easy and inventive method and design practice. Consequently, a grateful thought is for all students who accepted the challenge and enthusiastically followed his development.

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The Design-driven Material Innovation Methodology

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Abstract

A new materials research scenario emerges from design field, where scientists, enterprises, inventors, creative communities, and material industries are becoming deeply engaged in the creative challenge to achieve material functionality and meanings ideas for disruptive innovation. Considering and integrating design methods, technological approaches and studies on innovation, the Material Design Culture Research Center (MADEC) of Politecnico di Milano developed in the last years a specific methodology able to manage the whole design process from tailor-made material to product systems, integrating different actors of innovation, enhancing capabilities of open explorations, and reducing the time-to-market for materials and products. This paper presents the DdMIM (Design-driven Material Innovation Methodology) as a systematic approach and strategic tool for research centers, design schools, practitioners and SMEs. A specific material could be a starting point of the process, but not only. What the method really tries to do is to let understand how to use technologies (and advanced materials) contextualizing them within a wider socio-cultural and economic scenario. After a brief forward of the method theoretical premises, this paper will analyzes the seven steps suggested by the methodology: Data collection, Sensing, Sensemaking, Envisioning, Specifying, Setting up, Placing. These phases are associated with a selection of case studies to help its comprehension. Actually the DdMIM is part of the "Design for Enterprises" the European training program for SMEs, started this year and operating for the next two years in order to help SMEs to enhance the capabilities for Design-Driven. In the "Design for Enterprises" training program the DdMIM is part of the module "Design for Materials", and help enterprises to manage a design process for product and services innovation where different actors like materials scientists, suppliers, creative communities and consumers are getting engaged.

Keywords: *Design Research, Material Design, Material-product development processes, human-centred design, design methodology.*

1. Premise: the contemporary material design scenario

At the beginning of the new millennium, some authors theorized the dematerialization of products as an effect of the miniaturization and a new eco-friendly design agenda.

A guilt-feelings pushed design research community focusing towards immaterial production, and raising of environment awareness.

After many developments on intangibility, today we face a new idea of technology, based on increased environmental awareness and on greater control on productive processes, enables design push forward its horizons.

Design research strongly came back to materials topic dealing with the new materials reality in a globalized and fast changing world, in order to engender disruptive innovation.

Over the past several decades, scientists, chemical engineers and physicists in many part of the world, have been busy tailor-making new advanced materials, built one atom at a time, one layer at a time, leading to a great variety of new material and production methods. Today, Advanced Materials have a very large economic size and they are essential for industrial and business development. Advanced materials are ads functionalities to materials in order to increase the added value of the products. They are very important for the development and innovation system[36].

Advanced materials ads functionalities to materials in order to increase the added value of the products. This will enhance the competitiveness and also make it more difficult to copy a product.

Nevertheless the enormous effort of technological basic research for new materials only a small part of this work earns real applicative and market success. Very few materials succeed in being a determinant stimulus for products and systems innovation. Most material innovations fail[37]. While ideas abound, industrial research is less effective. While innovation is critical the usual process of managing innovation doesn't seems to work anymore.

In order to manage and expedite the conversion of technological innovation into marketable products[38] and to adjust development processes to meet customer demands, the research need the design knowledge and skills.

Within certain production contexts and sectors material design is yet very appreciated.

Design is able to identify the more suitable applications of new materials, developing their functionalities according to technical proprieties and to the possibilities owned by the material to be easily molded and manipulated in order to achieve sensorial characteristics. Design allows attributing a specific identity to new materials, as the case of several plastic materials that could not be recognizable from their counterparts without a color design or a specific superficial texture.

In a world were the number of products becomes greater and greater, material can make the difference to the competitors, for the product distinctiveness in the market. The material should be pleasant and easily understood by consumers thanks to its sensorial characteristics, to its symbolic elements and thorough the message transmitted by the visual communication design, which is able to clarify the innovation value.

[36] The *European Competitiveness Report 2010* has highlighted of KET (Key Enabling Technologies). Among KETs, Advanced Materials have a very large economic size and they are essential for further development of many other KETs.
[37] Smithers Rapra, an independent authority on rubber, plastics, and composite materials, report that around 80% of plastic products fail prematurely, 45% of these failures are due to poor material selection and characterization, 20% to unsatisfactory design and 15% to mis-use.
[38] Actually take up times for the adoption of a new material, considering its technical development and its firs commercial application and diffusion, are very long: almost 20 years.

Therefore what in the engineers' language is a question of physical parameters and technical proprieties has to be translated in terms of users' experience, perception and emotion. Only in this way consumers will accept the new material.

Today the appreciation acquired by design among the enterprises world goes beyond the consolidated modalities. Both in the field of scientific research and in business research, design skills are increasing their significant role, because they "close the cycle of innovation".

Scientists and engineers are problem solver as the designers can be, but to engender innovations of success requires not only technological exploitations but also a broader understanding of materials meaningful application for costumers, consumers and users. It is important to understand the trend of innovation driven by social, cultural, economic and environmental drivers and operate with a users and human-centred human approach.

Since design is capable of improving communication between different actors, it promotes mechanisms of innovation, lowering the risk that, after substantial funding, and scientific research being not adequately exploited. When new materials, products and production processes are conceived together, the industrial take-up time as well as time to market is minimized.

Therefore, design experts are approaching to a new collaborative research scenario where scientists, technology experts, humanists, material developers, suppliers, manufactures, product industries, distributors, societal stakeholders and final users are becoming deeply engaged in the creative challenge to achieve material functionality and meanings, playing a role in results of quality of life, productivity, economic progress, and sustainability.

Design faces many challenges regarding the collaboration between creative and production communities (Adamovic, 2014)[39]:

- Different understanding in the limitations and complexity of the technology and timing;
- Gap between technology maturity and the short term expectations of creative partners;
- Small flexibility of the technology to adapt to the designer and end-user requirement;

Examples of recently launched projects seeking the collaboration between designers and scientists in the context of materials research are: "Light.Touch.Matters" a design driven development of touch sensitive luminous flexible plastics for applications in care & well-being coordinated by Erik Tempelman of the TUDelft (Netherlands) form 2013; "Solar Design" for On-the-fly alterable thin-film solar modules for design driven applications coordinated by Nadja Adamovic form 2013 and "INNOMATNET" a networking of materials laboratories and innovation actors in various industrial sectors for product or process innovation.

Replaying to these challenges, it is necessary to define a new framework, even a method, by that the design research could work with the different actors of innovation, managing open explorations. Designers cannot know everything but they can open their minds and develop a more conscious understanding of this new field of design practice starting from a cultural point of view (Ferrara & Lecce, 2015).

[39] Nadja Adamovic, Vienna University of Technology, Austria

2. MADEC: the Material Design Culture Research Center

At the end of 2013, a team[40] of researchers of Design Department of Politecnico di Milano proposed a research project for the creation of a Research Center to deal with the topic of the relationship between design and innovative material in the era of open innovation: the “Research Centre of Material Design Culture”. (Lecce, 2015).

The research project combined different approaches starting from an historical, theoretical and cultural point of view reaching a more technical and advanced scenario related to the materials design research. The MADEC’ funding research underlined the historical identity of Italian Design approach to materials (Bosoni & Ferrara, 2014), and its possible evolution along the contemporary research trajectories of technological innovation scenarios with developing new approaches and methodologies (Ferrara & Lecce, 2015).

MADEC has stressed on the issue that today the relationship between material and innovation is increasingly correlated to the creation of values and design competences, also depending to cross-disciplinary processes in which different skills are integrated. In these processes the implementation of Co-design and Open Design practices is fundamental.

Therefore, the *Open Innovation* paradigm presented by H. W. Chesbrough (2006) has been a critical starting point for our research model because it was presented as the antithesis of the traditional vertical integration model where internal research and development (R&D) activities lead to internally developed products that are then distributed by the firm (Chesbrough, 2006). Maybe is useful to report the synthetic definition made by Chesbrough himself: “Open Innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively”. So, the Open Innovation paradigm treats R&D as an open system. It assumes that useful knowledge is widely distributed, and that even the most capable R&D organization must identify, connect to, and leverage external knowledge sources as a core process in innovation. A similar model generates flux of information and ideas exchange adaptable to the contemporary socio-economic models, and a reduction of the transition times between the material/product ideation and its effective commercialization.

Indeed, university research centers could stimulate SMEs and national economic development, adopting this model, which fosters the passage from a traditional model to more open one made of research and innovation development based on the integration of enterprises, consultants and different types of internal and external resources whit which it could be possible to cooperate.

So, MADEC research group dedicated time to open investigation methods and innovation through materials. In the spirit of the Open Innovation we worked to establish an open process for exploring and sharing knowledge, techniques and applications related to materials science, in order to encourage discourse and experimentation with the broadest range of materials.

The Open Innovation paradigm is sometimes confuted with *Open Source* methodologies; there are some concepts that are shared between the two, such as the idea of greater external sources of information to create value. More over, we strongly believe that opened and shared knowledge is the only way that will enable us to pin ourselves toward the future. In this direction MADEC’s website is intended as a platform

[40] The work team coordinated by Marinella Ferrara and composed by Giampiero Bosoni, full professor of Interior Design and design historian; Giulio Ceppi, senior researcher of Industrial Design and architect, who cooperate in Domus Accademy with Ezio Manzini and Antonio Petrillo on the issue of materials identity; Andrea Ratti, associate professor of Industrial Design, designer in the nautical sector and expert on composites materials based on fibers; Chiara Lecce, PhD in Interior Architecture and Exhibition Design; Sebastiano Ercoli, PhD student and Naike Cogliati a young designer.

to share knowledge, resources and discoveries, as well as document experiments and processes, which aims are:

- Collect different resources (news, techniques, theory, artworks, videos, etc.) and share them via links and blog posts;
- Create a repository of relevant materials, papers, tools and techniques;
- Document experiments, and share them via tutorials (video).

3. Building the Design-driven Material Innovation Methodology

Within the MADEC research program, one critical point has been to build a specific methodology able to integrate the tailor-made materials design process in the design research process, in order to create new scenarios of design concepts in which materials and products are conceived at the same time in relation to the specific contests of development.

So, the “Design-driven Material Innovation Methodology” arose to enhance new products innovation and suggesting a method able to manage the design process in its whole complexity: form the material to the product and back including the commercialization models. Sometimes a specific material could be a starting point of the process, but not only. What the method really tries to do is to let designers, enterprises and innovators understand how to use technologies (and advanced materials) contextualizing them within a wider socio-cultural scenario.

As previously outlined, the methodology is part of an Open Innovation strategic learning context. This includes single innovators and start-up communities, business plan competitions, spin-off, research centers and universities, as receivers as well as contents developers, collaborating to the integration of different competencies, languages and founds supply.

The premise of this paper explains how the role of design is thus to look more comprehensively at materials, to respect the technical insight for considering sensory, emotional and symbolic qualities and, from this, giving a message to the consumers: a meaning that increases the value of products in the market.

Furthermore creative communities, scientists and material industries are becoming deeply engaged in the creative challenge to achieve material functionality and meaning and when new materials, products and production processes are conceived together, the industrial take-up time as well as time to market is minimized. As shown in *Fig. 1*, an exchange of trust occurs between stakeholders in a competitive environment. (Caisse & Montreuil 2014, p.10).

Fig 1. The community face of the "Offer−Creation−Character−Stakeholder" tetrahedron framework. Caisse & Montreuil (2014).

4. Method's referees

4.1 Integrative Thinking

At the begging of this work it was essential to have a conscious knowledge of the actual panorama about generic creativity-driven methodologies.

An important referee to develop a correct methodology process was the publication titled *Innovation Methods Mapping: de-mystifying 80+ years of innovation process design* edited by GK VanPatter and Elizabeth Pastor with the *Humantific Lab*[41]. Essentially the publication concerns an in deep analysis of a wide variety of innovation process models created since 1920s. In particular two main innovation process models have been compared: *Applied Creativity* (or *Creative Problem Solving* - CPS) and *Design* (or *Design Thinking*). The research found that there are three basic types of innovation process models: "Script models" that prescribe a series of detailed actions or behaviors, often with the caveat that nonlinearity is intended; "Zone models" that are more like scaffolds or frameworks inside which many action options are possible, often without any behavior prescribed; and "Script/Zone models" which combines the two. An other useful indication is that most CPS process models contain graphically-depicted behaviors signals: diverge <, converge > and deferral of judgment. Also "Open innovation", defined as multiple, internal and external humans engaging together to address challenges with open tools, has been part applied creativity (CPS) history since the 1940s. (Van Pattern & Pastor, 2013)

The analysis ends with a list of ten "Common Innovation Method Design Missteps". Form that list we depict the most relevant for our intents: "Missing Meta Process", "Missing Separation of Content from Process", "Missing Behaviors", "Missing Visual SenseMaking", "Missing Cognitive Surfacing", "Missing Culture Connections". (Van Pattern & Pastor, 2013)

The results of the entire work lead to the *Integrative Thinking*, which is the disciplined ability of recognizing, orchestrating and integrating the diverse brainpower of cross-disciplinary teams as they grapple with and navigate complex innovation challenges. *Integrative Thinking* is about recognizing and respecting the default thinking preferences of individuals regardless of discipline, and how those preferences map to innovation process. (Van Pattern, 2013)

41 A multi-disciplinary consultancy specializing in the creation of strategies, tools, and organizations that enhance adaptability and innovation based in New York.

4.2 Design-Driven Innovation

A second step to define our methodology was looking outside of the design world. The management researches are now very interested in the successful practices of “design-driven innovation” in various industries. These design practices happens stressing design, instead of technology, in their innovation (Utterback et al., 2006). Design practices, focusing on new applications of materials as well new behaviors in society, are able to generate unexplored design solutions for new product concepts. To produce products which are design-driven innovation, companies need researchers who “envision and investigate new product meanings through a broader, in-depth exploration of the evolution of society, culture, and technology acting as interpreters who are able to envision how people could give meaning to things through intense involvement in the design discourse” (Verganti, 2009).

A research[42] conducted in creative industries on the basis of Verganti’s theory affirms: “To design new product meaning for new costumers, the company should sense the trend forecasting data which are collected with various methods by which various possible new meanings are produced. Then, the designer with his/her design paradigm helps the company do the *sensemaking* process in which the one of the possible new meanings is considered to be the best in anticipating a new trend is selected and defined. To translate the defined new meaning into a new product, the most suitable product language to express the defined new meaning –supported by selected appropriate technologies – is selected. The result will be used as specification to develop the new product.” (Kembaren et al., 2014)

4.3 Material Driven Design (MDD)

Getting closer to the material design field, another relevant referee is looking at a newly founded research direction that scrutinizes materials’ active role in shaping the users experiences with products (Ashby & Johnson, 2009; Pedgley, 2009; Karana, Pedgley, & Rognoli, 2014) and how to design for experiences (Wilkes et al., 2015).

In that direction, our attention focused on the *Material Driven Design (MDD)* methodology developed by a group of researchers, coordinated by Elvin Karana, from the Department of Design Engineering of the Delft University of Technology in collaboration with the Design Department of the Politecnico di Milano. The MMD method tries to give aesthetics character to DIY materials facilitate designing for material experiences. The design method starts focusing on a particular material. The design process individuate three main scenarios (Karana et al., 2015):

- *Designing with a relatively well-known material* in order to seek new application areas, evoke new meanings and to elicit unique user experiences;
- *Designing with a relatively unknown material*, accompanied by a fully developed sample in order to define application areas introducing unique user experiences, identities for materials, and new meanings;
- *Designing with a material proposal* with semi-developed or exploratory samples (e.g., food waste composites, living materials made of bacterial cells, 3D printed textiles, flexible OLEDs, etc.). Since the material is semi-developed its properties are to be further defined through the design process in relation to a selected application area. Furthermore, since the material is novel, the designer have to propose meaningful applications through which unique user experiences and meanings.

42 The contribution of the research by P. Kembaren et al. (2014), was to reveal that to deliver a new meaning successfully to the market, at least for the design-entrepreneur-led creative industry, there are ways other than the ones suggested by Verganti (2009).

The method proposes four main steps: (1) Understanding the Material: Technical and Experiential Characterization, (2) Creating Materials Experience Vision, (3) Manifesting Materials Experience Patterns, (4) Designing Material/Product Concepts. As synthetized in *Fig 2*, the MDD process starts with a material (or a material proposal, based on the three possible scenarios previously listed), and ends with a product and/or further developed material. (Karana et al., 2015)

The method emphasizes the journey of a designer from tangible to abstract (i.e., from a material to a materials experience vision), and then from abstract back to tangible (i.e., from a materials experience vision to physically manifested, further developed materials/products). (Karana et al., 2015)

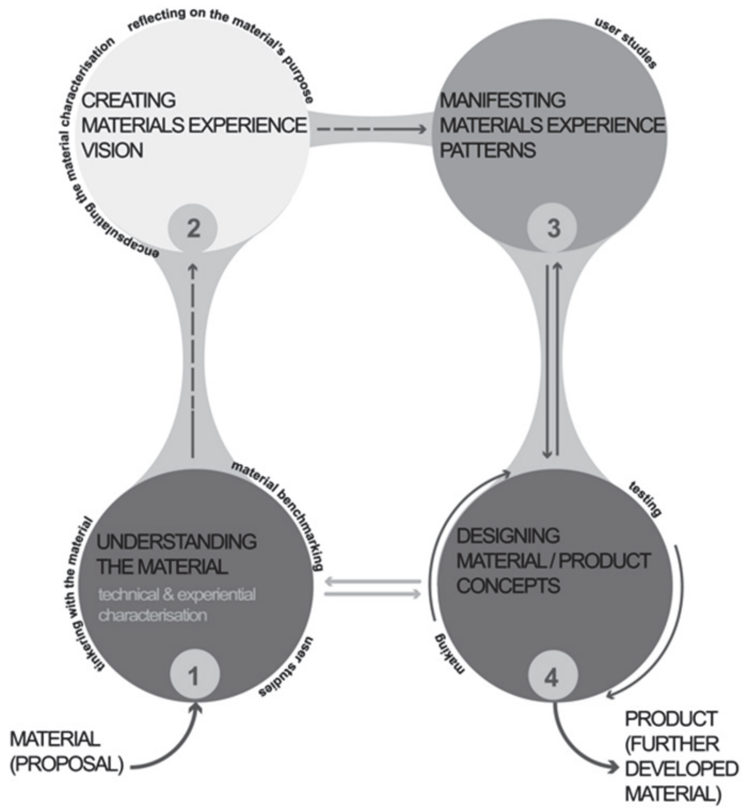

Fig 2. Material Driven Design (MDD) method. Karana et al. (2015).

5. The Design-driven Material Innovation Methodology

MADEC's "Design-driven Material Innovation Methodology" is the model that allows the development of one or more materials starting from scientific discoveries, material patents or production processes, in order to individuate applicative scenarios, to profile products lines, to develop specific products and to valorize them for the market launch.

Mixing and connecting all the referees previously displayed, MADEC's "Design-driven Material Innovation Methodology" (*Fig 3*) is based on a "Script/Zone" innovation process model. It consists in the reversal of the traditional problem solving approach to material design: material doesn't exist in its peculiarity before to be chosen, but is born out of the interpretation of the technical opportunity and the discussion with social necessities coming from a community of actors that acts in order to define and develop the innovation of a material and of a product simultaneously.

Another relevant character is the "meta-method" model, because to enable multiple participant orchestration is much more important than any technique, today most forms of cross-disciplinary work, not only require an externalized meta framework, but deep knowledge regarding how to apply it in various innovation contexts.

The material and its application are designed and realized starting from a "scenario" (*sensemaking*) that derives from a combined "sensing" process. The process converges to the Concept. The product concept itself defines the idea of the material, of its texture, performance and behaviors on the base of scientific advances and technological platforms (*specifying*). Then before to get the final product prototype a "design discourse" phase is necessary to complete the design-driven process. Once the product has been fixed, to deliver the new product with its defined new meaning into the markets, a storyline is carefully designed along with its product language to amplify and to relate the massage of the defined new meaning to the mind of the potential costumers (*setting up*). (Kembaren et al., 2014) Finally the product position inside the market diverges from different possible approaches connected to production processes (B2B or B2C).

Sometimes a specific material could be a starting point of the process, but not only, what the method really tries to do is to let designers or enterprises understand how to use technologies (and advanced materials) contextualizing them within a wider socio-cultural scenario.

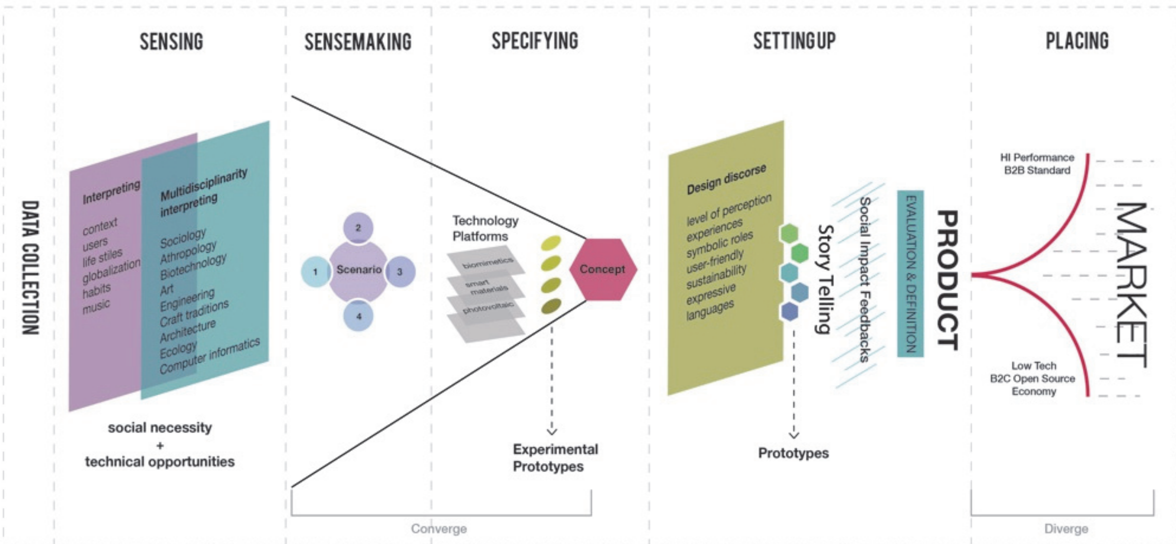

Fig 3. The Design-driven Material Innovation Methodology by MADEC.

5.1 Data Collection

The first step of DdMIM is the Data Collection, a "technical-cognitive" and "sensory-analytical" phase of the materials and its characteristics.

This step includes three main actions (*Fig 4*):

- A deep analysis of the starting point material in order to acquire technical knowledge from scientists, technologist and material suppliers. This allows to acquire information about material potentialities, its opportunities to be molded and manipulated gaining sensorial characteristics defining the material for "what it is", "what it can do", "how it appears" and it behavior. It could be also useful to compare the material with similar o alternative ones to highlight differences and similitudes;
- Activities of benchmarking positioning the material in the contemporary materials scenario, among similar or different, without any preclusion to other production sectors, in order to find space of opportunity. This is a way of discovering which could be the best performance to achieve in application, use – whether in a particular sector, and in many other sectors. The information can be used to identify gaps of production in order to define potential spaces and new market;
- To "feel" the material trough manipulation: "hands on" approach and interpret the sensory potential of the material. About this last point, is important to stress on how physical encounters with materials or the aesthetic experiences that derive from "hands-on" (Nimkulrat, 2012) manipulation of materials can positively influence the creative process. The "learning by doing" often allows a deeper understanding of the relationship between materials, processes, and forms. For the first time in design history at the Bauhaus school were particular advocates of learning about/with materials. Around 1920, Johannes Itten formulated his "theory of contrasts". He asked students to explore sensorial contrasts relevant to materials, such as smooth-rough, soft-hard, and light-heavy. The theory of contrasts gave attention to the nature of materials, having the purpose of showing the essential and diverse characteristics of different matter. (Itten, 1975)

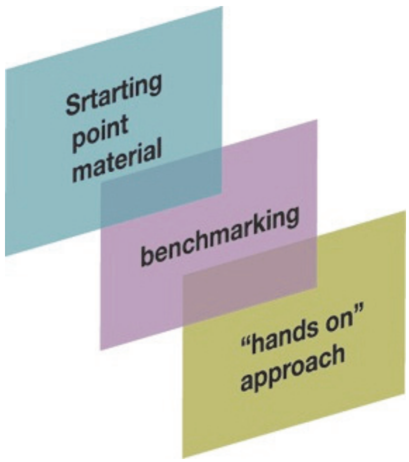

Fig 4. "Data Collection" phase from the D-DMIM method.

5.2 Sensing

The term sensing means: the perception that something has occurred or some state exists. During this phase it is very important to decide the context (geographical, cultural, social and economical) of the project to define cultural and behavioral characters and other emerging changings. Designers are able to scan lifestyles in a certain socio-cultural context. They recognize users tastes orientation and interpret them.

This phase must involve different actor (all the previously cited) and experts of various disciplines: humanistic (sociologists, anthropologists, psychologists, aesthetic experts) and technical and as well as users, in different section, in order to "extrapolate" helpful information and guidelines for the concept development.

Today's huge interest in multiple participant co-creation and collaboration, behaviors have become critically important, behavior synchronization is a key ingredient in any robust methodology-based, innovation-culture-building initiative. (Van Pattern & Pastor, 2013)

Furthermore innovation design method is not just about making an abstract drawing of steps or assembling techniques: it is about to understand the role of innovation process in designing and deciding what kind of culture you want to create in your organization. This phase let define users' aptitudes, necessities and desires in relation to their physical, physiological, ideological and social well-being.

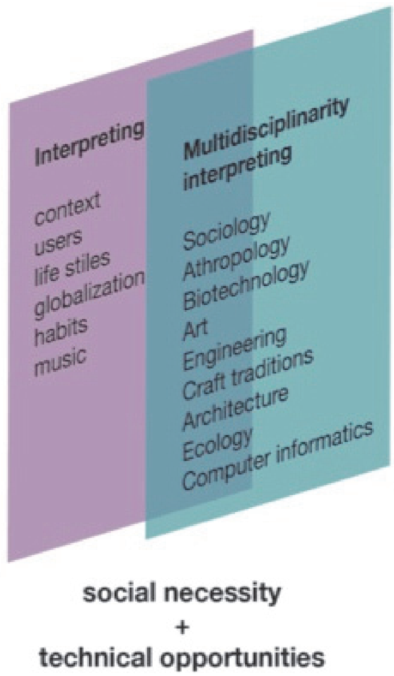

Fig 5. "Sensing" phase from the D-DMIM method.

5.3 Sensemaking

Using only words and numbers to solve problems and explain solutions, rather than words, numbers and pictures, significantly foreshortens the viewing lens and certainly the possible outcomes, today "sensemaking" is being recognized as a key 21st century leadership navigation skill. (Van Pattern & Pastor, 2013)

So, during the "sensemaking" phase designers develop ideas about what could or should be possible with the material, envisioning a concept, i.e. a "material vision" that defines the new meanings for the material anticipating new trends. Designers have to use imagination to innovate and open up different visions compared to the past defining specific "scenarios" where the general concept can be collocated. To help this activity is possible to individuate four “W” questions (*Fig 6*): What (describe), Why (explain), Will (predict) and What if (foresee).

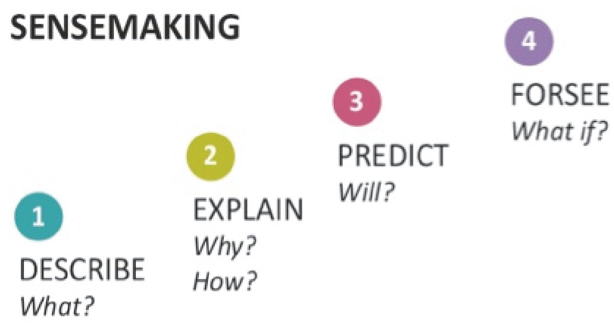

Fig 6. The four W scheme individuated by the “sensemaking” pahse.

To better understand the “sensemaking” phase we can choose a possible “scenario” and an applicable case study. Sustainability is becoming a social need and can represent an “ideo-pleasure”[43] which means pleasures that are connected to people’s values, and this reflection derives from the “sensing” phase. After that, since materials are at the core to the question of sustainability in terms of resources and energy, in an environmentally conscious society, the use of a product manufactured from bio-plastic fully recyclable and biodegradable, could create appreciation and user satisfaction.

This is the scenario from which the *Kuskoa Bi* chair project derives. Designed by the Alki workshop is the first chair made of a plant-based polymer, using oak from sustainably managed forests and upholstery made from 100% natural materials. If we read the premise presented by the creators of this project is quite evident the scenario where they collocate their product concept: “Set against the backdrop of the Pyrenees, nestling in a valley at the foot of the mountains is the village of Itsasu and the Alki workshop. Surrounded by nature, this is a unique environment in which it is a privilege to work and one which we strive to protect by seeking out new and integrated methods of production”.

And the specific choice of that particular material derives also form a previous step of “data collection” because they have analyzed the material in its technical proprieties evidencing that similarly to synthetic polymer, it can be injected, extruded and thermoformed but it is made from plant-based renewable resources (beet, corn starch, sugarcane, etc.). The bio-based polymer is also fully recyclable and its organic properties mean that, when subjected to an industrial process, it is biodegradable. Moreover, another significant environmental aspect lies in its reduced carbon footprint as bioplastic production results in reduced greenhouse gas emissions.

[43] According to Lionel Tiger’s pleasure model described in his book *The Pursuit of Pleasure* (1992), Patrick Jordan (2002) adapted it to products individuating four types of pleasure that can be considered when interacting with products: “physio-pleasures”(sensorial pleasure), “socio-pleasures”(the pleasure that comes form social life), “psycho-pleasures”(cognitive load-matching mental models) and “ideo-pleasure”(identity, intellectual).

Fig. 7 The Kuskoa Bi chair by Alki workshop, (2014).

During the sensemaking phase designers develop ideas about what could or should be possible with the material, envisioning a concept , i.e. a “material vision” that defines the new meanings for the material anticipating new trends.

5.4 Specifying

In order to translate the defined new meaning into a new product, the most suitable product language is selected. The result will be used as specification to develop the first experimental prototype of new material product. This process converges to the Concept. The product concept itself defines the idea of the material, of its texture, performance and behaviors on the base of scientific advances and technological platforms (*Fig. 8*).

Another useful case study can be associated to this phase: the Wood-Skin® project. It was developed by a young Italian start-up composed by a team of four members combining ten years of knowledge, from university study to professional activity. The variety of skills and approach brought by each member of the team made possible to transform pure creativity into practical applications. The vocation and area of knowledge of each team member has merged seamlessly to produce a well-rounded group, each complimenting the others. Their concept derives form a “specifying” phase that combine together different characteristics starting form a traditional material – wood – revolutionizing it through transforming it in a composite material and a new “one step fabrication process”. The wood becomes tissue-alike and able to be shaped in many forms yet retaining their structural and aesthetic value intact, simultaneously. More over Wood-skin, combining the rigidity of traditional materials with the flexibility of textiles, it allows countless applications both to entirely customizable architectural and design elements.

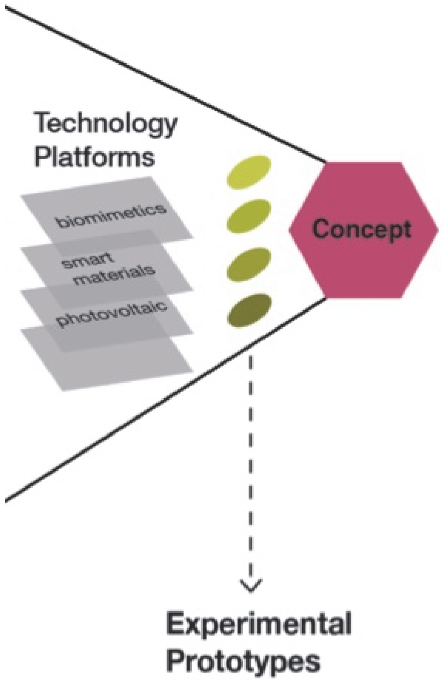

Fig. 8 "Specifying" phase from the D-DMIM method.

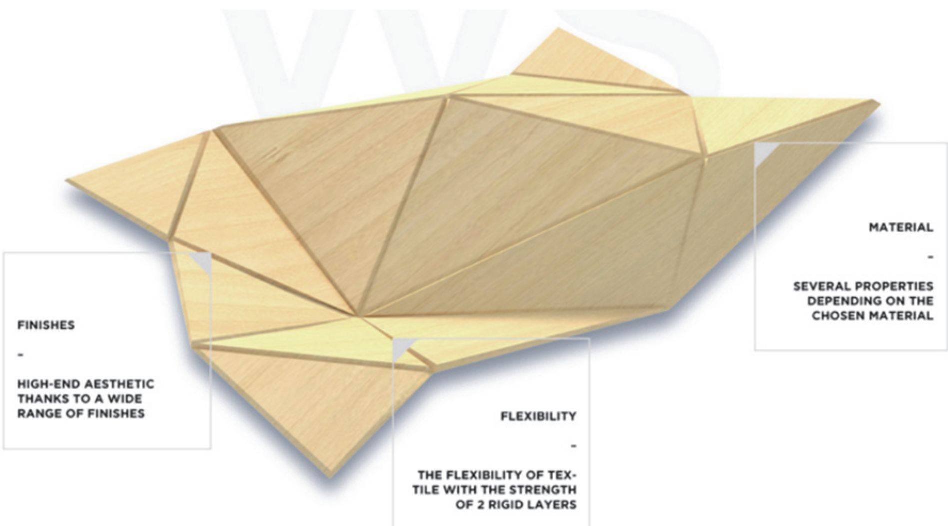

Fig 8. Wood-Skin®'s concept proprieties.

5.5 Setting up

When the design discourse on the material qualities is defined it can start a development stage of the material applications for products design. But, a really strategic step of this phase is the "storytelling". In fact, to deliver the new product with its defined new meaning into the markets, a storytelling has to be carefully designed along with its product language to amplify and to relate the message of the defined new meaning to the mind of the potential costumers.

The role of design is thus to look more comprehensively at the new product, to respect the technical insight for considering sensory, emotional and symbolic qualities and, from this, giving a message to the consumers: a meaning that increases the value of products in the market. Also the "User Acceptance" of a material/product depends on the correspondence of the experiences with the society needs or cultural trends, as well on the ability to communicate the meaning of material/product innovation. Visual communication skills are fundamental in this process: the message should be pleasant and easily understood by consumers to let the new product be accepted, desired and chosen by the consumers.

Finally, organizing a material experience session of potential users the innovation social impact could be evaluate before to place the product into the market.

There are several case studies of successful storytelling applications. One is related to material rather than a specific product. Litracon is translucent concrete invented by the Hungarian architect Áron Losonczi, who tackled the issue of glass in architecture, learned about optical fibers and made contact with Schott, a world's leading manufacturer of optical fibers, for his experiment with glass fibers cast in concrete (2001-2003). Litracon Classic® was listed among the most important inventions of the 2004 by TIME magazine but to get people confident with this new material/product the company understood that it was necessary to "tell" something more about it.

"You Are Energy" is the name of the installation designed by Gagarin Ltd. with Tvíhorf Architects to catch people's attention. It consisted of a big, interactive concrete wall made of Litracon Classic® blocks which illuminates from within when a force is applied to it. Visitors were invited to test their strength and met the challenge of inducing an explosion.

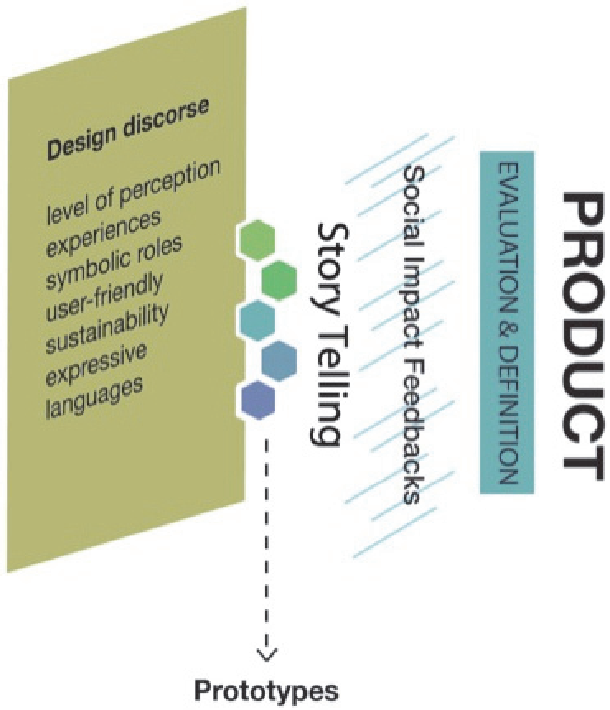

Fig. 9 "Setting up" phase from the D-DMIM method.

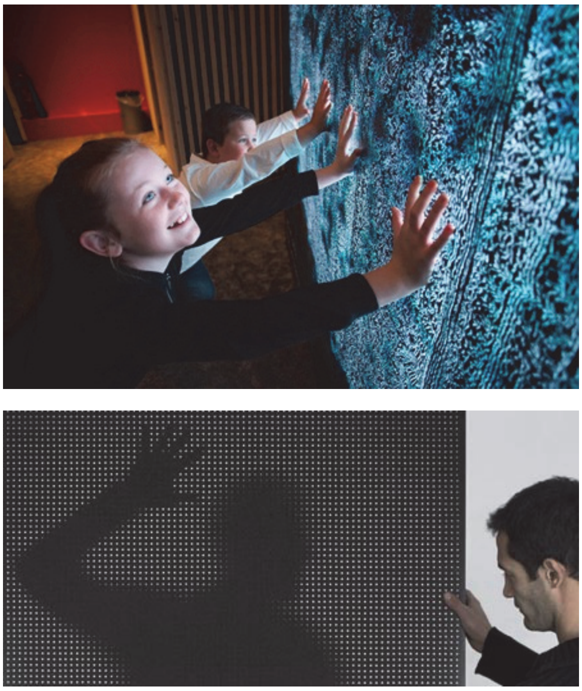

Fig 10. "You Are Energy" installation made of Litracon Classic® blocks at "Powering the Future" exhibition in Iceland, (2015).

5.7 Placing

Finally, the design can define how to place the material/product on the market. In this phase it is suggested to consider at the same time various distribution channels to the ultimate purchaser or end-user.

Today it is important assure that the product position inside the market diverges from different possible approaches connected to production processes – Business to Business (B2B) or Business to Consumer (B2C). But getting closer to this phase becomes competence of business experts rather than designers. The design contribute in this stage can be the implementation of the visual communication of the product.

Fig 9. "Placing" the final phase of the D-DMIM method.

6. Conclusions

Getting to the conclusion of this paper it is possible to summarize the principal DdMIM characteristics:

- It is based on material design and product design integration, trough a deeper understanding of material qualities;
- It focuses on new values and meanings, centered on human pleasure and consumers needs;
- It enables the collaboration between researchers, designers, and companies through an open innovation processes;
- It integrates multi-skills in a cross-fertilization process;
- It is useful for envisioning and developing new product concepts.

Moreover, a material innovation success depends on two other relevant design outcomes: *distinctiveness* and *user acceptance*. In a world were the number of products becomes greater and greater, material can make the difference to the competitors, for distinctiveness of your products in the market. An finally the material innovation value and message should be pleasant and easily understood by consumers, that means to increase the ability to communicate the material innovation (user acceptance).

Actually the DdMIM is part of the Design for Enterprises, the winner project of the Tender Capabilities for Design-Driven Innovation in European SMEs funded by EASME (Executive Agency for SMEs-European Commission). D4E is a consortium established between MIP- Politecnico di Milano, D'Appolonia and ADIPER and will be a three years long European training program in order to help SMEs to manage a design process for product and services innovation where different actors like materials scientists, suppliers, creative communities and consumers are getting engaged.

7. References

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Investigating Conceptual Foundations of Design Ability: An Analysis Through the Expressions of the Experiencing Mind

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Abstract

This paper aims to reveal conceptual foundations of design ability based on verbal expressions of students' insights. This goal is based on two propositions. The first one is about categorizing abilities in order to make them meaningful, while the second one is about the disadvantages of explaining the designer based on linear levels. So that, a group, which consisted of industrial design students who were newly graduated or in their last semester, was interviewed individually. The interviews were based on their experiences and the evolution of skills during four years of undergraduate education. Semi-structured interviews were used as the main data collection method, resulting over ten hours of recording which turned to be over one hundred pages of transcriptions. Later, the gathered data was analyzed using thematic analysis. Chunks of data were coded and codes were categorized under themes in a reductionist manner within several iterations. Three conceptual themes were generated and interpreted. Themes' reliability was ensured by using KALPHA in SPSS. Examples from four creative areas were given in order to broaden the field where the themes may be applied. As the final outcome, a model of fractal triangle simultaneously showing the findings is suggested. This model is claimed to indicate conceptual foundations which allow different states of design ability categories without being restricted to designer's expertise levels. So that, without depending on the specified designer level, different levels of ability categories become possible.

Keywords: *design ability, conceptual foundations, thematic analysis.*

1. Introduction

There are plenty of studies about design ability. One of the fundamental works about what the designers do is 'The nature and nurture of design ability' by Cross. In it, he explains the core features of design ability as "resolve ill-defined problems, adopt solution-focusing strategies, employ abductive/productive/appositional thinking, use non-verbal, graphic/spatial modelling media" (Cross, 1990, p.132).

There is also a variety of studies about the evolution of the designer itself based on the things he/she does through this development process. As a primary study, Dorst discusses design expertise and defines several levels including ‘naïve,’ ‘novice,’ ‘advanced beginner,’ ‘competent,’ ‘expert,’ ‘master’ and ‘visionary’ (Dorst, 2011, 2008, 2003). These levels are detailed based on what the designers do and how they behave on each level.

The argument of this paper is based on two propositions. The first proposition is that; dozens of abilities can be listed about what the designer does, but it may not be meaningful unless they are finely categorized and the categories are interpreted. The second suggestion is that; distinct levels of expertise can be identified but that does not necessarily mean that one must be restricted to a level while he/she can be ‘novice’ on some ability and ‘master’ on the other at the same time.

Based on these propositions, conceptual foundations of design ability are investigated. Design abilities are categorized under three main themes within several iterations, elaborating about where they belong and what they mean. Also because this categorization is not based on specified designer levels, but on themes of abilities instead, the designer is not restricted to any level through his/her development.

2. Methodology

2.1 Sampling

This paper studies design ability based on verbal expressions of students’ insights. Being a qualitative study, it focuses on a purposive and relatively small sample. The sample consists of fourteen participants who are newly graduated or in their last semester. These participants are selected in accordance with some specific criteria such as having a clear insight of their development as a designer, being able to reflect his/her experiences, having strong linguistic skills and being keen on an interview. They are chosen among two fundamental universities providing industrial design education in Turkey having two different systems of student acceptance. The selected universities are İstanbul Technical University and Mimar Sinan Fine Arts University.

2.2 Data Gathering

Semi-structured questions are asked about the participants’ evolution of skills and experiences during their undergraduate education. The questions are focused on differences of abilities between the time when they first came to school and reached the end of their undergraduate education. The interviews are carried out individually and seen as informal chats rather than formal meetings by both the participants and the interviewer. The shortest interview took about half an hour and the longest one about an hour. The gathered data consists of over ten hours of audio recording which turns into over a hundred pages of verbal transcriptions.

2.3 Data Analyzing

The main method used for analyzing the data is thematic analysis which is also called thematic synthesis. Braun and Clarke describe it as a method for “identifying, analyzing and reporting patterns (themes) within data” (Braun, Clarke, 2006, p.6); while Attride-Stirling identifies six steps to create thematic networks: “Code material, identify themes, construct thematic networks, describe and explore thematic networks, interpret patterns” (Attride-Stirling, 2001, p.391). Thomas and Harden identify three stages in the process: “The free line-by-line coding of the findings of primary studies, the organization of these ‘free codes’ into related areas to construct ‘descriptive themes’ and the development of ‘analytical’ themes” (Thomas, Harden, 2008, p.7); while Robson describes six steps: “Familiarizing yourself with the data, generating initial codes, identifying themes, constructing thematic networks, integration and interpretation" (Robson, 2011, p.476).

Whatever the description and the quantity of the process' stages may be, the main idea of this method is based on coding the data and categorizing the codes to create inclusive themes to gain a holistic view on the subject.

In this context, any segment of the data which refers to design ability - whether it is a section, paragraph, sentence, phrase or a word - is labeled with a code. The codes are grouped under subsets, the subsets under sets, and sets under themes. In the scope of this study, there emerged 320 codes, 35 subsets, 10 sets and 3 themes.

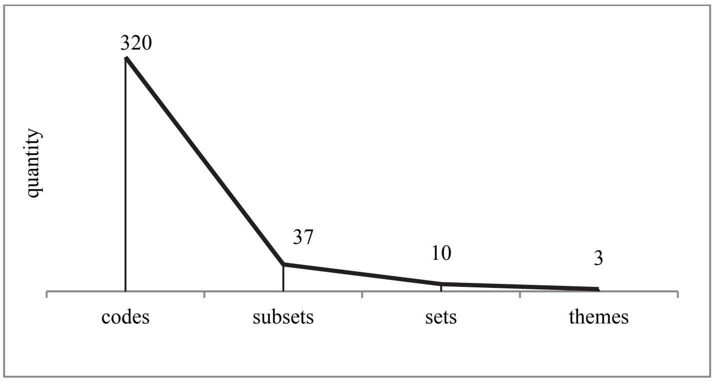


Fig. 1 Analysis Process Quantities.

The categorizing process is mainly based on establishing similarities of meanings and logical relations between the elements. Once these relations and similarities are established, they are categorized under one level higher. The categories are determined according to their cores rather than boundaries. This approach is mainly based on an example Rosch gives in which she mentions about "two neighbors" (Rosch, 1978, p.11).

She says that these two neighbors "know on whose property they are standing without exact demarcation of the boundary line" in her study about principles of categorization (Rosch, 1978, p.11). Based on this perspective, it can be inferred that the cores of the categories in this study are static, defined, definite and separate from each other while the boundaries are nested, cloudy, vague and intermingled. While an infinite number of relations exist between the categories, they still can be distinguished looking on their distinct characteristics of their cores.

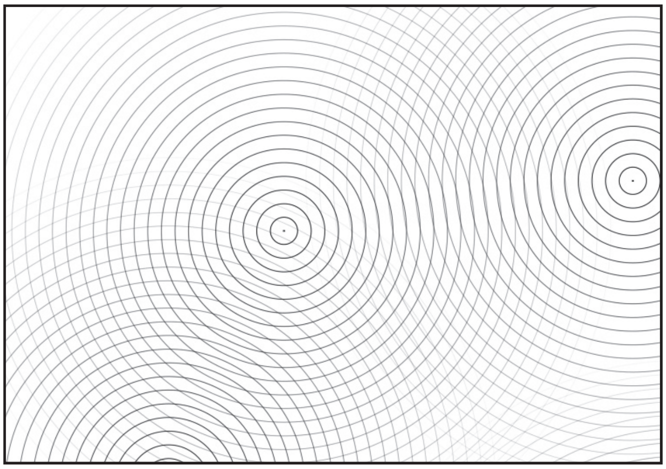


Fig. 2 Categories determined by their cores rather than boundaries.

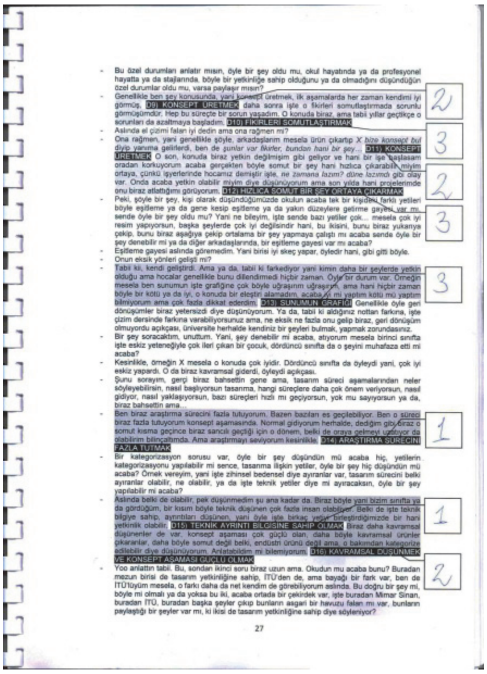
2.4 Reliability

As the final outcome of the categorization process, themes are tested for reliability using Krippendorff's Alpha (Kalpha). Kalpha is a macro for SPSS. Hayes and Krippendorff refer to it as "general in that it can be used regardless of the number of observers, levels of measurement, sample sizes, and presence or absence of the missing data" (Hayes, Krippendorff, 2007, p.77).

Four independent observers are given the segmented transcript of the interviews to code them individually. They are also provided with a brief description of the themes and are asked about which theme each of the 320 segments could fit into. The observers are informed that they can leave any of the segments blank in case they think that it does not fit into any of the themes, have a hesitation, or disagree with the themes. The transcriptions are divided into half and given to the observers in two sessions to reduce the risk of distraction because of the large quantity of data. As a result the Kalpha value is found to be '.6617'

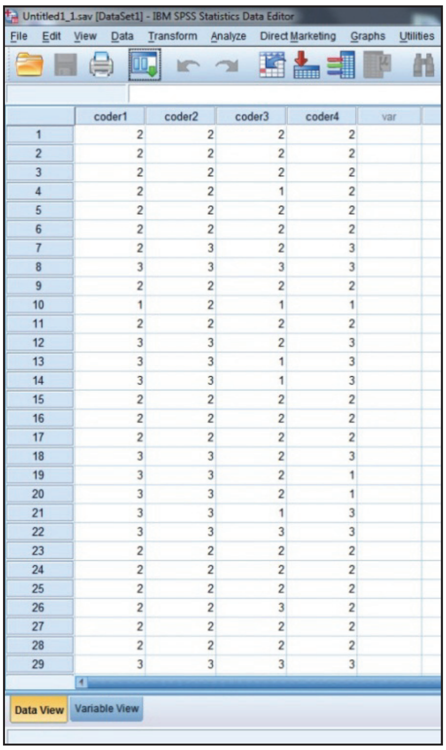
The Kalpha value indicates the level of agreement between the independent observers. Swert suggests that "Kalpha=.80 is often brought forward as the norm for a good reliability test, with a minimum of .67 or even .60 (when it is that low, you might give some specific information why this is low and why you still choose to accept this variable in your analysis)"(Swert, 2012, p.5).

The reason why this value is accepted is based on three arguments. The first one is about a bad coder noticed amongst the other three. Swert says "bad coders could give you a misleading Kalpha" (Swert, 2012, p.5). So when that coder is dropped from the test, the Kalpha value significantly raises to '.7352' as the agreement between rest of the coders. The second reason is about the large quantity of the segments. 320 pieces are thought to be an extreme number for coding compared to an example of 30 that Swert gives (Swert, 2012). The third point is the abstract property of the themes compared to some concrete criteria like presence of a physical entity.



- Bu özel durumları anlatır mısın, öyle bir şey oldu mu, okul hayatında ya da profesyonel hayatta ya da stajlarında, böyle bir yetkinliğe sahip olduğunu ya da olmadığını düşündüğün özel durumlar oldu mu, varsa paylaşır mısın?
- Genellikle ben şey konusunda, yani konsept üretmek, ilk aşamalarda her zaman kendimi iyi görmüş, D9) KONSEPT ÜRETMEK daha sonra işte o fikirleri somutlaştırmada sorunlu görmüşümdür. Hep bu süreçte bir sorun yaşadım. O konuda biraz, ama tabii yıllar geçtikçe o sorunları da azaltmaya başladım. D10) FİKİRLERİ SOMUTLAŞTIRMAK
- Aslında el çizimi falan iyi dedin ama ona rağmen mi?
- Ona rağmen, yani genellikle şöyle, arkadaşlarım mesela ürün çıkartıp *X bize konsept bul* diyip yanıma gelirlerdi, ben de *şunlar var fikirler, bundan hani bir şey...* D11) KONSEPT ÜRETMEK O son, konuda biraz yetkin değilmişim gibi geliyor ve hani bir işe başlasam oradan korkuyorum acaba gerçekten böyle somut bir şey hani hızlıca çıkarabilir miyim ortaya, çünkü işyerlerinde hocamız demiştir işte, *ne zamana lazım? düne lazımdı* gibi olay var. Onda acaba yetkin olabilir miyim diye düşünüyorum ama son yılda hani projelerimde onu biraz atlattığımı görüyorum. D12) HIZLICA SOMUT BİR ŞEY ORTAYA ÇIKARMAK
- Peki, şöyle bir şey, kişi olarak düşündüğümüzde okulun acaba tek bir kişideki farklı yetileri böyle eşitleme ya da gene kesip eşitleme ya da yakın düzeylere getirme gayesi var mı, sende öyle bir şey oldu mu? Yani ne bileyim, işte sende bazı yetiler çok... mesela çok iyi resim yapıyorsun, başka şeylerde çok iyi değilsindir hani, bu ikisini, bunu biraz yukarıya çekip, bunu biraz aşağıya çekip ortalama bir şey yapmaya çalıştı mı acaba sende öyle bir şey denebilir mi ya da diğer arkadaşlarında, bir eşitleme gayesi var mı acaba?
- Eşitleme gayesi aslında göremedim. Yani birisi iyi skeç yapar, öyledir hani, gibi gitti böyle.
- Onun eksik yönleri gelişti mi?
- Tabii ki, kendi geliştirdi. Ama ya da, tabii ki farkediyor yani kimin daha bir şeylerde yetkin olduğu ama hocalar genellikle bunu dillendirmedi hiçbir zaman. Öyle bir durum var. Örneğin mesela ben sunumun işte grafiğine çok böyle uğraşırım uğraşırım, ama hani hiçbir zaman böyle bir kötü ya da iyi, o konuda bir eleştiri alamadım, acaba iyi mi yaptım kötü mü yaptım bilmiyorum ama çok fazla dikkat ederdim. D13) SUNUMUN GRAFİĞİ Genellikle öyle geri dönüşümler biraz yetersizdi diye düşünüyorum. Ya da, tabii ki aldığınız nottan farkına, işte çizim dersinde farkına varabiliyorsunuz ama, ne eksik ne fazla onu gelip biraz, geri dönüşüm olmuyordu açıkçası, üniversite herhalde kendiniz bir şeyleri bulmak, yapmak zorundasınız.
- Bir şey soracaktım, unuttum. Yani, şey denebilir mi acaba, atıyorum mesela birinci sınıfta işte eskiz yeteneğiyle çok ileri çıkan bir çocuk, dördüncü sınıfta da o şeyini muhafaza etti mi acaba?
- Kesinlikle, örneğin X mesela o konuda çok iyidir. Dördüncü sınıfta da öyleydi yani, çok iyi eskiz yapardı. O da biraz kavramsal giderdi, öyleydi açıkçası.
- Şunu sorayım, gerçi biraz bahsettin gene ama, tasarım süreci aşamalarından neler söyleyebilirsin, nasıl başlıyorsun tasarıma, hangi süreçlere daha çok önem veriyorsun, nasıl gidiyor, nasıl yaklaşıyorsun, bazı süreçleri hızlı mı geçiyorsun, yok mu sayıyorsun ya da, biraz bahsettin ama...
- Ben biraz araştırma sürecini fazla tutuyorum. Bazen bazıları es geçilebiliyor. Ben o süreci biraz fazla tutuyorum konsept aşamasında. Normal gidiyorum herhalde, dediğim gibi biraz o somut kısma geçince biraz sancılı geçtiği için o dönem, belki de oraya gelmeyi uzatıyor da olabilirim bilinçaltımda. Ama araştırmayı seviyorum kesinlikle. D14) ARAŞTIRMA SÜRECİNİ FAZLA TUTMAK
- Bir kategorizasyon sorusu var, öyle bir şey düşündün mü acaba hiç, yetilerin kategorizasyonu yapılabilir mi sence, tasarıma ilişkin yetiler, öyle bir şey hiç düşündün mü acaba? Örnek vereyim, yani işte zihinsel bedensel diye ayıranlar var, tasarım sürecini belki ayıranlar olabilir, ne olabilir, ya da işte teknik yetiler diye mi ayıracaksın, öyle bir şey yapılabilir mi acaba?
- Aslında belki de olabilir, pek düşünmedim şu ana kadar da. Biraz böyle yani bizim sınıfta ya da gördüğüm, bir kısım böyle teknik düşünen çok fazla insan olabiliyor. Belki de işte teknik bilgiye sahip, ayrıntıları düşünen, yani öyle işte birkaç yetiyi birleştirdiğimizde bir hani yetkinlik olabilir. D15) TEKNİK AYRINTI BİLGİSİNE SAHİP OLMAK Biraz daha kavramsal düşünenler de var, konsept aşaması çok güçlü olan, daha böyle kavramsal ürünler çıkaranlar, daha böyle somut değil belki, endüstri ürünü değil ama, o bakımdan kategorize edilebilir diye düşünüyorum. Anlatabildim mi bilemiyorum. D16) KAVRAMSAL DÜŞÜNMEK VE KONSEPT AŞAMASI GÜÇLÜ OLMAK
- Yoo anlattın tabii. Bu, sondan ikinci soru biraz uzun ama. Okudun mu acaba bunu? Buradan mezun birisi de tasarım yetkinliğine sahip, İTÜ'den de, ama bayağı bir fark var, ben de İTÜ'lüyüm mesela, o farkı daha da net kendim de görebiliyorum aslında. Bu doğru bir şey mi, böyle mi olmalı ya da yoksa bu iki, acaba ortada bir çekirdek var, işte buradan Mimar Sinan, buradan İTÜ, buradan başka şeyler çıkıp bunların asgari bir havuzu falan mı var, bunların paylaştığı bir şeyler var mı, ki ikisi de tasarım yetkinliğine sahip diye söyleniyor?

Fig. 3 Example of one page from the transcriptions in Turkish after the Kalpha reliability test. The unpainted parts refer to sections which are not coded while the grey highlighted segments refer to coded ones. The phrases colored black are the codes. The numbers on the right hand side represent the observer's judgements of placing segments and codes together into themes. For example '1' is the number representing 'theme 1' and so on.



	coder1	coder2	coder3	coder4
1	2	2	2	2
2	2	2	2	2
3	2	2	2	2
4	2	2	1	2
5	2	2	2	2
6	2	2	2	2
7	2	3	2	3
8	3	3	3	3
9	2	2	2	2
10	1	2	1	1
11	2	2	2	2
12	3	3	2	3
13	3	3	1	3
14	3	3	1	3
15	2	2	2	2
16	2	2	2	2
17	2	2	2	2
18	3	3	2	3
19	3	3	2	1
20	3	3	2	1
21	3	3	1	3
22	3	3	3	3
23	2	2	2	2
24	2	2	2	2
25	2	2	2	2
26	2	2	3	2
27	2	2	2	2
28	2	2	2	2
29	3	3	3	3

Fig. 4 A part of the choices of four coders in SPSS. The column on the left hand side shows the list of the coded segments which goes down to 320, the upper row shows the coders, the numbers in the cells (1, 2 or 3) show the coders' choices of the themes.

```
[DataSet2] C:\Users\user\Desktop\kalpha.hepsi\Untitled1_1.sav

Run MATRIX procedure:

Krippendorff's Alpha Reliability Estimate


             Alpha    LL95%CI    UL95%CI      Units   Observrs      Pairs
Nominal      ,6617      ,5761      ,7443   320,0000     4,0000  1911,0000

Probability (q) of failure to achieve an alpha of at least alphamin:
   alphamin          q
      ,9000     1,0000
      ,8000      ,9999
      ,7000      ,8196
      ,6700      ,5458
      ,6000      ,0742
      ,5000      ,0000

Number of bootstrap samples:
  10000

Judges used in these computations:
 coder1   coder2   coder3   coder4

Examine output for SPSS errors and do not interpret if any are found

------ END MATRIX -----
```

Fig. 5 The calculated Kalpha value of '.6617'.

```
Run MATRIX procedure:

Krippendorff's Alpha Reliability Estimate


             Alpha    LL95%CI    UL95%CI      Units   Observrs      Pairs
Nominal      ,7352      ,6577      ,8054   320,0000     3,0000   956,0000

Probability (q) of failure to achieve an alpha of at least alphamin:
   alphamin          q
      ,9000     1,0000
      ,8000      ,9631
      ,7000      ,1874
      ,6700      ,0401
      ,6000      ,0001
      ,5000      ,0000

Number of bootstrap samples:
  10000

Judges used in these computations:
 coder1   coder2   coder4

Examine output for SPSS errors and do not interpret if any are found

------ END MATRIX -----
```

Fig. 6 The calculated Kalpha value of '.7352' after the 'bad coder' is dropped from the test.

3. Process and Findings

3.1 Codes

Following the procedures 320 codes are generated from the transcriptions. The codes are not listed here because of the large quantity.

3.2 Subsets

320 codes are distributed to 37 subsets based on similarities of meanings and logical relations. The subsets are as follows:

- Description (20 codes)
- Exploration (19 codes)
- Thinking (19 codes)
- Shaping (17 codes)
- Presentation (17 codes)
- Concept (14 codes)
- Process (14 codes)
- Analysis (12 codes)
- User (12 codes)
- Comprehension (10 codes)
- Idea (10 codes)
- Building (10 codes)
- Questioning (10 codes)
- Technical Data (10 codes)
- Material (9 codes)
- Method (9 codes)
- Scenario (8 codes)
- Semantics (7 codes)
- Production (7 codes)
- Management (7 codes)
- Knowing The Past (6 codes)
- Expression (6 codes)
- Mechanics (6 codes)
- Structure (6 codes)

- Technical Details (6 codes)
- Graphics (5 codes)
- Awareness (5 codes)
- Learning (5 codes)
- Solving (4 codes)
- Dissection (4 codes)
- Philosophy (4 codes)
- Keeping up to Date (4 codes)
- User Emotions (4 codes)
- Market (4 codes)
- 3D Comprehension(4 codes)
- Data Gathering (3 codes)
- Intuition (3 codes)

3.3 Sets

The reduction steps from the subsets to the sets and from the sets to the themes require establishing deeper relations and eventually a more thorough categorization. This way, in addition to the researcher's mind and word processor software, the elements are studied with actual slips of paper. As a result, 37 subsets are distributed to 10 sets based on similarities of meanings and logical relations.

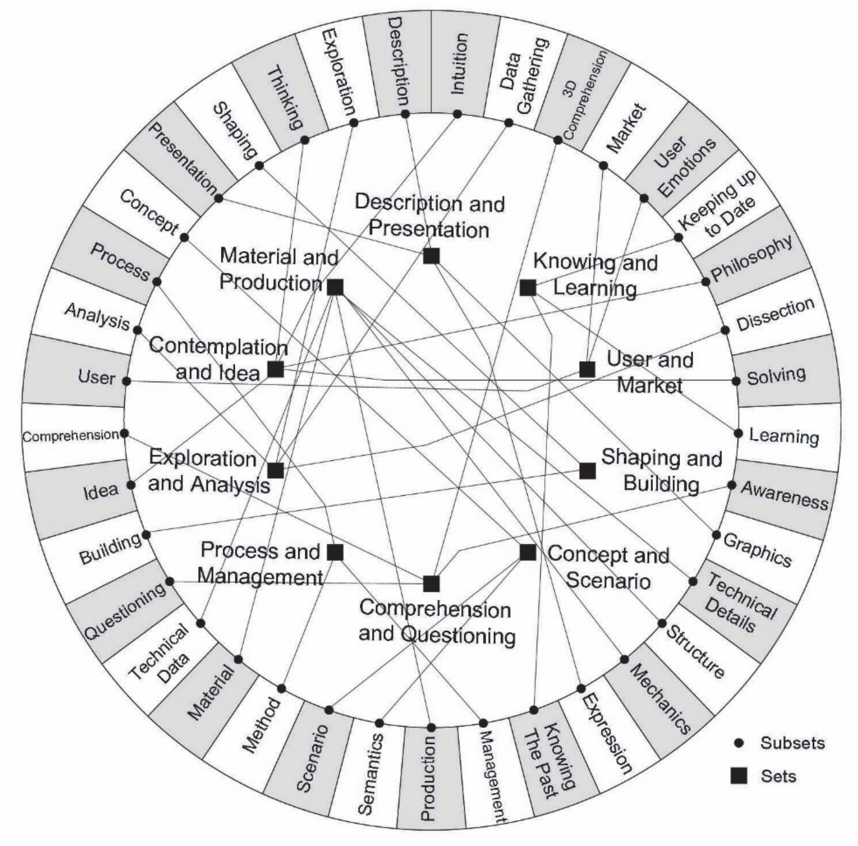


Fig. 7 37 subsets distributed to 10 sets.

The sets generated are as follows:

- ‘Description and Presentation’ set; refers to transmission of a mental entity towards the physical world. It contains ‘Description,’ ‘Presentation,’ ‘Expression’ and ‘Graphics’ subsets.
- ‘Material and Production’ set; refers to the restrictions and potentials of the production process and the data of how the materialized entity may be operational along with the physical terms of the outer world. It contains ‘Technical Data,’ ‘Material,’ ‘Production,’ ‘Mechanics,’ ‘Structure’ and ‘Technical Details’ subsets.
- ‘Contemplation and Idea’ set; refers to all kinds of abstract intellectual and emotional activities. It contains ‘Thinking,’ 'Idea,’ ‘Solving,’ ‘Philosophy’ and ‘Intuition’ subsets.
- ‘Exploration and Analysis’ set refers to activities of searching, finding and analyzing something that has not been known and discovered till that time. It contains ‘Exploration,’ ‘Analysis,’ ‘Dissection’ and ‘Data Gathering’ subsets.
- ‘Process and Management’ set refers to activities of governing, managing, leading, ruling and directing a process in a period of time. It contains ‘Process,’ ‘Method’ and ‘Management’ subsets.

- 'Comprehension and Questioning' set refers to a state of comprehension reached as a result of a questioning, criticizing and realizing process, including comprehension of 3 dimensions. It contains 'Comprehension,' 'Questioning,' 'Awareness' and '3D Comprehension' subsets.
- 'Concept and Scenario' set refers to activities of adding meanings to an entity, associating it with a conceptual level and integrating it within a fictional context. It contains 'Concept,' 'Scenario' and 'Semantics' subsets.
- 'Shaping and Building' set refers to the act of revealing any kind of abstract phenomenon by forming and also the shape itself at the end of the process. It includes 'Shaping' and 'Building' subsets.
- 'User and Market' set refers to users, usage attributions and the market. It includes 'User,' 'User Emotions' and 'Market' subsets.
- 'Knowing and Learning' set refers to a general knowing activity upon acting the present and a general learning activity towards looking at the past. It includes 'Knowing the Past,' 'Learning' and 'Keeping up to Date' subsets.

3.4 Themes

Finally 10 sets are distributed to 3 themes based on similarities of meanings and logical relations. The names of the themes; 'Exposure', 'Essence', 'Intervention' are determined according to their core meanings.

Exposure	Essence	Intervention
Material and Production	Contemplation and Idea	Explanation and Presentation
Exploration and Analysis	Process and Managing	Shaping and Building
User and Market	Perception and Questioning	
Knowing and Learning	Concept and Scenario	

Fig. 8 10 sets are distributed to 3 themes.

'Exposure' theme includes 'Material and Production', 'Exploration and Analysis', 'User and Market' and 'Knowing and Learning' sets. It refers to any kind of data its sets offer to which the designer gets exposed during the design process. This state of being vulnerable to any kind of data is the main attribution of this set. This is the passivity and inaction of the designer compared to the 'Intervention' theme. This theme stands for the relation between the designer and the existing terms of the outer world without any proposal or intervention of the designer. However, passivity of the designer here does not mean attaining the information without any effort. It refers to actions like analyzing, describing, explaining and using, by which the designer has no ambition to change the existing terms. 'Exposure' set, whether doing some technological study for an ongoing research for an advanced robot or observing the daily routine of a target group, is predominantly a mental transmission from the outer world into the brain through the senses of the designer. It involves descriptive claims for the 'past' by examining the 'world'.

'Essence' theme includes 'Contemplation and Idea', 'Process and Managing', 'Perception and Questioning' and 'Concept and Scenario' sets. The word 'essence', beyond indicating a physical part of the human body like brain, points to a center point which manages the 'Exposure' and 'Intervention' themes. 'Essence' theme transforms into 'Exposure' theme by means of being exposed to the outer world and transforms into 'Intervention' theme by means of intervening it. What gives this theme its 'essence' attribution is the fact that while the other two themes can be simulated, this one cannot be. 'Exposure' theme can be simulated by tape recorders, marketing departments, cameras, eye and face tracking devices, research departments etc. while 'Intervention' theme can be imitated by 3d software, 3d printers, model makers etc. 'Essence' theme however, indicates abilities that have no equivalence, hence cannot be substituted or replaced. It synthesizes descriptive and normative claims for 'now' through the act of 'designing'.

'Intervention' theme includes 'Explanation and Presentation' and 'Shaping and Building' sets. It refers to the existing terms of the outer world which the designer wishes to change through a proposal through its sets. The state of proposing is the main attribution of this set. This is the activeness of the designer compared to the 'Exposure' set. This effectiveness and action state describes the relation between the designer and the existing terms of the outer world which is subject to change through proposals and interventions of the designer. It refers to active actions such as intervening, changing, effecting and proposing by which the designer has an ambition to change the existing terms. 'Intervention' set, whether construction of a skyscraper through many years of designing and building or a sketch of a water glass on some napkin, is predominantly a physical transmission from the brain to the outer world through the body of the designer. It involves normative claims in order to project what will happen in the 'future' through designing 'products'.

3.5 Chart of Conceptual Foundations

In this section of the paper, themes are discussed more broadly, used in a chart and applied to creative human activities as well as design. Four cases from graphic design, music, painting and literature are given as examples. The aim of giving such examples is to make a connection between designing products, visuals, songs, art pieces and novels, so that foundations of design ability may broadly be applied to other areas.

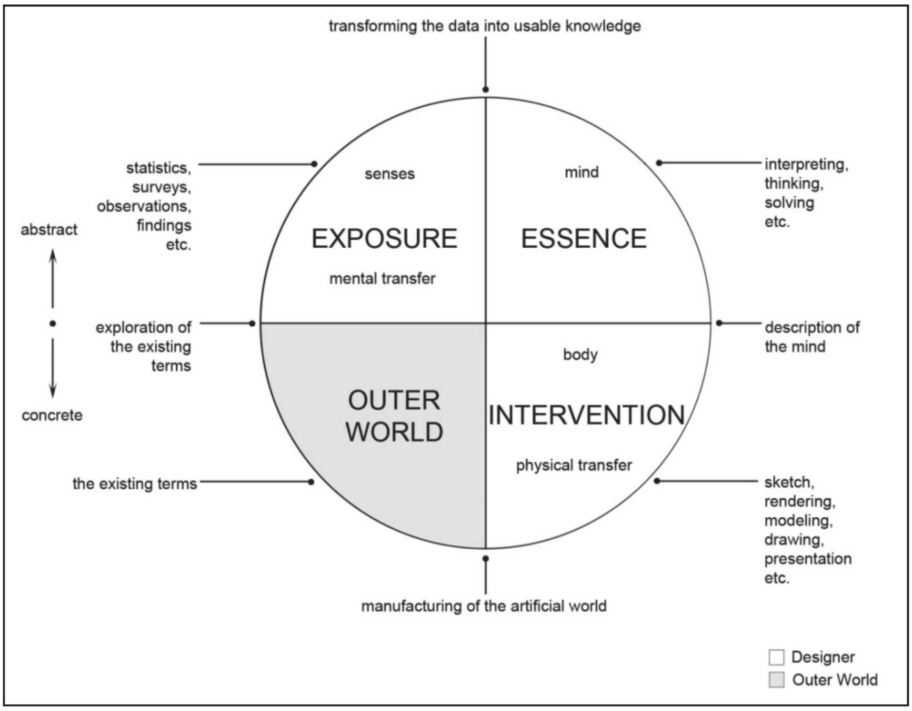


Fig. 9 Relations between the designer and the outer world shown in the chart.

The first example is an aphorism of an American graphic designer, Paula Scher:

“It took me a few seconds to draw it, but took me 34 years to learn how to draw it in a few seconds” (Airey, 2010, p.81).

Here it can be observed that Scher mentions but not underscores her drawing as an output. Instead, she emphasizes her life experiences which give rise to that drawing. In this sense she stresses 34 years which represent the ‘Exposure’ theme, rather than a few seconds which represent the ‘Intervention’ theme.

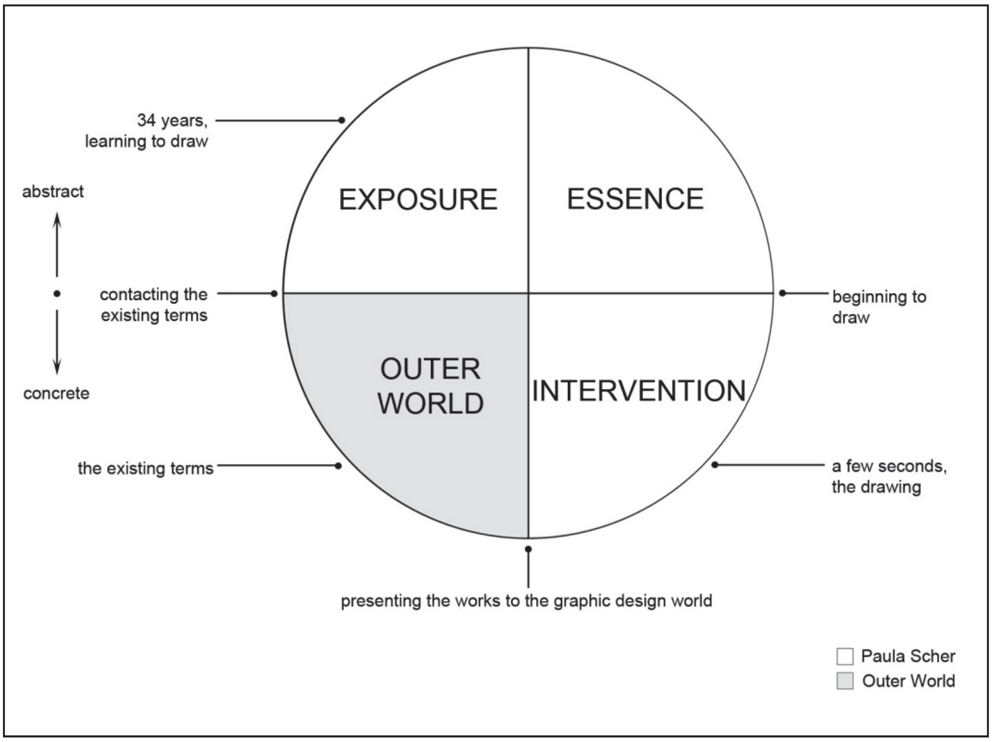


Fig. 10 Creation process of a graphical drawing shown in the chart.

The second example is about Ümit Besen, a Turkish singer, composer and song writer who discusses creation process of one of his famous songs, ‘Nikah Masası’ meaning ‘wedding table’ in English. He says:

“I wrote that song without knowing what it would be like. I wrote my feelings. I woke up from a dream and it just took me 20 minutes. I wonder there would be a wedding at that time! (…) The woman I was in love with would marry someone else according to the scenario of the first movie I acted in. That scenario overlapped with what I was experiencing at that time. That’s the reason I wrote it. (…) I do not write songs when I am happy. I necessarily have to have the experience of yearning and separation. Or I feed myself with my friends’ worries” (Aldinç, 2013).

In the background of this statement and beyond the time period of 20 minutes in which musical notes, melodies, chords or lyrics come physically into being as writings or sound waves; there are emotional experiences and a dream which the musician mentions implicitly on the creation of the song. If these elements are placed in the chart, it can be observed that the musician transforms data from outer world into experiences, yearnings and separations and transfers them into his brain, processes them in his mind consciously – or unconsciously like the dream he had – and turns them into a language suitable for the physical terms of the outer world in a time period of 20 minutes.

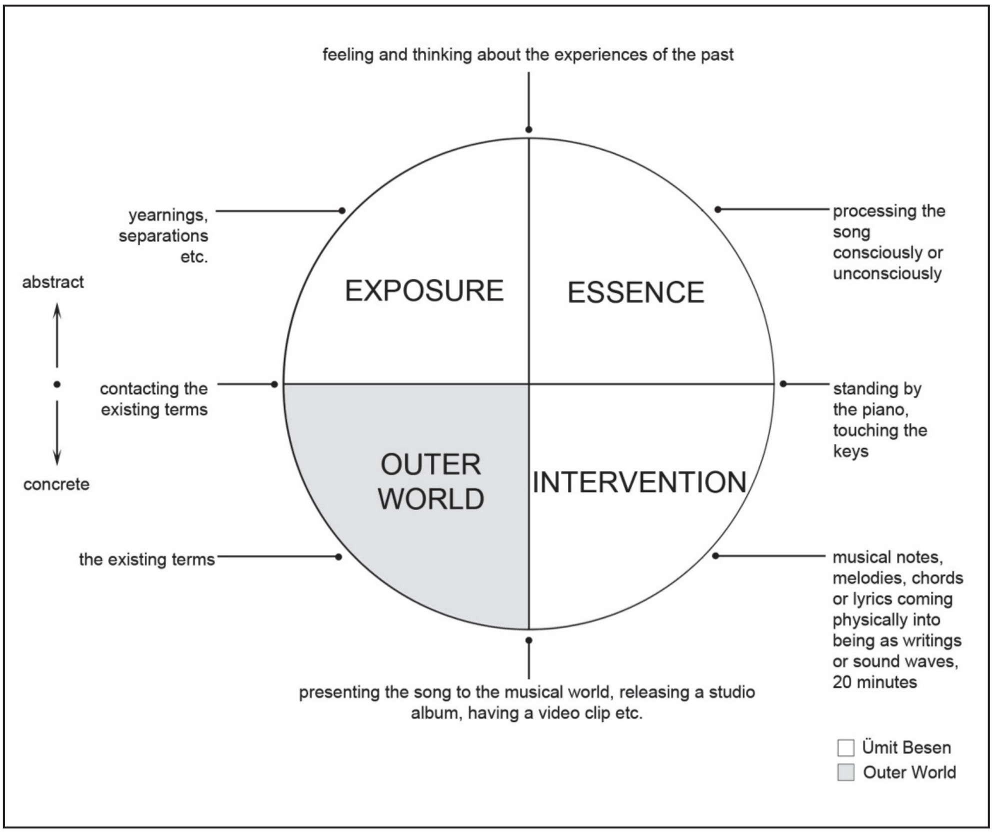


Fig. 11 Creation process of 'Nikah Masası' shown in the chart.

The third example consists of a famous anecdote about painting:

"In occupied Paris, a Gestapo officer who had barged his way into Picasso's apartment pointed at a photo of the mural, Guernica, asking: "Did you do that?" "No," Picasso replied, "you did", his wit fizzing with the anger that animates the piece" (In praise of ... Guernica, http://tinyurl.com/naatqx7).

Here it can be seen that Picasso emphasizes the background events that have effects on the context of the mural rather than the physical creation of it. In this sense it can be inferred that Picasso stresses the 'Exposure' theme. The bombing of Guernica, the impact it made and the impression it created on people, together, indicate the 'Exposure' theme while the physical entity of the mural, in other words the sum of the paint stains on the wall refer to the 'Intervention' theme. So that it can be said that the officer focuses on 'Intervention' theme while Picasso sticks on the 'Exposure' theme.

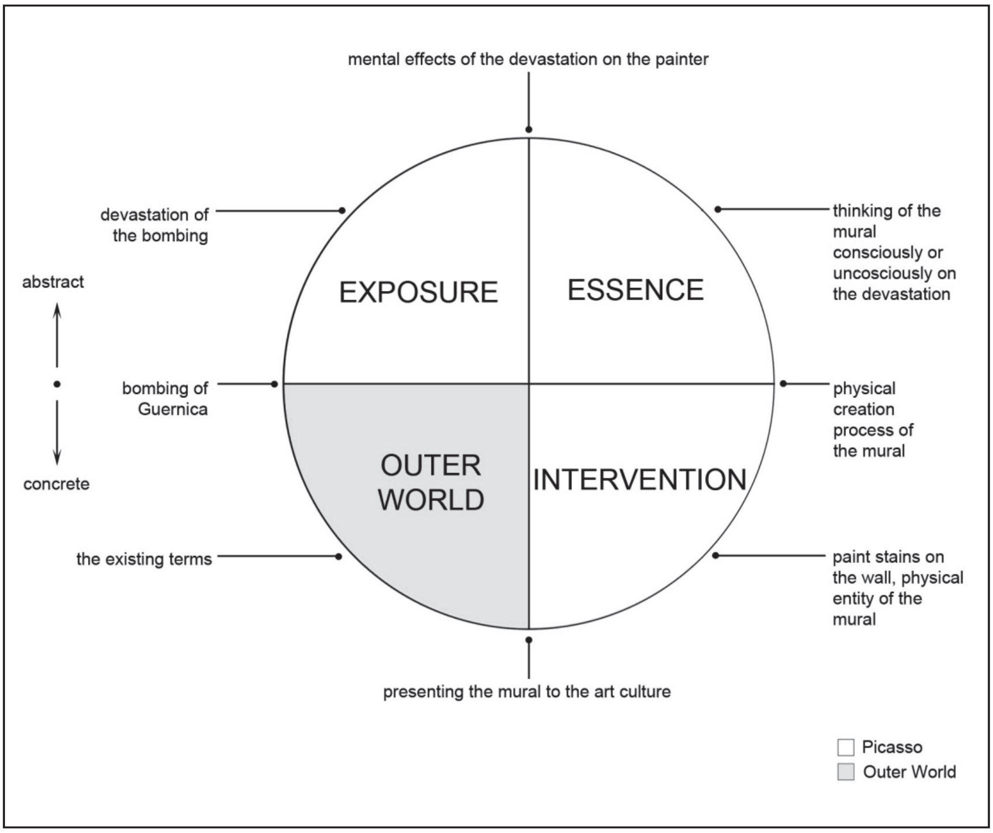


Fig. 12 Creation process of the 'Guernica' shown in the chart.

The fourth and last example consists of an aphorism on the field of literature narrated by Donaldson:

"Fitzgerald had been struggling to complete This Side of Paradise for two years – longer, if one considers how much of the book is borrowed from his undergraduate writing at Princeton – and it had gone through two substantial revisions before Scribners accepted it. But to the booksellers, Fitzgerald acknowledged none of these difficulties: "to write it … took three months; to conceive it, three minutes; to collect all the data in it, all my life""(Donaldson, 2001, p.164).

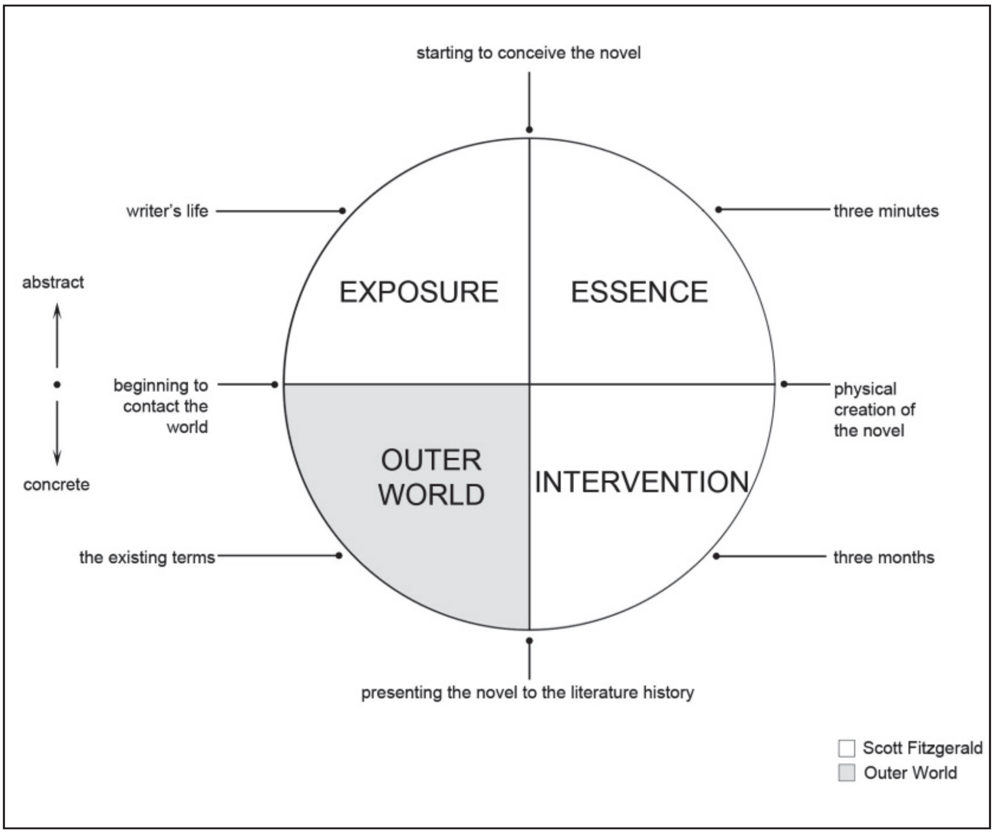


Fig. 13 Creation process of 'This Side of Paradise' shown in the chart.

Here it can be seen that Fitzgerald emphasizes his life experiences that has the largest effects on the creation of 'This Side of Paradise' rather than conceiving and writing processes of the novel. In this sense he stresses the 'Exposure' theme. The writer's life refers to the 'Exposure' theme; three months that represent the physical creation of the novel refer to the 'Intervention' theme and three minutes that represent the creation of the novel in his mind refer to the 'Essence' theme.

4. Model

The final outcome of this paper is a model used in order to show the findings of the process simultaneously. The findings can be interchanged, which means one element can be used instead of another one following its course in the model. To provide such mobility, a fractal triangle is suggested. One track goes 'exposure – senses – descriptive claim – past – world', one goes 'essence – mind – descriptive and normative claim – now – design' and finally one goes 'intervention – body – normative claim – future – product'.

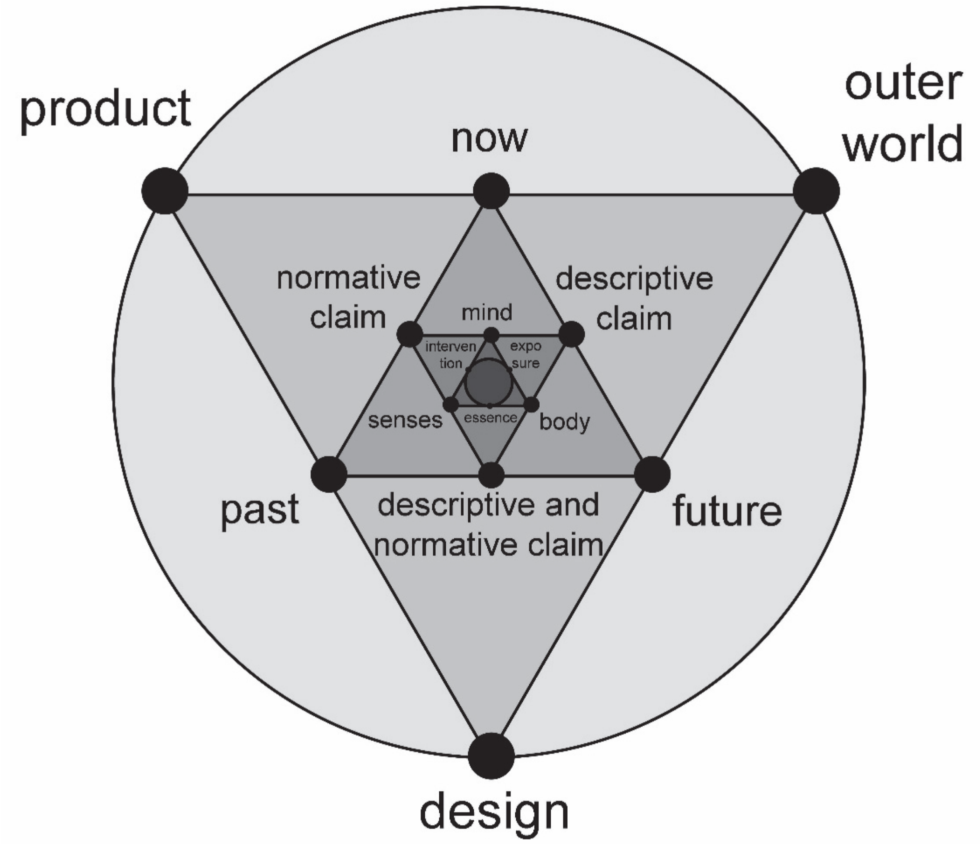


Fig. 14 A model of fractal triangles showing the findings of the paper.

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Estudio sobre los factores de diseño en un product mediante análisis de componentes principales

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Resumen

Se pretende determinar el grado de importancia de los factores a considerar en el diseño de un producto, a partir de las diferentes consideraciones contempladas, desde la perspectiva del consumidor y del diseñador. Mediante la aplicación del método de Análisis de Componentes Principales, analizamos a partir de esta investigación y mediante el estudio de un caso, los atributos deseables para un producto, según la opinión de expertos y consumidores. Se comprueba tras la aplicación del método la existencia de subsistemas que explican la necesidad de considerar determinados atributos (variables del sistema), teniendo en cuenta su grado de participación y afinidad en subsistemas diferenciados, mediante su agrupación en "n" factores, relativos a los componentes fundamentales utilizados comúnmente en el diseño de productos. El método persigue establecer la trazabilidad del diseño, determinando los constructos principales relativos a la función, ergonomía y forma de los productos , y todo ello orientado a la mejora en la definición conceptual de éstos, buscando en todo momento en lo que se refiere a gestión del conocimiento, la mejora en la aplicación de métodos, técnicas y procedimientos con objeto de optimizar el diseño y/o rediseño de los productos industriales.

***Palabras Clave**: Análisis Factorial, Diseño de Producto, Metodología del Diseño, Trazabilidad del diseño*

Abstract

It is intended to determine importance degree of the factors to be considered in the design of a product, from the considerations set out by both the consumer and designer perspective. By applying the method of Principal Component Analysis at the study of a case, we analyzed the desirable attributes for a product, in the opinion of experts and consumers. It is checked after the application of the method the existence of subsystems that explain the need to consider certain attributes (variables of the system), taking into account their degree of participation and affinity differentiated subsystems, by grouping them in "n" factors relating to fundamental components commonly used in product design. The method aims to establish design traceability, determining the main constructs on the function, ergonomics and form of the products, all aimed at improving the conceptual definition of the product, always seeking in regard to knowledge management, improvement in the application of methods, techniques and procedures in order to optimize the design and / or redesign of industrial products.

Keywords: Factorial**,** Design Analysis Product**,** Design Methodology**,** Design Traceability

1. Introducción

Las discrepancias detectadas en investigaciones pasadas (CABELLO, 2009) entre consumidores y expertos en cuanto a las características y atributos que debe de tener en cuenta el diseño de un producto, así cómo, las diferencias detectadas desde las perspectivas de sus posiciones, como consumidores de productos industriales o teóricos conocedores de los requerimientos que estos deben poseer, nos hace reflexionar en el análisis de esta problemática y su repercusión e importancia a la hora de diseñar.

Desde la antigüedad encontramos que el análisis de productos con objeto de determinar sus factores integrantes, se ha realizado de manera más ó menos intuitiva. Nos consta que Vitrubio ya infiere una división de sus características en el 32 a.C. en estética, funcionalidad y reúso (LE DANTEC & YI-LUEN DO, 2009). Tal vez esta sea la primera división de los factores integrantes del diseño. En el siglo pasado (MINTZBERG ,1991) comenta entorno a la forma, ergonomía y función. Actualmente y como consecuencia de la implementación de muchos modelos sistémicos podemos inferir patrones de recurrencia en esta división que prevén nuevas formas de trabajo, orientadas a una mejor definición del Diseño Conceptual (BRIEDE Y HERNANDIS, 2011).

Proponemos su análisis bajo la descomposición de los subsistemas fundamentales del diseño: forma, función y ergonomía considerando su isomorfismos en volúmenes, superficies y límites de contorno (Hernandis y Briede, 2009). Desde esta óptica del diseño analizaremos las características de los productos y estudiaremos mediante un caso propuesto cual es el resultado de esta investigación.

Es evidente que existen múltiples clasificaciones de los atributos del diseño que no se abordan en este trabajo, el motivo es evidente, al considerar que podría aplicarse el método a cualquier división pero su efectividad se ve enormemente mermada en caso de existir gran número de variables que se agrupan en muchos factores a su vez. Así mismo, también se han descartado otras metodologías de análisis (PAGE ET AL, 2001) por ser poco apropiadas según el objetivo planteado.

Los estudios sobre los factores o características del producto son habituales tanto en la investigación de mercado como en lo relativo a innovación en desarrollo de nuevos productos (MALHORTA, 2004).

2. Materiales y métodos

2.1. Metodología para el muestreo.

La metodología utilizada Análisis de Componentes Principales (ACP) (SIOTANI Y WAKAKI, 2006) fue realizada bajo una base de Estadística cuantitativa, descriptiva, con entrevistas personales, por medio de un cuestionario que se creó durante el curso 2008-2009 entre alumnos que cursaban el Master de diseño gestión y desarrollo de nuevos productos de la Universidad Politécnica de Valencia, teniendo en cuenta aspectos relativos a la gestión del conocimiento para el diseño conceptual de productos industriales (ULUSOY, 1999). Se optó mediante una decisión consensuada, por estudiar un caso en relación a un producto conocido por gran número de usuarios, siendo elegido por los participantes un carro doméstico para la compra.

Se hizo un estudio pre-test, que tuvo como consecuencia el cambio en algunas de las preguntas del cuestionario, así como en el formato, que facilitaba una mejor comprensión del mismo (MALHORTA, 2004). Ya que se iba a realizar la encuesta por muchos encuestadores, esto disminuiría el error cometido por equivocaciones de interpretación del cuestionario.

Dichas entrevistas fueron realizadas en dos fases, en la primera se realizaron encuestas a personas que utilizaban el carro de compra doméstico, de manera habitual o incluso esporádica. La segunda fase se realizó con una muestra totalmente diferente, alumnos del Master oficial de Ingeniería del Diseño, así como a diferentes expertos en diversos ámbitos del diseño (BALL ORMEROD Y MORLEY, 2004). Se pretende que la muestra esté suficientemente diferenciada como para realizar diversos análisis comparativos que nos ayuden a responder a nuestros objetivos, así como a crear una base de datos para estudios posteriores.

El cuestionario consta de 26 preguntas en donde se hace referencia a la actitud, comportamiento y percepción del consumidor frente a diversos atributos generales (LE DANTEC Y YI-LUEN DO, 2009) de un carro de la compra, así como preguntas de clasificación general.

Para determinar el tamaño muestral adecuado hemos supuesto las siguientes hipótesis (MARTÍNEZ ET AL, 2000): la población de 800.666 habitantes, correspondiente a la población de Valencia. Si tenemos en cuenta tan solo la población útil para nuestro estudio (población entre 20 y 76 años de edad), esta se conforma por 410.068 lo que significa casi el 52% de la población total. Para efectos estadísticos consideramos la población como infinita, con un error de estimación del 5% y nivel de confianza del 90%. Con estos datos, y aplicando la fórmula para intervalo de proporciones (Figura 1), hemos obtenido que el nivel adecuado de encuestas debe ser de 211.

$$n = Z^2_{\alpha/2} \frac{p*q}{\varepsilon^2} \qquad n = 1,45^2 \frac{0,5^2}{0,05^2} = 211$$

Fig.1 Tamaño de la muestral

α	Nivel de significación
p, q	Probabilidad de acierto, q= 1-p
Z	Asociado al nivel de significación α /2
n	Tamaño muestral
ε	Error en el intervalo de confianza para proporciones

Se realizó un muestreo no probabilístico por conveniencia (AAKER ET AL, 2001), de las cuales 100 han sido realizadas a consumidores y el resto realizadas tanto a profesores como a estudiantes de diseño de la Escuela Técnica Superior de Ingeniería del Diseño, de la Universidad Politécnica de Valencia, así como a diseñadores con reconocida trayectoria profesional.

El primer estudio, viene dado por el tipo de usuarios de los que se requiere información, para ello se hizo un muestreo por conveniencia enfocado en individuos entre 20 y 76 años de edad residentes en Valencia capital captados de forma mayoritaria a la entrada de supermercados de alimentación, por ser estos los lugares más óptimos para localizar nuestro público objetivo

Los entrevistadores fueron nueve alumnos pertenecientes al Master en Diseño, Gestión y Desarrollo de Nuevos Productos de la Universidad Politécnica de Valencia, en su edición décimo segunda impartida durante el curso 2008-2009 y por tanto, perfectos conocedores de la investigación siendo estos quienes encuestaron a los consumidores.

2.2. Análisis de los datos

Para el análisis de los datos, hemos utilizado el programa informático SPSS 15.17. Se han realizado análisis de frecuencias para el estudio de la caracterización de la muestra. Es interesante contrastar si es aceptable la hipótesis de que las medias de todos los grupos de observaciones obtenidas al repetir el experimento para cada nivel de factor son idénticas. Si los contrastes diesen como resultado que esta hipótesis es cierta, la pertenencia a un grupo o a otro sería irrelevante, y podríamos considerar todas las observaciones como una muestra de una única población. Un enfoque alternativo de esta hipótesis, que conduce al mismo resultado, es considerar los grupos idénticos si las diferencias entre sus medias son pequeñas. El análisis de la varianza simple es una técnica estadística utilizada para analizar la relación entre una variable dependiente (o endógena) métrica y una o varias variables independientes (o exógenas no métricas). El objetivo esencial de los modelos del análisis de la varianza es determinar si diversas muestras proceden de poblaciones con igual media. De modo que el modelo ANOVA mide la significación estadística de las diferencias entre las medias de los grupos determinados en la variable dependiente por los valores de las variables independientes (ROMERO Y ZÚNICA, 2005).

Por otra parte para el estudio de nuestro objetivo, al observar muchas variables sobre una muestra, se decidió utilizar algún método multivariante de reducción de la dimensión. Estos métodos combinan muchas variables observadas para obtener pocas variables ficticias que las representen con la mínima pérdida de información.

Si son variables cuantitativas, las técnicas de reducción de la dimensión pueden ser el Análisis de Componentes Principales y el Análisis factorial, si son variables cualitativas, puede acudirse al Análisis de Correspondencias y al Escalamiento Óptimo, y si son variables cualitativas ordinales se acude al Escalamiento Multidimensional (PÉREZ-LÓPEZ, 2005).

Teniendo en cuenta que las variables que se manejan son cuantitativas, y que ninguna de ellas se considera a priori dependiente principal de las demás, la técnica de reducción de la dimensión utilizada es el Análisis Factorial.

Dentro de esta técnica, se utilizó como método de extracción de los factores el método de los componentes principales, ya que SPSS considera este último como un caso particular del Análisis Factorial, utilizado para formar combinaciones lineales no correlacionadas de las variables observadas. Con este método, el primer factor será el que tenga una mayor varianza explicada, las componentes sucesivas explican menos varianza progresivamente, y no estarán correlacionadas entre ellas. Esto nos permite obtener una solución factorial inicial, así como la elección del número de factores más adecuado, para ello se tendrá en cuenta la varianza acumulada explicada por los primeros auto valores.

La finalidad del análisis factorial, es tener una interpretación clara de los factores, aunque esto no siempre es fácil, para ello se ha realizado una rotación de los factores a partir de la solución inicial, el método utilizado ha sido una rotación ortogonal por el método Varimax, que minimiza el número de variables que tienen saturaciones altas en cada factor.

3. Resultados

3.1. Caracterización muestral

En este apartado nos centramos en todas las características de la muestra objeto de nuestra investigación. Para ello hemos hecho un análisis de frecuencias de las variables referentes a: Género; Nacionalidad; Forma de vida y Nivel de Estudios; de los 211 encuestados, según

Tabla 1: **Clasificación de la muestra**

GÉNERO	hombre	39,82%
	mujer	60,18%
ESTUDIOS	sin bachiller	15,18%
	bachiller	29,46%
	diplomado	23,21%
	licenciado	32,14%

NACIONALIDAD	español	84,17%
	extranjero	15,83%
FORMA DE VIDA	solo	15,93%
	pareja	13,27%
	familia o comparte	70,80%

Como podemos apreciar la distribución de los encuestados en cuanto al Género hay un porcentaje mayor de mujeres que usan habitualmente el carro de compra. Mientras que los hombres encuestados representan sobre el 40%, las mujeres representan el 60%. Este es un dato que no nos sorprende, aunque presuponemos que irá igualándose en el tiempo, dada la evolución del papel de la mujer en la sociedad española.

Mayoritariamente nuestros encuestados son de nacionalidad española, la muestra en este sentido, ha sido seleccionada de forma aleatoria, por lo que podemos aproximar que la población está distribuida de la misma manera, con un casi 20% de extranjeros.

Hay que tener en cuenta que nuestra muestra no es aleatoria, ya que gran parte de ella se ha realizado entre alumnos de la Universidad Politécnica de Valencia, que además en su mayoría estaban realizando estudios de postgrado, por lo que más del 50% de los encuestados, tenían como mínimo una diplomatura realizada. Aún así se realizó el análisis de la muestra sin tener en cuenta las encuestas realizadas en la Universidad, dejando patente que seguía existiendo muy pocas personas que no tuvieran como mínimo estudios de graduación secundaria.

Vemos como mayoritariamente, se vive con la familia o se comparte piso con compañeros, por el origen de la muestra, (principalmente estudiantes de diseño), y la edad de los encuestados, parece bastante natural este resultado.

3.2. Comparación de medias

Comparamos las medias sobre la opinión respecto a los atributos del producto entre alumnos de diseño y los consumidores. Tomamos como variable independiente los alumnos de diseño, y como variable exógena los consumidores. Para determinar si existe verdaderamente diferencia entre las medias, aplicamos un análisis ANOVA para un factor.

Resumimos en la Tabla II los factores que por tener una significación menor al 10%, se puede rechazar la hipótesis de igualdad entre sus medias, y facilitar de esta manera la interpretación visual de los datos. Presenta las sumas de los cuadrados para cada fuente de variación, los cuadrados medios, el valor de la F de Fisher-Snedecor para el contraste global de diferencias significativas entre todas las medias de cada nivel de factor y los p-valores, que permite decidir entre aceptar o rechazar la diferencia significativa entre medias de cada nivel de factor. Si el p-valor resulta menor a 0,1 se acepta que las medias de las muestras para cada nivel de factor difieren significativamente al 90%. Por tanto serán estos valores los únicos dignos de estudio posterior. En la tabla también se muestran las medias de valoración para cada uno de los atributos según cada tipo de encuestado, en los que inferimos que la opinión de los estudiantes es distinta a la del resto de consumidores.

Tabla 2: Anova

ANOVA	Suma de cuadrados	Media cuadrática	F	Sig.		Alumnos de diseño	consumidor	Media totales
precio	3,731	3,731	3,524	0,063		2,68	3,05	2,92
impermeable	2,161	2,161	2,182	0,142		2,73	3,01	2,91
limpieza interior	3,919	3,919	3,647	0,059		2,63	3,01	2,88
limpieza exterior	4,901	4,901	5,043	0,027		2,53	2,96	2,81
acoplable a bici	4,707	4,707	3,893	0,051		2,31	1,88	2,03

Los alumnos le dan menos importancia al precio, a que sea impermeable, la limpieza interior y exterior, y sin embargo valoran más que el resto de consumidores que sea acoplable a una bicicleta.

3.3. Análisis de componentes principales

El determinante de la matriz de correlaciones nos da un valor de 3,984E-06, por ser muy pequeño, nos indica que la condición inicial para el análisis de las componentes principales es adecuada, ya que demuestra que el grado de intercorrelación entre las variables es muy alto. Así mimo, la correlación con respecto a los factores la confirma el test de esfericidad de Barlett. Como su valor p-valor es 0,000, se puede concluir que existe correlación significativa con las variables.

Observamos también en la Tabla 3 el estadístico KMO, cuyo valor 0,740 muy por encima de 0,5 nos asegura una muy buena adecuación de la muestra a este análisis.

Tabla 3: **KMO y prueba de Bartlett**

Medida de adecuación muestral de Kaiser-Meyer-Olkin.		,740
Prueba de esfericidad de Bartlett	Chi-cuadrado aproximado	1241,260
	gl	378
	Sig.	,000

Analizamos a continuación la comunalidad de las variables (suma de los cuadrados de sus cargas factoriales definidas en la matriz de componentes), comprobando así la variabilidad de cada atributo que es explicada por los factores. Observamos que la comunalidad de todas las variables después de las extracciones es superior a 0.3, excepto la referida a tener departamento para frágiles y a que sea plegable, que tienen un valor inferior.

Retenemos 4 de los 7 factores que tienen una varianza explicada mayor que uno, ya que estos son los que explican la mayor parte de la varianza, como podemos comprobar en la Tabla 4 de autovalores iniciales. Quedaría explicada el 47,27% de la varianza total.

Tabla 4: **Varianza total explicada**

Componente	Autovalores iniciales		
	Total	% de la varianza	% acumulado
1	6,24	22,29	22,29
2	3,14	11,23	33,51
3	1,97	7,04	40,55
4	1,88	6,73	47,27

Por lo que obtenemos la matriz de componentes. Utilizamos la Tabla 5 de componentes rotados para facilitar enormemente la claridad de pertenencia de cada una de las variables a un componente, el método utilizado para la rotación ha sido una rotación Varimax, ya que tiene la propiedad de que los factores siguen siendo incorrelados. Las celdas vacías corresponden a coeficientes menores de 0,2 que no aparecen en la tabla para facilitar visualmente la interpretación de los coeficientes representativos.

Tabla 5: **Matriz de componentes rotados.**

	1	2	3	4		1	2	3	4
estética		0,75			limpieza interior	0,47	0,47	0,23	
accesibilidad interior	0,60				limpieza exterior	0,26	0,41	0,28	-0,24
escaleras	0,57				lavadora		0,36	0,52	-0,21
manejabilidad	0,74				otros usos			0,60	
peso carga	0,62				desmontable	0,23	0,20	0,43	
peso vacio	0,45	0,24		0,32	manejo en la conducción	0,68	0,20		
volumen carga	0,38			0,41	comodidad agarre	0,73		0,23	
congelados	0,20		0,61		regulable altura	0,57		0,33	
frágiles			0,44		regulable volumen	0,53		0,35	0,25
precio	0,42	0,38	-0,35	-0,22	acoplable a bici			0,69	
maletero con compra			0,23	0,78	plegable			0,30	
maletero en vacío				0,78	moderno		0,80		
guardar en casa	0,54	0,47	-0,25		diseño interior		0,61	0,36	
impermeable	0,58			-0,36	diseño exterior		0,76		

3.4. Consulta a expertos

Con el fin de poder en un principio interpretar los cuatro factores retenidos en primera instancia con el análisis de componentes principales, se consulta a 6 expertos en diseño, procedentes de diferentes países, ya que de esta manera se contrastan diferentes opiniones según áreas de especialización heterogéneas y diferentes entre si. Como resultado de esta puesta en común de opiniones, refutamos la clasificación determinada por los conjuntos de variables determinados como FORMA, FUNCIÓN Y ERGONOMÍA sin caer en posibles subjetividades que podrían haberse creado con grupos u orígenes más homogéneos.

Cada uno de los factores implica una agrupación de características o atributos del diseño que intentamos identificar con la propuestas realizadas por autores representativos. En particular nos centraremos en la propuesta de Mintzberg que propone una división en Forma, Función y Ergonomía y que en la actualidad viene a ser una de las más utilizadas en las Escuelas de Diseño. En particular en la ETSID y dentro de los denominados Métodos Sistémicos (HERNANDIS, 2000) es una división habitual.

Consultados diversos especialistas con respecto a cómo las características se agrupan según los factores mencionados, proponemos identificar el Factor 1 con Ergonomía. Del mismo modo se concluye que los atributos del Factor 2 se identifican con Forma. Y de igual modo el Factor 3 se identifica con aspectos de la Función. Por último en el Factor 4 aparecen dos características aisladas, cuya explicación en este caso se debe a que implica a otro producto, siendo su existencia necesaria para que tenga sentido el producto complementario (vehículo). Suponemos por tanto que se refiere a accesorios. En la siguiente Tabla 6 se resume esta asignación.

Tabla 6: Atributos de Diseño

Factor 1: **ERGONOMÍA**	Accesibilidad interior Que suba escaleras Manejabilidad Peso que soporta Peso del carro en vacío Precio Fácil de guardar en casa Impermeable Manejo en la conducción Comodidad de agarre Regulable en altura Regulable volumen		Factor 2: **FORMA**	Estética Fácil de limpiar por fuera Moderno Diseño interior Diseño exterior
Factor 3: **FUNCIÓN**	Apartado congelados Apartado para frágiles Lavable en lavadora Posibilidad de otros usos Desmontable Acoplable a una bici Plegable		Factor 4: **ACCESORIOS**	Fácil de meter en el maletero con compra Fácil de meter en el maletero vacío

Es evidente la identificación de atributos según los especialistas consultados y su agrupamiento en los sub-sistemas forma, función y ergonomía.

4. Conclusiones

Esto posibilita el análisis de correspondencia entre los factores de diseño y la opinión del consumidor y diseñador con las características de éste, es decir, pretende ser un primer paso entre lo que denominaremos trazabilidad del diseño. Se pretende en futuras investigaciones buscar la máxima correlación entre los atributos, especificaciones o características que afectan al diseño de producto, las características demandadas por los consumidores y el conocimiento del diseñador como alquimista del diseño. El agrupamiento de los factores, sus posibles sub-agrupamientos en subsistemas fundamentales y el estudio de las relaciones existentes en razón de sus propiedades y comportamientos según la funcionalidad, ergonomía y forma, hacen prever un camino interesante para el uso del Análisis de Componentes Principales con objeto de determinar la trazabilidad de diseño.

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Systematic Design Method for Co-creation of 3D Printing Service

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Abstract

Background: As one of the objectives of Design for Additive Manufacture, the customized geometry promotes 3D printing to increasingly realize product customization in the service market. Defined as a business strategy which focuses on customer experience and interaction, co-creation is expected to obtain a fast-growing market volume. Recently, some co-creation of 3D printing service (3DPS) has been released to realize value creation. Despite of its rapid growth, there are rare researches on this field, especially those about its design method.

Aim: To define a systematic design method for developing the co-creation of 3DPS.

Method: Firstly, this research distinguished ambiguous type and definite type of 3DPS co-creation. The latter was taken as the current research object, because it presents the services scope more clearly. Furthermore, in order to solve the problem about the research, that is, what the essential components constructing the 3DPS co-creation are, evidence needed to be collected based on observation of the mentioned cases. Therefore, holistic multiple-case study of 3DPS co-creation samples was designed and conducted, as it was herein applied as the research method. This research is divided into three sections. The first section presents the preparation for data collection, including case selection and the formulation of evidence collection. The second section analyzes the collected evidences. Based on the evidence analysis, the third section concludes the knowledge of 3DPS co-creation.

In order to collect adequate evidences, a pair of models was applied to build a framework. The first one is the Den Hertog's service innovation model which presents four dimensions including new service concept, new client interface, new service delivery system, and technological options. The other model refers to the building blocks of interactions for value co-creation: dialogue, access, risk-benefits, and transparency. It presents the components in basis construction, which are necessary for the interactions between a consumer and a service provider.

Finding: the system of 3DPS co-creation is composed by three dialogues including related accesses and interfaces, and the to-be-3D printed outcome. The three accesses provide customers with the entrances of knowing service concept, co-creating geometry, and accepting service delivery. The interfaces bring corresponding dialogues between accesses *and customer to reach each process goal. The outcome of co-creation refers to the 3D printed artifact or 3D digital model.*

Conclusion: This research proposes a four-step systemic design method for co-creation of 3DPS. Firstly, the dialogue with the interface of service concept introduction and the access to know it is constructed. Secondly, the dialogue based on the interface of co-creation with design variables, and the access of co-creating geometry is built. WebGL supports its 3D graphics. Thirdly, the interface of purchasing or downloading, and the access of accepting service delivery compose the dialogue of this step. Fourthly, the customized artifact shall be treated by 3D printing and then delivered to customers; or a 3D digital model gets ready for downloading.

Keywords: *co-creation, 3D printing service, product customization, service innovation, design method*

1. Introduction

Co-creation is defined as an active, creative and social collaborative process between producers and users and aims to create values for customers (Piller et al., 2010). Nowadays, consumers join idea generation for new products, co-create products with firms, test finished products and provide end users with product support (Nambisan, 2002). As a business strategy which focuses on customer experience and interactive relationships, co-creation is expected to obtain a fast-growing market volume (Dervojeda et al., 2014; Sanders & Stappers, 2008).

What is the most powerful tool to realize co-creation? As one of the objectives of Design for Additive Manufacture, customized geometry can promote application of 3D printing technology to gradually realize product customization in the service market (Gibson, Rosen & Stucker, 2010). Meanwhile, in comparison with scanning-based customization, co-creation provides a flexible format in which the 3D printing technology is applied more efficiently and extensively. Until now, various kinds of co-creation of 3D printing service (hereafter referred to as 3DPS) were released on the Internet to realize value creation. Through the web-based 3D visualized interface, a customer can create and customize his or her own product, and can then obtain the tangible outcome which will be treated by 3D printing of the service supplier.

Despite of the rapid growth of 3DPS co-creation, there were rare researches on this field, especially those about its design method. In 2015, Rayna, Striukova, and Darlington investigated the changes brought by online 3D printing platforms in co-creation and user innovation. The authors concluded that co-creation initiates transformation from consumers to prosumers, and 3D printing technology helps co-creation to exert its full potential. Rayna et al. (2015) also suggested: “for this to happen, adequate co-creation platforms shall be built and this requires full understanding the different aspects of co-creation, the consequences of pro-consumption and the key roles of information systems.” (p.101). Nevertheless, the prior research may not be highly beneficial for 3DPS providers to build a co-creation format effectively.

Through investigation of specific essential components of 3DPS co-creation, this research aims to define a systematic design method for developing the co-creation of 3DPS. Based on a pair of theoretical bases, holistic multiple-case study was carried out here aiming at a group of 3DPS co-creation samples. The cases refer to the definite-type 3DPS co-creation which presents the clear scope of services.

The article is divided into three sections. The first section presents the preparation for data collection, including case selection and formulation of evidence collection. The second section analyzes the collected evidences. Based on the evidence analysis, the third section concludes the knowledge of 3DPS co-creation. The research findings benefit enterprises engaged in the 3D printing service and will also facilitate promotion of co-creation which is an emerging strategy in 3D printing. In addition, this study focuses on an interesting topic for DFAM research.

2. Theoretical basis

A pair of theoretical models was applied to build a systematic framework in this research. The first one is the Den Hertog's model of service innovation (hereafter referred to as the Den Hertog's model). As shown in Fig.1, this model presents four dimensions including new service concept, new client interface, new service delivery system, and technological options (Hertog, 2000). This framework maps service innovation and discusses the practical development of new services, such as the 3DPS co-creation, namely the topic of this paper.

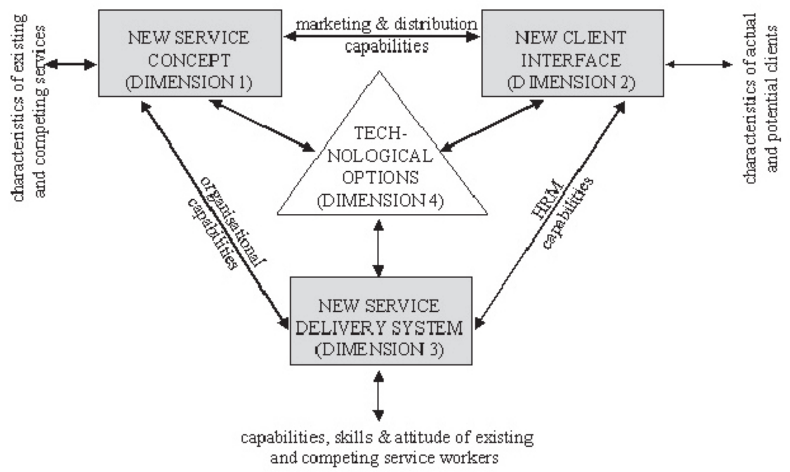

Fig. 1 Den Hertog's Model of Service Innovation (2000).

Another model, as shown in Fig.2, refers to the building blocks of interactions for value co-creation: dialogue, access, risk-benefits, and transparency (hereafter referred to as the DART model). It presents the components in basis construction, which are necessary for the interactions between a consumer and a service provider (Prahalad & Ramaswamy, 2004). This model describes how to build a system for co-creation of values.

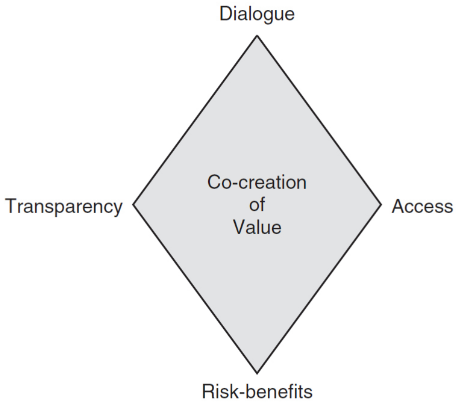

Fig. 2 Building Blocks of Interactions for Value Co-creation. Prahalad & Ramaswamy, (2004)

3. Research design

First of all, this research distinguished ambiguous type and definite type of 3DPS co-creation according to the service goal. The former, like CUBETEAM design app (https://cubeteam.io/) displayed in Fig.3, provides users with a completely open innovation environment in which any possible work might be created and then treated by 3D printing. The latter refers to flexible formats employed by users to reach a specific design goal, such as jewelry, decor, and characters. Fig.4 shows RADIOLARIA (http://n-e-r-v-o-u-s.com/radiolaria/), an online design application for designing and 3D printing customized earring. Its pieces were based on "physical simulation of springs arranged in a cellular mesh" (Derringer, 2010). With regard to the Nervous System, a US-based generative design studio launches Radiolaria and a broad range of 3D printing apps. Such definite-type samples were taken as the current research objects, because it presents a systematic scope of services.

Fig. 3 CUBETEAM Design Application

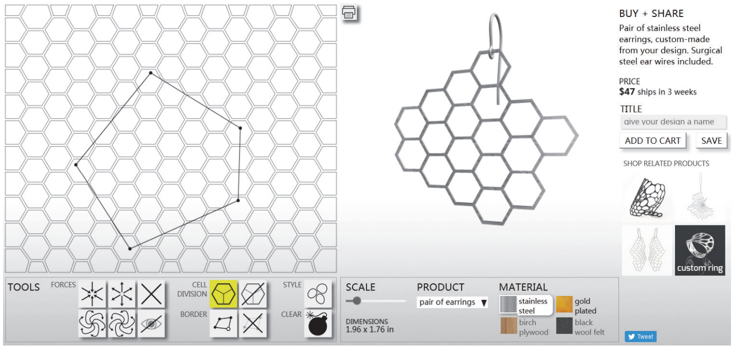

Fig. 4 RADIOLARIA Design Application

The research aims to solve one problem, namely, what the essential components constructing the 3DPS co-creation are. In order to explore the solutions, the evidence needed to be collected through observation and description of the definite-type samples. As a type of emerging technology application, the number of targeted 3DPS co-creation is still greatly limited. Therefore, an inductive approach based on qualitative case study was adopted (Eisenhardt, 1989; Yin, 2003). This study aimed to define a systematic design method for developing the co-creation of 3DPS, so multiple-case study became the most suitable manner for this kind of research (Yin, 2003).

Basically, current study was divided into three parts: preparation for data collection, collection of the evidences, and analysis of the evidences. The first part consists of case selection and formulation of the evidence-collection procedures; based on two theoretical models, an investigation framework is formulated and applied in this part. In the second part, the collected evidences are presented in a systematic way. In the third part, through analysis of the evidences, solutions to the research questions will be proposed.

4. Preparation for data collection

4.1 Case selection

With regard to the case study samples, authors selected four applications of 3DPS co-creation according to these standards. Firstly, as mentioned before in Chapter 3, the goal of samples must be clear and definite. Secondly, selected cases should respectively stand for a specific category. In particular industries, this criterion facilitates collection of adequate evidence from a responding co-creation process in 3DPS. As shown in Table 1, samples are classified into four categories including Jewelry & Fashion, Decor & Houseware, Characters & Creatures, and Terrain & Geography. Thirdly, these cases should be set up by different enterprises. Therefore, a wide range of co-creation features would be involved in the following survey.

Table 1 Case Study Samples

Samples	Categories	Summaries	Web addresses
RADIOLARIA	Jewelry & Fashion	A co-creation service which provides a customized earring and carries out 3D printing to it for the customer	http://n-e-r-v-o-u-s.com/radiolaria/
COOKIE CASTER	Decor & Houseware	A co-creation service which provides customized cookie cutter for the customer. The co-created outcome is ready for 3D printing through the customer downloading.	http://www.cookiecaster.com/
PUPWORKSHOP	Characters & Creatures	A co-creation service which provides a customized toy pup and carries out 3D printing of it for the customer	http://pupworkshop.com/
BENGLER TERRAFAB	Terrain & Geography	A co-creation service which provides a customized Norwegian miniature landscape and carries out 3D printing of it for the customer. The co-created outcome also gets ready for 3D printing through the customer downloading.	http://terrafab.bengler.no/

4.2 Formulation of the evidence collection

In order to collect systematic evidences of each case, this task was performed at two main steps based on the Den Hertog's model including service concept, client interface, service delivery system, technological options, as well as the DART model including dialogue, access, risk-benefits, transparency. As shown in Table 2, a framework, in which the essential components of 3DPS co-creation were investigated and defined, was developed.

Table 2 Case Study Framework

<table>
<tr><th>Sample</th><th colspan="2">Detailed items</th><th>Evidences</th></tr>
<tr><td rowspan="8">Sample name</td><td rowspan="4">Items of Den Hertog's model</td><td>Service concept</td><td></td></tr>
<tr><td>Client interface</td><td></td></tr>
<tr><td>Service delivery system</td><td></td></tr>
<tr><td>Technological options</td><td></td></tr>
<tr><td rowspan="4">Items of DART model</td><td>Dialogue</td><td></td></tr>
<tr><td>Access</td><td></td></tr>
<tr><td>Risk-benefits</td><td></td></tr>
<tr><td>Transparency</td><td></td></tr>
</table>

5. Collection of evidences

According to summarization the survey results based on selected 3DPS co-creation samples, the detailed case evidences are listed in following four tables.

Table 3 Case Evidences of RADIOLARIA

Sample	Detailed items		Evidences
RADIOLARIA	Items of Den Hertog's model	Service concept	• A co-creation service which provides a customized earring for the customer
		Client interface	• The interface for introducing RADIOLARIA service concept. • The interface for co-creating the earring features including form, scale, and material • The interface for purchasing the co-created earring.
		Service delivery system	• Displaying its purchase path, including knowing price, adding to cart, and paying, the co-created earring is ready for 3D printing and will be shipped to the customer.
		Technological options	• WebGL technology for rendering interactive 3D graphics of co-created earring within web browser • Multiple 3D printing technologies for producing the co-created earring • Generative design program for building flexible and complex 3D model of the co-created earring
	Items of DART model	Dialogue	• The dialogue between customer and introduction of RADIOLARIA • The dialogue between customer and co-creation of the earring • The dialogue between customer and purchase of the co-created earring
		Access	• The accesses of introducing RADIOLARIA • The accesses of co-creating earring • The accesses of purchasing the co-created earring
		Risk-benefits	• RADIOLARIA allows the consumer to make a purchase decision according to the personal understanding of risk-benefits.
		Transparency	• Each service process is transparent except for 3D printing of the co-created earring by the RADIOLARIA provider.

Table 4 Case Evidences of COOKIE CASTER

Sample	Detailed items		Evidences
COOKIE CASTER	Items of Den Hertog's model	Service concept	• A co-creation service which provides customized cookie cutter for the customer
		Client interface	• The interface for introducing COOKIE CASTER service concept • The interface for co-creating the cookie cutter features including shape, height, and thickness • The interface for downloading the co-created cookie cutter
		Service delivery system	• Displaying a button of 3D file download, the co-created cookie cutter is ready for 3D printing through the customer self-service.
		Technological options	• WebGL technology for rendering interactive 3D graphics of co-created cookie cutter within web browser
	Items of DART model	Dialogue	• The dialogue between customer and introduction of COOKIE CASTER. • The dialogue between customer and co-creation of cookie cutter • The dialogue between customer and downloading of the cookie cutter
		Access	• The accesses of introducing COOKIE CASTER • The accesses of co-creating cookie cutter • The accesses of downloading the co-created cookie cutter
		Risk-benefits	• COOKIE CASTER allows the consumer to freely download the co-created cookie cutter, which brings benefits without risk.
		Transparency	• Each service process is transparent.

Table 5 Case Evidences of PUPWORKSHOP

Sample	Detailed items		Evidences
PUPWORKSHOP	Items of Den Hertog's model	Service concept	• A co-creation service which provides customized toy pup for the customer
		Client interface	• The interface for introducing PUPWORKSHOP service concept • The interface for co-creating the toy pup features including shape of eyes, nose, mouth, ears, and tail, as well as color of base, eyes, ears, and tails. • The interface for purchasing the co-created toy pup
		Service delivery system	• Displaying its purchase path, including selecting size, adding to cart, and buying, the co-created toy pup is ready for 3D printing and will be shipped to the customer.
		Technologica l options	• WebGL technology for rendering interactive 3D graphics of co-created toy pup within web browser • Multiple 3D printing technologies for producing the co-created toy pup
	Items of DART model	Dialogue	• The dialogue between customer and introduction of PUPWORKSHOP • The dialogue between customer and co-creation of the toy pup • The dialogue between customer and purchase of the toy pup.
		Access	• The accesses of introducing PUPWORKSHOP • The accesses of co-creating toy pup • The accesses of purchasing the co-created toy pup
		Risk-benefits	• PUPWORKSHOP allows the consumer to make a purchase decision according to the personal understanding of risk-benefits.
		Transparenc y	• Each service process is transparent except for 3D printing of the co-created toy pup by PUPWORKSHOP provider

Table 6 Case Evidences of BENGLER TERRAFAB

Sample	Detailed items		Evidences
BENGLER TERRAFAB	Items of Den Hertog's model	Service concept	• A co-creation service which provides customized miniature landscape for the customer
		Client interface	• The interface for introducing BENGLER TERRAFAB service concept • The interface for generating the miniature landscape through the customer co-creation • The interface for purchasing the co-created miniature landscape
		Service delivery system	• Displaying its purchase path, including selecting size, adding to cart, and paying, the co-created miniature landscape is ready for full-color 3D printing and will be shipped to the customer. • Displaying a button of download 3D-mesh, the co-created miniature landscape also is ready for 3D printing through the customer self-service.
		Technological options	• WebGL technology for rendering interactive 3D graphics of co-created earring within web browser • Multiple 3D printing technologies for producing the co-created earring • MapServer technology for publishing interactive mapping applications to the web
	Items of DART model	Dialogue	• The dialogue between customer and introduction of BENGLER TERRAFAB • The dialogue between customer and co-creation of miniature landscape • The dialogue between customer and purchase as well as downloading of the miniature landscape
		Access	• The accesses of introducing BENGLER TERRAFAB • The accesses of co-creating miniature landscape. • The accesses of purchasing the co-created miniature landscape or downloading its digital 3D model
		Risk-benefits	• BENGLER TERRAFAB allows the consumer to make a purchase decision according to the personal understanding of risk-benefits.
		Transparency	• Each service process is transparent except for 3D printing of the co-created miniature landscape by BENGLER TERRAFAB provider.

6. Analysis of evidences

In order to find the essential components of 3DPS co-creation, the above evidences are analyzed in this section.

In this system, first and foremost, three accesses mainly facilitate the structure of this 3D printing-based customized service. These accesses provide a customer with the entrances of knowing service concept, co-creating geometry, and accepting service delivery. Secondly, the interfaces bring corresponding dialogues between accesses and the customer to reach each process goal. In particular, the WebGL-based co-creating interface displays a range of design variables, which can be adjusted by the customer to generate personal creation. Thirdly, the outcome of co-creation refers to the 3D printed artifact or 3D digital model. The service provider produces the co-created geometry through application of the 3D printing technology, and ships it to the customer. Sometimes, the 3D model file is available for downloading of the customer. Last but not least, transparency plays an important role in stabilizing the system of 3DPS co-creation as it helps the customer obtain clear understanding of co-creation, purchase and downloading.

Finally, this research found that the system of 3DPS co-creation is composed by three dialogues consisting of related accesses and interfaces, and the to-be-3D printed outcome.

7. Conclusion

In the context of co-creation service, 3D printing technology performs outstandingly in customized artifact production. A considerable number of 3DPS co-creation applications have been realized in these emerging industries. However, studies about the design method for building the 3DPS co-creation are quite insufficient. In this research, the holistic multiple-case study was carried out to find its essential components. Investigation findings showed that this type of 3D printing-based customized service was composed by three dialogues respectively regarding to service concept, co-created geometry, and service delivery, as well as the service outcomes such as the 3D printed artifact or its digital file.

In conclusion, the systematic design method for co-creation of 3DPS is presented in the Fig.5. This model has two basic tiers, with three components in the interface tire and three ones in the access tire. In order to design the co-creation of 3DPS, the service provider needs to follow four steps, wherein three dialogues and one outcome group are facilitated. At the first step, the dialogue 1 with the interface of service concept introduction and the access of knowing it is constructed. At the second step, the related dialogue is facilitated based on the interface of co-creation with design variables and the access of co-creating geometry. Here, WebGL and other technologies generate 3D graphics on this definite process. The third step requires the service provider to construct a dialogue for service delivery, in which two components including the interface of purchasing or downloading, and the access of accepting service delivery are occupied. At the fourth step, the customized artifact needs to be treated by 3D printing and then delivered to a customer; or a 3D digital model gets ready for downloading. In addition, the service provider needs to guarantee the transparency as it enables a customer to clearly recognize the possible benefits or risks.

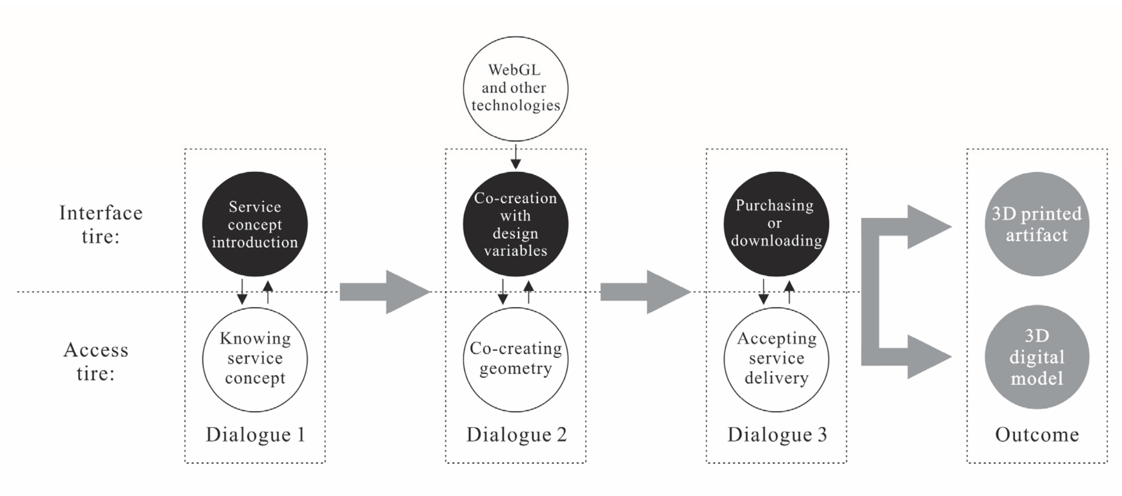

Fig. 2 Model of Systematic Design Method for Co-creation of 3DPS

8. Limitations

The first limitation lies in the research scope: this research only focused on the definite-type 3DPS co-creation, but failed to involve other types. The second limitation lies in that this research had not yet involved evaluation of the business efficiency of the 3DPS co-creation. This kind of service innovation requires an investment without the guarantee of success (Dervojeda et al., 2014, p.11), so the service supplier shall think carefully about the possible risks.

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City Branding – Planejamento estratégico de imagem e comunicação na gestão de cidades.

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Abstract

Over the past decade, it can be observed a steady growth in the use of terms such as Place Branding, Nation Branding, Destination Branding and City Branding. Both in academic research and in the practical applications of city management, this new paradigm takes shape and, along with it, the need for definitions and concepts, methods and methodologies and the establishment of technical and theoretical standards. This approach was born in the Marketing field, specifically in what was called Place Marketing. In this context Branding stands out as a solution tool for the necessity of differentiation, generation of solid images and establishing identity signs and symbols, in order to leverage economic advantages for countries, cities and regions. In a way, fulfilling, in the first instance, a similar role to the branding of products and services. But it was specifically in the Corporate Branding that were found the biggest matches to adapt this knowledge to the management of cities images. Ashworth & Kavaratzis (2009) highlight the fact that both present multidisciplinary roots, a multiple number of stakeholders, high degree of intangibility and complexity of social responsibility, the multiplicity of identities and the need of a long-term development are strong examples their similarities. The development and management of corporate identities, here expanded to the Corporate Branding, it is a prolific field of Design. Through it, great names of the area made their careers and built great legacy. In Brazil, the time of greater proficiency in the area were the 50s and 60s, dominated by modernist thought, and, coincidentally or not, exactly the time that focused efforts to assert the identity of the designer as a professional (STOLARSKI, 2006). In contrast, in the literature produced in the marketing field, often the role of design in this context is reduced to merely promotional measures, such as creating logos or advertising campaigns. In other words, defined as a work of low complexity. This approach comes at odds with contemporary theories of design, such as MetaDesign, Design Thinking and Collaborative Design, in which are presented methodological models of high relevance for the identification, analysis and solution of complex problems involving multiple elements and agents.

Keywords: *branding, city branding, design, identity*

1. Branding

"A gestão de marcas, também chamada de branding, é um processo disciplinado para desenvolver a conscientização e ampliar a fidelidade do cliente, exigindo determinação superior e disposição para investir no futuro. A ideia da gestão de marcas é aproveitar todas as oportunidades para expressar por que as pessoas deveriam escolher uma marca e não a outra. O desejo de liderar, de superar a concorrência e de dar aos colaboradores as melhores ferramentas para se comunicarem com os clientes é o motivo pelo qual as empresas utilizam a gestão de marcas". (WHEELER, 2012, p. 16)

Por representar todos os valores da organização perante o mercado, hoje os gestores cada vez mais pensam a construção das marcas de maneira estratégica, com a utilização de técnicas e recursos que buscam aumentar o valor agregado que um produto ganha a partir da percepção que os consumidores têm de suas marcas. O branding, assim, conforme Kotler & Keller

" [...] significa dotar produtos e serviços com o poder de uma marca. Está totalmente relacionado a criar diferenças. [...] diz respeito a criar estruturas mentais e ajudar o consumidor a organizar seu conhecimento sobre produtos e serviços, de forma que torne sua tomada de decisão mais esclarecida e, nesse processo, gere valor à empresa. Para que as estratégias de Branding sejam bem-sucedidas e o valor da marca seja criado, os consumidores devem estar convencidos de que existem diferenças significativas entre as marcas numa categoria. O segredo do Branding é os consumidores não acharem que todas as marcas na categoria são iguais". (KOTLER & KELLER, 2006, p. 269/270).

Da recepcionista ao entregador, todos devem ter consciência do diferencial da organização e imprimirem um esforço contínuo em comunicar a todas as pessoas externas à instituição. Ao estabelecer um padrão, a organização transmite à comunidade uma mensagem coesa e bem definida, que será lembrada nos momentos mais diversos e será determinante no momento de escolha do comprador. Desta maneira, cria-se a essência do que será o branding da empresa.

"(devemos entender) o branding como uma atividade interdisciplinar, um modelo de gestão empresarial que coloca a marca no centro de todas as decisões corporativas e tem, como objetivo central, construir o brand equity, que são os valores intangíveis que fazem uma marca ordinária se transformar em uma marca poderosa. Em uma empresa, cada um tem o seu papel nesse processo e todos são igualmente importantes. [...] Todos querem ter uma marca forte que conquiste o coração de seus stakeholders e não podemos esquecer, de forma alguma, que o principal stakeholders de uma empresa é o seu capital humano – seu grupo de colaboradores –, que será encarregado de levar os valores da empresa para fora". (HILLER, 2012, p. 131/132)

Gigantes do mercado como Starbucks, Apple, Nike, Ferrari ou Heineken são famosas pelo cuidado e pelo esforço empregado no mapeamento de momentos de diálogo com os consumidores e por aproveitarem essas oportunidades de forma criativa e focada na experiência dos usuários com a marca.

Com orçamentos grandiosos, mas igualmente criteriosos e disputados, estas empresas sabem da importância de cada ocasião junto ao seu cliente atual ou potencial e o quanto cada impressão pode ser o estopim de um enorme sucesso ou fracasso. Por isso cada passo é cuidadosamente planejado e diversos fatores são considerados antes de qualquer decisão. O planejamento estratégico é um processo respeitado e hoje já está mais do que provado que o atropelamento de etapas para o lançamento de um produto ou serviço pode ser o que levará uma empresa do topo ao abismo, um caminho que tem sido percorrido cada vez mais rapidamente pelas marcas menos atentas ao universo ao seu redor. Mas engana-se quem acha que praticar branding é algo para apenas as grandes instituições. A gestão de marcas pode e deve ser aplicada em segmentos de várias naturezas e dimensões, sendo aquilo que representará e comunicará os rumos estratégicos traçados pelo corpo diretivo. É necessário, porém, que o gestor tenha a consciência de que construir uma marca demanda tempo e um grande esforço criativo, entendendo também que muitas vezes o seu retorno não é facilmente percebido.

“ [...] se o objetivo for a construção de brand equity, os resultados não acontecerão no curto prazo, ainda que seja possível obter alguns resultados de impacto. Muitas ações táticas são eficientes para estancar os movimentos de promoções e preços dos concorrentes, mas um indicador importante de força da marca está na sua capacidade de permanecer na memória e preferência dos consumidores sem o esteroide constante da mídia”. (MARTINS, 2006, p. 45)

Com o avanço da tecnologia, tornou-se possível para vários pequenos empreendimentos trabalharem suas marcas. A internet, especialmente com a consolidação das redes sociais, é um parceiro fundamental para este processo. Porém o que realmente é crucial para um bom trabalho de branding a baixo custo é a criatividade e podemos ver exemplos facilmente no Brasil. O nosso país é famoso pelas belas praias e um clima que convida os turistas a desfrutarem de nossas belezas, logo é necessário que haja uma estrutura e alguns serviços básicos para garantir a diversão das pessoas, como bares, restaurantes e hotéis. Alguns lugares, porém, não possuem condições financeiras ou até mesmo geográficas para instalação de empreendimentos de alta complexidade, sendo assim a presença de vendedores ambulantes e das barracas de praia tornou-se tamanha que já fazem parte do nosso cotidiano.

“Dentro do processo de gerenciamento estratégico da marca, toda empresa e produto precisam representar uma grande ideia diferenciada na mente do mercado-alvo. [...] Toda estratégia de marketing é construída de acordo com o trinômio SMP – segmentação, mercado-alvo e posicionamento. A empresa descobre necessidades e grupos diferentes no mercado, estabelece como alvo as necessidades e os grupos que é capaz de atender de forma superior e, então, posiciona seu produto e sua imagem de modo que o mercado-alvo os diferencie. Se, nesse trabalho de posicionamento, houver uma falha, o mercado ficará confuso. [...] Se o trabalho de posicionamento for brilhante, será fácil traçar o restante do planejamento e da diferenciação de marketing com base na estratégia de posicionamento”. (KOTLER & KELLER, 2006, p. 304/305)

Na busca pela diferenciação e posicionamento, um empreendimento pode se destacar ao escolher diferentes estratégias, podendo se distinguir através de um produto único, um capital humano que entrega um atendimento de alta qualidade, canais de venda diferenciados ou ainda através de uma imagem marcante. Porém uma coisa deve ficar clara independentemente de qual será o caminho escolhido, a melhor forma de estabelecer uma conexão forte e emocional é pensar na experiência do usuário acima de tudo, pois é esse momento que ficará marcado para o bem ou para o mal na mente das pessoas e não pode ser subestimado.

O design apresenta-se novamente como um importante aliado, já que ao considerar elementos de usabilidade, durabilidade, estética e ergonomia em um projeto, o designer está atuando diretamente na experiência que o usuário terá com aquele bem ou serviço. Da mesma forma, as peças promocionais e campanhas comunicativas devem reforçar aquela proposta de valor e a experiência que será vivenciada com aquela marca.

Empresários bem-sucedidos em todos os campos se esforçam para entender que eles estão no negócio de projetar a experiência total dos clientes.

“Chamamos isso de rede de fornecimento da experiência dos clientes. O produto físico ou serviço é a parte central – mas, sozinho, não é uma parte suficiente – da equação para o sucesso duradouro. Design é trabalho de todos. É preciso mais do que bons designers para fazer bons designs. É preciso o compromisso de todos na empresa”. (BRUNNER & EMERY, 2010, p. 25)

Assim, um fator de grande importância na construção do perfil da organização é a definição e conhecimento do público-alvo.

Identificar necessidades latentes das pessoas e buscar formas de supri-las deve ser o princípio de qualquer ideia de negócio que almeje sucesso. O mundo está cada vez mais populoso e as configurações sociais mais complexas. Surgem a cada momento novos grupos que têm as suas necessidades e características próprias, criando nichos de mercado bem específicos e exigentes. Esses grupos tendem, ainda, a se subdividirem em tribos ainda menores e mais particulares, exigindo dos empreendedores um olhar clínico na procura por oportunidades. Para entender e melhor atender a demandas tão específicas e traçar corretamente o perfil dos consumidores potenciais, as organizações fazem uso de ferramentas de Marketing.

2. Do Branding de Corporações Para o Branding de Lugares

Segundo Wally Olins "o nome e sua identidade visual tendem a encapsular – com imagens – aquilo que o grupo retém como sua razão de ser mais essencial... Assim, a imagem serve para projetar para o mundo externo, e para refletir para a própria empresa, a natureza do seu próprio assunto. [...] A identidade visual, portanto, é uma parte da identidade mais profunda da empresa, o símbolo expresso de um compromisso interno, que serve para lembrar a todos o seu propósito mais real."

Segundo João de Souza Leite, Wally Olins representou um avanço significativo que alterou paradigmaticamente a profissão dos designers ao enunciar o valor da marca como um dos patrimônios empresariais e fator de ordenação da sua própria imagem, por sua vez concebida pelos usuários. Olins trouxe o design para o primeiro plano, utilizando-o não mais como ferramenta unicamente de ordem estética e proporcionadora de economia no sentido da racionalização de processos e materiais, mas sobretudo como instrumento de orientação estratégica corporativa.

A identidade corporativa é a expressão visual, verbal e comportamental, planejada de forma integrada, para traduzir os valores, visões e missões particulares de uma determinada empresa (KAVARATZIS, 2009). Criando diferenciações entre esta e seus demais concorrentes, assim como identificações frente aos consumidores. De mesma forma, deve unir funcionários, fornecedores, parceiros, colaboradores e agentes estratégicos em torno de uma visão compartilhada do que a corporação deve ser como marca, afim de propagar menssagens e ações consonantes, alinhadas com a estratégia e planejamento geral da empresa.

Somado a isso, a identidade de uma corporação abarca muitas vezes um número múltiplo de produtos e serviços oferecidos por uma mesma entidade empresarial. Criando, dessa forma, uma responsabilidade em manter a coerencia na comunicação dos valores de base da empresa, em uma gama de produtos com estratégias comunicacionais particulares, as vezes até divergentes. Nesses casos, a chancela de uma grande corporação, deve imprimir um sentimento de segurança no ato de compra de um novo produto ou serviço. Para isso, a mensagem característica da empresa, sua visão de mundo, deve ser transversal a toda gama de ofertas que ela disponibiliza para seus consumidores, seja produto, serviço, assistência ou promoção.

Isso amplia a complexidade da gestão estratégica da identidade corporativa, afastando o branding de corporações dos sistemas adotados pelo branding de produtos e serviços. Sobre isso Kavaratzis sintetiza Hatch e Schultz (2003), dizendo que o "branding de produtos e o branding de corporações diferem em vários aspectos: o seu foco (produto vs empresa), a responsabilidade pela gestão da marca (gerentes de nível médio/departamento de marketing vs – CEO/toda a empresa), o seu horizonte de tempo (curto vs longo) e os grupos que eles precisam atrair a atenção e buscar apoio (clientes vs agentes estratégicos)". Ao passo que, para um produto específico ter destaque no mercado, a experiência do consumidor é o objetivo maior, em uma corporação, além de incluir esse aspecto, a experiência de toda a rede envolvida se torna alvo do planejamento projetivo, afim de conservar e manter coerente as características base da empresa em questão, em um grande número de linguagens e situações com particularidades próprias.

Essa característica expandida e complexa do branding de corporações, torna-se a ponte do campo, para seu desdobramento na gestão de imagem e comunicação de lugares, cidades e nações –place branding, city branding, nation branding. A abordagem de gestão dirigida pela cultura de marca, tem sido assunto de destaque entre gestores públicos, profissionais e pesquisadores de mais diversas áreas, na busca por soluções para o contexto competitivo em que se encontram hoje as diversas regiões do globo. Sobre as similitudes do branding de corporações e do branding do cidades, Kavaratizis coloca que

"Ambos têm raízes multidisciplinares, ambos abordam múltiplos grupos de agentes estratégicos, ambos têm um alto nível de intangibilidade e complexidade, ambos precisam considerar fatores de responsabilidade social, ambos lidam com múltiplas identidades, ambos precisam de um desenvolvimento a longo prazo. Neste sentido, a marca corporativa parece oferecer uma infinidade de lições para a implementação da marca dentro das cidades". (KAVARATZIS, 2009)

Ainda segundo a autor, apesar das contribuições do branding de corporações para o branding de cidades, faz-se necessário desenvolver adaptações dos modelos, abordando a gestão de marcas de cidades, regiões e países, em suas particularidades, claramente mais complexas, interdependentes e de difícil controle. Especialmente naquilo que diz respeito a quesitos de responsabilidade sociocultural e ambiental.

Da mesma forma, uma imagem representativa da cidade, que ressoe em seus habitantes de maneira inclusória e participativa, é uma ferramenta que pode viabilizar grandes mudanças e melhorias sociais, aumentar o sentimento de pertença, assim como de responsabilidade com a própria cidade e seus habitantes. A cultura desempenha um papel fundamental nessas transformações urbanas, e deve ser ponto guia para gestão de marca eficaz.

3. City Branding

"Se a imagem de uma cidade é clara e coerente, então a vivência urbana tenderá a ser mais intensa. Os principais pontos de referência constituirão autênticas marcas simbólicas que funcionarão como estímulo à interação". (TEIXEIRA LOPES, 1998)

Dentro do cenário de crescimento da competição entre cidades por vantagens econômicas, sociais, políticas e culturais, o city branding surge, dentro do campo do marketing, como um ferramenta para gestão e planejamento estratégico. A imagem, o imaginário e a cultura das cidades, passam a desempenhar um papel fundamental nesse panorama, afim de promover identificações e diferenciações entre os diversos locais do planeta, destacando qualidades únicas dos lugares para seus visitantes, assim como reafirmando o orgulho cívico e o sentimento de pertença em sua população. Uma cidade, hoje pode ser encarada como um grande condensador de serviços e experiências, um lugar que oferece aos seus habitantes e visitantes, espaços e situações para serem vivenciadas e experienciadas.

"Cidades famosas e bem-sucedidas são normalmente associados na mente das pessoas com uma qualidade única, uma promessa, um atributo ou história. Essa simples narrativa pode ter um grande impacto sobre a decisão das pessoas para visitar a cidade, comprar seus produtos ou serviços, fazer negócios ou mudar-se para lá". (ANHOLT, 2006, tradução nossa)

Nesse sentido, várias disciplinas e atividades passam a desempenhar seu papel em um mesmo projeto de configuração urbana através da criação de imagens mentais que representem e afirmem as características e particularidades locais de cada cidade. Arquitetura, urbanismo, arte, cinema, gastronomia, música e design, se unem em uma mesma construção de imaginário, que passa a abarcar e permear os serviços públicos, a educação cívica, a cultura material e de serviços.

"Cultura e economia ocupam uma mesma plataforma e que a segunda é a tradução da primeira em termos materiais assim como a primeira não deixa sob algum aspecto de ser a consequência da segunda." (TEIXEIRA COELHO, 2008)

A economia criativa, ou o chamado setor criativo, passa a desempenhar um papel de destaque. Jovens trabalhadores, designers, artistas, cineastas, músicos, produtores, programadores de TI e agitadores culturais se mostram figuras importantes para tornar as cidades mais vibrantes e interessantes, assim como provocadoras e contemporâneas.

Ao traduzir as idiossincrasias locais para uma linguagem globalizada, através das mais diversas manifestações culturais, é possível formar imagens cosmopolitas e contemporâneas que impulsionem a economia local através do turismo, serviços e produtos, assim como atraiam pessoas para trabalhar ou morar na cidade.

"Uma cidade simbolicamente global será aquela que vê valorizada transacionalmente a sua imagem, por efeito, por exemplo, de acontecimentos singulares, rituais, ocasiões distintivas, ou em resultado do reconhecimento universal de seu patrimônio histórico e cultural ou recursos turísticos." (FORTUNA, 1997)

Nessa direção, a relação dos habitantes e visitantes com a imagem mental da cidade, torna-se foco da ação projetual e da estratégia de gestão de comunicação dos lugares. Tanto a informação adquirida de forma direta ou faca-a-face - caminhando e interagindo com a cidade, seus habitantes, suas ruas e marcos urbanos, seus produtos e serviços - ou de forma indireta - através de representações da cultura da cidade através das mais variadas mídias.

"A cidade tem a sua forma, conteúdo e significado na mente das pessoas. Pessoas "conhecem" e entendem as cidades pela aceitação de suas próprias percepções e processam essas percepções criando sua própria imagem compreensível da cidade. Em geral, as pessoas atribuem o sentido dos lugares em suas mentes por meio de três processos (Crang 1998; Holloway e Hubbard, 2001). Em primeiro lugar, através de intervenções planejadas, como planejamento, design urbano e assim por diante; em segundo lugar, através da maneira que eles mesmos ou outras pessoas usam lugares específicos e, em terceiro lugar, através de diversas representações do lugar, como filmes, romances, pinturas, notícias e assim por diante". (KAVARATZIS, 2008, tradução nossa)

Transformar a imagem de uma região em uma marca é uma decisão estratégica para promover confluência e sinergia entre os habitantes assim como expectativa entre os visitantes. Apesar de incluir logotipos e slogans é importante não restringir e simplificar esse processo a isso. City Branding trata-se de uma estratégia integrada de reposicionamento, transformação ou afirmação de uma cidade, centrada na sintetização e difusão de imagens representantes de suas características e particularidades das mais diversas esferas, incluindo paisagens arquitetônicas e naturais, estilo de vida e de comportamento, arte e música, cultura empresarial e de serviços.

"Berlim, Barcelona, e Nova York condensam inovações urbanísticas e se tornam núcleos do que podem oferecer ao mundo as nações às quais pertencem. São cidades a ser visitadas e admiradas como cidades globais, espaços demarcados onde o mundo se põe em cena por quatro razões: o intenso papel das empresas transnacionais, a mescla de culturas, a concentração de elites da arte e da ciência, e o elevado número de turistas. Esses traços costumam ser lidos como recursos para desenvolver focos de hipermodernização e revitalizar áreas históricas ou a qualidade geral da vida urbana. Aposta-se que esses modos de transnacionalização sejam impulsionadores do crescimento econômico e fontes de renovação sociocultural. São as cidades que conseguem reinventar-se." (CANCLINI, 2008)

Na publicação "The Anholt City Brands Index", foi desenvolvida uma extensa pesquisa, em formato de questionário online, a respeito das impressões que as pessoas tem de 60 grandes centros urbanos ao redor do mundo. Apesar da dificuldade de ser gerado um modelo comparativo, foi desenvolvido um método baseado num modelo hexagonal, composto pelos 6 seguintes aspectos: a presença, baseado na reputação e familiaridade da cidade; o lugar, relativo a aspectos físicos e geográficos das cidades; o potencial, relativo a oportunidade de trabalho e estudo; a pulsação, diz respeito ao apelo vibrante do estilo de vida oferecido pelas cidades; as pessoas, diz respeito à receptividade dos habitantes da cidade, assim como à segurança; os pré-requisitos, diz respeito a como as pessoas encaram a possibilidade de morar nessas cidades.

Existem outros métodos de avaliar a reputação – a marca – das cidades ao redor do mundo, como o "SAFFRON EUROPEAN CITY BRAND BAROMETER", porém é interessante notar que eles coincidem ao apontar as cidades com maior reputação ao redor do mundo. No "City Brand Index", de Anholt, somente uma cidade brasileira integra a lista, o Rio de Janeiro aparece como 41º colocado, seguido por Buenos Aires em 42º. Entre os primeiros colocados estão Sydney, Londres, Paris, Roma e Nova York, respectivamente. Claramente, cidades que desenvolveram qualidade de vida para seus habitantes e reputação internacional através de décadas de investimento e planejamento urbano.

É importante ressaltar que estratégicas de City Branding podem - e devem - ser direcionadas para os próprios habitantes da cidade. Fortalecer uma imagem própria do local, da identidade de seus moradores, seu modo de vida, incentivar o sentimento de pertença e de comunidade através de estratégias integradas, colocando a cultura como cargo chefe do processo, pode impulsionar grandes mudanças sociais e econômicas. Como nos diz Bettina Heinrich sobre o caso de Berlim:

"O aspecto interessante é como a campanha foi esboçada e implementada: Primeiramente, o prefeito não encarregou uma consultoria de marketing para produzir uma campanha. Em vez disso, uma espécie de think tank, um conselho de pessoas associadas a Berlim foi criado para elaborar a campanha de Berlim. Em segundo lugar, e esse aspecto poderá ser ainda mais importante, a campanha da capital está endereçada em sua primeira fase "ao berlinense", os moradores da cidade, os habitantes, e não ao turista global, ao investidor global ou à classe criativa global." (HEINRICH, 2008)

Porém, ainda é comum a confusão entre estratégias de city branding e medidas exclusivamente promocionais. Muitas vezes as ações práticas ficam restritas a um novo logo ou slogan, ignorando o caráter multidisciplinar do campo.

Em contraponto, os modelos de gestão de city branding, trazem uma visão olística e integrada da cidade, procurando incluir a complexa rede de sistemas presententes nas mesmas, afim de possibilitar o desenvolvimento de estratégias verdadeiramente abrangentes. Kavaratzis propôs, através de uma revisão de literatura do branding de lugares, um modelo para a gestão estratégica da marca de cidades sintetizando seis modelos de gestão apresentados por teóricos do campo – Rainisto (2003); Anholt (2006); Kavaratzis (2004); Hankinson (2004); Hankinson (2007); Trueman and Cornelius (2006). O autor objetivou "analisar esses modelos e procurar sintetiza-los; um processo que pode eventualmente levar a um modelo comum de como desenvolver e gerenciar marcas de cidades" (KAVARATZIS, 2009).

Apesar de existirem diferenças nas abordagens dos modelos selecionados, em suas analises, o autor observou fortes similaridades entre seus pontos chave, possibilitando um modelo síntese, agrupando as carcterísticas comuns observadas, em oito tópicos. Neles, estão integrados todos os modelos selecionados, possibilitando uma visão geral dos pontos chaves abordados, e por consequência, uma visão abrangente deste campo de estudo. Os pontos são:

[i] Visão e Estratégia - visão escolhida para o futuro da cidade e desenvolvimento de uma estratégia clara para realiza-la;

[ii] Cultura Interna - difundir uma orientação de marca através da gestão e marketing da cidade;

[iii] Comunidades Locais - priorizar as necessidades locais, envolvendo os moradores locais, empresários e empresas em desenvolvimento;

[iv] Sinergias - promover acordo e apoio entre todos os agentes estratégicos e prever a participação equilibrada;

[v] Infra-estrutura - atender às necessidades básicas sem as quais a cidade não pode tentar entregar as expectativas criadas pela sua marca;

[vi] Arquitectura da cidade e seus portões de conexão - a capacidade de construir um ambiente que represente a cidade, reforçando ou prejudicando sua marca;

[vii] Oportunidades - oportunidades disponíveis para os indivíduos (estilo de vida urbano, bons serviços, educação, etc.) e empresas (financeiramente, de trabalho, etc.), o que significa o potencial do lugar;

[viii] Comunicações - consonância de todas as mensagens intencionalmente veiculadas.

Através do modelo unificado de Kavaratzis, percebe-se de maneira clara a abregência das ações e estratégidas de city branding, e como elas devem estar alinhadas localmente com a cidade em questão, para serem obtidos resultados satisfatórios. Mais uma vez é destacado os valores simbólicos e emocionais presentes no campo, assim como a complexidade envolvida no processo. A questão multidisciplinar também é colocada como fator presente em todas as abordagens estudades pelo autor, e fator decisivo nos processos para o desenvolvimento de uma marca forte, presente e efetiva para cidades que procuram adotar esse modelo de gestão.

Similaridades entre os modelos de gestão de city branding	
componente e sua essência	**presente nos modelos**
Visão e Estratégia *Visão escolhida para o futuro da cidade e desenvolvimento de uma estratégia clara para realiza-la;*	• Kavaratzis: City's behaviour (parcial) • Trueman and Cornelius: Pace (parcial) • Rainisto: Vision and strategic analysis • Hankinson (2007): Vision, Strategy
Cultura Interna *Difundir uma orientação de marca através da gestão e marketing da cidade;*	• Kavaratzis: Organisational structure • Trueman and Cornelius: Pace • Hankinson (2004): Consumer relationships (parcial) • Rainisto: Planning group (parcial) • Hankinson (2007): Internal brand identity
Comunidades Locais *Priorizar as necessidades locais, envolvendo os moradores locais, empresários e empresas em desenvolvimento;*	• Kavaratzis: Behaviour (parcial), Organisational structure (parcial) • Trueman and Cornelius: Power • Hankinson (2004): Consumer relationships (parcial) • Anholt: People (parcial), Pulse (parcial) • Hankinson, 2007: External brand identity (parcial)
Sinergias *Promover acordo e apoio entre todos os agentes estratégicos e prever a participação equilibrada;*	• Kavaratzis: Organisational structure • Trueman and Cornelius: Pace, Purpose (parcial) • Hankinson (2004): Consumer relationships, Primary service • Anholt: People (parcial) • Rainisto: Public–Private partnerships, Political unity • Hankinson (2007): Multiple stakeholders
Infra-estrutura *Atender às necessidades básicas sem as quais a cidade não pode tentar entregar as expectativas criadas pela sua marca;*	• Kavaratzis: Infrastructure projects • Trueman and Cornelius: Presence • Hankinson (2004): Brand infrastructure • Anholt: Prerequisites • Rainisto: Place identity
Arquitectura da cidade e seus portões de conexão *A capacidade de construir um ambiente que represente a cidade, reforçando ou prejudicando sua marca;*	• Kavaratzis: Landscape strategies • Trueman and Cornelius: Presence, personality • Hankinson (2004): Brand Infrastructure, Primary Service • Anholt: Place • Rainisto: Place identity
Oportunidades *Oportunidades disponíveis para os indivíduos (estilo de vida urbano, bons serviços, educação, etc.) e empresas (financeiramente, de trabalho, etc.), o que significa o potencial do lugar;*	• Kavaratzis: Behaviour • Trueman and Cornelius: Pace, Purpose (parcial) • Anholt: Potential • Rainisto: Local development • Hankinson (2007): Multiple stakeholders (parcial)
Comunicações *Consonância de todas as mensagens intencionalmente veiculadas.*	• Kavaratzis: Intentional communication • Trueman and Cornelius: Presence (parcial), Purpose(parcial) • Hankinson (2004): Media relationships, Consumer relationships • Anholt: Presence (parcial) • Rainisto: Place image (parcial) • Hankinson (2007): Consistent brand communications
Alta relevância e importância dos aspectos emocionais e simbólicos	• Presente em todos os modelos (especialmente Trueman and Cornelius: Personality)
City branding como campo multidisciplinar e complexo	• Presente em todos os modelos
Branding como uma filosofia geral, e não simplesmente um conjunto de atividades.	• Presente em todos os modelos

Fig. 1 - Fonte: Adaptado de Kavaratzis (2009)

4. Conclusões - Lições do passado para uma nova prática

Apesar da abordagem na gestão de imagem e comunicação das cidades através dos modelos de city branding serem uma prática relativamente recente, é interessante notar que podem ser encontrados exemplos do passado em acordo com as propostas apresentadas hoje pelos autores do campo. A análise desses casos se tornam especialmente interessantes, pois suas consequências e efeitos podem ser observados sob a ótica do tempo, contribuindo para um melhor discernimento das práticas realmente efetivas no desenvolvimento de uma imagem integrada para uma cidade, diga-se, uma campanha de city branding. Um caso de especial importância no Brasil é a comemoração do IV Centenário da cidade do Rio de Janeiro, ocorrido 1965. A celebração da efemeridade foi uma pauta de importância singular na gestão da cidade naquele período, cercado por uma série de confluências que tornaram o momento ímpar.

"Os preparativos para o IV Centenário do Rio de janeiro envolveriam variadas formas de investimentos do poder público e da iniciativa privada na rememoraçãoo do passado e, calro, na pavimentação de seu futuro [...] Investimentos que também constituem hoje um grande legado sobre os modos de ver e fazer dessa comemoraçãoo um patrimônio cultural. A história do Rio de Janeiro ganharia uma popularidade sem precedentes na vida carioca". (TURAZZI, 2014)

Na ocasião, o então governador Carlos Lacerda, tomou com uma importância pessoal a gestão das comemorações que envolviam a celebração dos 400 anos de fundação da cidade, procurando integrar da maneira mais abrangente possível um número múltiplo de agentes estratégicos, assim como instituições e a população em geral. Em seus discurso inalgural destacou a nescecidade de que "a comunidade carioca tome a si a tafera das celebrações do IV Centenário. [...] A superintendência destina-se muito menos a fazer do que a 'fazer-'fazer', isto é, a estimular que se faça; a a premiar os que fazem; a ajudar os que querem fazer; a promover que se faça, muito mais do que ela própria fazer. (TURAZZI, 2014). O planejamento da celebração acompanhou todo o mandato de Lacerda (1960-1965), um período no qual tiveram especial importância questões ligadas a resgate histórico e patrimonial, afirmação e promoção da identidade carioca e um incentivo a toda manifestação cultural que enaltecesse o modo de vida tão particular da cidade. Mas não ficaram de lado as questões de infra-estrutura e configuração urbanística do Rio de Janeiro, que incluíram a inauguração do aterro do Flamengo, um parque urbano de 1,2 milhões de metros quadrados; a inauguração do Museu da Imagem e do Som; a construção do Túnel Rebouças; a abertura ESDI, a primeira escola de design do Brasil; uma nova iluminação da estátua do Cristo Redentor, obras de saneamento, abertura de escolas, avenidas, remoção de favelas, conjuntos de habitação social, além de festivais, publicações, torneiros, concursos, bailes e lançamentos de produtos e bens de consumo inspirados na celebração (MESQUITA, 2014). Tudo que se falava na cidade durante o período circulava a celebração do seu IV centenário, e mesmo antes da posse de Lacerda como governador, o assunto já era pauta de destaque na impressa:

"Desde 1959 já se pensava na criação de um organismo governamental voltado para a organizaçãoo dos festejos e a criação de um símbolo para a comemoraçãoo do IV Contenário do Rio de Janeiro". (LEITE, 2014)

Em meio a toda a efervecencia do período, o símbolo do IV Centenário representou de maneira especial o sentimento presente na cidade Rio de Janeiro antes e durante as comemorações. A marca do IV Centenário foi escolhida em um concurso de participação aberta e irrestrita, que contou com cerca de 500 propostas, realizado no final de 1963 pelo governo do Estado da Guanabara. O símbolo escolhido para representar a celebração, divulgado em fevereiro de 1964, foi a proposta do recém-convertido designer Aloísio Magalhães. Figura razoavelmente conhecida na impressa por sua trajetória como artista plástico, Aloísio apresentou uma proposta ímpar, de simplicidade, coesão e estética. O símbolo podia ser traçado em uma só linha, em sua aplicação em cores, ou mesmo em formato tridimensional (LEITE, 2014). Porém, apesar de suas qualidades estéticas, contrutívas e conceituais, a característica que claramente mais se destacou na marca de Aloísio foi sua instantânea apropriação por parte de toda a população carioca. Como coloca João de Souza Leite:

"Com a divulgação do símbolo, as intenções de licenciamento de sua utilização por parte do Governo do Estado da Guanabara foram atropeladas pela r´åpida e ampla apropriação feita pela população. Em vez de se transformar em sinal de solene de festejo, cercado de certa pompa e circustancia, aconteceu o oposto. Provindas de todos os seguimentos sociais e desenhadas sobre todas as vias possíveis de algum tipo de registro visual do sinal, surgiram reproduções fiés ou não em suas proposções, mas fosse qual fosse a sua natureza, a estrutura era inequívoca: o

símbolo vivia pelas ruas da cidade, sempre reconhecível, animando e multiplicando a vivência da efemeridade". (LEITE, 2014)

As características dessa comemoração, como colocadas acima, apesar de bastante resumidas dado a quantidade de fatores presentes nesse momento histórico, mostra claramente fortes similaridades com os modelos de city branding, apresentados cerca de quatro décadas mais tarde. Pode ser observado na campanha do IV Centenário do Rio de Janeiro, a importância dada aos aspectos simbólicos e emocionais, às particularidades culturais e históricas da cidade, uma preocupação com a identidade local do carioca assim como seu modo de vida. Mostram-se presentes ações infra-estruturais de grande porte, em acordo com a visão de futuro almejada no momento, trazendo inclusive marcos arquitetônicos hoje, indissociáveis da imagem do Rio de Janeiro. Além de claramente relatar uma forte sinergia ocorrida entre agentes estratégicos multidisciplinares e ampla apropriação por parte da população dos símbolos e ideais promovidos no Rio de Janeiro, naquele período.

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Practical urban: the urbanity and its relationship with the contemporary city

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Abstract

This article explains the concepts of city and urban practices - phenomena of human activity into the urbanity - that directly influence the life of the people, your own inhabits and customs, becoming the city the image from your own habitants. It is vitally important for the study understand the urbanity relation to the design of cities, as a complement of the public space, one of the ways that interferes at the urban landscape. We can understand how society is shown in front of herself and the world itself that surrounds it, and what are the devices that make city living when are connected - through uses and customs - vital forces of individuals and their communities at the space with some practices created by the tactics of the inhabitants to allow its ambiance, wellness, safety and comfort, sensations often perceived by the set of elements that constitute the cities. The city spaces are perceived through symbols and signs that are manifested through equipment, furniture, buildings, streets, squares, signage and parking lots that make up the identity of the place. Usually this identity is described by the image that people have of the place, of the resident population habits, social resentações and produced interventions. The city is more than a jumble of individual men and social conveniences, it is something more than a mere constellation of institutions and administrative provisions. The city is a state of mind, a body of customs, traditions, feelings and attitudes inherent organized the vital processes of the people who compose it. The city is a product of nature, especially of human nature. Urban space is a form of unconscious rationalization (individual and collective), disguised in the visibility of their urban layouts, buildings and monuments, which can be mistaken, suppressing critical reflection and self-criticism of inhabitants or social groups. Cities must offer good living spaces, leisure, integration and culture so that everyone can exercise the right to collective use, living on the street or in the park with the family, revaluing the humanase relations improving the quality of life of its residents. We identify with the places as we recognize its importance and representing a local or global identity.

Keywords: *urban practices, urban landscape, social representations.*

1. Introdution

The city as a backdrop of urban practices. Key issue in many disciplines, the city is always a recurring theme for scholars seeking to understand this phenomenon of human activity. The history of the city in a little account of the creation of urban space and its manifestations, its functions, transformations and complexity with which we are currently faced with various city typologies around the planet. There is no definition that applies itself to all its manifestations nor isolated description that covers all its transformations, from the embryonic social nucleus to the complex shapes of their maturity and bodily disintegration of his age. The city's origins are obscure, buried or irretrievably erased a large part of his past, and are difficult to weigh its future prospects. If we want to launch new foundations for urban life, we must understand the historical nature of the city and distinguish between their original functions, those which it emerged and those that can still be invoked. In our attempt to get a better view of its current state, we should peek over the line of the historical horizon in order to glimpse the dark traces of more ancient structures and even more primitive functions. However, not abandon this path as not to have followed in all its intricacies and setbacks, through the five thousand years of recorded history, until the emerging future. The author continues to write the city's origins to explain the transformations that the man experienced throughout history and that determined, so to speak, its model of social behavior in the cities: before the city, there was a small village, the sanctuary and the village; before the village, the camp, the hiding, the cave, the stone heap; and above all this, there was a certain predisposition to social life that man shares, of course, with several other animal species. At all levels of life, return to mobility for security or, conversely, immobility for adventure (Mumford,1998).

In the Park of words: “The city is more than a jumble of individual men and social conveniences, streets, buildings, electricity, tramways, telephones; It is something more than a mere constellation of institutions and administrative arrangements - courts, hospitals, schools, police and civil servants of various kinds. The city is a state of mind, a body of customs and traditions and feelings and organized attitudes inherent to these customs and transmitted by this tradition. The city is not merely a physical mechanism and an artificial construction. It is involved in vital processes of the people who compose it; It is a product of nature, and especially of human nature” (Park, 1973).

1.1 The city as a backdrop of urban practices

With the industrial revolution and the emergence of the steam engine in the mid-eighteenth century, we began the industrial age and the cities became industrial centers with a large population growth, mainly due to rural exodus caused by the onset of automation hand labor in agriculture, and improving the quality of life in cities with the arrival of light and lamp filaments surveyed by Sir Joseph Swan and Thomas Edison. The city, therefore, can be seen from different perspectives: the urban space that is composed of the material elements, and the social, the experiences and urban practices. In the words of sociologist Inaê (Brancaglion, 2006), the city can be defined as follows: “more than an architectural or geographical fact [the] city is a social phenomenon, a production - and also a producer - of human collective activities. More than all the buildings and roads, the city is home to each of its residents, is that one social space in the world because it houses the individual routes and the smaller centers of social life, those most economically significant: family, close friends, loves”.

This statement shows how the inhabitants of a city are faced with an urban landscape designed to offer the population greater identification and sense of belonging with their space, pride and memories, positive feelings of homeland only transpires when we are proud of environment to which we belong. Lynch (Brancaglion, 2006) explains: “To understand a city, we must consider not only the city itself, but the way its inhabitants to realize”. Thus, the deployment of street furniture equipment can contribute to qualify the image of cities, seen through its own inhabitants. In contemporary times, urban centers are specific scenarios of diversity and inequality. For this fact, it is necessary to think relational aesthetics (Brancaglion, 2006) as an alternative to sociability, and perceive it as stimulating experiences as well as a device to solve the lack of social ties that a capitalist society and global causes. Confirming such statements, is quoted also Norberg-Schulz, which says: “There must be “identification” a “friendly” relationship with the environment. And both the guidance and the identification are aspects of an overall relationship. Thus, the environment is experienced as meaning bearer, "character is a correspondence between the external world and the internal world, body and soul” (Norbert-Schulz, 2006).

1.2. Social representations to the organization of the city

According Jodelet, there is always the need to be informed about the world around us. In addition to adjusting to it, we need to know how to behave, physics master it and intellectually, identify and resolve problems that arise: is why we created representations. Faced with this world of objects, people, events and ideas are not (only) automatic, nor are isolated in a social vacuum: we share this world with others who serve in support, at times in a convergent way, others by conflict, to understand it, manage it or face it. That is why the representations are social and so important in everyday life. They guide us in the way of naming and jointly define the different aspects of everyday reality in the way of interpreting these aspects, makes decisions and eventually position yourself in front of them defensively (Jodelet, 2001). For the author, the social representations are complex phenomena always enabled and action in social life. As a phenomenon full of riches, we found many elements (some, studied in isolation): informational, cognitive, ideological, normative, beliefs, values, attitudes, opinions, images, etc.). However, these elements are always organized under the guise of a knowledge that says something about the state of reality (Jodelet, 2001). It is recognized that the social representations - as interpretation systems that govern our relationship with the world and with others - guide and organize behavior and social communications. Similarly, they are involved in various processes such as diffusion and assimilation of knowledge, individual and collective development, the definition of personal and partner’s identities, expression of groups and social transformation. As cognitive phenomena, involves social belonging of individuals with affective and normative implications, from the experiences of interiorizações, practices, role models and thinking, socially inculcated or transmitted by the media, that it is connected. From this point of view, the social representations are addressed concurrently as product and process an appropriation of activity of external reality to thought and psychological and social development of this reality (Jodelet, 2001).

To Mumford, it is possible to understand the space of a city only when you know the culture that developed it (social representations). The author states that the more you know the culture of a city, the more will be able to understand the development of this city. In the words of historicist and archaeologist Ulpiano Meneses: “The culturally qualified city is good to be known (at local, the tourist, so there is business to attend to, the technical etc.), good to contemplate aesthetically fruída analyzed, suitable for memory, consumed affective and their identities, but it is also good to be practiced in the fullness of their potential. It must be good as a city, need conditions of economic viability, infrastructure, adequate housing policies, transport, health, education etc.” [5. Meneses]. Therefore, the city is more than an urban and architectural space is the place where they develop social representations, is the "home". In the words of Lynch, the city is: “Characteristic and legible environment that offers not only security but also enhances the depth and potential intensity of human experience. Although life is far from impossible in the visual chaos of the modern city, the same daily action could take on a new meaning if it were practiced in a clearer scenario. Potentially the city itself is a powerful symbol of a complex society. If well organized visually, it can also have a strong expressive meaning” (Brancaglion, 2006).

For some scholars, such as Durkheim and Minayo (Brancaglion, 2006), social representations are categories of thinking that express reality. These concepts are closely linked to understanding the identity of meaning of space, ie, what is concerned this study, which aims to explain the reasons why the environments and public spaces in cities suffer interference from street furniture and how esa relationship can be raw state in a positive and harmonious experience. For Durkheim (Brancaglion, 2006), “collective representations reflect the way the group is thought in its relations with the objects that affect it. To understand how society represents itself and the world that surrounds it, we must consider the nature of society and not of individuals”.

The customs and habits practiced by these individuals manifest also the cul ture of a group that is defined by Taylor (Brancaglion, 2006) as "the whole complex which includes knowledge, belief, art, morals, laws, customs or any other capacity and habits acquired by man as a member of a socie-ness "that is, all behavior learned and transmitted from generation to generation in a cumulative process through communication (language) and which is independent of genetic transmission. To Laraia (Brancaglion, 2006), "communication is a cultural process and human language is a product of culture, but culture would not exist if man did not have the possibility of developing a coordinated system of oral communication." Here follows the same understanding of the subject in the words of Michel de Certeau in "The invention of daily": "Many works are dedicated to studying whether the representations is the behavior of a society. Thanks to the knowledge of these social objects, seems to be possible and necessary to guide the use of them do groups or individuals. The analysis of the images broadcast by television (representations) and of ancient times before the device (behavior) should be completed by the study of what the cultural consumer "manufactures" during these hours and these images. The same is true with regard to the use of urban space, of products bought in the supermarket or the stories and legends that the newspaper distributes (Certeau, 1994).

For more developed than are the communication systems, the participation of individuals in all the elements that make up their culture is limited, often by differences in profession, religion, sex, age etc. Individuals, because of the groups attending (collective representations) interpret differently received in-training. Lynch (Jodelet, 2001), in his study of the formation of the environmental image, states that "the creation of the environmental image is a bilateral process between observer and object. What he sees is based on the exterior, but the way he interprets and organizes it, and how to direct your attention, turn affects what he sees" (Brancaglion, 2006). "See the city, observe it, interpret your senses are the three stages of reading. Reading has the category everyday seized by its representations that are parameters for the manifestation of other paradigm but the perception as a way to produce behavior information. It is far empirical activity of any legislative terms, reading feeds on imagens / signs as a way to understand and interact with the city, appropriating it. Relate traces almost seen, is the assembly relacio-nated fragments remembered. The evocative image is representation, sign of existen cial ownership requires intelligibility and, therefore, it is necessary to see cross-dressing to observe. Reading is assembling fragments of images, completed imaginary senses that aim and reveal particular for mounting the reading" (Jodelet, 2001).

For Certeau, "the act of walking is to the urban system as the enunciation is to the language or to the statements uttered. It is a process of appropriation of the topographical system for pedestrians (as well as the speaker appropriates and assumes the language). For the author, the seats are fragmentary and isolated stories themselves, the past stolen legibility on the other, stacked times that can unfold but are there before and stories waiting and remain in the state of puzzles, riddles, symbolizations encysted and pain and body pleasure (Certeau, 1994). Jodelet states that ownership is the space of qualified city, informed by the use (city as living space, experienced, qualified, modified: socialized space, social). Such appropriation of images are until certain irrational point, triggered by emotional stimuli and can not be explained by institutional appeals. This subject of social action produces the city and builds an imaginary (Jodelet, 2001). However, this quality is not homogeneous, corresponds to rhythms and forms as diverse as the everyday experiences of city users. This heterogeneity is responsible for the fragmentation of the city into its pieces, their places of slow appropriation, but inexorable and without similar. The appropriate space qualified, socialized gives rise to the places in town. Without being self-employed or given, the place is constructed from socially produced relations and experiences. "Is an informational activity triggered by the imagery contained in the cultural repertoire of the inhabitants of a place; Corresponds to a relationship between the experiences of the present and comparatively driven past, to enable the production of information and learning responsible behavior and changes. Identify the places in the city assumes realize the process of present and past images that qualify and attests to ownership mode" (Jodelet, 2001).

As a metaphor of everyday practices regarding urban place, Certeau also clarifies that "talk is a provisional and collective effect of competence in the art of manipulating" commonplaces "and play the inevitable of events to make them "livable". He says that "every story is a travel story - a practice space. It has to do with the everyday tactics, part of them, from the alphabet of space indication ("turn right"), draft a report whose sequence is written by the steps to the "news" every day ("guess who I found in the bakery?). These narrated adventures, at the same time produce actions and geographies derive for the common places an order, not only constitute a "supplement" to set out pedestrians and rhetorical caminhatórias [6. Certeau]. To Nojima, "the orientation in space is critical and depends, among other factors, the permanence of certain environmental features, which means preserving the identity of the places" (Brancaglion, 2006). The city is therefore a scenario full of overlapping messages that characterize the urban communication. This is defined by Nojima as the result of the interaction between social representations and the scenario where they occur. And it is through the interpretation of these messages that appear in the urban design of the city (streets, buildings, gardens, squares, furniture), the individual defines the elements that identify the city. According to the author, “the interventions aim to characterize the environment and this representation is a necessity that has the man to establish vital relationships in your environment to make sense of their actions” (Brancaglion, 2006).

1.3. Memories of things and Urban Space

While collective memory, social representations establish how le-mos our city, we relate to others, we appropriate the urban space, we identified our "place". For Maurice Halbwachs, "we are not accustomed to talking about the memory of a group, even a metaphor. It seems that this faculty can not exist and last but to the extent that is connected to a body or an individual brain". According to the author, "the individual would participate in two spe-cies of memories, but as participate in one or the other, adopt two very different attitudes and even contrary. If the individual memory can, to confirm some of their memories, or even to cover some gaps, to rely on collective memory, move it, be confused momentarily with her; Therefore not to follow your own path. However, collective memory involves individual memories, but not to be confused with them. It evolves according to its laws, and some individuas memories sometimes penetrate it, change figure so are replaced in a set that is not a personal conscience: [individual memory] is not entirely isolated and closed. A man, evoque its own past, often needs to appeal to the memories of others. They reports landmarks that exist outside of it, which are set by society. The operation of the individual memory is not possible without these instruments are the words and ideas that the individual did not invent and borrowed from their midst. It is very closely limited in space and time. The collective memory is the well: but these limits are not the same. I carry a luggage of historical memories, which can extend the conversation or for reading. But it is a borrowed memory and it is not mine" (Halbwachs, 2003).

According to Halbwachs, the collective memory had no other materials It is no series of dates or lists of historical facts, it does not play a very minor role in setting our memories as often we reinstated our memories in a space and time, we also situate between the dates that only have meaning only in relation to which groups we belong [8. Halbwachs]. So there is also a mental balance to the world, to things and places, Halbwachs adds that much of the balance is given by the fact that the material objects with which we are in daily contact mu-dam little and therefore offer us an image of permanence and stability "when some event also requires us to transport ourselves to a new surrounding material before him to adapt, we crossed a period of incerte-za, as if we had left behind all our personality, so much verda-that the usual images of the outside world are inseparable from our self. Our surroundings stuff takes both our brand and that of others. Our house, millstone-ble and the manner in which they are arranged, remind us our family and friends who often saw this picture. When a group is inserted into a portion of the space, he turns to his image, while that subject and adapts the material things that he resist. It is not the isolated individual is the individual as a member of the group, is the group itself remains under the influence of material nature and participates in its balance. This explains how spatial images play a role in the collective memory" (Halbwachs, 2003).

For the author, the urban group does not "feel" the impression of change while the as-pect of the streets and buildings remains identical. Differentiation of a re-consultation city led to a diversity of functions and social customs; as the group evolves, the city in your outdoor space, changes more slowly. Local habits resist the forces that tend to make them, and this strength allows us to understand better the extent to which the collective memory has its foothold on the spatial images (Halbwachs, 2003).

2. The urban space

A Levi-Strauss defended the thesis that the urban space reveals the logic and underlying structures of a people. There would be inscribed right in order to have the houses of a village or a city. This ratio is not made aware by the villagers, but it can be discovered by the social scientist who is concerned with the study of specific culture and its forms of social and spatial organization. For the French anthropologist, the story itself is neither rational nor irrational value. There would be no logic inscribed in the cumulative time of a culture (Freitag, 2002). Ferrara (Barbosa et al., 2010), the most concrete manifestation of urban place consists of uses and habits, to the same extent that place is the concrete manifestation of space. Thus, in general, the urban space is seen as an environment in which the human being, as a citizen or host, has a total freedom of movement where you can free interaction and uncontrolled between supposedly autonomous individuals. According to the author, the public space is understood based meeting in the presence of strangers who share the same environment, a space of collective expression, community, of being with and among others, celebration. It is also a universal space, completely freely accessible at any time and for any person. For Tschumi, the memory evokes feelings from the city's memory: “We have an innate ability to remember and imagine places. Perception, memory and imagination are in constant interaction; the sphere of the present merges with memory and fantasy images. There are cities that remain as mere distant visual images when recalled, and there are cities that are recalled in all its vividness. The memory brings back the pleasant city with all its sounds and smells and light and shade variations” (Tshumi, 1984).

The spaces of a city are perceived through symbols and signs that manifest themselves through objects, furniture, buildings, streets, squares, signs, stairs, parking lots, among others, that make up the identity of the place (Brancaglion, 2006). “The identity of a place is usually described by the image that people have of this place, of the resident population habits, their social representations and also of the interventions that it produces with the implementation of signaling equipment, furniture and even ornaments such as vases and plants. It is worth mentioning the existence of “private spaces for public uses” that are operated by private companies and not pre-determine a specific target audience for its use, such as shopping malls and hospitals. There is also the “public spaces for private use” as we find empirically, without organization, created by street workers and merchants, keepers of cars and prostitutes [3. Brancaglion]”. When you have in mind space “city” can not think of each element that is in a particular way, it should be reflected as a set of parts that complement and pervade a population. Each element has its value and contributes to building an environment in which the community and the city structure work social way [3. Ferreira; Brancaglion]. Ferrara illustrates some of the major signs that are part of the urban area of a city: “The urban environment is a complex of signs: the formal (the very form of the built object), language (the street name), the advertising (posters), direction indicators, the aesthetic (the materials used, the stylistic features of facades, gardens, lighting etc.), contextual – the urban situation in which it is located (and the user signs) – the specificity of human behavior taken as a sign” (Brancaglion, 2006).

In the same sense, we can mention Kings: “Cities need to provide for its citizens living spaces, leisure, integration and culture, so that men and women can exercise the right to collective use of 'living on the street or in the park with the family, the (re) value of human relationships, finally, the city must have in place spaces that offer quality of life. Citizens identify with places, as they recognize their importance, they assume the condition of collective use spaces and representing the local or global identity” [11. Reis; Beraldo; Jorge; Levitan; Sielski; Silva]. So public space is one where, theoretically, you can find people of all social strata, cultural and economic, where diversity is one of its present characteristics. However, the current reality of the cities in shows another view, according to Ferreira (Reis, 2010 y Beraldo, et al., 2010). The loss and neglect of public spaces degrade the living relationship of individuals within these spaces, and thus there is a greater search for private entities to conduct such meetings. The apparent indifference of the State with the social spaces of the city has intensified since business groups have sought partnerships with the government to “gift” the city with works such as shopping centers, works with predominantly commercial character, which further accentuates uneven urban development. According to Harvey, “the common urban spaces should be designed so even for them to fulfill effectively their social role to the citizens. So there is an urgent need to make the citizens feel the characters themselves that space, capable of interfering in the city through their daily practices, even unconscious, as they have the right to the city” (Beraldo, et al., 2010).

2.1 Urban landscape

The “landscape” is a very broad phenomenon. It can be said that some phenomena form an “environment” for others. A concrete term for speaking environment is "place". In common parlance it is said that actions and events have a place. According to Schulz, when we refer to something more than an abstract location, think of a whole composed of concrete things having material substance, shape, texture and color. Together, these things determine an “environmental quality”, which is the essence of the place or the qualitative phenomenon “total”, which can not reduce any of its properties without losing sight of their specific nature, preventing the seats are defined by analytical or scientific concepts. For the author, phenomenology exists to solve this impasse, it is “a return to things” as opposed to abstractions and mental constructions (Norbert-Schulz, 2006).

Rodrigues, it states that the landscape is as a psychological resource and therefore a resource on human health. It is an indirect way, a resource of economic and material nature by the influence it has on certain activities such as tourism, residence and recreational activities. Research carried out over the landscape there is shown that [it] focuses powerfully on psychological functioning, as it can numb the most positive aspects of the subject's performance. The presence of a pleasant landscape for an individual can have a positive impact on their psychological functioning. The presence of a landscape can also generate reparative effects on the individual who is subjected overstimulation in the urban environment, particularly in large cities (Rodrigues, 1996).

The spaces of a city or a neighborhood are perceived through symbols and signs that manifest themselves through objects, furniture, buildings, streets, squares, signs, stairs, parking lots, among others, that make up the identity of the place (Brancaglion, 2006). The identity of a place is usually described by the image that people have of this place, of the resident population habits, their social representations and, above all, of the interventions that it produces with the implementation of signaling equipment, furniture and even loud as pots and plants. The importance of identity is reading it conducive to the individual, the possibility of appropriating the impressions that it will build in relation to the collective space, public, among others. Means for readability everything that can be read, deciphered and understood. To be readable, a city requires its spaces are conceived, designed to allow its inhabitants can interpret, recognize, as a whole, their neighborhoods, landmarks, roads (Brancaglion, 2006).

3. Final considerations

Cities are home to endless urban practices that reveal the culture of its people and their preferences, habits and customs. The urban landscape is a very comprehensive phenomenon that forms the environment for the people or in common language, "the place" of the acts and events. This is more than an abstract location, a totality of concrete things having material substance, shape, texture and color. Together determine a particular "environmental quality" essence of the place. Whether in relation to social habits or in relation to the use of practices and ownership of its streets, sidewalks, urban furniture or simply urban space, the city reveals the cultural and identity component from its origin and reflects the setting and the environment created to represent the political and community forces that control it. The city can be seen as the urban space that is composed of the material elements, and the social, the experiences and urban practices. And integrate this spatial and urban planning logic requires a technical and creative effort to qualify properly, public open spaces or closed. The city is more than an urban and architectural space is the place where they develop social representations, is the "home". This demonstrates how the inhabitants of a city are faced with a projected urban landscape that can offer greater identification and sense of belonging with their space, satisfaction and memories, positive feelings that only emerges when we are proud of the environment to which we belong. "To understand a city, we must consider not only the city itself, but the way its inhabitants to realize."

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A *cross fertilization* como instrumento gerador de inovação

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Resumo

O artigo aborda o processo de desenvolvimento de produtos orientado pela dinâmica da cross fertilization, que remete ao contexto das relações de contiguidade entre diferentes áreas do conhecimento. O conceito foi introduzido pelo matemático James Clerk Maxwell, e consiste na possibilidade de adotar inovações já experimentadas em campos distintos dando lugar a uma transferência de conhecimento entre setores. A sua aplicação como instrumento condutor de projeto no campo do design, tem demonstrado que esta transferência pode se manifestar de modo implícito – no caso de sentido ou significado que se transporta de uma entidade para outra; e de modo explicito – quando se trata de transferência de tecnologia, de fabricação ou de processo industrial que caracteriza um setor ou parte dele. No contexto das intersecções, este estudo aborda relações entre o design, a moda e a arquitetura. O pensamento estrutural tem direcionado cada vez mais os designers, que se apropriam de principios arquitetônicos para manipular a estrutura e o volume das vestimentas. Por outro lado, percebem-se materiais têxteis sendo transformados em estruturas duradouras. Identificam-se princípios condutores comuns que direcionam o pensamento projetual, bem como elementos que agem como ativadores de transferências de conhecimento e facilitadores de processos de geração inovativos. Dialogar com outros campos como forma de apropriação de novos conceitos, linguagens ou técnicas contribui para que o desenvolvimento de produtos, quer sejam físicos ou intangíveis, digam respeito ao novo. As atividades inovativas dos indivíduos e das organizações estão vinculadas à capacidade do aprendizado adquirido, que habilita construir novas representações dos ambientes e derivar-lhes novos usos. O argumento abordado no decorrer deste estudo comprova, mediante a análise das relações que se estabelecem entre os distintos setores, que é dentro das zonas de fronteira – aquele campo de intersecção que pode ser gerado entre uma área disciplinar e outra, que de fato são ativadas as dinâmicas que facilitam o surgimento de processos de inovação significativos. Confirma-se, portanto, a eficácia da cross fertilization como instrumento aplicado no campo do design.

Palavras chave: *design, arquitetura, desenvolvimento de produto, cross fertilization, inovação.*

Abstract

The article deals with the product development process guided by the dynamics of the cross-fertilization, which leads to the context of contiguity relations between different areas of knowledge. This concept, introduced by mathematician James Clerk Maxwell consists of the possibility of adopting innovations that were already experienced in different fields giving way to a knowledge transfer between sectors. Its application as project conductive instrument in the field of design has shown that this transfer can manifest in an implicit way - in the case of meaning or significance that is transported from one entity to another; and explicit way - when it comes to technology transfer, manufacturing or industrial process featuring a sector or a part of it. In the context of the intersections, the present study addresses the relationship between design, fashion and architecture. The structural thinking has increasingly focused designers, who appropriate architectural principles to manipulate the clothing structure and volume. On the other hand, we realize that textile materials are being processed in durable structures. Principles common conductors are identified to drive architectural design thinking as well as elements that act as enablers of knowledge transfer and facilitators of innovative generation processes. Dialogue with other fields as a form of new concepts ownership, languages or techniques contributes to the development of products, whether physical or intangible, relate to the new one. Innovative activities of individuals and organizations are linked to learning ability acquired that empowers to build new representations of environments and derive them new uses. The argument discussed in the course of this study proves, by analyzing the relationships established between the different sectors that is within the border areas - that intersection field that can be generated from a subject area to another, which in fact activates the dynamics that facilitate the emergence of significant innovation processes. It is confirmed, therefore, the efficiency of cross-fertilization as a tool applied to the design field.

Keywords: *design, architecture, product development, cross-fertilization, innovation*

1. A *cross fertilization*

Adota-se o termo *cross fertilization* para indicar um fenomeno de interdisciplinaridade ou relação de contiguidade entre as diferentes áreas do conhecimento humano; não diz respeito a uma determinada área específica mas sim à fronteira, a "zona de pesquisa" que é gerada entre um dominio e outro. Segundo Conti (2007), o conceito foi introduzido pelo matemático James Clerk Maxwell, em 1878, e consiste na possibilidade de adotar inovações já experimentadas em campos distintos dando lugar a transferência de conhecimento entre setores. No contexto do projeto, é possível afirmar que se trata de uma capacidade de "visão" acerca do que já existe para criar algo novo. Afinal, a essência de qualquer processo de inovação é a recombinação original de elementos provenientes de conhecimentos novos ou daqueles já existentes.

Os processos de tranferência entre setores mercadológicos diversos como os de vestuário, calçados, acessórios,`têxteis para mobiliário, entre outros, representam dinâmicas já consolidadas em determinados sistemas, a exemplo do Sistema Moda italiano. A partir dos anos 50 a Moda italiana desenvolveu uma prática de atividade de pesquisa, de projetação, de gestão e controle de processos de produção e distribuição do tipo implícito – aquele que se refere ao sentido ou significado que se transporta de uma entidade para outra. É como se nunca antes tivesse codificado de maneira mais científica as etapas, ações e combinações de atividades, que ao contrário, alguns outros setores orientados ao design já tinham esquematizado e já praticavam.

Na medida em que se observa a trajetória histórica da moda e se aprofundam as investigações nesse campo, se evidencia também a existência de uma relação muito estreita com a arquitetura e com o próprio espaço urbano. O processo de organização da indústria da moda pode ser correlacionado com a evolução da arquitetura contribuindo para elucidar o debate do início do século XX sobre a padronização arquitetônica – adotada como solução para os problemas individuais de estilo – e a identificação de tipos ideais. Para Quinn (2003), a relação da moda com o ambiente construído extrapola o limite das estruturas físicas e estende-se a outros aspectos que estabelecem a compreensão do espaço urbano, cuja essência híbrida, fragmentada e transitória , contribue para que tais conexões se desenvolvam. "Habitar, aqui, refere-se à relação da ocupação espacial entre o sujeito e o contexto no qual está inserido, assim, pode-se dizer que, tridimensionalmente construída, a roupa é um espaço no qual o corpo habita" (COUTO, 2010, p.135). Inúmeras são as conexões que se estabelecem a partir de tal premissa.

Na contemporaneidade, portanto, considera-se que o projeto dedicado aos mais diversos segmentos e ao sistema que é gerado em seu entorno é pensado de forma transversal, inserido no contexto dos fenômenos culturais, produtivos, midiáticos e consumistas. Isto significa que não basta elaborar o que se pretende: antes, deve-se analisar os processos que geram a intenção desta criação. Seria redutivo limitar-se à dimensão industrial e considerar o produto acabado como o único resultado deste desenvolvimento.

A moda, o design e até mesmo a arquitetura pertencem à ampla Cultura do Projeto onde se desenvolvem cenários complexos que consideram os objetos, os sistemas e os sinais que regulam as relações entre os seres humanos e seus contextos. Assim, qualquer atividade projetual participante desta cultura opera para que a realização de produtos, sejam eles físicos ou intangíveis, contemplem a história, a evolução e as mudanças da sociedade para a obtenção de resultados inovadores. Certamente o diálogo entre os campos do conhecimento como forma de apropriação de novos conceitos, técnicas e aquisição de competências além daquelas pertinentes à própria área poderá contribuir para gerar inovação.

Neste contexto, o presente artigo discute os processos de desenvolvimento orientados pela dinâmica da *cross fertilization*. Inicialmente abordam-se as interações projetuais e os aspectos ou elementos que podem agir como ativadores das dinâmicas de transferência de conhecimentos entre as áreas; na sequência, identificam-se princípios condutores comuns que direcionam o pensamento para projetar a arquitetura, o design ou a moda; finalmente apresenta-se um caso prático de aplicação da *cross fertilization* no desenvolvimento de produtos, no qual se evidencia o seu potencial como gerador de inovação.

2. As inter-relações projetuais

No processo projetual, áreas diferentes percebem problemas e soluções de formas diferentes. Apesar de concordar que a formação de projetistas tem algumas características muito comuns, Lawson (2011) adverte que é preciso cautela ao pressupor que todos os campos da atividade de projetar dividem o mesmo terreno. Existem algumas diferenças, em especial no que se refere ao conhecimento tecnológico requerido para alcançar os objetivos previstos. Os projetistas não decidem apenas o efeito que querem obter, mas precisam saber como obtê-lo: o arquiteto deve, por exemplo, entender as propriedades estruturais do concreto e do aço, enquanto o designer de moda tem que ter competência para avaliar os vários tecidos. Nesse sentido, continua o autor, com as tecnologias cada vez mais especializadas que pressupõem conhecimentos específicos de cada área, é preocupante que cada um esteja condicionado pela sua formação e pela tecnologia de processo que conhece, porque tal condição pode restringir, ao invés de aprimorar o pensamento criativo, essencial à projetação.

Por outro lado, para os inúmeros projetistas que se interessam por outros campos, utilizar a tecnologia que domina ou o material que conhece, de modo não habitual, isto é, se apropriando de práticas advindas de outras áreas, que não a sua, pode render bons resultados.

Da mesma forma, projetar produtos de outro segmento, utilizando os conhecimentos inerentes à própria área pode gerar novas possibilidades. Lawson (2011) ilustra tal aspecto quando relata que os projetistas de móveis costumam afirmar que conhecem as cadeiras projetadas por arquitetos. “Isso porque a maioria dos arquitetos está acostumada a manejar a madeira numa escala e num contexto diferentes e, portanto, já desenvolveu uma ‘linguagem da madeira’ com um sotaque arquitetônico perceptível.” (LAWSON, 2011, p.60). As solicitações para se resolverem os problemas arquitetônicos que envolvem a madeira não são as mesmas requeridas pelo projeto de móveis. Apesar de não ser comum ver cadeiras de tijolos e nem edificações de polipropileno, continua o autor, ambas são possíveis. Justamente nisto reside o diferencial propiciado pelas conexões estabelecidas entre os diversos campos.

Determinados elementos, ações ou posicionamentos podem funcionar como ativadores das dinâmicas de transferência de conhecimentos entre as áreas, para facilitar o surgimento de processos de inovação significativos. Neste sentido, recentes alianças da moda com a tecnologia e a segurança imbuem as roupas do contemporâneo com muitos dos sistemas característicos dos ambientes arquitetônicos. Projetadas para fornecer ao usuário um sentido de refúgio e um grau de proteção contra a violência urbana, conferem maior funcionalidade por meio dos materiais e dispositivos tecnológicos e ampliam a mobilidade do corpo na medida em que permitem a interação com seus sistemas (QUINN, 2009).

O outro fator que vem contribuindo para a aproximação das áreas é o avanço tecnológico, que possibilita o acesso de arquitetos a softwares de design cada vez mais sofisticados. Com eles é possível gerar formas mais complexas, muitas vezes referenciadas nos métodos de construção e manipulação de planos utilizados pela moda, que acumula uma longa história de lidar com a complexidade formal e construtiva. A transmutação de técnicas entre as áreas tem sido facilitada pelos avanços na tecnologia dos materiais e no incremento da tecnologia digital, além da globalização, que permite rápida disseminação de tudo que se desenvolve.

Para Dominoni e Tempesti (2012), explorar a realidade do design contemporâneo pelo ponto de vista das estruturas têxteis, permite evidenciar a importância do material como fator determinante de qualquer projeto. Lerma, Giorgi e Allione (2011), confirmam que a pesquisa de materiais está cada vez menos condicionada à tradicional segmentação por setores, e a investigação é conduzida no sentido de estudar e confrontar as inúmeras soluções possíveis, a fim de contemplar os conhecimentos dos diversos campos. A própria necessidade de projetar novos materiais e de unir tantas informações, constitui-se numa demanda dos distintos segmentos.

Em períodos anteriores, no entanto, já se evidenciava a crescente importância dos têxteis para arquitetos e designers de produtos. O interesse do designer catalão Martin Ruiz de Azúa por abrigos têxteis, por exemplo, resulta no projeto da Casa Básica, datado de 1999, que é uma casa que pode ser levada no bolso. Segundo Colchester (2009), ela transmite uma visão extrema do futuro, de edifícios que se materializam e se desmaterializam quando não são mais necessários; e de cidades onde as pessoas vivem como nômades em casas infláveis que se dobram e viajam com elas para onde quer que seja. Feita de poliéster dupla-face metalizado, permite o uso de um lado e do outro conforme a necessidade de proteção contra o calor ou o frio; pesa apenas 200 gramas e pode ser inflada pelo calor do sol, ou pelo calor do corpo do próprio usuário.

Esses espaços que se configuram como infláveis, que atualmente são utilizados também para exposições, podem ser montados e desmontados com grande rapidez, tendo suas dimensões consideravelmente reduzidas quando deflacionados. Tais estruturas itinerantes revelam o potencial da arquitetura para se tornar móvel e portátil, estabelecendo grande similaridade com produtos do vestuário.

Outros pontos congruentes que remetem à transferência de conhecimento são evidenciados por Geisel e Souza (2012), ao relacionarem a concepção do projeto do produto de moda com a concepção do projeto arquitetônico. Aspectos relevantes para o desenvolvimento de edificações, tais como: as necessidades dos habitantes com relação à construção, as condições do terreno e o entorno, podem ser – na moda, comparados à importância de conhecer o corpo do usuário, suas demandas e o meio no qual se insere.

O conforto é uma rede de inter-relacionamento que se conecta com as características do sujeito, do objeto e do ambiente, em determinado contexto (SILVA, 2010). Para desenvolver um projeto arquitetônico que atente para o conforto térmico do usuário, alguns aspectos devem ser observados, como a orientação quanto à insolação, o aproveitamento da ventilação natural e o sombreamento da fachada, entre outros.

Torna-se possível importar o conceito de conforto térmico da arquitetura para o campo da moda, estabelecendo um diálogo entre os dois campos do saber. A arquitetura é responsável pela criação de espaços confortáveis, assim como a moda é responsável pelo conforto do usuário na sua relação com o traje. Neste sentido, justifica-se o paralelo estabelecido entre as estruturas arquitetônicas que garantem o conforto térmico nas edificações e os recursos empregados na construção do produto do vestuário de moda que interferem diretamente no conforto térmico do usuário. O conforto trata da comodidade e do bem-estar e afeta diretamente a qualidade e o modo de vida do usuário, interferindo nas suas sensações e percepções (SOUZA, 2006). A arquitetura busca a harmonização das construções ao clima e às características locais, transformando os espaços construídos em espaços confortáveis, utilizando-se de recursos que favoreçam a iluminação e ventilação naturais.

3. Os princípios condutores

Ao longo da trajetória projetual, distintos graus de importância são conferidos aos vários aspectos do problema que são abordados levando em consideração as motivações, as crenças e os valores, que juntos, compõem a bagagem intelectual e cultural de cada um e definem maneiras peculiares de projetar. Esse conjunto, seja ele traduzido por uma série de ideias desarticuladas ou por um coerente método de projeto, é denominado por Lawson (2011) de princípios condutores – aqueles que direcionam e conduzem os processos projetuais individuais.

Em determinados contextos, constituem-se verdadeiras estratégias construtivas, em outros, podem surgir como resposta a uma necessidade gerada por uma restrição de projeto. De um lado, os princípios condutores influenciam e determinam a trajetória de cada processo. Do outro, como o aprendizado do projeto está na experimentação do seu fazer, cada problema solucionado permite ao projetista lidar com as diversas naturezas das restrições, e aprender mais sobre elas, de modo a materializar as suas ideias com clareza cada vez maior.

Estudos de registros de processos de projeto comprovam que não existe uma rota única para transitar entre a definição inicial do problema que desencadeia tal processo, e a solução final encontrada. No entanto, identificam-se alguns princípios condutores comuns, que direcionam o pensamento ao projetar.

No contexto da presente pesquisa, eles se revestem de um caráter especial porque são flagrados na condução de projetos absolutamente distintos que permeiam áreas do conhecimento, as mais diversas.

Em 1898, afirma Quinn (2003), ao identificar na vestimenta uma forma de abrigo para o corpo, o arquiteto Adolph Loos, autor da obra *The Principle of Dressing*, sugere que o conhecimento próprio da engenharia têxtil, bem como suas técnicas, sejam empregados como princípios construtivos das edificações. Ao serem aplicados em materiais mais rígidos que os têxteis poderiam estruturar espaços mais amplos. Ao traçar tal paralelo, possivelmente Loos tenha sido um dos primeiros a estabelecer conexões entre moda e arquitetura a partir de um pensamento direcionado por aspectos de estrutura.

A ideia de honestidade estrutural, tão difundida no período do Modernismo, mostra como os elementos estruturais podem ser parte essencial dos princípios condutores. Insere-se neste caso o projeto de Bill Howell para o University Centre, em Cambridge, que se enquadra na filosofia de edificação chamada de arquitetura vertebrada na qual a forma final é gerada a partir da estrutura, tendo seu volume interior definido e articulado por ela. Trata-se de um processo guiado por um conjunto de princípios a respeito do papel da estrutura para desenvolver a anatomia de cada edificação.

Outro projetista que se enquadra neste contexto é o espanhol Santiago Calatrava, que apesar da dupla formação em arquitetura e engenharia, é um estudioso do corpo humano – como os designers de moda – além de fascinado pela sua capacidade de se mover e assumir uma série de configurações completamente estáveis e resistentes. Demonstra grande interesse por estruturas móveis e dobráveis e seus projetos refletem a ideia de equilíbrio dinâmico. Justifica-se, assim, a afirmação de que seu processo projetual é, em grande parte, conduzido por princípios estruturais e que se apropria de conhecimentos advindos de outras áreas para projetar a sua. Em geral estas estruturas transformam-se em elementos esculturais de grande apelo estético, como comprovam duas de suas recentes obras, inauguradas em dezembro de 2015 e março de 2016, respectivamente: o Museu do Amanhã no Rio de Janeiro e a estação de trens do World Trade Center em Nova York.

Conduzidos pelo mesmo pensamento estrutural, profissionais da moda utilizam princípios arquitetônicos para manipular a estrutura e o volume das vestimentas: Ralph Rucci, Junya Watanabe, Teng e Isabel Toledo, cada um a seu modo, aplicam princípios de suspensão para estruturar seus produtos. Em uma das coleções, Watanabe mostra produtos em nylon com mecanismos e estruturas semelhantes ao modo como um paraquedas aberto pode ser manipulado por suas alças – apesar do emprego de um material rígido como o nylon é relevante a delicadeza transmitida pelas peças; Teng apresenta vestidos com cabos que içam o tecido de uma maneira similar às estruturas das pontes suspensas (HODGE, 2007).

Na medida em que, arquitetos e designers, interpretam estratégias de trabalho uns dos outros, forjam novas conexões. Segundo Quinn (2009), novos paradigmas da arquitetura estão a transformar as técnicas de alfaiataria e os materiais têxteis em estruturas duradouras, aproximando edifícios de produtos do vestuário para que possam ser igualmente concebidos como uma série de estruturas permanentes e habitações portáteis. Assim como os designers utilizam materiais macios e métodos de costura para projetar abrigos portáteis, arquitetos implantam técnicas semelhantes para promover novas redes estruturais, e edifícios móveis.

As novas tecnologias têxteis vêm, gradualmente, modificando o caráter e a forma de edifícios permitindo aos arquitetos explorar a geometria orgânica. A pesquisa acerca de formas naturais como as das teias de aranhas ou das bolhas de sabão que vinham sendo estudadas, é ampliada pelo uso do design e da manufatura auxiliados por computador. Formas como estas foram elaboradas por arquitetos australianos para o projeto do *National Swimming Centre*, construído para as Olimpíadas de Pequim, em 2008, mais conhecido como *Water Cube*. Segundo Colchester (2009), centenas de formas diferentes de almofadas criam uma estrutura não linear, aparentemente casual, mas de grande complexidade, que não teria sido possível construir três anos antes. As almofadas são arranjadas de tal modo que conferem ao edifício uma aparência acolchoada que lembra a superfície dos tecidos em matelassê, muito empregada no vestuário de moda.

Flexibiliza-se, portanto, o conceito de construção e abordam-se diferentes formas de construir, identificando princípios similares que estruturam tanto o produto de moda quanto a edificação, evidenciando um pensamento construtivo análogo entre as áreas.

4. Piquadro: um estudo de caso[44]

Para melhor ilustrar os processos relacionados à *cross fertilization* bem como evidenciar a aplicabilidade deste instrumento como gerador de inovação, optou-se por abordar o estudo de caso realizado por Giovanni Maria Conti, na Piquadro, o que possibilitou seu confronto direto com a realidade da empresa e com o seu fundador, Marco Palmieri, cuja entrevista concedida fundamenta este texto.

Piquadro é uma empresa italiana fundada em 1987, que trabalha o couro com maestria artesanal e tecnologia de ponta. Oferece uma ampla gama de produtos e acessórios de alta qualidade no que diz respeito aos materiais e ao design. A filosofía se traduz em uma série de objetos que vão desde agendas, pastas porta-documentos e carteiras, aos bolsões de viagem, entre outros, desenvolvidos para responder as exigências de praticidade cotidiana e ao gosto estético, onde o acabamento feito à mão personaliza um estilo inconfundível. A empresa começou como fabricante de outras marcas de luxo italianas e, a partir de1998, iniciou a produção de artigos de couro da própria marca.

O estudo abordou os seguintes aspectos: o diálogo entre a moda e o design percebido na empresa e o início desta hibridação; o processo produtivo; a comunicação;a visibilidade externa; a lógica estabelecida entre local e global.

Em determinado momento percebeu-se a necessidade de mudar o foco da empresa para transformá-la em "marca" e foi preciso alterar aspectos empresariais para contemplar tal decisão. Resolveu-se dar um direcionamento centrado no valor cultural e aspiracional do design, que é diferente da abordagem da moda para inúmeros fatores. A moda é mais propensa ao impulso e em alguns aspectos vinculada a um consumidor mais superficial do que o consumidor do design que talvez seja mais atento e pese mais a relação com o dinheiro, com o produto, com a funcionalidade e a utilidade. Neste caso, o valor dado ao produto é outro e isto determina grande diferença na motivação para a tomada de decisão de compra.

Definiu-se por este posicionamento de marca porque no mercado não havia ninguém que produzisse artigos de couro voltados para o design e para a funcionalidade do produto. A empresa soube comunicar de modo claro e coerente quem queria como cliente e a quem aspirava com a sua imagem técnica, de design, de função, de conforto e uso, em comparação com a linguagem mais lúdica, em alguns aspectos, da moda.

Este novo modo de pensar deveria, então, ser comunicado e traduzido em produto. Embora se tratassem de produtos clássicos que não demandavam nenhum tipo de tecnologia específica, uma série de funcionalidades foram acrescentadas.

[44] A íntegra do estudo de caso "Piquadro: la pelletteria tech-inside" abordado neste artigo de modo sintético, encontra-se publicada na Magazine della Ricerca SDI. Design ReView n° 4: "Moda e Design. Cross Fertilization per l'Innovazione". Edzioni Poli.design, 2006.

O primeiro aspecto estudado foi a "pega" que deveria ser ideal e possibilitar uma sensação tátil de prazer. Para tanto, foram acolchoadas e preenchidas internamente, de modo que cada vez que era tocada dava a sensação de se ter na mão algo extremamente agradável, assim como uma espuma. Em seguida, vieram as bolsas masculinas com porta guarda-chuva: o compartimento posicionado do lado de fora, não só recobria o guarda-chuva depois do uso como também evitava que o conteúdo interno se molhasse. Além disso, as bolsas mais tradicionais foram estudadas a partir de outro ponto de vista: se girar, de um certo modo, tornam-se mochilas, portanto, se o usuário se locomovesse em uma *scooter*, poderia mantê-la em seus ombros e não a tiracolo. Outras bolsas foram pensadas para acomodar o capacete ao invés dele ficar sobre o assento da moto quando retirado: nelas há um ziper que se abre e dali pode ser retirado um compartimento confeccionado em material elástico no qual se guarda o capacete. Estes pequenos detalhes fizeram diferença e foram percebidos por aquele comprador um pouco mais racional.

É na Cultura do Projeto Industrial, portanto, e nas suas habilidades projetuais desenvolvidas na tradição do "saber fazer" italiano que a empresa se referencia para projetar os acessórios de viagem, que partem do compromisso de querer satisfazer as necessidades e as exigências demandadas pela sociedade. Trata-se de uma contínua pesquisa de estímulos e sensações que através dos objetos Piquadro vão sendo transmitidas aos consumidores.

No estudo de caso fica evidenciado como o objeto da pesquisa ativada pela Piquadro pode conduzir a empresa para identificar as metodologias de projeto e de gestão de recursos criativos para apoiar os processos de inovação, do tipo transversal, entre moda e design. É a Cultura do Projeto industrial o fator determinante que entra na atividade projetual da empresa e que influencia significativamente os processos, a organização e a estruturação produtiva. A necessidade de hibridação de competências entre as diferentes áreas do projeto acaba por ser a única chave de leitura para compreender o produto Piquadro.

Muitas empresas do setor da moda ainda tem operado de modo isolado, não explorando o potencial de colaboração com outros setores mercadológicos. Na Piquadro, a consciência de implementar dinâmicas de inovação relacionadas com os processos de transferência de conhecimento – *cross fertilization* – que podem levar à identificação e à experimentação de competências, processos projetuais e modelos organizacionais com capacidade de operar dentro do todo do sistema projetual, parece ter se tornado uma prática metodológica de trabalho.

Outro aspecto relevante é o fato do interesse de Marco Palmieri, pela eletrônica e pela tecnologia da informação, ter sido transferido para os processos industriais utilizados para a produção de seu produto. Considerando a importância do couro na economia do processo de produção do produto buscou-se otimizar a fase de processamento inventando um sistema de corte diferenciado que corta o couro por meio de jato de água. Até então os sistemas automatizados só eram utilizados para o corte de tecidos e não para o couro, devido à sua irregularidade e às especificidades do material. Desenvolvido internamente pela Piquadro foi posteriormente vendido a empresa francesa Lectra, líder mundial nos sistemas automatizados para tecidos, que assumiu a tecnologia e se tornou parceira.

Da mesma forma aplicou-se os conhecimentos advindos da tecnología da informação para descobrir como sistematizar o estoque e torná-lo flexível para as vendas on-line e para o abastecimento das lojas. Criou-se um sistema eficaz totalmente automatizado, sem a necessidade de operador. A empresa acredita que o fator estratégico para o êxito é ser inovadora, tanto na abordagem quanto no posicionamento, seja nas questões de mercado, marca ou produto. O fato de Marco Palmieri afirmar que não encontrou ninguém capaz de combinar o conhecimento do setor de couro com os processos de TI, e então ele mesmo com seus conhecimentos de informática trabalhou pessoalmente para o desenvolvimento de um sistema de controle de toda a cadeia, admite a necessidade da transferência de conhecimentos dos diferentes âmbitos disciplinares para a construção de um projeto global, que tem a inovação como valor agregado e elemento distintivo.

Assim, no contexto das reflexões sobre dinâmicas de inovação relacionadas com os processos de *cross fertilization*, Piquadro classifica-se como um modelo de sucesso.

Detecta-se que a necessidade de inovação, mesmo em setores maduros do mercado, ainda é um grande desafio e evidencia-se a complexidade projetual do objeto *fashion design oriented*, no qual o valor agregado não é simplesmente uma bela forma ou uma bela cor mas a história – vinculada ao produto – que a empresa é capaz de construir e transmitir para o consumidor.

5. Considerações finais

O argumento abordado no decorrer da pesquisa – em especial, no caso Piquadro – permite definir a inovação como um processo de mudança evolutiva que possibilita às organizações desenvolver-se. No âmbito da empresa investigada, a *cross fertilization* atuou como: ferramenta estratégica para a inovação de produtos e processos; prática metodológica para a busca do novo; fonte de conhecimento continuamente alimentada pela curiosidade da pesquisa.

A análise das intersecções que se estabelecem entre os distintos campos comprova que é dentro destas áreas de fronteira que são ativadas de fato as dinâmicas que facilitam os processos de inovação significativos. O pensamento projetual denota uma troca contínua e um diálogo constante entre conhecimentos diversos e diferentes métodos de abordagem à projetação.

A inovação é para o design e para a arquitetura fonte de constante mudança e lugar para a experimentação ; em um contexto mais amplo de sistema-produto, onde a moda é um dos muitos fenômenos produtivos de diversas categorias mercadológicas, hoje é necessário assumir uma visão sistêmica do próprio processo de inovação. É cada vez mais evidente que se esteja passando da projetação de um produto à projetação de um processo que, em seguida, trará possíveis repercussões para o sistema de produtos, sejam eles físicos ou intangíveis. A palavra sistema refere-se as atividades típicas dos setores, que passam a se integrar e a configurar cenários, isto é, aqueles lugares nos quais se realiza o cruzamento de experiências e se efetiva, de fato, a *cross fertilization*.

Dentro deste contexto que define a contemporaneidade – um cenário dinâmico, fluido, complexo, mutante e imprevísível onde várias realidades convivem de forma simultânea – é possível vilumbrar as contribuições do presente estudo para outros campos. Este panorama impõe contínuas adaptações e a reorganização dos sistemas nos diversos níveis, favorecendo a interação de forma transversal entre os setores.

Acredita-se, portanto, que a *cross fertilization* possa ser aplicada a outros campos, bem como dar origem a processos a partir do contato com outros conhecimentos codificados, sejam eles, projetuais, técnicos, profissionais, culturais ou outros ampliando-se, assim, a abrangência da inovação – prerrogativa do design, da arquitetura e da moda.

6. Referências

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The meta-design of systems: how design, data and software enable the organizing of open, distributed, and collaborative processes

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Abstract

The challenges posed by the complexity of our times requires the Design discipline to understand the many complex relationships behind the social, business, technology and territory dimensions of each project. Such nature of complex systems lays not only inside design projects, but also inside the design processes that generate them, and the ability of organizing them through meta-design approaches is becoming strategic. Since the turn of the century, the design discipline has increasingly moved its scope from single users to local and online communities, from isolated projects to system of solutions. This shift has brought researchers and practitioners to investigate tools and strategies to enable mass-scale interactions by adopting several models and tools coming from software development and web-based technologies: Open Source, P2P, DDD (Diffuse, Distributed, and Decentralized) systems. This influence has matured over the years, and if we observed in the past how such systemic models can be applied in the design practice (part 1), we are facing now a new phase where Design will have an increasing role in enabling such systems through the analysis, visualization and design of their collaborative tools, platforms, processes and organizations (part 2). This scope falls into the Meta-Design domain, where designers build environments for the collaborative design of open processes and their resulting organizations (part 3). In this paper, we address this phenomena by elaborating the Open Meta-Design framework (part 4), that provides a way for designing open, collaborative and distributed processes (including those in the professional design domain). The paper positions the framework among current meta-design and design approaches and develops its features of modeling, analysis, management and visualization of processes. This framework is based on four dimensions: conceptual (describing the philosophy, context and limitations of the approach), data (describing the ontology of design processes), design (visualizing designing processes) and software (managing the connections between the ontology and the visualization, the data and design dimensions). We believe that such a framework could potentially facilitate the participation and the creation of open, collaborative and distributed processes, enabling therefore more relevant interactions for communities. As a conclusion, the paper provides a roadmap for developing and testing the Open Meta-Design framework, and therefore evaluating its relevance in supporting complex projects (part 5).

Keywords: *Open Design, Meta-Design, Design Process, Data Visualization, Organization*

1. Introduction

During the last century, the industries of manufacturing, commerce, distribution and design have been expanding their borders globally. At first through the slow evolution of industrial infrastructures and then rapidly since the last decades through connectivity enhancement and the service industry that is transforming management and organizations. Globalization has quickly eroded the borders of national economies by redistributing activities, business, and actors all over the world, while connecting them at the same time with ICT technologies.

This phenomenon has changed the nature of several economic - and to a larger extent also social and cultural - structures, and their consequent dependency to national laws: supply-chains and value-chains are increasingly distributed, opaque, and less and less under public understanding and control. Tools and approaches for mapping and understanding such distributed systems in an open and participatory way are therefore increasingly relevant. The rise in global communication capacity, and the distributed workflows had scaled-up the complexity of economy, its impact on a global scale, its sustainability risks; it also generated many possibilities to organize distributed collaborative processes that would benefit and affect also cultural, non-profit industries, and those initiatives that addressed global sustainability challenges.

By its connection with economic and management domains, the Design discipline is also being affected by this global changes. Design is increasingly focused on speculating and experimenting on the complex and systemic nature of projects, practices and issues to be addressed, in many different disciplinary streams. Through many approaches, the scope of design projects moves from single users to local and online communities, from isolated projects to system of solutions, reaching groups at a larger scale and within global domains. This shift has brought researchers and practitioners to investigate tools and strategies that enable mass-scale and remote interactions, by adopting several models coming from software development and web-based technologies: Open Source, P2P, DDD (Diffuse, Distributed, and Decentralized) systems. The integration of Design projects with large groups of users and of their localities has increased the level of complexity (or rather, the focus on the level of complexity) of the Design discipline not only inside design projects, but also inside the design processes that generate them, and the ability of organizing them, especially through meta-design approaches, is increasingly becoming strategic. Such direction is important for the management and visualization of the intangible aspects of design processes, and for the enabling of changes within the design processes and thanks to them through society and the economy.

In this paper, addressing the relationship between design and the action within complexity, we focus on the visualization challenge of meta-design: how you do represent a system, its relationships, the complexity of social and local dimensions, and at the same time how visualization can inform the design of meaningful complexity in within organizational, productive, and information structures. We will conclude providing a framework of practice for Design when dealing with: the visualization of complex systems, the participation to complex social interactions, the contextualization of projects in complex local systems, and the implementation of Open Source, P2P, DDD Systems.

The article provides a first an overview of Open Source, P2P, DDD systems and their application in design practice (part 2), an overview of existing meta-design approaches (part 3) and then propose the Open Meta-Design framework as the synthesis of these two domains (part 4).

The framework, named Open Meta-Design, enables designers to model, analyse, manage and visualize open, collaborative and distributed processes. It is composed by 1) conceptual dimension; 2) data format; 3) data visualization layout; 4) software guidelines. The proposed framework however needs experimentation, testing and refinement: therefore, as a conclusion, we highlight possible limitations in the Open Meta-Design proposal and we propose a possible roadmap for its further development and testing (part 5)

2. Open source, P2P, Distributed, Decentralized,Systems, and Design

Designers and design researchers have been increasingly interested in tools and strategies that can enable their interactions with larger groups of people distributed in several localities. This interest has especially focused on approaches coming from software development and web-based initiatives and technologies, like Open Source, P2P, Distributed, Diffuse and Decentralized (DDD) Systems. In the recent decades ICT technologies have shaped new ways of working, participating, and assessing projects, which in turn have contributed to shaping these technologies and adapt them to larger community of users and variety of cases. In fact, although the roots of online collaborative organizations of any kind can be traced to Free Software and Open Source first, and and P2P afterwards, these new technologies and their related organizational forms have been experimented not only within software and web domain, but basically in all the field of human creativity, music, biotechnology, movies, science, art, design and so on (Goetz 2003).

The variety of these implementations has been discussed and interpret through many theories, cases studies, and analytical framework, such as Web 2.0 (O'Reilly, 2005), Wikinomics (Tapscott & Williams, 2010, 2006), Crowdsourcing (Howe, 2008, 2006), Collective Intelligence or Wisdom of the Crowds (Leadbeater, 2009; Levy, 1997; Shirky, 2011, 2008; Surowiecki, 2005), Peer Production (Benkler, 2002). Free / Open Source and P2P software were initially technological projects, but then innovateed critically the organizational level (Fogel, 2005; Weber, 2005), and time after time they became promising formats for the management of online, distributed, and community based activities.

For instances, since the new century Open Source principles and practices have been adopted outside the software industry (Goetz, 2003), and shaped large cultural phenomena such as the so called Open Source Everything (Steele, 2012). P2P dynamics have been generalized from software and adopted in many other contexts as well: the nodes in the network (devices, but also users, or any entities you may have as your network components) are not related to any central servers or middleman; this configuration has been considered a more efficient distribution model for a large variety of contents and flows (Benkler, 2002). Furthermore, many principles and guidelines based on P2P dynamics have been elaborated out of the scope of software applications as grounds for whole scenarios of sustainable future social structures (Bauwens, 2005; Kostakis & Bauwens, 2014). All these models mostly refer to decentralized communications where each participant is a peer, where the work is based on shared assets and outcomes, and agency and work are distributed over networks. It is this property of diffuse, distributed and decentralized networks the central structure to the nature of bottom-up phenomena such as Open and P2P systems; and they represent the broad framework we have to underst the formats of online mass-participation that have emerged in the past decades.

The relevance of Open, P2P and DDD systems with design discipline displays along two directions: 1) by embracing them in design practice, as collaborative and methodological tools at a local and global scale, or 2) by having them as objects of design, and applying design principles and creativity to their improvement and implementation. More recents examples of the first direction include Open Design cases (Abel et al., 2011; Ciuccarelli, 2008; Romano, 2015), which are especially linked to the emergence of the Distributed Manufacturing scenario (Bauwens, 2009) and of the Maker Movement (Anderson, 2012; Hatch, 2014): the collaboration around manufacturing technology is evolving around design projects developed collaboratively in a global community of Maker Laboratories - Fab Labs, Makerspaces, Hackerspaces and so on - that share traditional and digital manufacturing technologies (Abel et al., 2011; Anderson, 2012; Gershenfeld, 2005; Menichinelli, 2016).

On the second direction, design acts to enable and replicate such Open, P2P and DDD Systems through the analysis, visualization and implementation of their softwares, toolkits, platforms and collaborative processes and organization models. Examples as follow, cover the broad span of design outcomes: projects focusing on tools and components to support Open, P2P and DDD interactions such as OpenStructures (TEDx Talks, 2012), an open grid designed in order to facilitate the effective integration of several open projects into larger assemblies. As another case, P2P platforms have been designed to support interactions among participants - mostly in physical local contexts - and to offer comprehensive methodologies where the main design goal is to facilitate the emergence and growth of new network of participations (Cottam & Leadbeater, 2004). Custom online platform have been designed to build global community of designers that produce open projects, contributing this way to innovative but not-mainstream knowledge bases and organizational forms: a major example is OpenIDEO (Fuge & Agogino, 2014), the online platform (coupled with a toolkit) developed by IDEO for the development of solution to global scale social challenges. Further in this direction, other approaches have integrated open and p2p organizational forms feeding with the design practice in theOpen P2P Design framework (Menichinelli, 2006), and lastly introducing open and collaborative approaches to reflection and practice of meta-design in the Open Meta-Design framework (Menichinelli, 2015).

3. Meta-Design for the design of open processes and organizations

3.1 Meta-Design: an overview

The Design discipline adopts and learns from Open Source, P2P, DDD systems, it also builds and improves them, and designers can furthemore have a role in building environments for the collaborative design of open processes and their resulting organizations: we are particularly interested in reflecting and contributing to this cross-influence of Open Source, P2P, DDD systems and meta-design issues. In fact, in literature we found Meta-Design has been associated with many technologies which are now related with such systems - to mention: mass-customization, digital fabrication, generative design, open processes and the participation in online communities (Giaccardi, 2003). The technological variety has been crucial for the development of design processes and projects scaled and adequate to each community and their context.

Furthermore, Open Source, P2P, DDD systems and their integration with design bring new roles for both users and designers. The Design discipline has been discussing extensively about the integration of users in the design process, and elaborated many established approaches such as Participatory Design, User-Centered Design, User Experience Design and Co-Design (Rizzo, 2009). This literature offers many reflections about the meta-design practice. For example, Participatory Design implies a forecasting activity about how a design outcome will be used before it is designed, since this is also something that will be elaborate collectively through common design choices. Ehn (Ehn, 2008) identifies meta-design as a successful strategy to this design challenge, by considering it as a way to leave space for user participation in the design process even after the design concludes, suggesting the concept of ‘design-after-design’. Also Fischer has valued the meta-design approach for its capacity to extend designed systems beyond their original nature, and because it includes the ongoing process in which stakeholders become co-designers. For Fischer, meta-design takes place not only at the time of design implementation, but throughout the whole existence of the system (Fischer & Scharff, 2000). According to Fischer, Meta-design characterizes objectives, techniques, and processes for creating new media and environments that allow the owners of problems to act as designers. Within this perspective on meta-design, the activity of designing is more about generating the seeds for the emergence of projects, rather than carefully and precisely planning all the features and specifications (Fischer, 2003). He speculates about Meta-Design being more elaborate than User-Centered Design and Participatory Design because it shifts the control of the design process from designers to the hands of the users, embedding the action of 'designing the design process'; he ultimately acknowledge that *"creating the technical and social conditions for broad participation in design activities is as important as creating the artifact itself"* (Fischer & Scharff, 2000), to the extent of elaborating a framework for understanding Meta-Design processes, known as "the Seeding, Evolutionary growth, Reseeding process model" (SER) (Fischer et al., 2009):

- Seeding: provide seeds that evolve over time through the small contributions of many people instead of complete systems.
- Evolutionary growth: a decentralized evolution of the seeds through use, exploration and extension by users.
- Reseeding: a deliberate, centralized effort to organize, formalize, and generalize solutions and artifacts created during evolutionary growth.

Being Meta-design a broad concept with different context of usage and understanding - extending from design to technology, society and biology - we here refers also especially to the broader overview offered by Giaccardi, who traces its roots, meanings and implications with a particular interest to creative industries (Giaccardi, 2003). Giaccardi considers Meta-Design an an emerging design culture more than an established design approach; it generates at the intersections of ICTs and Design, and to the extent, to Interaction Design and Net Art. The implications of "meta-" change the perspectives to designers from objects to process, from contents to structures; Giaccardi identifies three different declinations of Meta-Design, crossing etymological facts with extensive literature review: *meta-* as.

- *behind* (or *designing design*): "Design of Design processes" / "Design of the generative principle of forms" / "Design of the Design tools";
- *with* (or *designing together*): "Design of media and environments that allow users to act as designers" / "Design of the organization of flows";
- *between/among* (or *designing the "in- between"*): "Designing the spaces of participation" / "Design of relational settings and affective bodies".

The focus on evolutionary environments brought by Fischer and the cultural value that Giaccardi refers to meta-design both imply that design projects are not acts of planning of features and procedures to be implemented; they are instead the (creative) configuration of possibilities that will emerge from opening the mechanism of participation and manipulation. Both of these approaches to meta-design practice value grandly the property of emergence, that we learn from complex system being the ability of the individual components of a large system to coordinate actions together, and rising diverse productive behaviors; emergence happens when this coordination arises spontaneously from simple interactions among the parts, and include to consider their effect on the environment. This inspiration from the emergence property of complex systems would require meta-design propositions to support the process of continual adaptation of the project organization within an ever-changing environment.

To say and favour that processes need to be emergent, however, is not to abandon all plans and structures, rather to make them open: an effective way to display complex processes is by focusing on creating effective opportunities for interaction. These rules ensure alignment among participants that increases the likelihood of emergent solutions leading to the intended goal, a phenomenon that is being studying as collective impact.

We contribute through this paper elaborating the Open Meta-Design framework, that provides a way for collaboratively design open, collaborative and distributed processes (including both the professional design domain and the amateur design domain), and that embraces this proposition of facilitating interactions and stimulate unplanned changes on the design environment. Implementing an open approach to meta-design strategies will more favourably generate design projects that can adapt and scale to each specific context, its constraints and requirements, and therefore will facilitate organizations to adapt the process of collaboration to their own configurations of actors, places and networks.

3.2 Tools for Process Design and Meta-Design

For the purpose of *the design of design processes*, Meta-Design has to adopt or create frameworks, tools, and methods, that allow to implement visualizations, analysis, modelling, managing, and controlling processes. Because of the aim of this paper to contribute a new framework outline for Open Meta-Design, and because of the interest in contextualizing the proposed framework among similar approaches, in this section we briefly cover the main existing frameworks in literature used to design processes, and compare them (Table).

Table 1: Comparison of tools, frameworks and approaches for visualizing processes

Family	Origin	Name	Focus	Understanding	Purpose
Engineering & Management	1910-1915	Gantt Chart	Time Dependencies	Intuitive	Planning Management
Engineering & Management	1921	Gilbreth's Process Chart / Flow Chart	Logic Tasks	Codified	Planning Management
Engineering & Management	1950s	Functional Flow Block Diagram (FFBD)	Logic Tasks Dependencies Time Network	Codified	Planning Management
Engineering & Management	1957	Program Evaluation and Review Technique (PERT)	Logic Time Time needed Tasks	Codified	Planning Management

			Dependencies Network		
Engineering & Management	1970s	Data Flow Diagram (DFD)	Data Flows	Intuitive	Planning Management
Engineering & Management	2006 - ongoing	Business Process Model and Notation (BPMN)	Time Logic Data Tasks Flows Network	Codified	Planning Execution Control Standard Data format Prescription
Meta-Design	2005 - ongoing.	Open P2P Design	Activities Flows Participation	Intuitive (Flows, participation) Codified (Activities)	Planning Visualization Communication Discussion
Meta-Design	2013 - ongoing	Open Meta-Design	Activities Flows Participation Data Time Network	Intuitive	Planning Visualization Analysis Democratization Communication Discussion Data format API

The development of such frameworks emerged with scientific management, proceeded with large engineering and military efforts, then embraced also information and computing disciplines with the introduction of digital technologies, and recently focused on the standardization of data formats, visualization and execution tools (Henrink von Scheel et al., 2015: 2). Henry Laurence Gantt developed his methodology and the Gantt Chart while working for Frederick W. Taylor in the realization of major infrastructure projects. Frank B. Gilbreth was studying and documenting the movements associated with physical labor, and implemented Process Charts to reduce them and make the flow of the process more efficient. In 1947, the American Society of Mechanical Engineers (ASME) became the first organization to develop and establish an international standard of process symbols by extending Gilbreth’s work. Functional Flow Block Diagrams (FFBD) were introduced in the 1950s to describe production environment as systems, by showing the sequential relations between all the functions. Later, the introduction of PERT methodology changed the use of timelines by adding the estimation of necessary times and possible delays. The Data Flow Diagram was instead introduced in order to enable the visualization of where information (data) is stored, and how inputs, outputs and flows of information are organized in the process among the tasks.

In the 2000s, the Business Process Model and Notation (BPMN) emerged as a standard for graphical notation by extending previous flowchart techniques, with the goal to ensure that BPMN models can be executable through a machine-readable XML data format. The standard and its specification are currently at the third draft (1.0 in 2004, 1.1 in 2008, and 2.0 in 2011). BPMN focuses on process and it is not therefore comprehensive; for example several authors note that it does not attempt to model organizations and strategic direction: for example, it does not cover the relation between organizational structures, including business competencies, capabilities, and resources to processes (Henrik von Scheel et al., 2015).

Through the decades, several framework have been developed with ontology more appropriated to processes, improved elements for its graphical notation, integrated softwares.

Despite the large case study value, most of these approaches from engineering and management domain mainly consider processes as business processes: "*a collection of tasks and activities (business operations and actions) consisting of employees, materials, machines, systems, and methods that are being structured in such way as to design, create, and deliver a product or a service to the consumer*" (Henrik von Scheel et al., 2015: 1); moreover, in such frameworks, graphical notation is much more than intuitive, and therefore they are mainly accessible only to stakeholders already trained or used to business settings. These might be relevant limitations for their adoption in Open and P2P systems, based on a potentially large participation of users with a different background and which which may not always be a driven by business relations and values.

A first attempt at building a bridge between meta-design and business process modeling has been done by Selim Erol, whose research focused on applying meta-design guidelines from Fischer (Fischer et al., 2009) to BPMN. Erol noticed that research on business processes has mainly focused on creating flexible process modeling techniques, and workflow management systems, rather than on the flexibility and openness of modeling environments, especially to enable end-user or diverse and unplanned stakeholders participation in modeling. Furthermore, typical process modeling follows a linear model limited to design-time, and where requirements are previously defined (Erol et al., 2010). He therefore developed and tested a flexible and open wiki-based BPMN meta-design modeling environment called xoProcessWiki (Erol, 2012): the environment proved to be very useful but at the same time it showed a strong need for instruction and facilitation during the modeling process, showing the limitation in large-scale adoption, and missing function of evaluation and assessments.

In the last decade, a more direct connection between meta-design and Open, P2P and DDD Systems has been investigated outside of the business domain by the two frameworks of Open P2P Design, and its derived Open Meta-Design: these frameworks are oriented to collaborative processes generated by communities and deployed within their social networks. The Open P2P Design approach develops at the intersection between Service Design, Activity Theory, and Participatory Urbanism and focuses on communities and their open and p2p processes, meaning networks of activities with different levels of participation (Menichinelli, 2011, 2006). It is mainly based on open methodologies and toolkits for modeling processes, which are shared with the community the process is intended for. Open P2P Design have been experimented in a series of short workshops about Open Design and Distributed Manufacturing, where it proved to be promising but with limitations in the lack of the time dimension in the visualization, an overtly complex description of activities, and the difficulty in working with several unrelated visualizations. These workshops pointed to the need of a simpler approach, an unified visualization in a single image or poster, and on the need for a framework for evaluating the real-life processes generated from the documentation of the designed processes. These results led to its simplification into the Open Meta-Design framework (FAD Barcelona, 2013; Menichinelli, 2015).

The Open Meta-Design framework is linked to Activity-centered Design (Gay & Hembrooke, 2004; Kaptelinin & Nardi, 2009); it defines that platform where collaborative communities can act are more than online services, they are instead network-based architecture that support also online services by shared productive components within the social network of the participants, such as artifacts, rules and roles. Having activity as its core goal, Open Meta-Design aims to clear communication, to produce easy visualization, to offer integrated tool and data format and the versatility to more generic domain of application. Implementing Meta-Design principles and the properties of Open, P2P and DDD Systems for the facilitation of socio-technical communities can be useful to benefit their openness, adaptability to local conditions and emergent behaviours. Such approaches should be intuitive and not restricted to professionals only, should have a clear data strategy that enables tools, functionalities and data interchange, and should provide the function of development assessment.

We believe the Open Meta-Design will be promisingly explored with further research and practice; however it is still a very recent framework who is lacking complete formulation in current literature. For this reason, in the next section we contribute to elaborate its structure, which is based on:

1. A contextual description of Open Meta-Design within the lifecycle of projects and their organizations;
2. A data format that describes a process ontology, and it represents the basic layer for a tool for collaborative design;
3. A visualization format that renders the data format in an intuitive way;
4. A software layer which binds together data, visualization, graphical user interface and collaborative editing, being this one the interface of production.

4. Open Meta-Design: a proposal for a meta-design framework along four dimensions

4.1. The conceptual dimension of Open Meta-Design

The main concept of Open Meta-Design is that designers and stakeholders can work together as network of peers in defining the process and the methods of their collaborative activities. The meta-design component refer to the design of a tool that enables stakeholders to collaboratively design processes in online environment where they can discuss their participation. The open component focuses on the open source and p2p features of the relationships that are generated and of the projects that are developed. The roots of Open Meta-Design for both concepts and tools can be traced in the Open P2P Design framework along three directions:

- Cultural-historical Activity Theory (CHAT): a framework that focuses on studying work and organizations, analysed through the model of Activity System which enables a complex overview of the mediational structure of the activities, the contradictions within activities and among activities as critical issues but also potential paths for development, since activities incessantly reconstruct themselves (Engestrom, 1987). An activity-centered approach focuses also more on how tools mediate activities among multiple actors, and is therefore more apt to the meta-design of a process where multiple actors interact.

- Service Design: a design discipline dedicated to the planning of services between providers and customers with a focus on both immaterial interactions and flows among people, infrastructures, organizations, and on physical touch-points in space, artifacts, interfaces. The Service Design community has developed several tools useful to map the interactions and flows among people, spaces and artifacts (Alves & Nunes, 2013; Tassi, 2008) that can be adopted for Meta-Design. Furthermore, some approaches tried to adopt Activity Theory in Service Design as reference model for service evaluation thanks to its systemic, social and artefact-mediated conception of activity and are therefore promising for meta-design processes (Maffei & Sangiorgi, 2006; Sangiorgi, 2004).

Studies on the structure and classification of participation: several researchers and practitioners pointed out that participation is not just a final goal, but also an intermediate tool for structuring design processes and that there are different levels of participation of stakeholders (Arnstein, 1969; Friedman & Miles, 2006; Hamdi & Goethert, 1997). Participation is not always uniform and tota: these approaches can be considered as a tool for shaping the amount and quality of participation in processes; the participation matrix is an example in this direction (Hamdi & Goethert, 1997).

These directions outline an implementation scenario of Open Meta-Design approach, compliant to the classification of meta-design from Giaccardi (Giaccardi):

1. *behind* (or *designing design*): Open Meta-Design is a framework of design tools that generate the design of processes;
2. *with* (or *designing together*): Open Meta-Design is a framework with an online environment and a data format that allow users to design the organization of flows;
3. *between/among* (or *designing the "in-between"*): Open Meta-Design is a framework for collaboratively designing the organization of participation in processes through an open discussion.

Furthermore, the Open Meta-Design framework offers a new model for how phases of the project are organized over time.(figure 1). Any design process (intended as the development of human-made artifacts) undergo two basic stages: design time and use time. (Fischer 2009) (Figure A). When a meta-design approach focuses only on design tools and processes, it tends to take place at the beginning of such generic processes, befor design time (Figure B). When a meta-design approach focuses on the development of an interactive environment, this approach last for all the life of a project since the environment sustains it (Figure C). In the Open Meta-Design framework instead, the meta-design approach precedes all the other phases, and beside design time and use time it includes production (which is increasingly important in Open Design projects and in new initiatives with many non-professionals), distribution, and project life cycle, and possible future projects time that is the case when the project is open source.

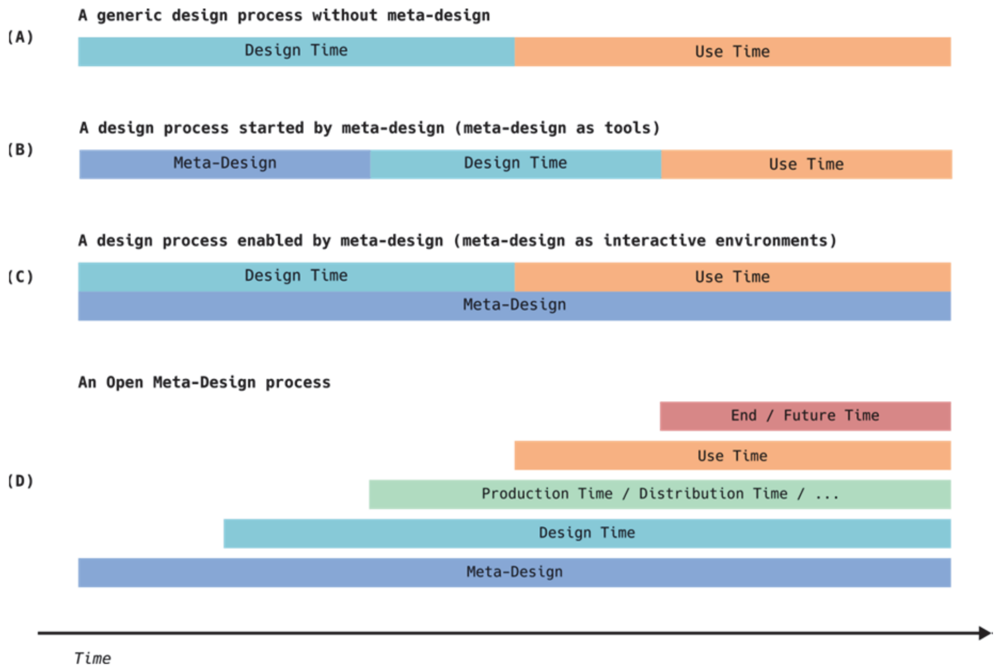

Fig. 1: Time and activities in Open Meta-Design process compared to other conventional design processes

The Open Meta-Design framework has been developed as a more general version of the Open P2P Design framework, making its application broader. As any framework, it cannot encompass all the complexity of sociotechnical systems, therefore it is important to understand its limitations. The framework is thought for developing processes, but these are part of a larger system: when they are implemented, they generate social interactions and therefore social networks; these networks give place to organizations for the management of their social dimension; such organizations then bring governance structures and rules for the management of the system, and the governance influences the processes and their design (Figure).

The Open Meta-Design framework has then a specific and limited place in the life cycle of the social and organizational dimension of the projects it enables, and other approaches might be coupled to it in order to improve all the aspects of its life cycle: social network analysis for understanding the networks, visualization and other techniques for making the organization visibles, conflict management for facilitating the governance. All these approaches can be implemented in Open Meta-Design platforms with time, extending the design of processes to a complete management of collaborative systems.

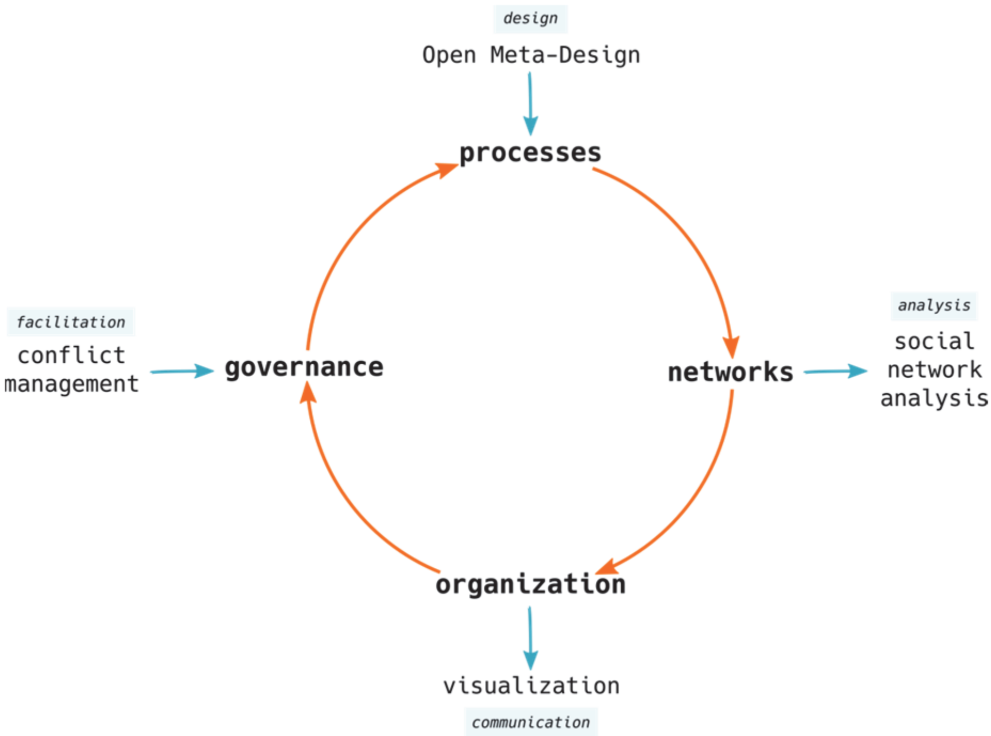

Fig. 2: The role of Open Meta-Design in the life cycle of the social and organizational dimension of a project

4.2. The data dimension of an Open Meta-Design ontology

A custom data format that store a specific process ontology is needed in order to enable the development of an interactive environment for design, discussion and sharing, The data dimension and the design dimension of the following section have been designed in parallel way with multiple feedback loops between them. In this case therefore, the ontology has been designed from the bottom-up, re-elaborating previous tools and experiences into a single tool, multiple sources of data into a single data format. The data is managed by a software dimensione (section 4.4) that connects it to the design visualization and that manages its sharing, accessibility and export: for an online platform, the implementation of custom APIs can manage the access to the data through different file formats. For these reasons, the data ontology has been structured from the bottom-up starting with software code, from which a graphical representation in UML has been automatically generated (Figure). After this iterative design phase, the results point out how Location (online or offline) is the starting point of a process, from which Time Intervals, Persons and Activity Elements generate. Activity Elements constitute together Activities, which are linked by Flows into Processes and by Contradictions into a Discussions (based on single items called Issues to mirror the collective discussion in open source projects on platforms like GitHub) among the participants in the meta-design project. More Processes constitute an Open Meta-Design Project, which is shared through a License that governs its IP. Activities and the flows among them constitute processes, activities and contradictions among them and in them generate discussions, and discussions and processes constitute Open Meta-Design projects.

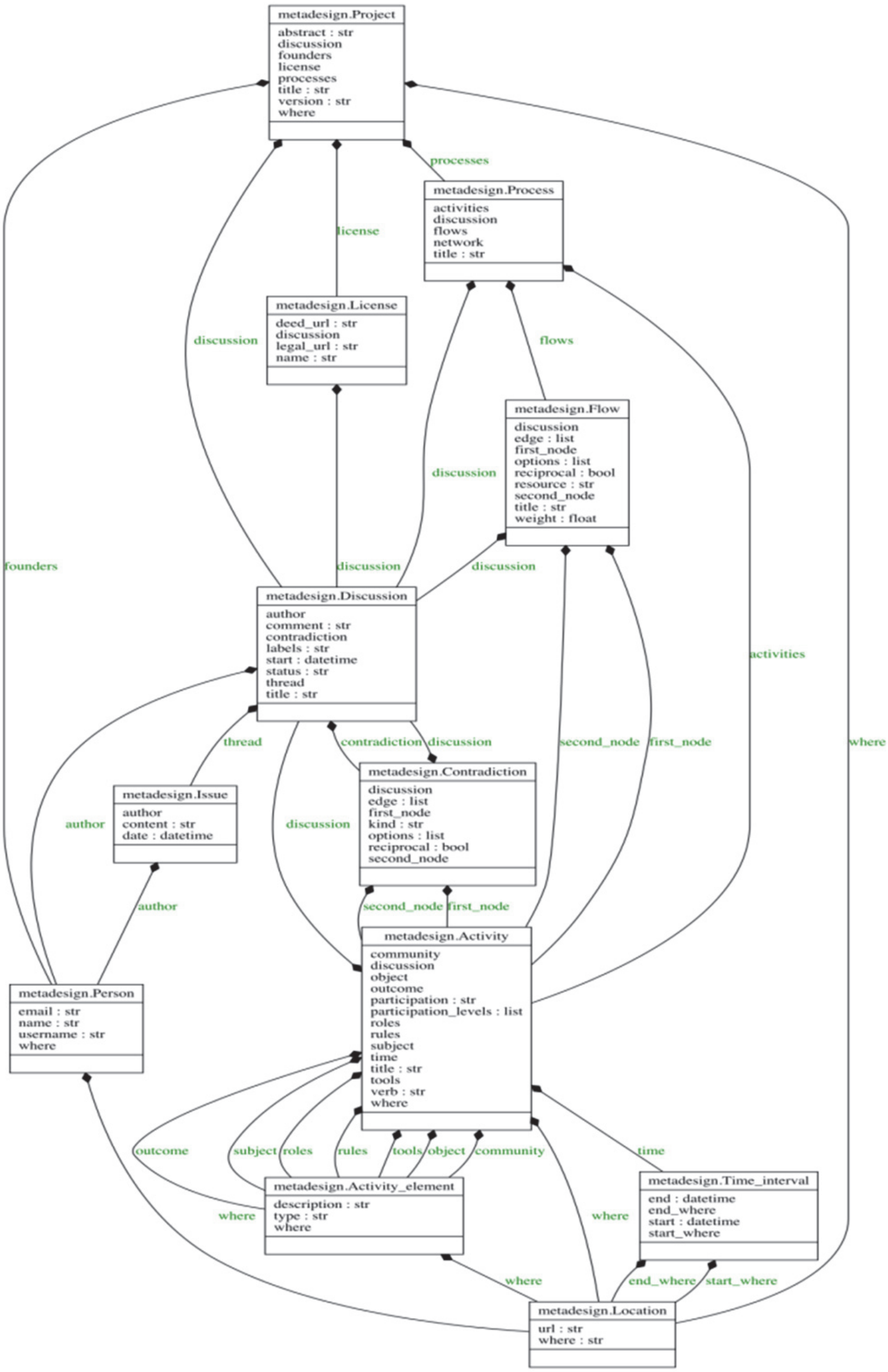

Fig 1: A preliminary UML visualization of the classes describing the data structure of an Open Meta-Design project.

4.3. The design dimension of an Open Meta-Design tool

The first proposal of the design dimension of Open Meta-Design (Figure 3) has been developed during several iterations together with the data ontology, since they are interconnected: processes are visualized by the design dimension that renders the data and the data dimension describes the design of processes which are designed on the platform or environment. Furthermore, it integrates the various design tools tested within the Open P2P Design framework in one single visualization, and tries to simplify the more complex tools (Menichinelli, 2015). The workshops where the Open P2P Design framework was tested showed in fact that one single visualization would have been more understandable and easy to use, and that activities were too complex to be designed and analysed with Activity Theory by untrained users. Furthermore, the time element was missing or poorly implemented. For these reasons, some of the tools adopted by Open P2P Design (System Map, Participation Matrix) are now integrated in one single visualization where time is represented and managed like in Gantt charts and where activities are represented in a textual way in order to make it easier for the users to understand them. The Activity System is a powerful framework for understanding and designing activities, but its visualization is not very useful to untrained users. Therefore, the Activity Systems are here represented as a short text scripts that explain their structure and help the users to edit them. Activities are then grouped by similarity in processes. The script analogy has been also adopted for the title and a short description of the main project at the top / beginning of the visualization. The use of the script metaphor could be useful then for obtaining a clear representation of complex and intangible activities, and it could also be useful for their data analysis. The text as an interface for complex systems, that could be analysed and visualised later with a global overview of all the activities. Movies script have been adopted for data analysis and visualization several times; an interesting example can be found in the Star Wars movies, which have been at first depicted in a hand-drawn chart on the XCKD website (Munroe, 2009). The popularity of this visualization has lead data scientists and designers to develop software for automatising the analysis and visualization of such scripts as processes (Franklin et al., 2015), but also for understanding their social networks (Gabasova, 2016, 2015) and activities and performance (Diamond et al., 2015). From a single script (or shorter scripts) it is therefore possible to analyse and visualize complex processes and activities.

Contradictions and flows are instead represented as connections between different scripts or elements of the scripts, in order to show the systemic nature of processes generated by several activities. Furthermore, a preliminary study of a possible integration of the design dimension with a GUI for an online platform has led to the integration of elements for user interaction (the orange elements in Figure).

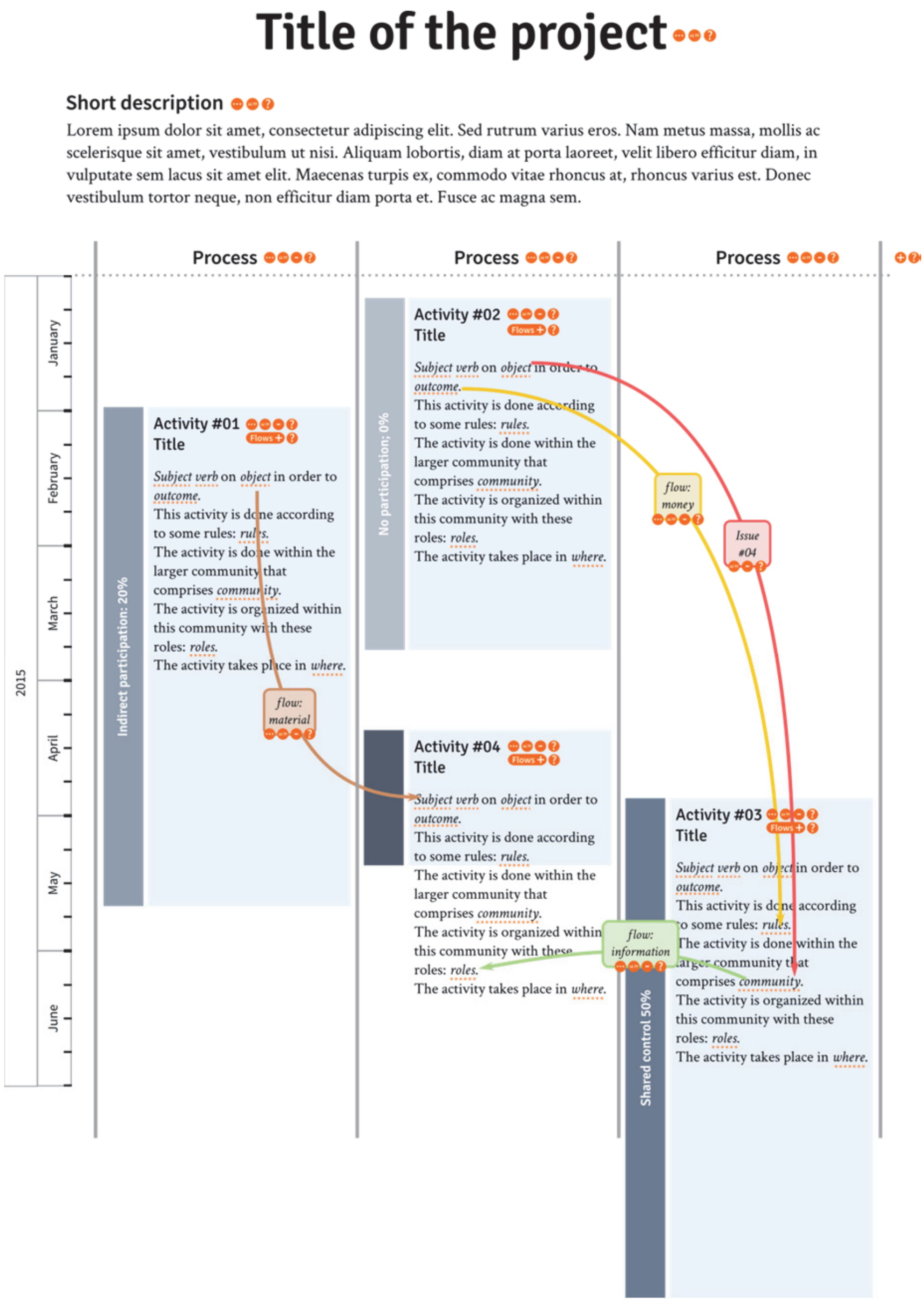

Fig. 4: A proposal for an Open Meta-Design visualization tool and interface

4.4. The software dimension of an Open Meta-Design tool

The conceptual dimension clarifies the position of Open Meta-Design within design, analysis and meta-design approaches and within the life cycle of the organizations behind projects. The data dimension describes the ontology of projects as processes built from networks of activities. The design dimension renders the ontology and enables the users to understand it and design it. These dimensions could be implemented with analog tools like a paper toolkit as in the Business Model Canvas (Osterwalder & Pigneur, 2010), but we think that the complexity of socio-technical systems could be facilitated with more flexibility and scalability with digital platforms and data. In this direction, the software dimension of Open Meta-Design would represent the common layer that binds together the data, design and user interface dimensions. Such layer would enable the collaborative editing of processes by multiple users, the sharing and accessibility of projects, the interfacing and application of meta-design approaches to other platforms and therefore contexts as well. For example, the UML visualization of the data structure (Figure) was already automatically generated from software code. Such a dimension would require extensive development, but for the scope of this proposal we identify some design guidelines, following the example of Erol (Erol et al., 2010) that defined the guidelines for the xoProcessWiki platform according to Fischer's guidelines for meta-design environments and software systems (Fischer et al., 2009)(Table).

Table 2: Key features of an Open Meta-Design software platform derived from (Fischer 2009)

Meta-Design guidelines (Fischer et al., 2009)	Related key features to be implemented in software
1. Support Human-Problem Interaction	GUI for collaborative design Clear explanations or tours of the GUI and the visualization Open APIs and libraries for developers
2. Underdesign for Emergent Behavior	Empty or half-empty templates of projects
3. Enable Legitimate Peripheral Participation	Discussion with issues Analyse and visualize the contribution of participants Analyse and visualize the reputation obtained by participants
4. Share Control	Data export Open APIs Open source software and libraries
5. Promote Mutual Learning and Support	Discussion
6. Reward and Recognize Contributions	Document motivations in discussions Analyse and visualise contributions in the discussion
7. Foster Reflective Communities	Describe the background and expertise of each participant Foster the collaboration and sharing among participants with different background and expertise

5. Conclusions

The increasing complexity brought by globalization and by the quest for sustainability in society and the economy might find suitable approaches in the increasing involvement of all stakeholders in the design processes and in the management of such processes. Open, P2P and DDD Systems could represent a promising direction for enabling the participation of a potentially large pool of distributed users in design processes. These systems however brings also new organizational forms and new principles and practices, making their design not a straightforward task. Stakeholders could be therefore involved in the definition of such systems and of their processes, and meta-design approaches could be useful for enabling designers to have a role in the definition and management of such systems and processes. Existing frameworks and tools for designing, managing or meta-designing processes are complex to use for non-professionals or incomplete: for this reason we propose the Open Meta-Design framework in this article. The framework represents a bridge between design, meta-design, social sciences, computer science. Compared to previous frameworks like Open P2P Design, this framework provides a more structured approach, based on the modeling, analysis, management and visualization of open, collaborative and distributed processes. This framework is based four dimensions: concept (describing the philosophy, context and limitations of the approach), data (describing the ontology of design processes), design (visualizing designing processes) and software (managing the connections between the ontology and the visualization, the data and design dimensions). Such approach and framework could potentially lower the barriers to the participation in the design and discussion of open, collaborative and distributed processes, enabling therefore mass-scale interactions and a new role for designers, based on an augmented awareness of the possibilities of design processes and organizations.

The proposal is still preliminary, and a complete implementation and testing is needed in order to understand its viability. More dimensions, domains, features or tools could be added but this direction requires a careful consideration in order to balance the trade-off between ease of use and complexity. Since most of the process design frameworks focused only on business processes, the current proposal does not include a business dimension. This could be a critical limitation, given the fact that even collaborative processes needs to reach a sustainability in order to proceed with their activities. Furthermore, a final implementation in an online platform for example, could show more critical issues and missing elements. As a conclusion, we suggest a roadmap for developing and testing the Open Meta-Design framework, and therefore evaluating its relevance in supporting complex projects. The conceptual dimension of the framework (Figure) could represent not only a way for understanding its limitations, but also a way for testing it and developing it further. For this reason, we suggest that the impact of such framework could be analysed along the dimensions of networks, organization and governance. However, the conceptual dimension could need further refinement in order to constitute a complete evaluation framework for the testing of Open Meta-Design. The next steps in this direction could be: 1) implement and refine the framework within an online platform; 2) test the platform: the adoption of the same or similar context of the testing of the Open P2P Design framework could provide a useful reference; 3) dissemination of results, tools and documentation for the replication and diffusion of the framework through its platforms or similarly related platforms.

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Translating Place Identity into Transmedia Communication Systems: Communication Design Process and Methods

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Abstract

The paper discusses the role of Communication Design in promoting cultural heritage and enhancing local identity. It deals with the need of designing communication systems able to increase people's understanding and engagement with a given place.

We argue that a communication strategy able to leverage on both tangible and intangible aspects of place identity leads to a more mindful tourism consumption, and it is a means to strengthen citizens' sense of belonging as well. To this aim, we highlight the importance of blending cultural information with technologies and languages to make the exploration of a place more accessible and meaningful. Specifically, our research focuses on the contribution given by "immersive languages" to strengthen the relation between human and environment.

Here, great emphasis is put on the transformative function of design that lies in the ability of translating and transferring intangible elements into digital products and communication systems. As an example of this translating process, the paper presents a didactic experience with a class of MSc students in Communication Design. They were asked to design transmedia communication systems for exploring the city of Milan through literary paths. Every transmedia system aims to represent the specific point of view of an author and the context in which he lived and worked. The main project goal was to create a complex mixing of media, languages and medium, in order to engage users on different channels, foster the exploration of the city and support the development of new knowledge about its identity.

The paper will describe each step of the design process focusing on approach and methods adopted to foster and nurture the projects development.

Keywords: *Communication Design, Place Identity, Design Process, Design Methods, Transmedia Systems.*

1. Introduction

People's identity has been always bound up with the sense of belonging to a place but today this bond is progressively vanishing. The 'local dimension', which represents the features of places and their communities, is threatened by globalization and by cultural and economic interconnections.

The phenomenon observed by EZIO MANZINI in 2004, that is to say the «inclinations towards turning what remains of traditions and landscapes into a show for tourist purposes (the tourist-related 'supermarket type' of localism, which is just another side of the standardising aspect of globalisation, from which there is the desire to break away)» (Manzini, 2004, p. 103), is still ongoing. The commodification of territories - which are presented to the eyes of tourists according to the diffused stereotypes - is leading towards a progressive disappearance of local identity. It is important to notice that this process affects the image of places not only from an outside perspective (tourists' perspective) but also and especially from the inside perspective (locals' perspective). Inhabitants start to feel they are part of a 'staged authenticity' (MacCannell, 1973) - a term that refers to the staging of local culture to create an impression of authenticity for a tourist audience. Locals can refuse to identify themselves with that image or start to mirror it (Maoz, 2006); in both cases, the result is a decreased sense of belonging.

The safeguarding and the enhancement of local identity and cultural heritage is a crucial issue in our contemporary society. They are indeed considered key drivers for social cohesion and economic growth, as it is pointed out in the introduction to the *Work Programme 2014 – 2015 Europe in a changing world – inclusive, innovative and reflective Societies* which claims: «In challenging times for its internal coherence, Europe should improve the understanding of its cultural heritage and of its identities in order to strengthen cohesion and solidarity and to encourage modern visions and uses of its past. [...] In these efforts, new technologies and digital cultural heritage should play an important innovative role as they enable new and richer interpretations of our common European culture while contributing to sustainable economic growth» (European Commission, 2013, p. 5). In the Work Programme, the European Commission makes explicit reference to the role of cultural heritage in tourism industry. In other words, it seems that tourist promotion could be also a means to communicate and describe a place to its inhabitants.

Understanding cultural heritage has always been a travel motivation but, as pointed out by RICHARDS (2014), recently the concept of "culture" has been reframed. He observes a shift from tangible to intangible culture and a consequent decline of the traditional cultural consumption model. New technologies and digital media play an important role in allowing the access to this kind of 'intangible culture' because they offer several opportunities to explore, understand and engage with a place and its intangible aspects. Consequently, a communication project should be thought and designed in terms of system as it is able to create different touch points between people, places and culture.

In this context, the design disciplines should have a crucial role since, according to the words of RAFFAELLA FAGNONI, design «uses technologies and chooses according to its own "sensitivity" [...] in order to diffuse meaning and cause the project, the design to become not an added value, but a meaning, a concept implicit in things and products [...] free from restrictions and cliché» (Fagnoni, 2004, p. 222). Therefore, we argue that design can be a bridge able to develop a deep and extended knowledge of territories, both in a local and global context.

In the following pages we will describe how the transformative power that lies behind design process allows to re-connect the traces of the past to our present and future. Specifically, the paper focuses on the contribution of communication design in developing models (communication systems and formats) to exploit different media channels and technologies in order to shape and disseminate intangible culture, as well as to foster the understanding and the sustainable enhancement of local resources, not only physical but also (and especially) socio-cultural.

2. Design transformative function: formats and tools to "translate" the intangible culture

As stated above, to foster a deep understanding of places a communication project cannot focus only on promoting physical resources but also (and especially) it should describe the intangible aspects of local identity. Basically, a communication project should present and describe a *Cultural Landscape*[45], which is made by the combination of both tangible and intangible cultural values (Mitchell et al., 2009). Indeed, as pointed out in the EUROPEAN LANDSCAPE CONVENTION, *Landscape* is «an essential component of people's surroundings, an expression of the diversity of their shared cultural and natural heritage, and a foundation of their identity» (Council of Europe, 2000, p. 11).

Considering that these cultural contents (those that enable to reveal a *Landscape*) have also an intangible character and/or can relate to abstract concepts, they could need to be transformed (or somehow "translated") into other forms (visual, for instance) in order to become comprehensible. To this aim, different media content (photos, videos, audios) can be combined in different *multimedia package* (Zerba, 2004) and delivered through several communication channels.

As already pointed out, new technologies and digital media offer a bunch of opportunities to access, understand and engage with a place and its intangible culture. The ongoing developments that involve the current media context (e.g. the upgrading of network capacity and the development of more sophisticated programming languages) are leading toward multimedia convergence fostering the combination, overlapping and blending of different media content (Taiuti, 2005). Consequently, we observe the rise of several *hybrid formats* which exploit the possibilities offered by digital technology to provide users with new opportunities of engaging with content. We used the term 'hybrid' to describe these formats because they combine traditional communication forms, like the video documentary or the journal article, with the features of digital media (Gifreu, 2011; Lassila-Merisalo, 2014; Grabowicz et al., 2014) - e.g. interactivity, multimedia, a nonlinear structure, etc.

The understanding of all of these "tools" is crucial to design an effective communication strategy because they strongly affect our media consumption and, as it will be better described in the following paragraphs, allow to provide users with the meaningful experiences they are seeking. Today, people want to be completely absorbed by the media contents provided, and expect to interact naturally and smoothly with them; in other words, their cognition and perceptions should be entirely engrossed by the experience. For this reason, we suggest that the bond between people and places can be strengthened, or even created, if it enables to make experience of the *Cultural Landscape* ('experience' is here understood, according to Aristotle's definition, as a type of knowledge based on sensible perception). Considerable efforts have been made, especially in tourism industry, in order to understand the role of experience in shaping the relationship between people and places. From this perspective, one of the most interesting contributions is a work by FABIO FORLANI that looks at the tourist experience through the PINE AND GILMORE's four realms of experience (Pine and Gilmore, 1999). Specifically, in his model, FORLANI considers the *aesthetic dimension* as the necessary condition to gain a richer tourist experience (Forlani, 2004,).

45 "Cultural landscape" is here understood according to UNESCO's definition: «Cultural landscapes are cultural properties and represent the 'combined works of nature and of man' designated in Article 1 of the Convention. They are illustrative of the evolution of human society and settlement over time, under the influence of the physical constraints and/or opportunities presented by their natural environment and of successive social, economic and cultural forces, both external and internal» (UNESCO, 2013, p. 14).

Representing cultural landscape can be conceived, indeed, as an *aesthetic work*[46]– which is, in a broader sense, as a work of Design (Griffero, 2010) - because it involves the ability to turns cultural content into aesthetic experiences. Therefore, we argue that to promote a place and foster the knowledge about its identity we have to develop sensorially rich mediated environments. For this reason, communication designers should focus on the way contents are displayed, as well as on how and when users interact with them, in order to create a complex mixing of media, languages and medium, able to create different touch points between people, places and culture.

2.1. Immersive languages for translating cultural content

According with FORLANI, tourism is always a comprehensive aesthetic experience that allows people to immerse themselves in an event or environment (Forlani, 2004) therefore, the need of 'immersion' seems to be the driving force for experiencing a place. This statement is supported by ORTOLEVA in his book *Il secolo dei media. Riti, abitudini, mitologie*. The author claims, indeed, that in tourism industry the demand for experience is precisely a demand for immersion (Ortoleva, 2009). The connection between experience and immersion is also highlighted by FRANCESCO D'ORAZIO (2003). He points out that the term 'experience' is strictly connected to the idea of 'immersion' because both of them arise from the interaction between space and body. To be more precise, he argues that experience is a quality of immersion. Starting from these assumptions, we can reasonably hypothesize that a communication project able to foster the feeling of immersion could meet the tourists' demand for experience.

But immersion is a quite tricky concept to deal with because can be addressed by two divergent perspectives. On the one hand, there's the technology-driven viewpoint, which basically considers immersion as the result of using specific immersive technologies and is by far the most widespread approach to the topic. People usually relate immersion to Virtual Reality which, in its turn, uses the term to indicate what the technology delivers from an objective point of view (Slater, 2003). On the other hand, there is a second school of thought which considers immersion in terms of cognitive and perceptual absorption - a kind of experience that «takes over all of our attention, our whole perceptual apparatus» (Murray, 1997, p. 98). In cinema, for instance, LAURENT JULLIER (1997) defines *figures de l'immersion* those representations aimed at eliciting in the audience the sensation of 'being surrounded by a sea of sensations'. This non-technical perspective relates to the way users engage with content and is the one we have adopted as a frame of reference to investigate the phenomenon of immersion. Indeed, although with the 1990s debate on Virtual Reality the semantic dimension of immersivity seems reduced only to this kind of experience (D'Orazio, 2003), we agree with GANDER when he claims that «the VR definition of immersivity says nothing about how this technological factors affect the feeling of immersion» (Gander, 1999, p. 4).

Basically, we consider immersion as the result of using immersive languages[47] rather than immersive technologies. For this reason, our research focuses on the hybridizations of languages and codes resulting from multimedia convergence (Taiuti, 2005) with the aim of defining and developing communication formats able to generate this kind of cognitive and perceptual immersion by means of the combination, overlapping and blending of different media.

2.2. Transmedia communication systems to understand and experience a place

In the previous section we have seen how it's fundamental to present a place through different tools able to show the several peculiarities of a local reality.

[46] 'Aesthetics' understood as the science of sensible knowledge, according to Baumgartens's definition of *scientia cognitionis sensitivae*.
[47] the term "languages" is here understood as the way contents are displayed.

A territory can be considered as a complex system and often we need a large amount of contents in order to narrate its identity. In order to find the right way to narrate the place identity we need to take a closer look at all the aspects that we want to represent (historical, morphological, socio-cultural, etc.) and define how to communicate the different information: the content has to be narrated through the right language and the right media.

Furthermore, the main aim of a communication system is to lead a strong "experience”. A new toolset and new techniques are necessary to reach and engage audiences in the digital age. For this reason, we have to design the specific role of every part of the communication systems in order to catch the user attention and make accessible the right information at the right time.

We found in transmedia systems and transmedia storytelling the right choice because of their communicative qualities. They respond to the request of users to have an immersive experience that leads interactive and impactful narrations (Phillips, 2010). Transmedia communication strategies, mostly applied for movie launch and brand communication, are instead here used in order to communicate the identity of urban environment.

We want to offer an integrated and overlapping sense of experience (Jenkins, 2006) able to increase the relationship between visitors and the environment. Narrations need to be accessible through an array of media platforms, and the story must be designed to play to the strengths of the platform (STARLIGHT RUNNER ENTERTAINMENT).

The experience of the users has to evolve at every step, taking advantage from the specificity of each device. In order to do that we need to define a design process that has a strategic management of different media to achieve different objectives.

We have divided the user experience primarily in three stages: a pre-experience of the place, the exploration itself, and the post-experience (Calabi et al., 2013)

During the pre-experience the user comes into contact with media that offer immersive representations of the places enticing the user to a direct contact.

Mainly we can design a pre-experience through media such as web-based platforms and paper artefacts.

The exploration's moment is essential to create a strong relationship between the user and places. It has to be supported by media that can offer a high interaction level. An example are the mobile devices or installations that provide timely information directly on site.

In order to build new visions of a specific place it is also important to collect bottom-up feedbacks from of the users and involving them in the creation of new shared stories. This is fundamental to building a post-experience that will not get exhausted after the places' exploration. Social media and participative archives are the main tools and media that we can use to share and collect in real-time stories, images and memories.

What we want to present here is a methodology able to design innovative transmedia integrated systems for the communication of places that can offer a specific contents' distribution on different media.

Communicative systems have to present several layers of access, therefore, our aim is to offer contents in order to foster audience engagement. So the visitors and citizens become a knowledge community, where users can exchange ideas and clues with each other. We want to design immersive and engaging communication experiences.

3. Methods

The communication context previously described is constantly evolving; new hybrid formats will arise and, in their turn, they will entail further linguistic transformations and opportunities to engage with content. Consequently, the setting of a theoretical ground is quite challenging and requires specific skills to bridge the gap between theory and practice.

From our perspective, design can provide a key contribution in this field because its main expertise consists in the ability of extracting the tacit knowledge that lies behind practice, to transform it in replicable models which can be used to disseminate cultural content and communicate 'landscapes'. For this reason, our approach is basically phenomenological; we start from the analysis of the state-of-the-art in order to understand and identify which are the tools at our disposal and develop replicable models (formats) that can be used in the design activity. This is the transforming function of design, which suggests methods to convert intangible knowledge (cultural content) into replicable tangible solutions (communication formats and systems).

Part of our research activity consists in developing and refining a design method (a process) which is continuously tested and refined through research - both theoretical (Chalabi and Chiodo, 2014) and applied (Scuri and Calabi, 2015) - and didactic activity.

Basically, our method consists in three main steps:

3.1. Phase one: analyzing the territory

The first step consists in collecting and analyzing all the contents (documents, pictures, etc.) that describe the main features and resources of the place we have to represent. This work, both qualitative and quantitative, aims to build a visual map of the contents (stories, traditions, socio-cultural habits, natural characters) which together describe the local heritage and identity. These content are then grouped in thematic categories and analyzed in order to understand and identify: a) hierarchies (their relevance in representing the local identity); b) typologies of media available to represent them (texts, images, videos, etc.); c) their main communication function - predictive, informative or directive (Giannitrapani, 2010) - and consequently, when it would be more interesting for the audience to get in touch with them (e.g. before the visit in order to acquire some historical information that can be useful to understand what they will see once on-site) .

3.2. Phase two: looking at the state of the art

Once realized the map of territorial contents, we start to look at the-state-of-the-art in order to identify the formats and languages most suitable to provide and represent the contents gathered. The case studies analysis is grounded on a comprehensive investigation carried out between 2010 and 2013 by ELISA CHIODO (2013), which resulted in the development of a systematic and upgradeable tool - *The Observatory* - that collects and organizes several examples of projects (best practices) for the communication of territory. After this experience, we are continuously updating and extending the collection which still serves us as a tool in the research and design activities.

3.3. Phase three: design the communication system

The last phase is the core of the design transformative function as it consists in the development of the communication system - that is to say, it consists in mixing the design "ingredients" (contents, media and languages) to transform them in tangible solutions able to represent and provide cultural contents in the more effective way possible. This work of design is still part of the research process because it allows us to assess and refine the theoretical findings through the design practice (Laurel, 2003).

As stated above, we argue that the value of communication design consists in the ability of transforming the tacit knowledge of practice into replicable formats and models that can be used to support design activity and disseminate knowledge. This transformative process involves two kind of knowledge: on the one hand, the intangible knowledge related to territories (local identities and cultural heritage), which must be transformed ("translated") into other forms in order to be comprehensible. On the other hand, there is the specific knowledge of design, which is basically methodological and results in the development of new design tools.

Basically, the contribution of communication design for the promotion of cultural heritage and the enhancement of local identity consists in developing formats and models that exploit different media channels and technologies in order to shape and disseminate intangible culture, as well as to foster the understanding of territorial resources (not only physical but also and especially socio-cultural).

In the next section we will present a didactic experience with a class of MSc students in Communication Design in order to better explain the transformative function of design and describe our research method.

4. "Microcosmi d'autore. Luoghi e percorsi nella capitale dell'editoria": a didactic experience

The design process previously described drove the work made in the last semester by the students of the course Laboratorio di Sintesi Finale at Politecnico di Milano. The assignment, titled *Microcosmi d'autore. Luoghi e percorsi nella capitale dell'editoria* (Authorial microcosms. Places and paths in the publishing capital[48]), was to design a transmedia communication system for exploring the city of Milan through literary paths based on the work of some well-known writers whose lives and/or stories are strictly connected with the city. Their goal was to create a complex mixing of media, languages and medium, in order to engage users on different channels, foster the exploration of the city and support the development of new knowledge about its identity.

To reach this goal, they were divided in teams and assigned to a specific author. As first step, each team analyzed the author's works and realized a map to represent places narrated and content available to describe them (textual descriptions, images, video, etc.). They used this map to identify possible thematic paths for exploring the city from the specific view point of the author.

The second step was to carry out a case studies analysis. Each team analized different kind of communication projects (e.g. web documentaries, literary maps, geo-located content applications, installations and social media campaigns) to find the most suitable media and languages to represent their paths and the contents gathered.

One of the team worked on Alberto Savinio, the younger brother of the 'metaphysical' painter Giorgio de Chirico. He was a very eclectic person, not only a painter but also writer, musician, journalist, essayist, playwright, set designer and composer. The students focused on the book *Ascolto il tuo cuore, città* (1984), where Savinio describes the unknown side of Milan through a combination of dreamlike visions and real events. Here, the personality of the author emerges clearly in the vivid and detailed descriptions he makes of a city transfigured by his look. Therefore, they decided to pivot the project, titled *Divagando. La Milano di Alberto Savinio,* on the dichotomy between realism and surrealism, that results in a sensorially rich immersive experience.

[48] Milan was the "city of book" in 2015.

The interesting aspect of this work consists in the impactful visual style that characterize all of the medium involved in the transmedia system. On the website users can virtually explore some of the places described by Savinio starting from an interactive panoramic which presents a collage of locations and environments (Figure 1). From this main page, the user can choose a place and start the experience. All the places are presented through a set of tools (Figure 2), which were identified by the case studies analysis: interactive walkthroughs, 360 degree panoramic photos, soundscapes and impactful illustrations.

Fig. 1 The interactive panoramic which shows a collage of locations and environments described by Savinio

Fig. 2 Some screenshots of the mobile application and web platform

To enrich the on-site exploration, the team designed also a mobile application that guides users along a path between the statues described by Savinio. In his book the author presents these pieces of art as ghosts; as the witnesses survived to the bombings of the WWII. Each statue tells a story with its own voice and perspective; it describes how the city was before the war and also the deep changes in the urban landscape followed.

Another project, that well represents the third and last phase of the design process previously described, is *Prospettiva Scerbanenco* (Scerbanenco's Perspective) that represents the city of Milan through the point of view of Giorgio Scerbanenco.

Scerbanenco was an Italian journalist and writer born in Ukraine. He worked as a freelance writer for many Italian magazines as *Corriere della Sera* before becoming a novelist. Scerbanenco is famous for his crime and noir stories, and the strong and realistic writing style used to describe the city of Milan and its inhabitants (from the low and middle bourgeoisie to weak people like criminals and prostitutes).

The project relies on a strong transmedia strategy that involves several media (Figure 3): a mobile application for tablet, the main social media (as Facebook and Instagram), a collection of printed fanzines and also different forms of outdoor advertising (from posters to installations).

All the media are strictly connected to each other and designed to follow a specific timetable that drives the user from the pre- to the post-experience. The temporary installations, placed in the location described in the author books, are thought to be launched concurrently with the Scerbanenco Prize. There, the user can find some copy of the printed fanzines that provide in-depth descriptions of the socio-cultural dimension of Milan during the Sixties and Seventies, through a collection of original newspaper articles. Fanzines and installations link the user to the core of the transmedia system: the mobile application, which is a combination between a digital magazine and a storymap. It guides the users into the Scerbanenco's world through three thematic paths connected to a specific character (a prostitute, a Milanese middle-class, and a criminal kid). The user can choose between these paths and access several stories which are told by means of photos, animations and some interactive multimedia packages.

Fig. 3 The media involved in the project

The social media (Facebook and Instagram) are used to support and disseminate the communication system. On the one hand, they are linked in different ways to posters, temporary installations and fanzines, playing a role in the pre-experience and during the exploration on-site. On the other hand, they take part in the post-experience because push users to leave comments and feedback about their personal experience in real time. *Prospettiva Scerbanenco* is therefore a good example of using an integrated system of media to offer several accesses to a large amount of information, as well as to provide users with different opportunities to be engaged with contents.

5. Conclusions

Our aim, as communication designers and researchers, is to find out and develop replicable solutions (formats and models) able to enhance the intangible aspects of a local dimension and meet people's needs and interests as well (that is to say, their desire of experiencing and engaging with a territory). To this aim, great emphasis should be put on the transformative function of design that lies in the ability of translating and transferring intangible elements, like the memories of citizens, into digital products and communication systems. In order to describe this transformative process, we have presented our research methodology and an example of its application, focusing on the designer's ability of experimenting with technologies, media and languages (the tacit knowledge that lies in the design practice) to increase people's understanding and engagement with a given place.

We argue that the transforming function of design serves as a bridge that allows people to access and understand the system of intangible aspects that characterize the sociocultural dimension of a place. This transformative process involves two kind of knowledge: on the one hand, the intangible knowledge related to territories, which must be transformed ("translated") into other forms in order to be comprehensible. On the other hand, there is the specific knowledge of design, which is basically methodological and is part of the process itself.

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El planteamiento de un proceso de diseño sistémico, para la gestión de la habilidad creativa en los estudiantes que cursan la clase de proyecto arquitectónico en las universidades de México.

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Resumen

Los proyectos realizados en las escuelas de arquitectura de México centran sus esfuerzos en cuestiones de dimensionamiento y convencionalismos funcionales; En un país con el mayor número de alumnos en la disciplina de arquitectura, existe una falta de interés por la apropiación del conocimiento, la exploración de las ideas, y la expresión de la creatividad. Tal trivialidad llama a la evolución de los métodos de diseño impartidos en las clases de proyecto. Esta investigación plantea que es posible gestionar la fuerza creativa del ser (el estudiante). Un modelo de trabajo integrado por distintos componentes, se generará para estimular las áreas relacionadas con el desarrollo artístico. En la preparación, los componentes esenciales del modelo han sido extraídos del análisis del curso preliminar de la Bauhaus desarrollado por Johannes Itten, teniendo en cuenta el momento histórico en que fue impartido, así como su influencia en los tutores secuenciales. El objetivo es transformar la pedagogía Itten en un proceso de diseño sistémico, centrado en el desarrollo de la capacidad creativa del ser. El enfoque metodológico trabaja con los tres campos temáticos identificados en la pedagogía de Itten, cada uno estructurado en conjuntos que se relacionan entre ellos de acuerdo a su papel en el desarrollo del talento, como el medio para discernir y revelar el carácter artístico. Una parte cohesiva actúa de elemento estructural y dirige las capacidades estimuladas dentro de cada conjunto, por medio de ejercicios que guían a los estudiantes en la definición de una trayectoria auténtica. Al afirmar al estudiante como el centro de su propio trabajo, la aplicación de este método en los talleres de arquitectura permite la asignación de cualquier ejercicio creativo y es adecuado para todos los niveles de investigación.

Palabras clave: *estudiantes, creatividad, educación, metodología, diseño.*

Abstract

Projects at Mexican schools of architecture often focus on conventional issues of dimension and function. In a country with the largest number of students in the architectural discipline there is an existing disinterest in the appropriation of knowledge, exploration of ideas, and expression of creativity. Such triviality calls for the evolution of the design *methods at use in project classes. This research proposes it is possible to manage the creative forces of individuals. A working model composed of distinct components will be generated to stimulate areas related to artistic development. In preparation, essential components of the model have been extracted by analysis from the Bauhaus Preliminary Course developed by Johannes Itten, considering its influence on sequential tutors as well as its moment of historic implementation. The objective is to transform Itten´s pedagogy by means of a systemic design process focusing on the development of the student creative skills. The first methodological approach has been extracted from three of Itten's thematic fields, each structured by a set of common elements. The sets are related according to their role in the development of talent as a means to discern and reveal artistic character. A responsible party, acting as structural element, directs the capacities stimulated within the group and materialized them by cohesive exercises, guiding students to define an authentic trajectory. By asserting the student is the center of his or her unique working model, the implementation of this method in architectural studios allows for the assignment of any creative exercise and is suitable for all levels of investigation.*

Keywords: *student, creativity, education, methodology, design.*

1. Introducción

Para presenciar nuevas visiones en las propuestas arquitectónicas desarrolladas en las escuelas de México este articulo plantea la opción de re-dirigir el foco en la enseñanza de las clases de diseño, de lo funcional y dimensional hacia el fomento de las capacidades de creación e innovación del estudiante.

Creatividad es generar, es la síntesis de las ideas y los conceptos creados a través de la radical re-construcción y re-asociación. Innovación es aplicar, es la implementación tangible de la creatividad. (Hernandis, 2009).

Ante la meta del desarrollo de un proceso de diseño creativo con objetivos tangibles, la metodología proyectada se apoya en la lógica de los modelos sistémicos, fundamentada en la acertada definición de sus componentes y la eficiencia de las relaciones entre estos para estimar el logro de los objetivos. (Hernandis, 1999).

El foco de la investigación se dirige a extraer tales niveles del curso preliminar de la Bauhaus por ser considerado el núcleo estabilizador y la constante que permitió la formalización del sistema de enseñanza de la escuela. El análisis estudia los factores del contexto histórico que determinaron el surgimiento de la Bauhaus y la relevancia de su curso preliminar en la determinación del éxito de esta escuela, así como la influencia del los principios pedagógicos de Johannes Itten, creador del curso preliminar, sobre los siguientes directores del mismo y la evolución que estos aportaron a las funciones originales del curso.

El objetivo de la metodología es transformar la pedagogía del curso preliminar de la Bauhaus en un modelo de trabajo a instrumentar en las clases de proyecto en las escuelas de arquitectura, planteando un cambio a la manera habitual de abordar los problemas de diseño y la consecuente evolución a los procesos pedagógicos al habilitar la gestión del desarrollo de la fuerza creativa en los estudiantes de nuestra época.

2. Historia de la formación académica artística

En el discurso pronunciado el 9 de julio de 1920 ante el Parlamento Regional Turingio, Walter Gropius (1833-1969) argumentó que la Bauhaus no se trataba ni de un experimento ni de una idea original emanada de una sola cabeza, sino de la realización procedente de las ideas reformistas típicas de una época, una evolución lógica en la historia de la formación artística y no una ruptura de la tradición. (Wingler & Stein 1969).

2.1 De la logia medieval a las academias del renacimiento.

El ideal de un arte aplicado fundamentando en la comunidad del taller artesanal comienza con las logias medievales, comunidades de trabajo desarrolladas por artistas y artesanos que entre los siglos XII y XIII establecieron un sistema social jerárquico y subordinado a una ideología colectiva que aspiraba a la nivelación de las diferencias sociales a partir de la educación. Empleando el simple principio de la imitación, el conocimiento del taller se transmitía desde el maestro de la construcción, al maestro de artesanía, al oficial y al aprendiz.

La búsqueda un arte libre que parte de la libre expresión surge con el establecimiento de la burguesía urbana en el siglo XIV y su creciente interés por el consumo de productos artísticos; pintores y escultores emanciparon de las logias medievales para convertirse en empresarios reconocidos como gremios de artistas profesionales, liberados de la subordinación colectiva de la logia pero aún limitados por las normas sociales para la innovación estética.

La posibilidad de una individualidad artística se percibe hasta el siglo XV ante la emoción provocada por la idea de una formación artística libre, que en realidad lo que supuso fue la separación de los gremios y la perdida de la unidad colectiva de la logia medieval. Así la educación se extrajo de los talleres y se transfirió a las aulas establecidas con el claro propósito de institucionalizar la educación en academias estructuradas por planes de estudio que hacían de dispositivo político para incrementar el prestigio de la monarquía.

La búsqueda de tal libertad se desvía de ser la posibilidad de una expresión creativa a el “derecho” de una formación de especialización profesional de diferenciación progresiva. Dando inicio a un proceso que favorecerá la producción industrial sobre el desarrollo de las capacidades vitales del ser.

2.2 La era industrial y a la reforma educativa.

Tras la Exposición Universal de Londres en 1815 Gottfried Semper (1803-1879) arquitecto del siglo XIX, propone en su escrito: Ciencia Arte e Industria la fusión de lo bello y lo necesario, la ciencia, la industria y el arte, la idea de ofrecer a partir de los productos de consumo una educación estética popular tanto a consumidores como a productores. Alentando el regreso a los talleres para la enseñanza del trabajo con textiles, madera y piedra, y motivando la participación mercantil con el objetivo de elevar las profesiones artesanales. Dignificar desde la educación constituia la única garantía para alcanzar la unidad entre arte, artesanía e industria.

John Ruskin (1819-1900) hace un llamado de atención hacia la alarmante deformación del gusto estético del consumidor y la subsecuente muerte de la realización del productor. Este nuevo comportamiento social sumado al desánimo provocdo por la derrota de la primera guerra, estimuló el prospero deseo por la creación un nuevo contexto que permitiera el acontecer de un hombre nuevo lleno de fuerza creadora.

Con el objetivo de resarcir el contraste entre arte, artesanía e industria, en la segunda mitad del siglo XIX surge la reforma a la educación artística. En 1906 la Escuela Gran Ducal Sajona de Artes y Oficios, cien años más tarde a su establecimiento, intenta dignificar la relación entre arte, técnica y función por medio de la educación. Planteando que el diseño del producto debe llegar hasta el último detalle antes de entrar a su producción haciendo posible ofrecer productos de belleza y calidad a un amplio sector público, una idea reformista proyectada por Semper y que posteriormente será adoptada por la Bauhaus. “El arte no debe ser nunca más deleite de unos pocos, sino felicidad y vida de las masas: la creciente consciencia de clase de la clase hasta entonces oprimida”. Taut, Behne & Gropius (1920 apud Wick, 1998).

Gropius estaba seguro de poder alcanzar esta meta postulando el resurgimiento de un arte total, un concepto de la Edad Media que entendía el trabajo artístico como la manifestación de la unidad. La integración del arte, la artesanía y la industria permitiría re-direccionar la producción industrial mediante la incorporación del artista, quien infundiría su alma al proceso mecánico. En 1916 Gropius presenta, ante el Ministerio de Weimar, su propuesta para el Centro Orientador Artístico para la Industria y la Artesanía aspirando a incorporar el arte a la vida cotidiana como estrategia para regenerar la cultura social a partir del desarrollo de los siguientes objetivos. La síntesis estética: integrar todos los géneros artísticos y los sectores artesanales, y la síntesis social: orientar la producción estética hacia las necesidades de los amplios círculos de la población. (Wick, 1998).

3. La importancia de la pedagogía de la Bauhaus en la formación del Ser creativo

La relevancia en el análisis de la Bauhaus refiere a la comprensión de un sistema pedagógico que al centrarse en la capacidad creativa del alumno logró establecer el concepto de diseño que practicamos en la actualidad. Un período de sólo 14 años que comenzó en 1919 encontrando sus ideas fundacionales en el expresionismo y la idea artesanal de la Edad Media, pasando por la lógica del constructivismo, para concluir en 1933 con el fomento de la construcción objetiva que defendía la tecnología, la industria, y la funcionalidad.

3.1 Los talleres en la Bauhaus

Ante al fracaso de las academias, la reforma a la educación artística argumentó que no es el arte, sino las técnicas artesanales las que pueden ser enseñadas, acordando así la fusión entre artista y artesano como la base para el desarrollo social. Con el objetivo de consolidar una academia unitaria de arte libre (como anhelaron los gremios) y arte aplicado (como defendieron las logias medievales) la pedagogía de la Bauhaus asumio como emblema la visión de Lyonel Feininger (1871 -1956): El objetivo final de toda la actividad artística es la construcción, comenzando en el taller entre artista y artesano, donde no hay diferencias.

Aun y cuando se asume el principio formativo de esta fusión a partir de los talleres que permitían reemplazar la abstracción académica con la actividad plastica, permaneció indeciso si los talleres deberían servir soló para la enseñanza de las técnicas artísticas y la experimentación creativa, o si su objetivo podría ser también el de la producción para un cliente o un mercado; una pregunta que nunca encontró respuesta y que caracterizó tanto los conflictos como la evolución de la Bauhaus.

3.2 Las etapas de la Bauhaus

En la historia de la Bauhaus existieron tres etapas representadas en cuatro aspectos distintos y esenciales en el desarrollo de su pedagogía.

Tabla 1. Etapas en la historia de la Bauhaus

	1919	1920	1921	**1922**	**9123**	9124	**9125**	1926	1927	**1928**	1929	**1930**	9131	1932	**1933**
Directores	Gropius									Meyer		Mies			
Localización	Weimar						Dessau								Berlín
Ideología	Creación				Consolidación					Desintegración					
Fundamentos	Expresionista			Formal						Funcional					

Adaptación de Wick (1998)

3.2.1 Etapa ideológica: Creación

El plan escolar 1919 ofrecía un amplio catálogo de oficios y distribuía la enseñanza en: preliminar, taller de aprendizaje, y construcción. El estudio configuraba una pequeña comunidad de quienes trabajan en el "arte total" y constituía la célula germinadora de un nuevo orden social más humano basado en el concepto de armonía. La educación artesanal representaría un componente pedagógico de carácter fundacional e independiente a las formas de la economía global. Los alumnos obtenían una calificación artístico-artesanal a partir un sistema de aprendizaje dual en el que cada taller tenía dos tutores: el artista de la forma responsable del complemento artístico y el maestro artesano que enseñaba la base armónica.

3.2.2 Etapa ideológica: Consolidación

En 1925 técnica e industria se incorporan explícitamente en el programa académico y el estudio se fragmenta de manera similar a lo establecido en las academias del renacimiento: el taller básico de la educación (trabajo con diferentes materiales y herramientas) y la enseñanza de la forma (teoría y ejercicios prácticos); limitando considerablemente la auto-exploración y el desarrollo del ego creativo del estudiante. Arte, artesanía e industria se enseñan por separado y la enseñanza se dirige a la formación de arquitectos alcanzando tal grado de especialización que el conocimiento obtenido apenas se diferencia del ofrecido en las escuelas politécnicas.

3.2.3 Etapa ideológica: Desintegración

Diez años más tarde de su fundación, al aprobar el curso preliminar el estudiante decide por su formación en un campo específico y la educación se limita a ofrecer el conocimiento práctico, científico y técnico necesario para el trabajo en los diversos campos. Las artes plásticas tienen una existencia periférica en el conjunto de producción de la escuela que prepara especialistas profesionales ya no se percibe ninguna huella de la antigua idea de la síntesis de todos los géneros artísticos y artesanales: como si nunca hubiera existido una reforma de las escuelas de arte. (Wick & Grawe, 2000).

3.2.4 El carácter fundacional del curso preliminar de la Bauhaus

Considerando que el progreso decisivo con respecto al plan de estudios de la Bauhaus de 1919 fue la institucionalización del curso preliminar creado por Johannes Itten (1888-1967), esta investigación analiza los principios pedagógicos del curso preliminar, que tuvo como objetivo el desarrollo de la expresión y la liberación de la fuerza creadora de los estudiantes.

El carácter del curso era obligatorio a todos los estudiantes de recién ingreso y ofrecía una educación preliminar que reunía todas las ramas de la actividad artística en una sola entidad pedagógica. (Lupton & Miller 1994). La base para que mediante la auto-exploración el alumno construyera las herramientas necesarias para la adecuada toma de decisión sobre el destino de sus estudios futuros, sus principales objetivos eran: desarrollar la libre personalidad, depurar los conceptos académicos y obtener las habilidades para el desarrollo de un lenguaje creativo que figuraría como la base para la comunicación entre los miembros de la Bauhaus. Un lenguaje que sería diferente de acuerdo a la personalidad del tutor y los directores presentes. En este ámbito durante sus primeros años la Bauhaus fue objeto de una dura prueba a causa del conflicto Itten-Gropius que enfrentaba la creación de un arte autónomo con la producción del desarrollo social.

4. El curso preliminar de Johannes Itten (1888-1976), Suiza

Motivar a los estudiantes a enfrentarse con ellos mismos, por medio de la exploración con los conceptos fundamentales de la creación artística, en una época de desorientación en la que las circunstancias de la sociedad industrial habían dividido las funciones corporales, emocionales e intelectuales del ser humano. Preocupado por la existencia de un hombre intelectual no creativo Itten postuló la educación como la necesaria condición liberadora para la aparición de un ser creativo y en virtud de un principio de respeto absoluto ante la personalidad del estudiante, lo ubicó en el centro de sus esfuerzos, estableciendo como la base de su pedagogía la necesidad de descubrir la particularidad en cada uno para trabajar en el desarrollo de su temperamento, talentos y habilidades.

4.1 Objetivos del curso preliminar de Itten

Pionero en hacer efectivo el principal objetivo de la reforma educativa: mantener el período de crecimiento de los niños y proporcionar a la cara de la cultura una expresión diferente, Itten postulo la educación del hombre artístico:

> Por un lado, debemos aspirar a formar a cada hombre joven de tal modo que se desarrolle de una manera original, característica de sí mismo para que continúe siendo creador; por otro, le debemos hacer entrar en contacto con todas las vías reguladoras del medio de expresión artístico para poder configurar sus ideas originales y novedosas. Por ello es evidente que el conocimiento de los medios creativos no es un fin absoluto sino que únicamente presenta un carácter instrumental para poder alcanzar el autodesarrollo creador. (Itten,1919)

El automatismo creador es el objetivo final de todo proceso de creación artística y la educación artística es el medio para animar el razonamiento y los sentidos hacia la percepción refinada, la creación espontánea.

4.2 Metodología del curso preliminar de Itten

Su metodología de enseñanza comenzaba por el despertar del cuerpo para la expresión libre a través de ejercicios gimnásticos; seguido por la activación de la inteligencia para la construcción armónica de la mente utilizando principios y métodos racionales. De acuerdo a Itten son los opuestos los que permiten la existencia de la percepción, basando su pedagogía en el estudio de tales fenómenos: de la sensación al pensamiento, de la intuición a el intelecto, de la expresión a la construcción. El objetivo siempre sería alcanzar la creación artística por medio del experimentar subjetivo y el conocer objetivo.

El dibujo no se utilizó como medio para representar la realidad, sino como herramienta para encontrar la expresión característica y estimular el refinamiento de los sentidos; mientras que la práctica con los materiales y la textura servía al estudiante para descubrir la experiencia que le inducía a la actividad creativa.

5. Metodología para el desarrollo del modelo de trabajo a instrumentar en las clases de proyecto en las escuelas de arquitectura

Existen tres pasos esenciales en la metodología de esta investigación, el primero establece los componentes o subsistemas del modelo de trabajo describiendo su pedagogía, función y las variables que le confieren valor en el desarrollo de las capacidades de creatividad e innovación del estudiante; el segundo define los conceptos que facilitan la implementación practica de cada subsistema; y el tercero constituye los elementos cohesivos que construyen las relaciones entre los subsistemas y que permitirán evaluar el grado de cumplimiento de los objetivos y realizar los ajustes necesarios en el proceso de trabajo.

5.1 Paso uno: Subsistemas del modelo de trabajo

El análisis del marco teórico concluye con la síntesis de la pedagogía de Itten en tres campos temáticos que se convierten en los subsistemas del modelo; a cada uno le corresponde una función y una serie de variables que provienen de los ejercicios impartidos por Itten en su curso preliminar.

5.1.1 Ser en construcción

Una educación integral para el desarrollo de un ente físico-anímico-espiritual. Itten hacía la analogía entre el trabajo del profesor y del jardinero, quien prepara la tierra para la semilla (el alumno) que de manera intuitiva tomará todo lo necesario para crear su propio mundo de pensamiento, sentimiento y acción.

- Subsistema: 1 *(ver Fig. 2, gráfico (a))*
- Función: Liberar las fuerzas para la creatividad artística, configurar un ente físico-anímico-espiritual.
- Variables: Movimiento, Ritmo, Esencia, Organización.

5.1.2 Análisis por comprensión

Ejercicios de abstracción para extraer lo fundamental de lo complejo. A través de los ejercicios para el análisis de los viejos maestros se enseñaba el trabajo sistemático de los sentidos (el entendimiento a partir del sentimiento), con los que el alumno aprendía a comprender la obra de arte no a través de la disección intelectual, sino descubriendo la esencia en la acción.

- Subsistema: 2 *(ver Fig. 2, gráfico (b))*
- Función: Proporcionar las leyes fundamentales de la creación artística, construir la observación.
- Variables: Entender intuitivamente, Descubrir la estructura formativa, Identificar lo fundamental, Observar, Criticar, Refinar.

5.1.3 Composición por contraste

Experimentación subjetiva y reconocimiento objetivo. A través del diálogo de opuestos para el estudio de la forma, la adquisición de las capacidades artísticas-creativas, el conocimiento de la técnica y la artesanía estaban dirigidos a instrumentar la percepción armónica del estudiante.

- Subsistema: 3 *(ver Fig. 2, gráfico (c))*
- Función: Compromiso con el trabajo propio, sentir-pensar, intuición-intelecto, expresar-construir.
- Variables: La serie de opuestos en la composición artística.

5.2 Paso dos: Conceptos, aplicación práctica de los subsistemas

Cuando en 1923 Gropius anuncia que será imposible seguir justificando ante el gobierno de Weimar el curso de Itten: Análisis de los Viejos Maestros, el primero decide renunciar a la Bauhaus. Esta ruptura deja de manifiesto el componente ausente en la pedagogía de Itten y que los siguientes tutores intentarán compensar, introduciendo en los objetivos del curso preliminar la relevancia de garantizar la participación activa de el ser en la evolución de la sociedad.

El hecho de que la presencia de estos tutores coincidiera con el cambio de foco en la Bauhaus hacia la especialización en la práctica de la arquitectura, otorga certeza en que el retomar su trabajo aportará al modelo de trabajo plantado en esta investigación un valor más para su introducción en las escuelas de arquitectura.

Aún y cuando László Moholy-Nagy, Josef Albers y Oscar Schlemmer ofrecieron con sus ejercicios, una posibilidad práctica para la existencia de la síntesis social postulada por Gropius en la fundación de la Bauhaus; es evidente que la pedagogía de Itten ejerció en ellos una fuerte y especifica influencia. Cada uno de estos tutores consagró, consciente o inconscientemente, su práctica pedagógica al desarrollo de uno de los campos temáticos de Itten; dejando al descubierto que el curso preliminar de Itten fue la fuerza creadora de la Bauhaus.

Cada componente del modelo se relaciona con la pedagogía de uno de los otros tutores a cargo de la dirección del curso preliminar. El objetivo de este paso en la metodología es utilizar los conceptos establecidos por éstos para transformar cada subsistema en un ejercicio practico en el que se exploren las variables de Itten a través de los conceptos definidos por los consiguientes tutores. *(ver Fig. 1)*

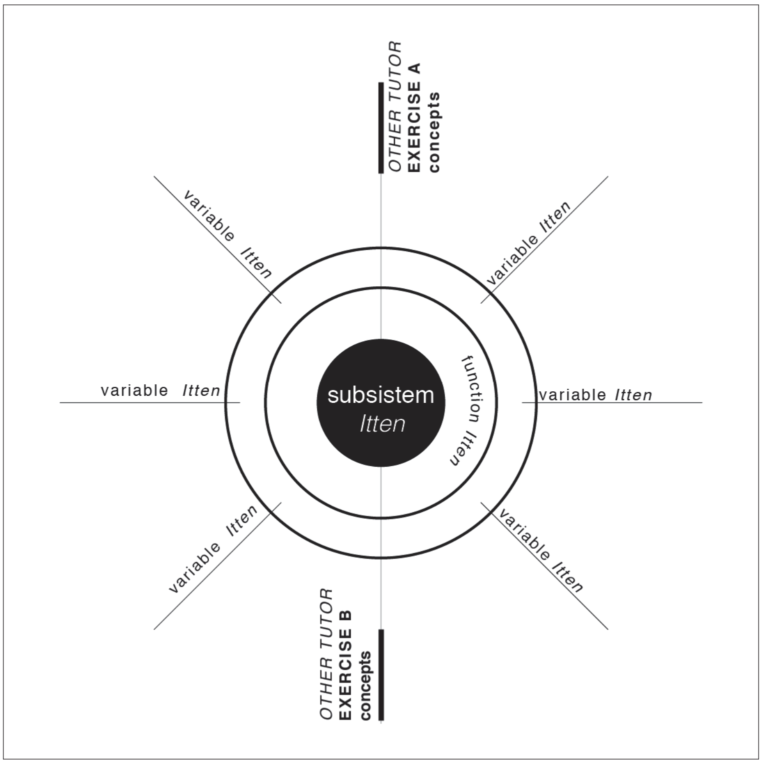

Fig. 1 Propuesta del autor para la estructura de un ejercicio.

5.2.1 László Moholy-Nagy (1895-1946, Hungría). De 1923-1928 director del curso preliminar.

Otorgar al arte una nueva posición en una era industrial avanzada, con la ambición de dominar la industria mediante la humanización de sus técnicas de producción.

El arte como la voz de la época, un instrumento preciso y universal para despertar en el hombre la habilidad para construir su realidad por medio de sensaciones elementales y asegurarle así una posición activa-creativa frente a los imperativos de la tecnología.

Su curso preliminar ofrecía un entrenamiento casi científico para el adiestramiento de las percepciones sensoriales, a partir de ejercicios de diferenciación el estudiante exploraba estableciendo relaciones a partir de la forma en que los materiales y el espacio se presentan ante los sentidos. El objetivo era alcanzar composiciones estéticas, simples pero completas que tendrían un sentido fundacional para la futura práctica del estudiante en cualquier campo de la creación. “Las fórmulas nunca serían la base para la creación”, su curso preliminar enfatizaba la síntesis del intelecto y la intuición, difundiendo una teoría general de elementos “una caja de herramientas bien organizada, a partir de la cual transformar el conocimiento en un impulso para el trabajo creativo, compuesto con el espíritu de economía que aportan los elementos más simples”. Moholy-Nagy (1923 apud Wick, 1998)

- Relación con campo temático de Itten: Composición por contraste.
- Subsistema: 3 *(ver Fig. 2, gráfico (c))*
- Ejercicio A: El adestramiento de la habilidad táctil y óptica.

- Conceptos ejercicio A: Estructura, Fractura, Textura.
- Ejercicio B: La experimentación del volumen, el pensamiento plástico con vistas a la construcción.
- Conceptos ejercicio B: Ejercicios para Bloque, Modelado, Perforado, Ligereza, Cinética.

5.2.2 Josef Albers (1888-1976, Alemania). De 1923-1925 tutor y de 1926 -1933 director del curso preliminar.

Garantizar la mayor inclusión posible del individuo en los eventos que definen la sociedad.

Fundamentar la educación en el espíritu de una época en la que toda ideología habría de albergar una perspectiva económica, adoptando la educación estética del arte por su capacidad de difundir la limpieza y la exactitud, factores fundamentales a toda disciplina y que trasmiten el valor de la relación esfuerzo y efecto como parámetro para el desarrollo de un trabajo en el que la existencia de dos o más elementos aporta más que una simple suma, una relación interesante.

Sus ejercicios recurrían al trabajo en series ya que para Albers no existía una única solución para un problema estético, creía que la libertad de exploración despertaba la observación atenta que estimulaba en el estudiante la obtención intuitiva del conocimiento y la generación de ideas auténticas. Tal libertad se otorga dentro de la base del análisis de similitudes y diferencias, con las que el alumno desarrolla una clara comprensión de las características fundamentales de los materiales y los principios básicos de construcción, aprendiendo a utilizar los materiales de una manera simple y elemental pero adecuada, estimulando la creatividad hacia la definición de nuevos conceptos.

- Relación con campo temático de Itten: Análisis por comprensión.
- Subsistema: 2 *(ver Fig. 2, gráfico (b))*
- Ejercicio A: El material, el estudio de los aspectos externos del objeto.
- Conceptos ejercicio A: Estructura, Fractura, Textura.
- Ejercicio B: La materia, estudio de las características inherentes del material.
- Conceptos ejercicio B: Estabilidad, Resistencia, Consistencia, Capacidad.

5.2.3 Oscar Schlemmer (1888-1943, Alemania) De 1919-1921 tutor del Curso Preliminar junto con Itten y posteriormente director del Curso de Teatro.

Definir el objetivo de la educación desde el concepto del hombre, toda creación debe venir de él y hacia él.

Formar un ser canónico adecuado a su tiempo, reducido a su forma esencial y capaz de aportar una creatividad universal y atemporal. La grandeza del artista se mide en la cercanía que alcanza con el gran estilo, que constituye la habilidad de ser creador sobre el caos propio y la fuerza necesaria para transformarlo en expresión objetiva, lógica, sencilla y clara; la máxima precisión de la idea simbolizada por el contraste entre lo intuitivo y lo racional de cuya combinación surge el hombre realizado y la obra de arte total. Nietzsche (apud Wick, 1998)

Encontró en el teatro de caracteres la plataforma para desarrollar su idea personal sobre el hombre cosmológico un ente compuesto de espíritu, alma y naturaleza. El escenario del teatro servía como el espacio en el que el hombre crea su propio mundo imaginario que le permitirá alcanzar la trascendencia con base en la razón común. Los intérpretes se movían en el espacio siguiendo una "geometría coreográfica una danza matemática que despertaba en los estudiantes el deseo y la habilidad de la participación colectiva en el escenario", sin reprimir sino relacionando individualidades. Schlemmer (1921 apud Wick, 1998)

- Relación con campo temático de Itten: Ser en construcción.
- Subsistema: 1 *(ver Fig. 2, gráfico (a))*
- Ejercicio A: El trabajo sobre lo esencial.
- Conceptos ejercicio A: Movimiento, Contextura Ósea, Musculatura.
- Ejercicio B: El conocimiento del hombre como ser cósmico.
- Conceptos ejercicio B: Sustancia, Espacio, Tiempo, Alma.

4.3 Paso tres: Elementos cohesivos, relaciones entre los subsistemas

La relación entre los tres subsistemas se establece a partir de su ubicación dentro del modelo de trabajo y se fortalece mediante los elementos cohesivos que son los responsables de transferir las capacidades estimuladas de los estudiantes de un componente a el siguiente. A partir de estos el alumno es capaz de discernir el conocimiento obtenido en el primer subsistema y transformarlo en el aprendizaje que le permitirá desarrollar el siguiente ejercicio. La redirección es el elemento que permite ajustar y reanudar el trabajo guiando a los estudiantes en la definición de su propia trayectoria creativa. *(ver Fig. 2)*

- Subsistema: 1 *(ver Fig. 2, gráfico (a))*
- Elemento cohesivo autor: FAMILIARIZACIÓN
- Función Oscar Schlemmer: El hombre en su arte y en su enseñanza en el espacio.
- Función autor: Alcanzar la LIBRE EXPLORACIÓN DE LAS IDEAS.
- Método autor: El alumno aborda dinámicas que puedan resolverse desde la libre experimentación, permitiendo que la sensibilidad funde lo etéreo.

- Subsistema: 2 *(ver Fig. 2, gráfico (b))*
- Elemento cohesivo autor: APROPIACIÓN
- Función Josef Albers: Aprender a través de la experiencia: construir inventando, descubrir observando.
- Función autor: Alcanzar la LIBRE APROPIACIÓN DEL CONOCIMIENTO.
- Método autor: El alumno analiza referencias mediante la exploración la dialéctica entre lo subjetivo y lo objetivo, estimulando el desarrollo de la observación crítica.

- Subsistema: 3 *(ver Fig. 2, gráfico (c))*

- Elemento cohesivo autor: EJECUCIÓN
- Función László Moholy-Nagy: Alcanzar la clara expresión-percepción lingüística: el arte como conocimiento.
- Función autor: Alcanzar EL DESARROLLO DE LA EXPRESIÓN CREATIVA.
- Método autor: El alumno confronta sus ideas con la configuración espacial y recurre a la vía racional para explorar desde la plástica la serie de regularidades que pueden existir en cualquier concepción física, destacando en su propuesta aquellas nociones irreductibles que existen en estado de oposición.

Tabla 2. Integración del modelo de trabajo

Subgrupo	**Ser en construcción**		**Análisis por comprensión**		**Composición por contraste**	
Función Itten	Liberar las fuerzas para la creatividad artística, configurar un ente físico-anímico-espiritual.		Proporcionar las leyes fundamentales de la creación artística, construir la observación.		Compromiso con el trabajo propio, sentir-pensar, intuición-intelecto, expresar-construir.	
Variables Itten	Movimiento, Ritmo, Esencia, Organización.		Entender intuitivamente, Descubrir la estructura formativa, Identificar lo fundamental, Observar, Criticar, Refinar.		La serie de opuestos en la composición artística.	
Función Otros Tutores	**Oscar Schlemmer**		**Josef Albers**		**László Moholy-Nagy**	
	El hombre en su arte y en su enseñanza en el espacio.		Aprender a través de la experiencia: construir inventando, descubrir observando.		Alcanzar la clara expresión-percepción lingüística: el arte como conocimiento.	
Ejercicio Otros Tutores	Ejercicios para el conocimiento del hombre como ser cósmico.	Ejercicios para el trabajo sobre lo esencial.	Ejercicios con el material, el estudio de los aspectos externos del objeto.	Ejercicios con la materia, estudio de las características inherentes del material.	Ejercicios para el adestramiento de la habilidad táctil y óptica.	Ejercicios para la experimentación del volumen, el pensamiento plástico con vistas a la construcción.
Concepto Otros tutores	Sustancia, Espacio, Tiempo, Alma.	Movimiento, Contextura Ósea, Musculatura.	Estructura, Fractura, Textura.	Estabilidad, Resistencia, Consistencia, Capacidad.	Estructura, Fractura, Textura.	Bloque, Modelado, Perforado, Ligereza, Cinética.
Cohesivo	**FAMILIARIZACIÓN**		**APROPIACIÓN**		**EJECUCIÓN**	

Propuesta del autor para la síntesis de los pasos 1,2 y 3 comprendidos en la metodología.

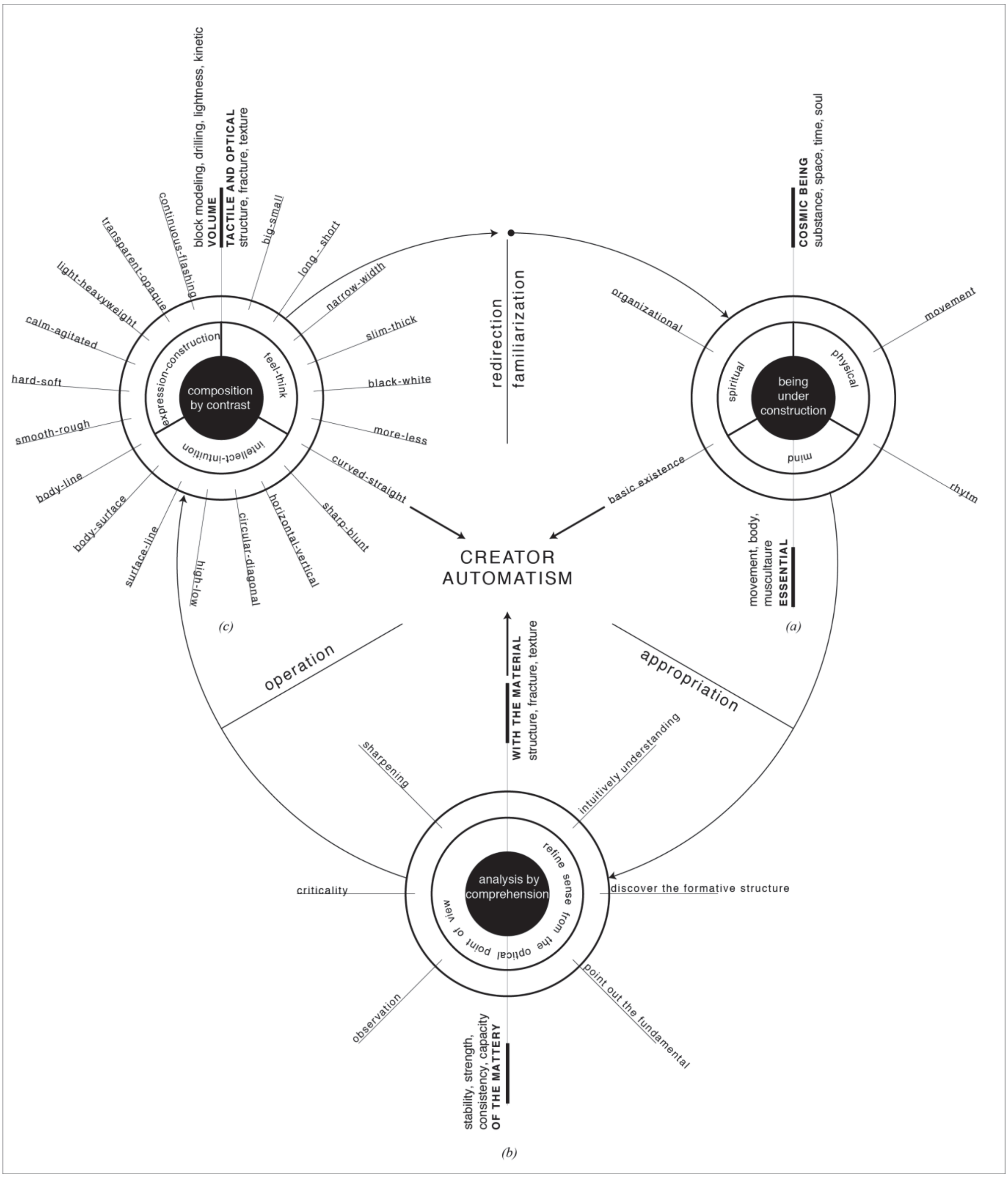

Fig. 2 Propuesta del autor para el modelo de trabajo a implementar en los talleres de arquitectura.

6. Discusión

En el contexto de una sociedad industrial en la que tomaba fuerza la clara y aún creciente diferenciación entre las profesiones, los cuatro artistas analizados se comprometieron con el ideal de síntesis social de la Bauhaus: Reconstruir el hombre y la sociedad por medio de la formación de generalistas en lugar de especialistas (Thoner, 2009).

Conscientes de que el arte no pude ser enseñado pero si aprendido, la búsqueda y el descubrimiento constituyeron el máximo componente en su practica pedagógica, que de manera común buscaba: liberar las fuerzas creadoras, aprender de la experiencia libre, ir de la intuición a la razón para el desarrollo del pensamiento constructivo que garantizara una traducción objetiva del conocimiento y remplazar la enseñanza unilateral de contenidos enciclopédicos por una educación creativa integral.

A partir de la relación entre: la búsqueda de Itten por ensamblar el ser, el método de trabajo conceptual desarrollado por los tres consecuentes directores del curso preliminar de Bauhaus y la identificación de cuatro factores cohesivos por el autor, se establecieron los pasos seguidos en la metodología de está investigación que resulto en un modelo de trabajo a implementar en los talleres de arquitectura de las escuelas de México, caso para futura investigación.

7. Conclusión

El modelo de trabajo desarrollado otorga un carácter vigente a la pedagogía del curso preliminar de la Bauhaus, sirve como guía a los estudiantes en el desarrollo de su habilidad creativa y ofrece las herramientas necesarias para afrontar la condición pronosticada por Albers: después del conocimiento y los medios, un día nos encontraremos con las manos llenas de medios y con nada que contar, nada que expresar, estamos en posesión de los medios pero falta la idea.

Los problemas funcionales y dimensionales no se suprimen del proceso de diseño, sino que se convierten en herramientas que facilitan en el alumno la traducción de sus ideas en un resultado innovador y tangible.

"El objetivo de la educación es la capacidad de dominar la vida con las propias fuerzas creadoras, para así poder lograr algo bueno y bonito". Götze (1898 apud Wick, 1998). Al afirmar al estudiante como el centro estructural del modelo de trabajo, la implementación del mismo en las clase de proyecto arquitectónico permite la asignación de cualquier problema de diseño y es adecuado a la fase inicial o conceptual del proceso de diseño.

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Infographics as a tool for business agreement

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Abstract

The paper analyzes infographics as a problem solving tool acting as a medium for establishing dialog in the business context. Business needs agreements, usually made in a written-form in a document called "brief". The infographic work can be considered a form of visual agreement for the participants. We present two case studies that consider the use of particular elements and cognitive processes involved in this visual agreement strongly connected to synthesis in dialog, memory and message clarity.

By analyzing the visual language structure of real case infographic projects of the national housing social debt collection process (Infonavit, 2010) and the problem of child obesity (OMS, 2008) where drawing plays a major role as a tool to communicate the operation of visual imaginary, we suggest a prominent role of infographics in the shaping process of the client´s inner topology.

We introduce a preliminary analytical framework –drawn from studies and theories like Dual-coding Theory (Paivio, 2006), rhetoric, neurocognitive processes (Kosslyn, 1986), aesthetics and language philosophy (Goodman, 1978)– to understand how this visual agreement denotes and connotes unstated viewing conventions and prioritize particular interpretations that can affect the final solution.

Keywords: *infographics, agreement, business, visual language.*

1. Business briefing: creating agreement between the parts involved

During business practices it is common, at the beginning of a project, the staging of a negotiation act, where the clients seek to have a problem solved under certain conditions that are to be met by a service provider. This initial problem is usually solved by the provision of a written statement of the project requirements, broadly known as a project or design brief its intention is to state all of the possible needs that its necessary to solve. The project brief aims to communicate clarity in all of those needs expressed by the client and are to be met by the business team.

2.Agreement as sharing common ideas about a subject

The brief is a written medium intended to create agreement between the parts involved, all parts in a business project must have the same perceptions about the project necessities in order for the team to deliver an unified effort and answer to its requirements.

Traditional business models brief their team members in a number of meetings where the brief's contents are reviewed until common sharing and understanding is supposed to be achieved. If no consensus is found the brief's points are usually debated until some degree of agreement is met. If we understand briefing as a way of sense making in business, then it is about the creation of a perceptual structure of the problem that enables solutions, the structure of problem in few cases is purely linear so it can respond to the linear nature of the text in a brief. In this paper we explore the possibility of using imagery as a way to better understand complex problems and it implications in a business process.

3. Image as a way of enhancing agreement

Communication has a direct connection with human production, it is possible to say that business is a sophisticated form of communication that has the intention of generating economic profit. The dialog between parts in a business negotiation is focused in embracing contextual information to make decisions, and to then propose solutions, all of the variables included in this process are complex and have cause and effect relationships among them, this causes the agreement process to rely on the effectivneness of communication.

Communication, in order to be more effective, needs to expand the linear linguistic representations (the brief) as we can see in the construction of any knowledge that uses charts, graphs, flow diagrams, icons, etc. where images represent a complementary resource to understand a specific circumstance. This kind of thinking is regarded as complex by neuroscientist S.M. Kosslyn and it involves the use of several mental representations, one main reason for this, is the use of the different parts of the brain involved in the cognitive process (Kosslyn, 1999). The representational parts of the brain do cognitive processes and Kosslyn, named the result of this process *visual mental imaginary*; it is the result of the activity that relates associative memory with the capacity of internal visualization.

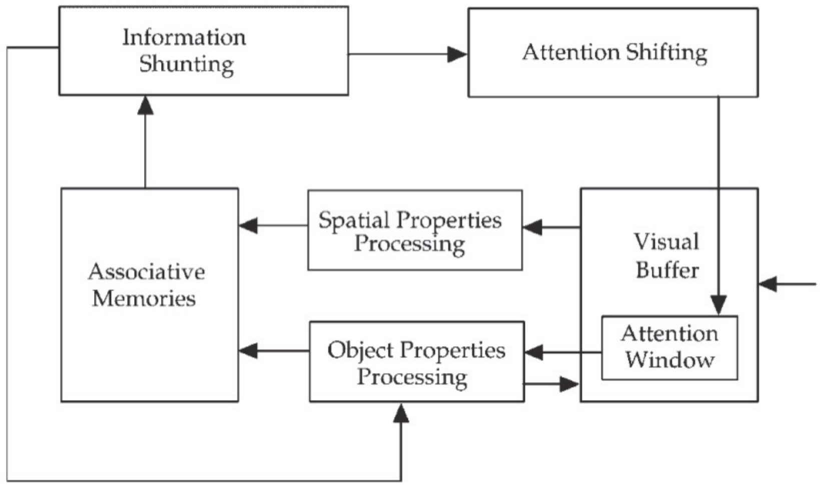

Figure 1. *The major processing systems posited to be used in visual imagery and the later phases of visual perception.*

Images can project more information than the linguistic content in the beginning, for example something that we visualize we can be sized, moved, compared, analyzed and remembered, as it is operated and kept in memory.

4. Dual Code Theory and memory

Dual coding theory has its roots in the practical use of imagery as a memory aid 2500 years ago (Yates, 1966). The memory emphasis evolved into broader applications of imagery aimed at accelerating the acquisition of knowledge. Language was always implicated but became explicitly involved as an educational partner when imagery began to be systematically externalized as pictures. (Paivio, 2006. p.1)

Cognition according to DCT involves the activity of two distinct subsystems, a verbal system specialized for dealing directly with language and a nonverbal (imagery) system specialized for dealing with nonlinguistic objects and events. The systems are assumed to be composed of internal representational units, called logogens and imagens, that are activated when one recognizes, manipulates, of just thinks about words or things. The representations are modality -specific, so that we have different logogens and imagens corresponding to the visual, auditory, and haptic (feel), and motor properties of language and objects. The representations are connected to sensory input and response output systems as well as to each other so that they can function independently or cooperatively to mediate nonverbal and verbal behavior. The representational activity may or may not be experienced consciously as imagery and inner speech. (Paivio, 2006. p.3) It is important to consider the use of both systems can provide a wider conceptual network that conveys ample meaning to ideas exposed. Visual language is an increasingly used medium to provide support for verbal language, creating image-enabled discourses (Snyder, 2011)

5. Visual language as a facilitator of symbolic systems for dual coding in business

Visual representation is a language that enhances verbal language and also can show us an expanded territory of the experience or discourse. Visual representation is a synthetic form of communication, it is an abstraction of the relevant variables of a problems represented in a synthetic maps of relations, as Elliot Eisner describes, visual representation stabilizes an idea, like the impression of the problem, the relationships of the related variables, the universe of a concept, or the multiple elements of a business situation, as Eisner (2002) explains:

> "Representation can and often does begin with an elusive and sometimes evanescent idea or image. I say evanescent because there is nothing quite so slippery as an idea; here now, gone a moment later. Images emerge and, like the subtle changes of the setting sun, may be altered irrevocably with a blink of the eye. Representation stabilizes the idea or image in a material and makes possible a dialogue with it. It is through "inscription" (I use the term metaphorically) that the image or idea is preserved—never, to be sure, in the exact form in which it was originally experienced, but in a durable form [...]

Trough visual representation a common code or symbolic system is constructed in a way that it makes possible to socialize ideas, to communicate and explain them, to generate common sense, it constructs a common map of the elements and relations involved in a business facilitating the agreement process among participants. (Gumperz, 1982) Some visual representations used in business practices include, diagrams, schemes, maps and infographics.

6. Infographics as a symbolic system for business process

Infographics are useful tools to forecast possible scenarios for business outcomes and are helpful to create a strategy roadmap that responds to these outcomes, it allows adapting resources in accordance to them. Graphical representation of the business process is a way to see the future and plan the desired outcomes in accordance. In this way images represent, not only, the business process itself, but an agreement about the trajectory of its possible results. These symbolic systems facilitate sharing of ideas and knowledge, during a business briefing these images become the nonverbal part of a dual-coding process while the moderator or participants listen to the explanation of the briefing accomplishing both a non-linear interpretation of the problematic and an enhanced memory of its arguments. Making easy the evaluation of opinions and planning ahead (Bresciani et al., 2010), fundamental needs of a business process. Infographics become a symbol of the agreed terms.

The use of symbolic systems in business is useful to determine boundaries, relation of parts of a problematic and its relative scale, so as their evolution in space-time. The use of a dual-coding approach engages participants' perception: infographics are a common way to integrate image, narrative, and non-linear reading to a business meeting completing stimuli for both symbolic systems. Both systems, verbal and image, although independent, have some degree of overlap that facilitates long term memory, context grasping, and making inferences and transformations of the symbolic information (Paivio, 1971), as a result, participants are likely to pay more attention (Kerbach et al. 2015), therefore facilitating dialog, that uses the same codes, during business briefings and negotiations.

In contrast, the exclusive use of textual briefing has the major disadvantage of presenting the structure of the problem in an one-dimensional fashion, not making easy for the problem-solver to grasp all of the possible interactions and parallel processes that a problem may present and how these processes are affected by other elements in the relationship structure.

Visualization, as in the case of business infographics, is a way to provide a criteria-unifying picture system based on conceptual depiction and notation of the relationship structure. According to Goodman (1976), pictures are mainly denotative, diagrams as pictures, generally are non-notational, but in the case of business infographics images can stand for both a representation and a notation depending on the degree in which a symbolic system is conveyed to express the meaning or the structure of the depicted elements in the infographic. Images play a key role in the mapping of these relations. Context-rich graphic alternatives complement textual briefing by the use of coding alternatives that incorporate symbolic systems in the form of sketches, graphs and images constituting an infographic.

Graphic information helps to make sense of data by linking it to a formal structure that explains, by nature of graphical language, certain traits of the problem such as the elements involved, the relation of its parts, the succession of events and the magnitude of its elements. Images create a *frame* for the business process. Infographics represent trough graphic information a cognitive structure that guides perception and the understanding of a [business] reality. (Goffman, 1974, p. 11-12). These principles are acquired in an unconscious way along with communication processes, and effectively structure which elements of reality are perceived. Infographics is a way to represent and explain the relations of the elements of a problem in an open space that allows to add layers of complexity and develop deeper explanations in a way the viewer is able to see at once many of its characteristics instead of dissociating them as in the case of textual reading, where events happen one by one, and one after the other.

The textual brief can be interpreted in a visual sketch, which later is refined in a graphic image of the relationship network of its components (Infographic). Infographics become the *imagery system* while the exposition of ideas works as the *verbal system* of a dual-coding approach. (Paivio 1978 p. 41)

The infographic as a representation of the elements of a problematic and how these elements relate becomes a powerful tool to provide understanding to each part of the problem while making clear how the possible solutions can impact the whole network. The infographic becomes a tool to forecast how solutions will impact the outcome of a problem.

Gaining comprehension on how proposed solutions can impact the outcome represents an advantage in terms of communication with the client and what makes the agreement process easier. The use of visual language in the agreement process not only clarifies possible doubts but also gives a general view of its complexity.

7. Case studies

Case studies are shown in a synthetized form, using some aspects of (Hullman et. al 2011) framework for rhetorical analysis.

7.1.Infonavit. Towards a consolidation of efficiency in the collection process of Government loans

7.1.1. Context

Infonavit is the most important government institution for home loans in Mexico, since its foundation in 1972 it has granted more than 7 million 659 and 965 credit loans (Infonavit, 2013). In 2008 their social collection office wanted to reposition their retribution process within their inside employees and communicate their model to the external audiences integrated by credit holders, developers and general public because there has been some conflicts and misunderstandings regarding public perception and media actions. Infonavit main commitment is to develop and promote good quality house solutions that create economic and social wellness for Mexicans and less impact in their environment.

7.1.2. Challenge

They were looking for opportunities regarding better communication and operative practices towards a user centered and social collection as well as better achievement for the Non Performance Loans (NPL).

Infonavit's Social Collection model was not clearly communicated from the inside of the organization, there were mainly four departments in charge to operate the model: Preventive, Management, Non performance Loans and Specialized Collection. Each of them had only a fragmented view of the process. Another problem was that in order to operate the collection of the credits Infonavit relies on Centers of services call (CESi) –where the credit holder needs to contact directly in case he or she has a problem– and an external supply network (called "Infonavit ampliado") a force of promoters that go directly to the home and leave messages with different language tones and have their own methods of collection, some of them, could easily be qualified as threatening. As a result Infonavit collection strategy is confusing and not coherent for the credit owners, some of them might even be afraid to contact the organization and some times they would even not open the door to their home or get away as soon as they see a promoter coming.

7.1.3. Case development

Insitum is a Mexican innovation consultancy that relies on ethnographic methods and user centered approaches to help clients innovate. Infonavit had been working previous projects with us and attracted by the deliverables that included an infographic instead of a thick report asked us to help them with this particular project.

We had a first encounter in a meeting and set the business agreement within the realm of a communication piece that would help organize the messages and could evolve in an Identity guide of procedures and educational materials. One of the key aspects was the client pushing for the generation of the infographic without the design research phase, but we convinced them that in order to make the infographic we needed to understand the process and scope of the project from the different collection departments. We started the with a series of interviews with directors of each area and mapped the process according to their perspective.

7.1.4. Editorial Layers

According to Hullman's analytic rhetorical framework, an information visualization piece is generated based on various design definitions based on the presentation of the information, which significantly influence audience responses. They call this editorial judgments mixed with rhetorical techniques used to convey meaning.

The editorial judgments used to map the collection process of Infonavit was based on a metaphor of a popular board-game called "Ladders and Snakes" its general structure is a hive-like group of cells, where the player starts from the bottom, roling the dices and advancing sequentially, if the player falls in a space of a "good deed" he will climb up the ladder a few steps further and if the player falls in a space where a "bad situation" is represented he will go down following the trace of a snake and goes back some steps toward the beginning, at the end the player that falls in the most "good deed" cells is the one that advances fasters until it reaches the top cell.

The tone of language that Infonavit used to get in touch with their stakeholders was coded similarly to road's and transportation color system, where green is a state of normal condition and continuity, while yellow conveys a state of preventive alert, orange is the middle alert stage, it continues to evolve until it reaches extreme alert represented as red. At this stage messages needed to be more precise, focused on actions more than in threatening.

Interviews' data was mapped for each department in a visual display that showed each area´s approach of collection and their own logistics: main actors involved in the interaction, pieces of communication with type of messages and product solutions for each stage. The visual display was divided by a horizontal line that separated all the internal activities and the external audiences that were identified. (see Fig. 1.0).

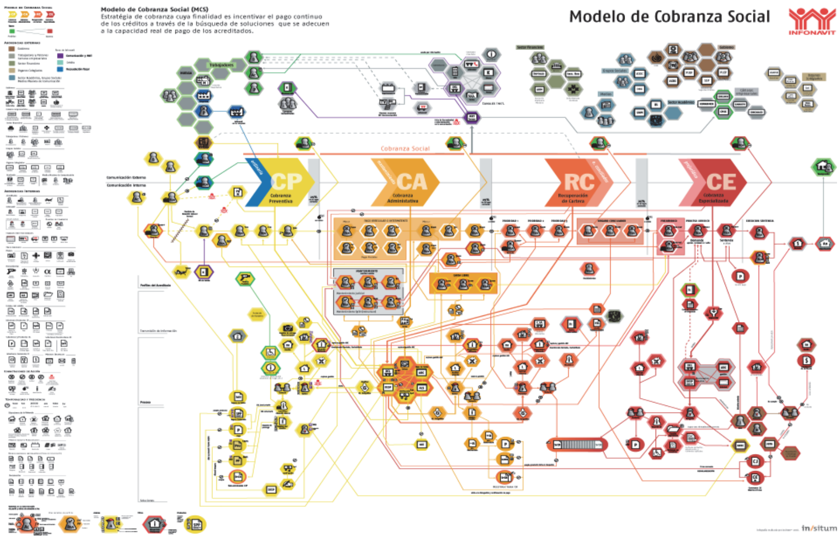

Fig. 1 Infographic of Infonavit's social collection process

Based on Dan Roam's framework (2008) of "6 W's" or six problem "clumps" that can be solved with pictures we considered the next variables in the visualization:

1. - *Who and What problems.* Actors involved in the process and type of messages generated

2. *How much problems*. Challenges that involved measuring and counting but we did not analyzed costs but resources.

3. - *When problems.* Challenges that relate to scheduling and timing as well as frequency.

4. - *Where problems.* Actual places where interactions where taking place. (CEsi's, homeowner's homes and neighborhoods, Delegations (Infonavit regional centers of operations).

5. *How problems.* We analyzed the media and channels the messages were communicating to the audiences and kind of activities they were taking place

And finally

6. - *Why problems.* We also analyzed the relation of all the actors, places, tools and facilitators involved in this phenomena aligned with the Institution's mission statement.

It is important to stress, that Infonavit had never seen the whole process together at this level of detail; each department only knew the process from its perspective. The design of an infographic of their debt collection process, opened new perspectives, making possible to share tangible information and seeing causes and effects of each stage.

Being able to see the whole message system made possible to understand what does that the abcensce of solutions and omission meant for the process. It allowed promoters and managers to plan targeted actions to problems and to detect customers that were not reciving or received incoherent messages. One example refers to the "chapulines" (grasshoppers): workers that the system flaws to identify because every two months they change working places, Infonavit already knew about their existence since their initial stage in preventive collection, but after the mappings they saw that there were no channels or efforts being done to communicate with them, so they considered to implement alternative methods. (See Fig. 2.0.).

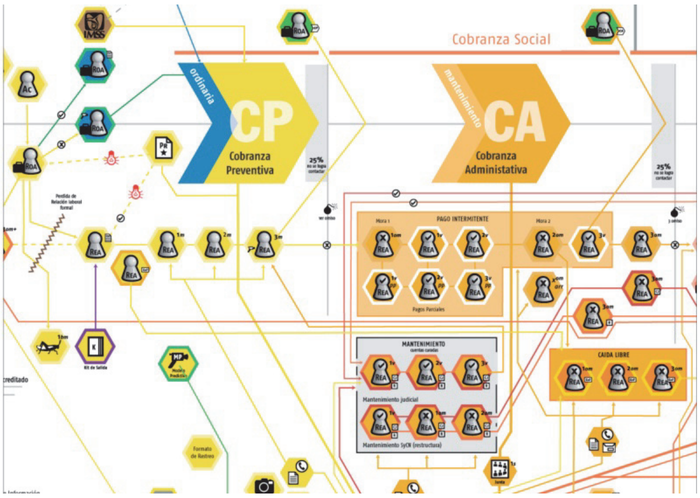

Fig. 2 Infonavit visualization's detail on the lower left side the "chapulin" cell is shown without any visible communication channel.

Workshops around the country were organized for different groups to validate the information, and every time people found new insights and shared the information among them.

After the workshops a guide was designed to explain each stage in the collection process also, templates of messages that set the commnication tone for each stage were shared. These materials were used to create short animated videos to communicate Infonavit collection process to external audiences. (See Fig 3.0).

Fig. 3 Infonavit's promoters participating in a workshop.

7.1.5. Results

Infonavit's infographic provided a general understanding to external audiences and resulted an excellent strategic tool for employees to identify restrictions, locks and barriers within the process. It evolved into educational material that helped the organization move towards a better understanding of their clients and achieved a more efficient collection process. (See Fig. 4.0).

Fig. 4 Infonavit's Education materials

7.2. Fighting together against child Obesity

7.2.1. Context

The National Survey of Nutrition and Health in 2012 scored Mexico as the first ranking country of population obesity. It created an exponential reaction from media and official sectors. Obesity problem in Mexico involves different scales of approaches and involves all kind of groups from government, academic researchers, organizations, industry and the family nucleus in relation with the environment. In august, 2012 we were approached by a strategic design consultancy specialized in communication and public polices to develop graphic materials to make this complexity understandable and create awareness for possible actions.

Excessive weight problems start from feeding habits of a person, but are imbedded in culture, life style landscape, deficiency of health services regulations that affect the individual and the collective. To solve this problem we need to act collectively and in an integral way.

The government policy in Mexico at the time, was leaning towards an increment on prices of some industry products like sodas, candies and snacks so the industry was worried and wanted to communicate that besides those regulations the population needed to take action about their feeding habits based on the understanding and control of their own energetic consumption.

7.2.2.Challenge

The visualization needed to communicate information for different stakeholders without blaming actions on any particular actor or sector, at the same time, it needed to convince the audiences of the problem dimensions in a wider context and communicate concrete actions based on their immediate solutions.

7.2.3.Case development

After the first encounter with the strategic firm a business agreement with three different visualization examples was sent, the proposals varied in the illustration style and complexity of what they were picturing. The approach was very helpful to identify the level of complexity the client was expecting and the iconic language of the piece, it also helped to set the the visual style tone, which was linked directly to the diverse audience spectrum.

In Fig. 5.0 an example of the actual business proposal is shown, using different levels of complexity in infographics so the client could understand the amount of worked involved in each category based on style.

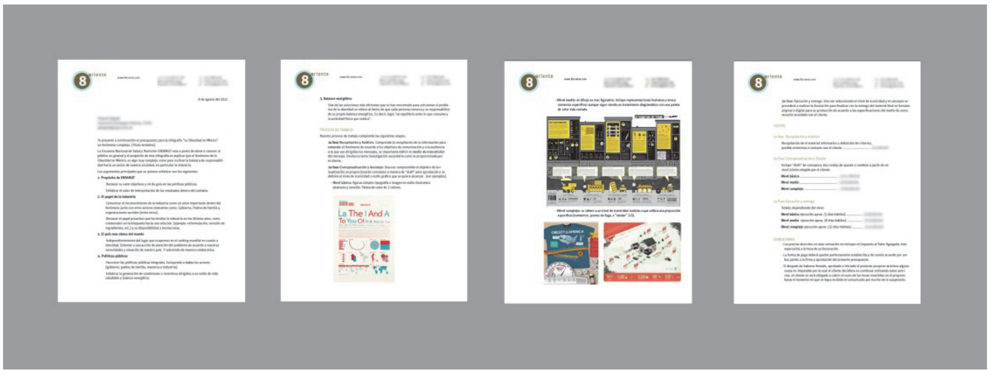

Fig. 5 Business proposal agreement showing types of infographic categorization.

Once the tone and iconic complexity level of the piece was set, we continued to explore the concept with the client who provided statistical and academic research regarding the problem.

After reviewing all the information we concluded that the piece needed to address 5 concrete immediate actions suggested to the government by the OMS (Armstrong et al 2008).

1. Diminish consumption of sugar, fat and sodium.
2. Reduce energy density of the diet
3. Increase consumption of fruits, vegetables and fiber.
4. Promote the consumption of plain water.
5. Increase physical activity.

We reached three conceptual sketches and the client chose one that depicted the problem as complex but it left the 5 concrete actions for different stakeholders clear. The development of the final concept took a lot of rounds and almost at the final stage the client decided to change the concept to a dual composition where we showed the main causes of child obesity in one side and the solutions for each stakeholder on the other. (see Fig. 6.0).

This change compromised the design because it led to a busy display of information which was difficult to read by all audiences. We let them know, but they considered to be in the safe zone if they relied on textual information instead of just iconic information. At this point we believed decision-making was rushed for having the design done so there wan not enough time to reflect on how the different audiences were going to approach the information piece.

7.2.4.Results

The final infographic was never released to the public because of contextual and political circumstances that we don't need to aboard on the scope of this paper. The idea is about how designers have been able to implement a visual dialog with their clients imbedded in the process, going from the business agreement materials to the series of iterations in the conceptual stage. In this case by showing a typology of infographics, it made easier for the client to understand concepts such as complexity and level of iconicity.

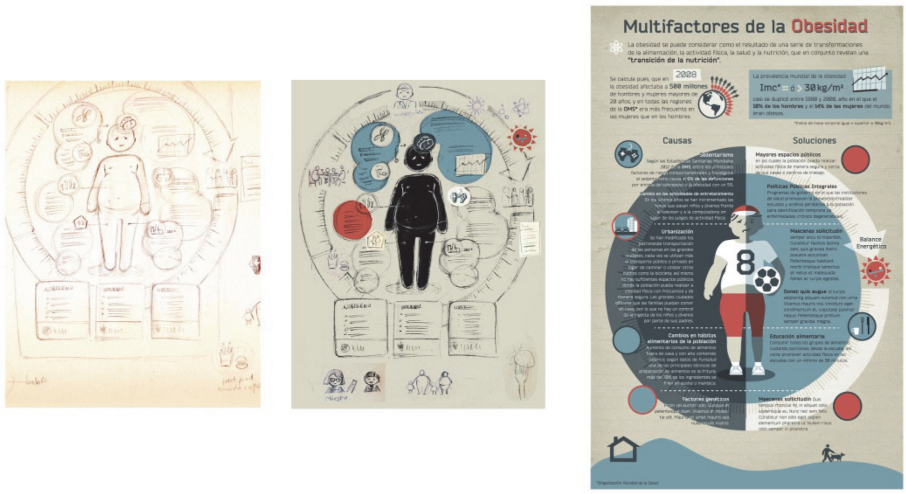

Fig. 6 "Multifactores de la obesidad" conceptual development process, on the left earlier sketches and final piece in the right.

Infographics is a business agreement tool because it involves making sense of a problem and its relations. The cases shown in this paper represent evidence that demonstrates how infographics help to identify the elements involved in a complex process. An infographic is a spatial and kinetic representation of cause and effect, hierarchy and relations. It works by creating a visible map to assign commonly agreed symbols that act as a referent for all actors therefore creating agreement.

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Multidisciplinary information application for structuring design

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Abstract

Designers in teams continuously discuss information connected to design ideas, problems or solutions that whey developed in problem solving process. However some moments are more relevant for the process, thereby decisive for the final design. The "Critical situation method" (Badke-Schaub and Frankberger, 2003) which was developed in order to evaluate the data of the design work distinguishing between critical situations and routine work have been used to focus on those moments. Critical situations determine choice points with importance for the subsequent design process and the result. To track the information behavior patterns of the design team members provoking crucial design decision we concentrated critical situations of the types 'goal analysis, goal decision' and 'solution-search, solution-analysis and, solution-decision'

Keywords: *Design Process, Information, Multidisciplinary Design Teams*

1. Introduction

In response to changing markets, increasing global competition, and technological developments, companies strive to create successful products. The role of the designer has changed over the last years; in current industrial practice the most of the designers work as part of a team. The creation of design often happens with the cooperation among experts from various disciplines due to require wide heterogeneous information. Throughout the design process stages information processing in a multidisciplinary context is integral part of any design process. Information is shared or not shared, is applied or not applied among design team members. Thus, how this information processing takes place, has become increasingly vital to the overall success of product design.

During product development designers have to make countless decisions by utilizing multidisciplinary information. Design decisions constitute critical situations in the product development process (Badke-Schaub and Frankenberger, 1999) in the sense that they have a tremendous impact on the quality of the design solution. Thus, information used as part of the critical situations is one of the most important issues that influence the quality of the design decisions/outcome.

The design process can be seen as an information process where the design space of the problem will be gradually transformed into a space of solutions (Restrepo, 2004). Design problem solving is a process of application of information to construct the design solution space and which can be seen as a web of all possible solutions linked with operators presenting problem-solving operations. Generally application of design information determines the structuring of the design problem and the defining of the solution space. During design process multidisciplinary team members generate and share large amounts of information and knowledge in multiple context. Information shared by the teammates in critical situations has a decisive role on the direction of design process.

This paper aims to 1) investigate the application of multidisciplinary information and 2) explore the process of structuring design solutions in Critical Situations (Badke-Schaub & Frankenberger, 1999).

2. Design team studies

2.1 Information Behavior in Design Teams

The number of studies aimed at understanding how designers design in teams has been increasing. In one of the first studies on design teams Tang and Leifer (1988) empirically investigated small group design sessions to understand collaborative workspace activity. The first systematic studies about design teams were presented in a session at the ICED93 conference. In 1994, the seminal Delft Protocols Workshop (Cross et. al., 1996) brought a number of researchers with an interest in design research together to apply different forms of protocol analysis on a common dataset. Team design aspects includes group aspects such as communication (Stemple and Badke-Schaub, 2002, Carrisoza and Seppard, 2000, Chiu M, 2002), collaboration (Kalay 2001), and interaction (Brereton at. al.1996).

2.2 Aspects of Information in Critical Situations

Critical situations are defined as ‘turning points’ with an important influence on the further direction of the design process and the product (Badke-Schaub and Gehrlicher, 2003). We derived from the types of critical situations regarding their aim in the problem solving process, such as goal analysis, goal-decision, solution-search, solution-analysis and solution decision.

Goal Analysis and Goal Decision: These two categories combine analysis and clarification of requirements, that means questioning and generating the demands and wishes of the given problem

Solution Search: This is the creation and generation of solutions and is mostly interconnected with the analysis of solutions

Solution Analysis and Decisions: These two categories refer to situations where the evaluation and selection of solutions take place (Badke-Schaub and Frankenberger, 2002)

3. Experimental studies of design teams

In order to observe and record multidisciplinary information aspects in design teamwork, it was decided to set up a group design task in a laboratory environment. The controlled settings in laboratory enable the observer to reduce the impact of context variables and allows to repeat the study. The group work was recorded, transcribed and then categorized. Using a group rather than an individual denoted that verbal articulations occurred in an unconditioned contrary to thinking-aloud protocols in an individual laboratory setting.

Two design teams were analyzed. Three members for each of the teams were selected from different disciplines, working in the same company. Professional experts, consisting the design teams, had comparable background and experience of professional life.

The design task given to design teams has been considered to be able to be completed in assigned time. After briefing the experimental set-up of the study by researcher, participants had time to work on the assignment individually. The assignment was to design a portable brazier (barbecue) specific for the Turkish market that can be used at outdoor during picnic attractions in recreational green areas. The design task was common and is stated as follows:

> *"Design a portable brazier (barbecue) specific for the local market that can be used at outdoor during picnic attractions in recreational green areas. The company wants differentiation from other products in the market with design, innovation, quality and price in order to ensure a prestigious penetration to the market."*

The research outlines the analysis of information behavior to gain a better understanding of multidisciplinary information activities in design teams and the relationship between information and structuring design solution. In order to observe and record the application of information in design team work, two multidisciplinary design teams were analyzed, each consisting of three professional experts from different disciplines. The design teams' working processes, in a laboratory environment that has been set up, were recorded, transcribed and then categorized. For deeper understanding of the process the verbal transcripts have been categorized and coded according to coding schemes (a) information behavior and (b) information content. Latter one used to explore the complexity of the design process and to be able to code information behavior activities more precisely.

3.2 Method of Analysis

In this study, protocol analysis was used as method for analyzing the structure the information behavior of design teams. Protocol analysis is accepted as a efficient approach for investigating the human cognitive processes and it has been widely used to gain insight into cognitive processes of individuals as well as teams (Cross et al., 1996, Dorst, 1997; Valkenburg, 2000; Stemple and Badke-Schaub, 2002). Interview and document analysis were also used for the data collection together with protocol analysis method.

Applying Protocol Analysis Method enables the researcher to investigate the verbal records which reflects the mental processes. Teamwork situations are especially helpful as every verbal expression presents the own mental model which between members is a separate communication message. Thus every message is part of cognitive activities of information processing in order to develop the design as the goal of the task. Members in a design team talk about different issues and generate more than one explanation in different contexts, often even in one expression. Every meaningful piece of verbal expressions, one or more consecutive sentences, a word or even an exclamation indicates a cognitive action. In our analysis each expression may consist of one, two or more meaningful segments which are accepted as a cognitive action.

Protocol analysis depends on the segmentation of the transcription into meaningful pieces. Primarily verbal expression of the members are transcribed. Every package of message including a cognitive action or reasoning accepted as segmented part of protocol. Although, recognizing segments requires sociological aspects to be considered, mostly recognizing the segments including design information or a cognitive action in design process is easy for a design expert.

The main idea of our method is separating the transcribed design process of team to routine situations on one hand and critical situations on the other.

One of the most crucial steps in protocol analysis is the development of a coding system. The categories of a coding system should be theoretically consistent and exhaustive to ensure that every information behavior can be assigned to one category. In this research the coding schemes were developed; (a) information behavior, (b) critical situations and (c) design content. Latter one used to explore the whole design process and to be able to code information behavior activities more precisely. Information behavior categories formulated based on previous empirical studies, on theoretical models in cognitive psychology and on design methodology, and then tested and further refined based on data from the experiment.

Documents produced by the design team during the design process have been utilized to detect the design issues the team discussed. Additionally semi-structured interviews and questionnaires were conducted. Design content is different from design issues due to design issues are specific topics related to given design task. Design teams continuously discussed issues coming from design ideas, problems or solutions that whey developed in problem solving process. Those issues could be discussed in the context of one content, or as mostly happened, they were discussed in the context of multiple design contents.

The critical situations have been detected among information behavior of team to trace the multidisciplinary design information by considering their contexts. The context of the information determines the influence of that information in a design solution

4. Results

Although design team members have to apply different information to structure the design problem, generate and develop solutions, and evaluating design solutions, often actual design activity does not progress in this direction. In design team, situations of disagreement, conflict or misunderstanding between designers arises and generally flaw ensues. Hence design solutions are not only based on rational cognitive processes with utilizing needed information (Cross and Cross, 1996).

The results gained from two case studies, one was according to defined criteria evaluated as successful design process and the other one as unsuccessful, have been compared. The analysis of the data explore different information behavior during the design process and show patterns of information application within the critical situations. The results of the research confirm

- that designers are not necessarily aware of the presence of different multidisciplinary information through design team work,
- that designers can make decisions with insufficient information or
- that designers can’t reach decisions because of redundant information generation.

This research is one attempt to provide a foundation for describing design solving patterns by means of information processing behavior in critical situations of decision making.

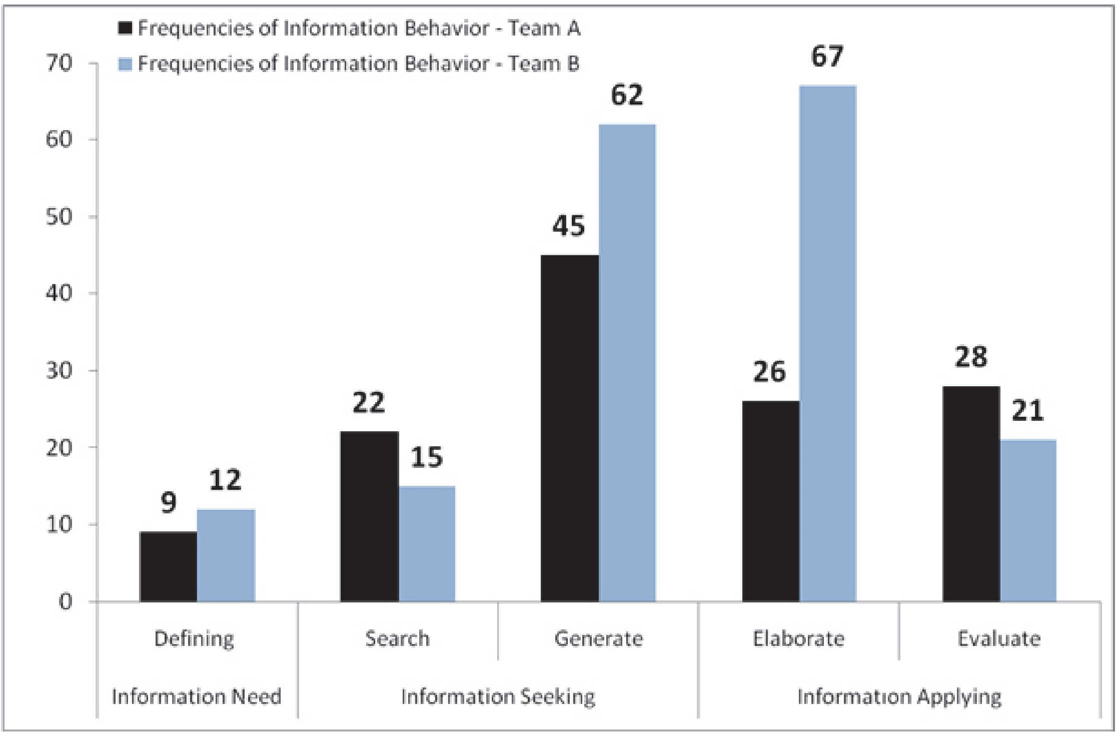

Fig. 1 Information Behavior Frequencies of Team A and Team B

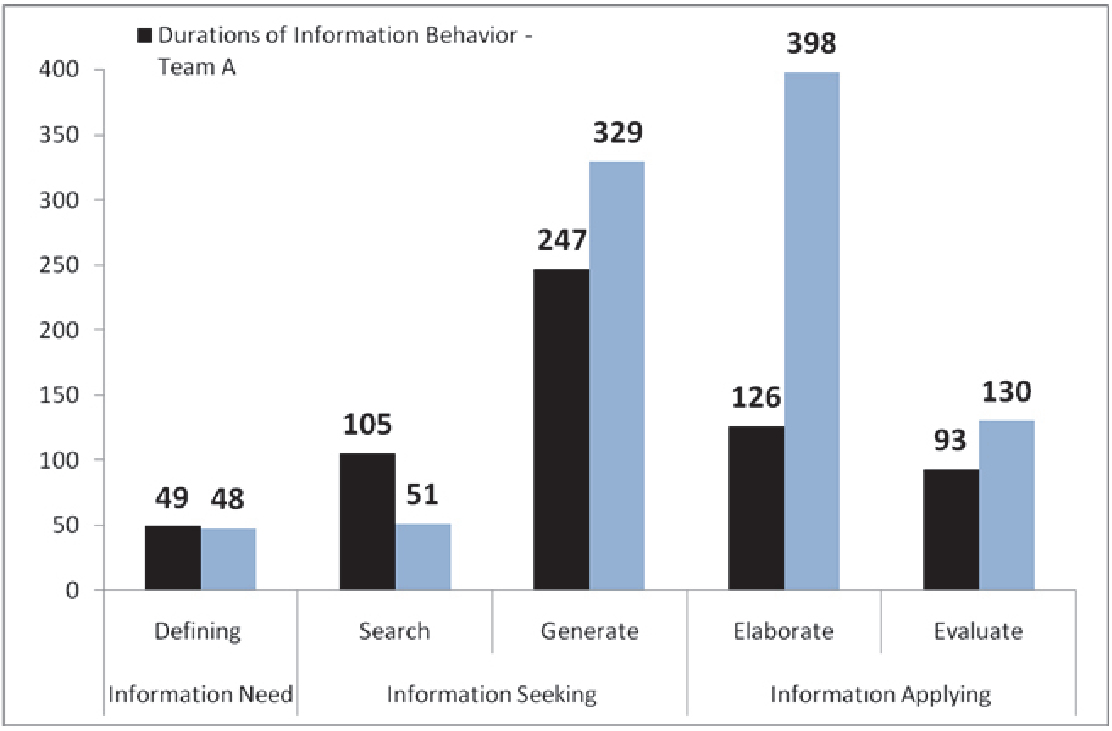

Fig. 2 Information Behavior Durations of Team A and Team B

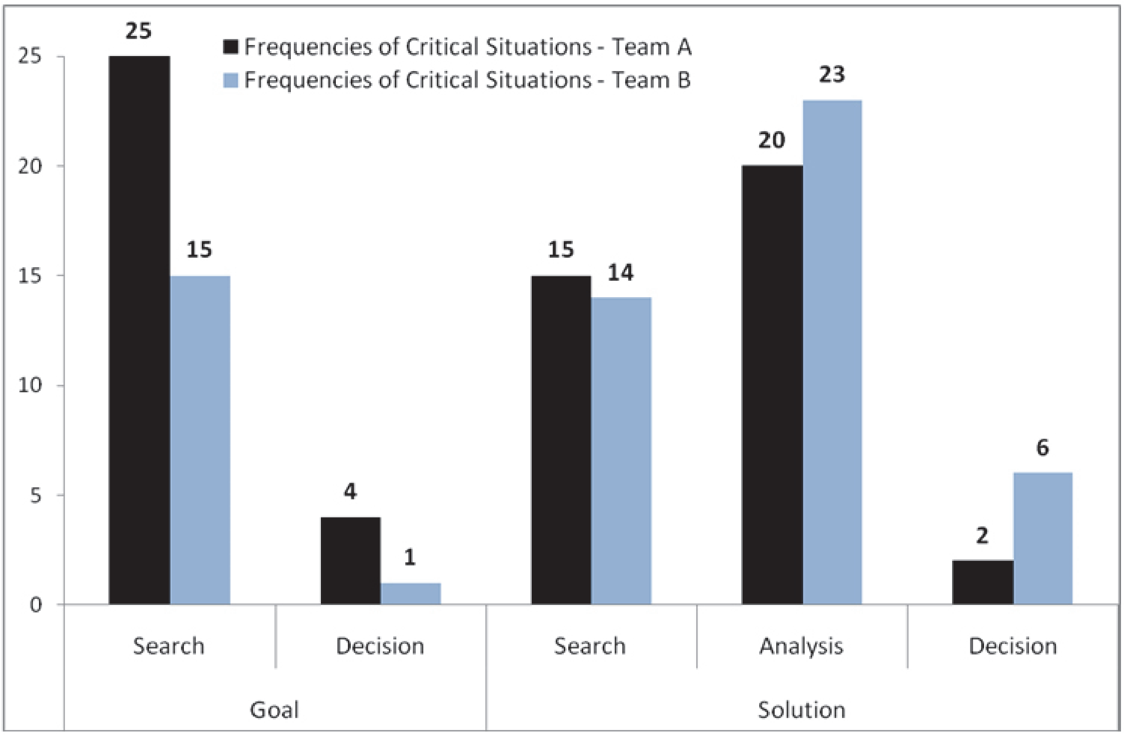

Fig. 3 Frequencies of Critical Situations occurred within Information Behavior: Team A and Team B

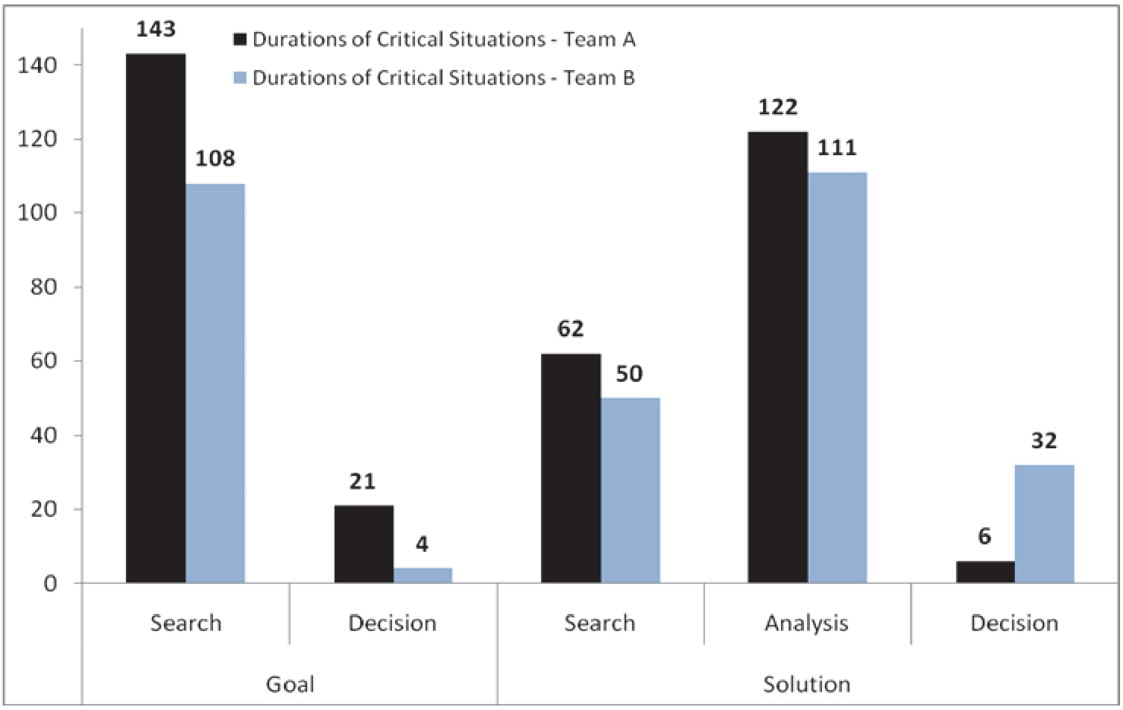

Fig. 4 Durations of Critical Situations occurred within Information Behavior: Team A and Team B

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Efecto de las variables de la gestión de diseño en el producto terminado

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Resumen

La incorporación de métodos de siembra directa en lugar del laboreo tradicional, el aumento del valor de los granos, la demanda creciente de proteínas en el mundo, y los cambios de políticas económicas empujaron al sector agrícola argentino a una fuerte expansión productiva. La consecuencia directa de esta transformación fue que durante los últimos años aumentó la superficie sembrada y los rendimientos en la producción agrícola. Esto impulsó la demanda de máquinas agrícolas, y en consecuencia renacieron innumerables empresas fabricantes, surgiendo la necesidad de nuevos diseños que optimizaran el trabajo de mecanización con una única meta: bajar costos y tiempos.

Aplicando los conceptos de la Teoría General de Sistemas, en el proceso de diseño que se desarrolla en una pyme (pequeña y mediana empresa) agroindustrial interactúan distintas variables cuyo origen puede ser interno o externo. Esto influye en el éxito comercial de la organización, fundamento suficiente para analizarlo y comprenderlo.

En una primera instancia, en el presente trabajo se analizó cuáles son las variables características del proceso mencionado de la pequeña y mediana empresa agroindustrial de la Región Centro de la República Argentina. Como segunda instancia, se evaluó el impacto de las variables en el producto terminado, relacinándolas a través de un análisis retrospectivo con las no conformidades que surgieron en el período de garantía; de un grupo de máquinas elegidas para tal fin. Se comprobó que las influyen directamente pero en distintos grados en las no conformidades y en la percepción de confiabilidad del cliente. Se demostró que la comunicación y la gestión profesionalizada son las variable más influyentes. Se originaron como consecuencia dos realidades: por un lado la necesidad de una evolución tecnológica incorporando nuevas tecnologías en la gestión de la información y por otro lado, la necesidad de profesionalizar el proceso, demandando nuevos programas de capacitación adaptados a la realidad del rubro.

***Palabras claves**: confiabilidad, caracterización, productos agroindustriales, usuario, gestión de diseño.*

Abstract

The incorporation of direct sowing methods instead of traditional tillage, increasing the value of grains, the growing demand for protein in the world, and changes in economic policies pushed the agricultural sector to strong production growth, the direct consequence was that over recent years in the Argentine agricultural sector increased plantings and yields in agricultural production, this pushed the demand for agricultural machinery, reborn so many manufacturers dragging the need for new designs that will optimize the work of agricultural mechanization, with a single goal: cut costs and times.

Applying the concepts of General Systems Theory we think that in the design process that develops in an agroindustrial SME different variables interact whose origin can be internal or external, this undoubtedly influences the commercial success of the organization, foundation enough to analyze and understand. As a distinctive feature of it we can say that its identity depends on the type of organization, the product produced, the technological level, the market and history and idiosyncrasies of the company and its environment.

In this work in the first instance it will be elucidated what are the variables of the process mentioned an agribusiness small and medium industry of the Central Region of Argentina also their impact on the finished product so they were related through a retrospective analysis with the non-conformities that emerged in the warranty period of a group chosen for this purpose machines, proving that these directly influence but to varying degrees nonconformity and perceived reliability of the customer, being able to demonstrate that communication and professional management are the most influential variables, originating as a result two realities: on the one hand the need for technological evolution incorporating new technologies in information management such as integrated systems and on the other the need to professionalize the process , claiming this new training programs adapted to the reality in the field.

Keywords*: Function, Variables, non conformities, Relationship*

1. Introducción

El sistema de producción agrícola en la República Argentina ha sufrido profundas transformaciones en los últimos decenios. La incorporación de métodos de siembra directa en lugar del laboreo tradicional, el aumento del valor de los granos, la demanda creciente de proteínas en el mundo, y los cambios de políticas económicas empujaron al sector agrícola a una fuerte expansión productiva (Satorre, E. (2005). La consecuencia directa de esta transformación fue el aumento de la superficie sembrada y los rendimientos en la producción agrícola. Esto impulsó la demanda de máquinas agrícolas, y en consecuencia renacieron innumerables empresas fabricantes, surgiendo la necesidad de nuevos diseños que optimizaran el trabajo de mecanización con una única meta: bajar costos y tiempos.

Las máquinas que trabajan en la agricultura y sus partes componentes están predestinadas a cumplir las funciones asignadas en determinadas condiciones de producción y explotación técnica. El estado técnico de las maquinas durante el proceso de explotación cambia, así como cambian los valores de los parámetros desde lo nominal al límite (Shkiliova*, et al*., 2011).

Una forma de caracterizar la maquinaria agrícola es aplicando el concepto de sistema. De acuerdo a la cantidad de sistemas que la conforman y el grado de nivel tecnológico de los mismos se definen: productos de alta tecnología (ej. tractores, cosechadoras), productos de media tecnología (ej. sembradoras, embolsadora de granos, extractora de granos), y productos de baja tecnología (ej. Implementos), existiendo una estrecha relación entre la confiabilidad y la caracterización tecnológica. Productos de alta tecnología son más confiables que productos media y baja por múltiples razones. Entre ellas, la gestión del diseño, procesos de fabricación, acceso a tecnología del conocimiento, nivel de facturación de la empresa de origen, organización empresarial, valor del producto, competencia, entre otros.

Según la Teoría General de Sistemas (Bertoglio, 1982), en una organización industrial existen variables de entrada que se transforman en un producto tangible por lo cual deben existir procesos que interactúan internamente y externamente. Uno de éstos procesos es el de diseño (Léon, *et al*., 2010), que influiría en el éxito comercial de la organización, fundamento suficiente para analizarlo y comprenderlo.

Como característica distintiva del proceso de diseño (pdd) su identidad depende del tipo de organización, del producto, del nivel tecnológico, del mercado y de la historia e idiosincrasia de la empresa y de su entorno.

En el presente trabajo, en una primera instancia se analizó cuales son las variables características de un proceso de diseño de la pequeña y mediana empresa (pyme) agroindustrial (productora de máquinas agrícolas de media y baja tecnología) de la Región Centro de la República Argentina. Como segunda instancia, se evaluó el impacto de las variables en el producto terminado, relacinándolas a través de un análisis retrospectivo con las no conformidades que surgieron en el período de garantía; de un grupo de máquinas elegidas para tal fin.

2. Objetivos e Hipótesis

El objetivo del trabajo fue detectar las variables propias del proceso de diseño característico de una pyme agroindustrial de la Región Centro de la República Argentina y analizar la influencia de las mismas en las no conformidades que surgen en el producto terminado en su período de garantía.

Se plantea como hipótesis que las variables intervinientes en el proceso de diseño influyen directamente en la percepción de confiabilidad del producto desde el punto de vista del cliente.

3. Descripción del área de estudio.

La Región Centro de la República Argentina, conformada por las provincias de Córdoba, Santa Fé y Entre Rios es una de las regiones más productivas del país con el 59% de la producción nacional de granos de soja y el 95% de la producción nacional de aceites y harinas derivados de este cultivo. Esta región concentra el 17 % del Producto Nacional Bruto y tiene una participación del 37% en las exportaciones anuales (INDEC censo 2010).

La organización empresarial de las mayoría de las empresas agroindustriales de la Región Centro tiene una base familiar. Éstas se concentran en nucleos territoriales. influenciadas directamente por el peso de la agricultura y de la ganadería, tratándose de un mercado complejo y heterogéneo según la particularidad de la zona. Este conjunto de empresas tiene un denominador común: una extensa localización territorial acorde con las demandas productivas regionales. La gran mayoría de las empresas son básicamente pymes, con un promedio de 30 años de antigüedad, cuyo tamaño va desde 10 hasta 300 empleados. El resto del mercado se distribuye en los segmentos de mayor valor económico y complejidad tecnológica.

3.1. Distribución porcentual de máquinas de media y baja tecnología fabricadas en la Región Centro

Como se observa en la (fig.1) las fabricas de baja tecnología (desmalesadoras, rastras, hileradoras,) suman un 27%, las de media tecnología (acoplados tolvas, cultivadores, embolsadoras de granos, ensilladoras para granos y forrajes) un 51% y de alta tecnología (sembradoras, pulverizadoras,) un 31%.

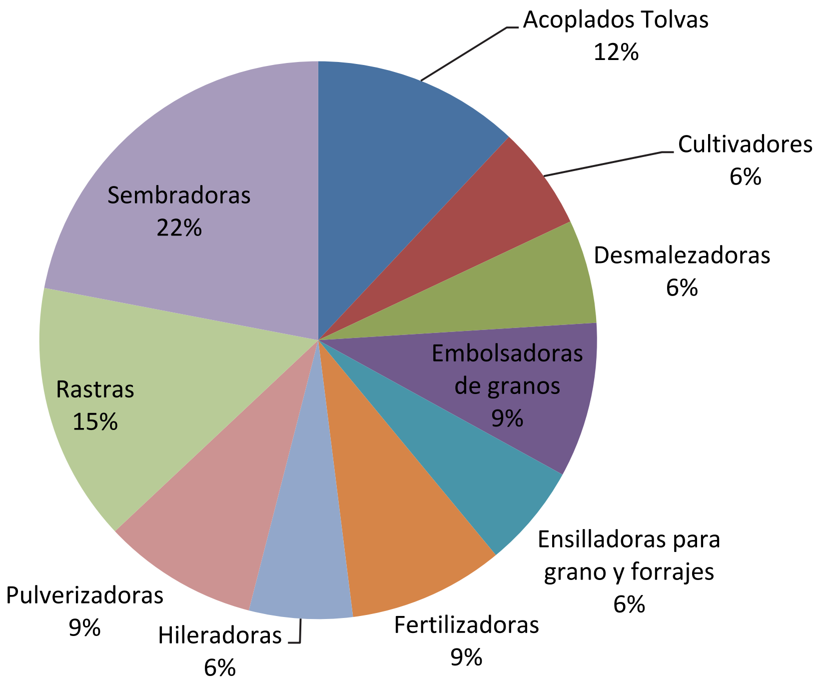

Fig.1 Distribución porcentual de máquinas de media y baja tecnología fabricadas en la Región Centro.(fuente propia)

4. Metodología

4.1. Determinación de variables características de una pyme agroindustrial

Se realizaron encuestas con el método de entrevistas en profundidad a 10 expertos cuyo desempeño profesional está relacionado con el ámbito del proceso de diseño. La entrevista fue estandarizada abierta con un cuestionario de 33 preguntas. Las preguntas se elaboraron según los referenciales correspondientes de la norma VDA 6.3 (Aguilar, *et al.*, 2006) sobre el método de auditoria de proceso de diseño. Se consideraron los siguientes ejes principales: entradas del diseño, planificación, herramientas del diseño, información, sistema de gestión de la calidad, resultado del proceso. La selección de los expertos fue multidisciplinar en cuanto a las funciones que desempeñan.

4.1. Relevamiento de las No Conformidades de un grupo de máquinas agrícolas.

La no conformidades se relevaron a través de un estudio del caso realizado en la empresa Micrón Fresar SRL productora de máquinas agrícolas de marca AKRON situada en la Región Centro de la República Argentina (provincia de Córdoba). La organización de la empresa representa el estándar típico de una empresa agroindustrial, sus productos son de media y baja tecnología. Sus procesos están certificados según la norma ISO 9001 y la mayoría de sus productos certifican las normas IRAM 8076 relativas a la seguridad de la maquinaria agrícola.

4.2.1. Datos relevantes de la firma

Cantidad de personas empleadas: 150 (70% directos y 30% el resto indirectos). Capacidad productiva de la empresa: 120 máquinas mensuales. Modelo organizacional de sus líneas productivas: fabricación por líneas continúas de producción.

4.2.2. Máquinas analizadas

Se eligió un conjunto total de 450 máquinas producidas por la firma durante el año 2012, el seguimiento de las mismas finalizó en el año 2015 de modo que en la totalidad de las máquinas se cumplió el periodo de garantía otorgado por la empresa: 2,5 años.

Los reclamos procedente de los clientes se agruparon en: "mal funcionamiento" (se consignaron todos aquellos problemas que ocasionaron un mal funcionamiento en la máquinas), "roturas imprevistas", "error o faltante de piezas" (máquina despachada al cliente con piezas o subconjuntos faltantes) , y "otros" (categoría donde la causa del reclamo no deriva a una no conformidad a la empresa).

Posteriormente, se realizó un análisis para determinar las causas potenciales de las no conformidades, utilizando como metodología el Análisis de Modos Potenciales de Fallas (AMFE) (Stamatis,2003) ordenando las mismas según su índice potencial de riesgo (IPR) según lo indica la metodología.

4.3. Determinación de la influencia de las variables del proceso de diseño y las no conformidades.

Se utilizó la metodología del análisis estructural (Cortezo, 2001) para evaluar la influencia de las variables y no conformidades. Ésta consistió en remitir al grupo de expertos una serie de cuestiones descriptivas del problema planteado. El proceso metodológico se repitió tres veces para asegurar la exactitud de las respuestas y disminuir los errores de interpretación. Los resultados se ordenaron en una matriz denominada estructural. Los valores discretos de 0 a 3 ponderaron la influencia de las variables entre sí, el 3 se le asigna a una influencia fuerte, 2 moderada, 1 leve y 0 sin influencia.

El procesamiento de la matriz estructural se realizó con el software libre MICMAC (Posso, 2010), el cual permite determinar la influencia directa de un conjunto de variables respecto a una determinada.

5. Resultados

5.1. Percepción de la confiabilidad del producto según el entorno

La tabla 1 muestra el resultado de las encuestas realizada a los expertos, describiendo el eje temático, el promedio porcentual de concordancia de los mismos, las variables detectadas y su procedencia, es decir si ésta es externa, interna, salida y transversal a la organización.

Tabla 1: Variables intervinientes en la función del diseño

Eje temático	Promedio	Variables	Procedencia
Entradas del diseño	86%	Mercado	Externa
		Clientes	Externa
		Competencia	Externa
		Exposiciones	Externa
Planificación	95%	Metodología	Interna

		Verificación Validación Dirección	Interna Interna Externa
Herramientas de diseño	80%	Softwares de diseño Métodos de cálculo Adquisición de datos Gestión profesionalizada Diseño de Ensayos	Interna Interna Interna Interna Interna
Información	96%	Comunicación Documentación Técnica Relación Clientes	Transversal Interna Externa
Sistema de Gestión de la calidad	75%	Gestión No conformidades Política de calidad	Transversal Transversal
Resultado del proceso	98%	Producto terminado Confiabilidad	Salida Salida

5.2. Variables sensibles de la percepción de la confiabilidad

Los expertos consideraron a la variable confiabilidad como una variable de percepción. Si bien ésta se asocia en los primeros momentos de vida del producto con la trayectoria comercial y técnica de la organización, a medida que el producto se va consolidado en el mercado pasa a caracterizarlo. Según una encuesta realizada a clientes del rubro y región (ver artículo de Goirán en la presente edición), éstos construyen individualmente una percepción de confiabilidad a través de tres variables. Las cuales según el orden de importancia son: bajo índice de roturas imprevistas y desgastes prematuro (variables agrupadas por su origen mecánico), referencia de uso, disponibilidad en tiempo y forma del servicio técnico por parte de fabricante. (Fig. 2)

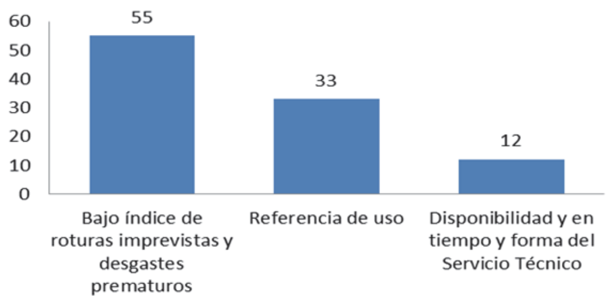

Fig. 2: Porcentaje de opiniones afirmativas respecto a las variables de confiabilidad del producto de acuerdo a la importancia de la prestación del servicio técnico.

5.3. No Conformidades del grupo de máquinas agrícolas

5.3.1. Cuantificación porcentual de las no conformidades

Las no conformidades se conformaron de la siguiente forma: rotura imprevista 45 %, mal funcionamiento con el 30%, Error o faltante de piezas el 25%, y otros 2% (Fig.3).

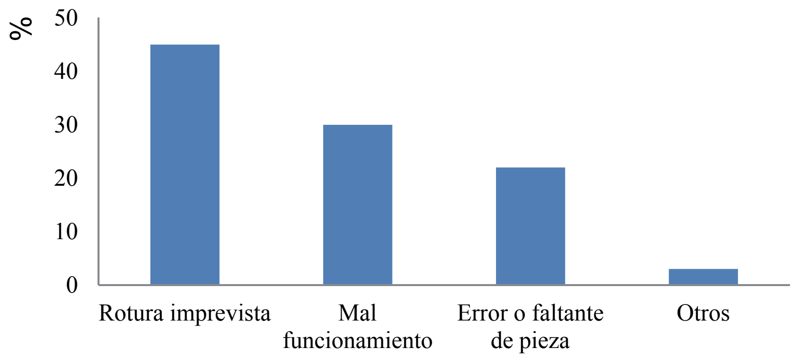

Fig.:3 Pareto de las no conformidades halladas.

5.4. Análisis de las causas raíz de las no conformidades detectadas

5.4.1. No Conformidad: Mal Funcionamiento

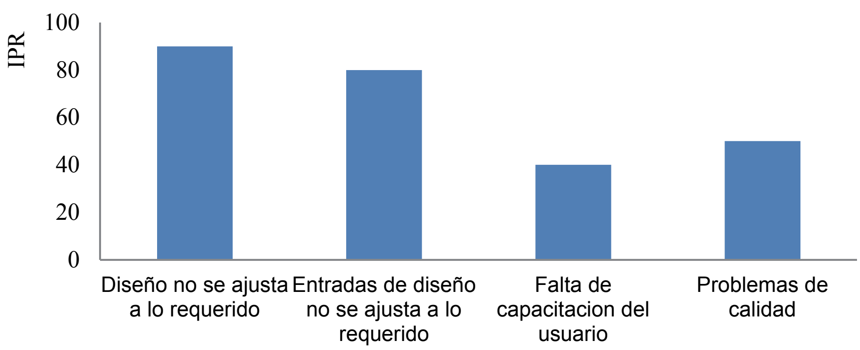

Fig.:4 Índice potencial de riesgo (IPR) de las causas raíz de la no conformidad mal funcionamiento.

El análisis de las causas raíz de la no conformidad Mal Funcionamiento (Fig. 4) da como resultado que la causa con mayor IPR(90) fue el "diseño no se ajusta a lo requerido" seguido por la "entradas de diseño no se ajustan a lo requerido" con un IPR de 80. Si bien a primera vista ambas parecen ser similares, la causa de mayor IPR se asocia a la gestión interna de la función de diseño y la siguiente con los requerimientos del mercado.

La causa "falta de capacitación del usuario" se puede atribuir a la falta de experticia en la operación de la máquina, reflejando esto último una deficiencia en la comunicación entre la empresa productora y el usuario. Por último se encuentra con un IPR de 40 "problemas de calidad y procesos", esta causa se relaciona directamente con el sistema de gestión de calidad y con la comunicación tecnológica entre la función diseño y la definición de los procesos productivos.

5.4.2. No Conformidad: Rotura Imprevista

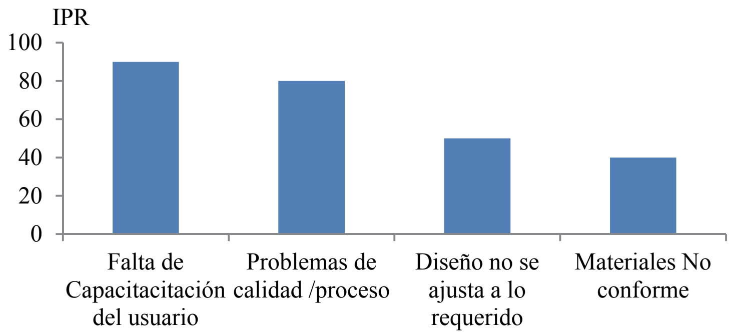

Fig.:5 Índice potencial de riesgo de las causas raíz de la no conformidad rotura imprevista.

El análisis de las causas raíz de la "rotura imprevista" (fig.5) da como resultado que, con un IPR de 90, la "falta de capacitación del usuario es la causa con mayor influencia, en segundo término "problemas de calidad y procesos" con un IPR de 80, en tercer lugar "diseño no se ajusta a lo requerido" con IPR de 50 y en un cuarto lugar materiales no conformes con IPR de 40.

Se destaca que la falta de capacitación del usuario radica en un problema de comunicación e información de la empresa sobre los modos de usos y capacidades funcionales de la máquina, en estos casos el usuario excede los límites de operatividad y la rompe.

5.4.3. No Conformidad: Error faltante de Montaje

El análisis de la no conformidad "error o faltante de pieza" (fig. 6) da como resultado que las primer causa raíz se debe a "instrucciones de proceso incorrectas" con un IPR de 120, en segundo lugar "falta de capacitación al operario" con un IPR de 80 y en tercer "planimetría incorrecta". Estas causas tienen denominador común relacionado con el manejo de la información y comunicación en la empresa. En cuarto lugar, "falta de control de calidad" con un IPR de 30, esta causa está relacionada con el sistema de gestión de calidad de la empresa.

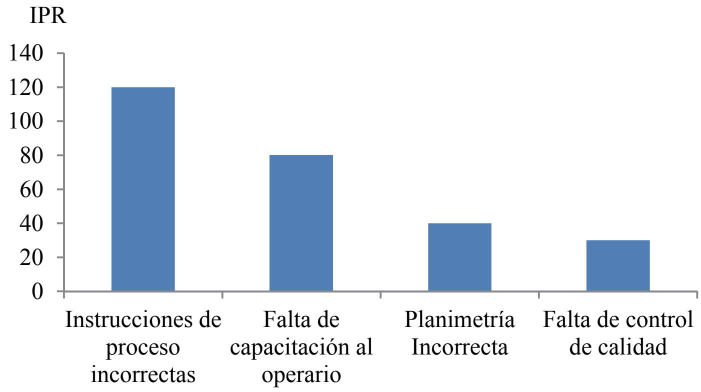

Fig. 6: Índice potencial de riesgo de las causas raíz de la no conformidad "Error faltante de Montaje"

5.5. Análisis de la relación causa raíz y las variables de mayor influencia

El resultado del análisis se expresa en la tabla 2, en ella se puede observar el nivel de influencia entre distintas variables del PDD y las causas raíces de las no conformidades.

En el gráfico de la figura 7 se muestra el nivel de influencia porcentual de las variables características del proceso de diseño calculado a través del software MICMAC .Se observa que las variable comunicación, gestión profesionalizada y documentación técnica tienen la mayor influencia con un el porcentual acumulado que no supera el 80%.

Tabla 2 Cuadro relación causa raíz variables de mayor influencia

No conformidad	Causa Raíz	Variables	Influencia		
			3	**2**	**1**
Mal Funcionamiento	Diseño no se ajusta a lo requerido	Gestión profesionalizada	X		
		Diseño de ensayos		X	
		Relación clientes	X		
		Comunicación	X		
	Entradas del diseño no se ajusta a lo requerido	Comunicación	X		
		Dirección		X	
	Falta de capacitación del usuario	Comunicación	X		
		Relación clientes	X		
		Política de la calidad		X	
		Dirección	X		
	Problemas de calidad o procesos	Comunicación	X		
		Documentación Técnica		X	
Rotura imprevista	Materiales no conformes	Métodos de cálculo		X	
		Adquisición de datos			X
		Gestión profesionalizada	X		
		Diseño de Ensayos		X	
Error o faltante de montaje	Instrucciones de proceso incorrectas.	Comunicación	X		
		Documentación Técnica	X		
		Relación otras áreas de la organización	X		
	Falta de capacitación al operario.	Comunicación	X		
		Documentación Técnica		X	
		Relación otras áreas de la organización	X		
	Planimetría incorrecta	Gestión profesionalizada	X		
	Falta de control de calidad	----------	-	-	-

Fig. 7 Nivel de influencia porcentual de las distintas variables en las no conformidades detectada

6. Discusión

El proceso de diseño en una organización tiene relación directa con el producto terminado no solo en el aspecto técnico sino también económico. Al considerar que éste es un proceso dentro de la organización estará constituido por variables de distintos tipos que interactúan internamente y externamente con mayor o menor influencia pero todas sin lugar a dudas influyen en el resultado. no solamente en las no conformidades que se van produciendo a lo largo durante el período de garantía del producto sino que también influyen la percepción de confiabilidad del cliente factor clave y decisivo en la decisión de compra de una máquina.

Comunicación y gestión profesionalizada se pueden considerar como variables claves en el PDD, ésta situación plantea un gran desafío en las organizaciónes que es la de en primer lugar sobrevivir en un mercado tan competitivo y por el otro lade crecer por lo que tendrán que ajustar los canales y formas de comunicación además de reveer los procesos de profesionalización.

La dirección de éstas pymes también influyen en el PDD, éstas en términos generales deciden que fabricar, como relacionarse con los clientes y cuales son las políticas de calidad a implementar, muchas veces por razones de mercado, la dirección debe prioriza el factor económico teniendo en esos caso una mayor influencia en los procesos internos del PDD.

7. Conclusiones

Las variables comunicación, gestión profesionalizada y documentación técnica son las variables de mayor influencia aunque no hay un predominio categórico respecto a las demás variables. Sería ilógico pensar que estamos antes la presencia de variables absolutamente independientes, en mayor o menor medida hay una influencia entre ellas, por ejemplo la comunicación tiene relación directa con la profesionalización de área, a su vez la documentación técnica es una forma de comunicación.

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Design management: diagnosis based on competitiveness, differentiation and sustainability in an association of artisans in Southern Brazil.

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Abstract

Design management, which is defined as the management of design resources (processes, projects, people and procedures), contribute to align its actions with organization's strategic objectives. Regarding this context, many authors consider the diagnosis as a fundamental step in design management. In this way, the objective of this article is to diagnosis the level of development and implement design strategies in the Associação Ribeirão de Artesanato (Ribeirão Artisans Association), located in the city of Florianópolis, Brazil. For this, the CDS Model was chosen because of its applicability which has its focus on design management. This model, developed by the Design Management Lab of the Federal University of Santa Catarina its based on the analyse of three dimensions: Competiveness, Differentiation and Sustainability, characterizing its applicability in systemic form. About the methodological procedures, this article is classified as exploratory, applied goal and qualitative. It is a case study which was carried out by on-site visits, systematic observation and interviews. As a result, the application of the CDS Model allowed to identify design opportunities and proposing strategies and actions to enhance the artisanal activity. An example of an action which was proposed was the creation of graphic mark and major applications such as labels and packaging, which besides its benefits to the product presentation, it has contributed to emphasize the cultural and historical value of the artisans products by adding information about the craftsman, materials and techniques used and including the history of each piece of craftsmanship.

This action sought to address some of the weaknesses identified in the dimension differentiation: lack of visual identification and standardization for the association and absence of standardization in the packages' identification, which contained little information about the production of the products. It was observed that the handicrafts, due to the focus being on the manual labor, sometimes lacks in a systemic vision. It can be concluded that the diagnosis in design management, through the implementation of the CDS Model, helped to identify potential and associated weaknesses, allowing better visibility enabling us to have a complete overview of everything and propose design solutions such as production planning according to the seasonality of tourism and the profile of tourists. Thus, the CDS Model, through its simplified graphical representation, has facilitated the understanding and visualization of the diagnosis to the design manager and the members of the association.

Keywords: *Design management, Diagnosis, CDS Model, Handicraft*

1. Introdução

Antes considerado como uma atividade puramente operacional, o design vem incorporando cada vez mais aspectos estratégicos a sua atividade, integrando perspectivas do fazer com o pensar por meio da gestão de design (Martins; Merino, 2011).

O CPD (1997) coloca que o design é um processo que necessita ser gerenciado, visto que atua de forma multidisciplinar, e é fator chave para a incorporação de estratégias ao desenvolvimento de novos produtos. Esse contexto contribuiu para reforçar o estatuto da gestão e colocou o verdadeiro potencial do design num lugar de destaque nas agendas das organizações (Best, 2009).

Além da crescente conscientização da atividade como um meio para atingir objetivos estratégicos organizacionais, existe também um crescente desejo de compreender as ferramentas do design (métodos e formas de pensar do processo de design) e o planejamento e implementação de design que efetivamente a gestão de design pode trazer (Best, 2009). É necessário que o designer disponha de informações precisas e de qualidade (Strunk, 2004) para que a solução proposta pelo design venha a considerar uma perspectiva holística na qual a organização está inserida, contemplando as diversas áreas em que o design irá sofrer influência, bem como influenciar a partir das soluções geradas pelos seus projetos.

As organizações são afetadas por diversas variáveis internas, como missão, objetivos, estrutura hierárquica, finanças; e externas, como concorrência, valores étnicos, geográficos, culturais, política (Best, 2009). A compreensão dessas variáveis ajuda a equipe de design a determinar como criar produtos que agreguem e evidenciem valor, satisfazendo as necessidades dos consumidores (Oda, 2010).

É possível identificar as oportunidades de contribuição e de inserção do design nas organizações com a visão sistêmica por meio do diagnóstico de gestão de design, e para isso existem uma série de ferramentas e métodos que podem ser usados (Best, 2009).

Uma destas ferramentas é o Modelo CDS de Competitividade, Diferenciação e Sustentabilidade, desenvolvido pelo Núcleo de Gestão de Design da Universidade Federal de Santa Catarina[49] (NGD/UFSC). O Modelo apoia-se na análise de três dimensões: Competitividade, Diferenciação e Sustentabilidade, caracterizando sua aplicabilidade de forma sistêmica na gestão de design.

Desta forma, o objetivo desse artigo é diagnosticar por meio do Modelo CDS o estágio de desenvolvimento e implementar estratégias de design na Associação Ribeirão de Artesanato (ARA), localizada na Ilha de Santa Catarina (Florianópolis), no estado de Santa Catarina, ao sul do Brasil[50].

Para tanto, esse artigo encontra-se dividido em 6 tópicos que podem ser visualizados na Figura1.

Fig. 1 Estrutura do artigo. Fonte: os autores (2016).

2. Procedimentos Metodológicos

A pesquisa classifica-se como qualitativa quanto a forma de abordagem, pois considera a existência de uma relação dinâmica entre o mundo real e o sujeito e que não pode ser traduzida em números (Silva, Menezes, 2005). Quanto a natureza é considerada aplicada, pois envolve verdades e interesses locais com o objetivo de gerar conhecimentos para aplicação prática, procurando solucionar problemas específicos (Silva, Menezes, 2005). Quanto aos seus objetivos, compreende-se como exploratório. Na maioria dos casos a pesquisa exploratória assume a forma de pesquisa bibliográfica, envolvendo o levantamento da bibliografia já tornada pública em relação ao tema de estudo, como livros, monografias, dissertações, revistas, artigos; entrevistas com pessoas que tiveram experiências práticas com o problema pesquisado; análise de exemplos que estimulem a compreensão (Markoni, Lakatos, 2007; Gil, 2002).

Quanto aos procedimentos técnicos, foi feito inicialmente uma pesquisa bibliográfica em livros, teses, dissertações e artigos científicos que abordassem os temas: gestão de design e diagnóstico. Após essa pesquisa, foi realizado um estudo de caso na ARA, onde foram realizadas visitas *in loco,* observação sistemática e entrevistas. Considera-se estudo de caso por envolver o estudo profundo de objetos, permitindo o seu amplo e detalhado conhecimento (Silva, Menezes, 2005). Nessa etapa, foi feito um diagnóstico de gestão de design para obter um panorama do estágio de desenvolvimento da Associação a

[49]O NGD/UFSC desenvolve atividades de pesquisa e extensão que possuem como foco investigar, aplicar e disseminar o design como ferramenta estratégica para as organizações, tendo como pilares de sustentação a competitividade, a diferenciação e a sustentabilidade, aplicada a projetos, produtos e serviços (NGD/LDU, 2016).

[50] A pesquisa foi desenvolvida como Trabalho de Conclusão de Curso de Graduação em Design Gráfico na Universidade Federal de Santa Catarina - UFSC (Aguiar, 2013).

partir de três indicadores: competitividade, diferenciação e sustentabilidade. Para isso, foi utilizada a metodologia Guia de Orientação para Desenvolvimento de Projetos (GODP) (Merino, 2014) para gestão de design e em específico no diagnóstico foi utilizado o Modelo CDS, que será descrito em detalhes a seguir.

3. Gestão de design e diagnóstico

Há uma crescente conscientização entre as organizações de que o design é um meio de valor para atingir objetivos estratégicos (Best, 2009), deixando de ser visto apenas como a adição externa de estética e passando a atuar de forma concreta no desenvolvimento consciente de projetos em toda a sua complexidade (Martins, Merino, 2011). No entanto, para que obtenha os resultados esperados, é preciso gerenciá-lo (CPD, 1997).

Neste contexto, tem-se a gestão de design, que vem da tradução do termo *design management*. De acordo com Mozota (2003), os conceitos de design e gestão são, em sua maioria, comuns e convergem entre si, visto que ambos estão relacionados a questões como solução de problemas, gerenciamento de ideias e inovação, sendo assim mutuamente benéficos. Segundo a autora, o *design management* é a implantação do design como uma atividade programada e formalizada na organização, com a função de coordenar os recursos do design em todos os níveis de atividade, visando atender objetivos organizacionais. Martins e Merino (2011) também corroboram com esta visão, definindo a gestão de design como a organização e a coordenação das atividades de design, baseadas nos objetivos e valores da empresa, de modo a planejar e coordenar as estratégias, assegurando o cumprimento das mesmas de acordo com prazos e custos planejados.

Em um nível mais profundo, segundo o DMI - *Design Management Institute* (2016), a gestão de design visa vincular design, inovação, tecnologia, gestão e clientes para oferecer vantagens competitivas por meio da linha de base tripla: econômica, social/cultural e fatores ambientais. A gestão de design visa obter uma perspectiva mais ampla dos projetos de design, refletindo sobre questões organizacionais e econômicas, considerando os diversos *stakeholders*[51] envolvidos nesse processo (Simeone, 2014).

Para Mozota (2003) existem três níveis de gestão de design, que encontram-se detalhados na Figura 2: operacional, funcional e estratégico. Estes correspondem aos três níveis de decisão para o gestor de design e representam uma escolha quanto ao escopo de atuação do design e os objetivos da empresa. O nível operacional, considerado o primeiro passo para integração do design, está relacionado com a percepção do projeto e com as atividades realizadas durante esse processo (Mozota, 2003; CPD, 1997). No nível funcional a empresa já realizou alguns projetos de design e possui certa experiência para coordenar as atividades de design. O nível do design estratégico consiste em gerir a contribuição do design para o processo de formulação da estratégia, propondo e comunicando estratégias que deem suporte às metas da organização (Mozota, 2003).

[51] Os *Stakeholders* de uma organização podem ser definidos como qualquer grupo ou indivíduo que afeta ou pode ser afetado pela realização dos objetivos dessa empresa (FREEMAN, 2010).

AÇÃO de Design	FUNÇÃO de Design	VISÃO de Design
O Valor de Diferenciação do Design	O Valor de Coordenação do Design	O Valor de Transformação do Design
O design é uma competência econômica que muda as atividades primárias na cadeia de valor.	O design é uma competência de gestão que muda as atividades de suporte na cadeia de valor.	O design é a competência principal que muda a cadeia de valor do setor e a visão da indústria.
GESTÃO DE DESIGN OPERACIONAL	GESTÃO DE DESIGN FUNCIONAL	GESTÃO DE DESIGN ESTRATÉGICA

Fig. 2 Três níveis da Gestão de Design. Fonte: Mozota (2003, p. 259, tradução nossa)

Mozota (2003) ainda aponta que a introdução da gestão de design nas empresas deve feita de maneira gradativa e responsável, ou seja, em etapas e por meio de uma sequência de vários projetos, para que possa ser inserida de maneira espontânea e que ao longo do tempo ajude a formar uma cultura de design na organização. (Martins; Merino, 2011).

A gestão de design envolve mais do que a atribuição de tarefas administrativas (Martins, Merino, 2011), pois sua característica diferenciadora é seu papel na identificação e comunicação de caminhos pelos quais o design pode contribuir em relação ao valor estratégico da empresa (Mozota, 2003). É necessário entender como e onde a atividade se integra a um contexto global, e como todo este potencial pode ser explorado, gerido profissionalmente e utilizado como ferramenta para a inovação e a mudança (Best, 2009). Se o propósito da gestão de design é identificar e comunicar as formas pelas quais o design pode contribuir para o valor estratégico da empresa, então identificar oportunidades para o design é o primeiro passo para isso (Mozota, 2003; Best, 2009).

Desta forma, visualiza-se a contribuição do diagnóstico para a identificação destes caminhos e, consequentemente, para apontar as oportunidades de atuação do design e do designer nas organizações. Autores e organizações como Merino (2002), Oda (2010), Centro Português de Design (1997) e BCD (2015) citam o diagnóstico como uma das etapas fundamentais da gestão de design.

“Para manter em longo prazo uma posição de vantagem competitiva, a empresa deve acompanhar e analisar frequentemente as variáveis internas e externas que afetam sua competitividade, uma das ferramentas que pode fornecer estas informações é o diagnóstico” (Oda, 2010, p. 28). De acordo com Merino (2002), o diagnóstico consiste em uma das principais etapas em qualquer projeto relacionado ao design, principalmente se o mesmo tem ênfase na gestão de design. Trata-se de “uma atividade específica de observação e análise que tem por objetivo detectar situações-problema que possam estar afetando a empresa como um todo, dificultando o alcance dos resultados operacionais esperados” (Oda, 2010, p. 34).

No diagnóstico é realizada uma análise da situação frente à problemática que originou a demanda, utilizando-se de ferramentas e técnicas de levantamentos de informações. Neste sentido, é fundamental conhecer e reconhecer as variáveis, os atores diretos e indiretos, suas capacidades e limitações, suas expectativas e projeções, dentre outros fatores (Merino, Merino, Figueiredo, 2007). Segundo o BCD (2016), o diagnóstico de design aborda a análise da história da empresa e de sua situação atual frente aos concorrentes; análise de recursos internos de pessoal, organização e gestão; análise geral da relação entre a situação e recursos, pontos fortes e fracos da empresa. Após o diagnóstico, é possível definir uma estratégia, um cronograma de atuação para atuação do design; em seguida, inicia-se a implantação e a gestão do processo.

Dentre as ferramentas que podem ser utilizadas para o diagnóstico na gestão de design destaca-se o Modelo CDS. A base conceitual desse Modelo é configurada pelas dimensões Competitividade, Diferenciação e Sustentabilidade, considerando não só a situação pontual de cada uma dessas dimensões, mas também as relações existentes entre elas (Merino; Gontijo; Merino, 2012).

O design contribui para áreas fundamentais que afetam a competitividade das empresas e de seus produtos: insere qualidade e estética aos produtos, introduzindo valores simbólicos, culturais e funcionais, contribuindo para sua diferenciação; racionaliza processos produtivos; aperfeiçoa a comunicação, diferenciando produto e empresa; diversifica e foca a oferta de produtos considerando a tecnologia existente; substitui as linhas de produto em declínio por novos; melhora a comunicação e a imagem da empresa ao atuar em sua comunicação interna e externa (Gimeno, 2000).

"Consequentemente é necessário que produtos e serviços, além de competitivos, se diferenciem" (Merino, Gontijo, Merino, 2012, p.76). A diferenciação pode ser obtida por meio de atributos dos produtos (exemplo: aparência visual, origem, sanidade, qualidade, sabor, durabilidade, estilo), dos serviços (exemplo: frequência de entrega, ou formato de entrega, instalação, treinamento do consumidor, serviços de manutenção), bem como por meio da marca, que simboliza a imagem da empresa no mercado (Neves, Castro, 2003).

"Porém, ainda que a competitividade e a diferenciação estejam no centro das atenções no mundo globalizado, uma terceira dimensão se apresenta como indispensável, trata-se da sustentabilidade" (Merino, Gontijo, Merino, 2012, p. 76). No caso desta dimensão, o Modelo a considera como estrutural e fundamental, abrangendo, além dos fatores ambientais, outros aspectos tais como econômicos e sociais (Merino, Gontijo, Merino, 2012). Para Manzini e Vezzoli (2008), a sustentabilidade extrapolou a dimensão ambiental, acreditando que os fatores sociais são relevantes e na atualidade são tão importantes quanto os econômicos e ambientais. "O desenvolvimento sustentável e o desenvolvimento social não podem ser dissociados, sendo que a pobreza e os problemas ambientais guardam uma relação causa e efeito, refletindo de forma direta nos aspectos econômicos individuais e coletivos" (Merino, Gontijo, Merino, 2012, p.431).

Para mensurar as três dimensões (Competitividade, Diferenciação, Sustentabilidade) são definidos diferentes indicadores. "Estes indicadores são aqueles que medem e/ou avaliam, de forma quantitativa e/ou qualitativa, os desempenhos relacionados e correlacionados" (Merino, Gontijo, Merino, 2012, p.429). Assim como a gestão de design e o diagnóstico variam de acordo com cada organização, devido aos seus contextos particulares, consequentemente os indicadores também podem variar. A incorporação dos indicadores se complementa "no sentido que possibilita um maior auxílio no processo decisório, mediante a explicitação de informações (na forma qualitativa/quantitativa), que servirão de base para as ações definidas pelos gestores alcançarem as metas propostas" (Merino, Gontijo, Merino, 2012, p.431-432). Na figura 3 pode ser visualizado o Modelo CDS. Como exemplo, foram colocados 5 indicadores para cada uma das dimensões. No entanto, esse número pode variar dependendo do diagnóstico em questão. Recomenda-se utilizar o mesmo número de indicadores em cada uma das dimensões para que a avaliação e análise dessas seja feita de forma mais igualitária.

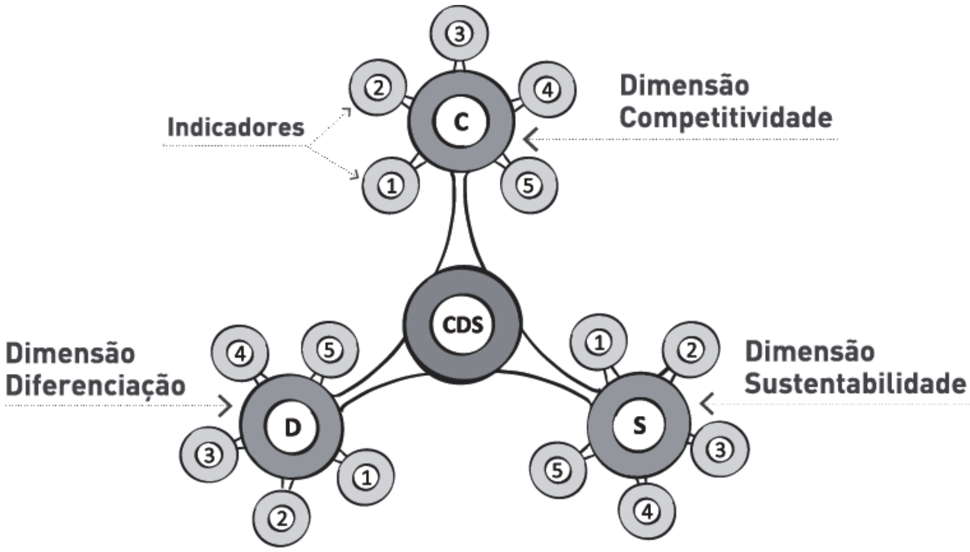

Fig 3 Modelo CDS. Fonte: Merino e Merino (2016).

Por meio do CDS "é possível identificar de forma completa as três dimensões de análise, bem como o comportamento de cada um dos seus indicadores" (Merino, Gontijo, Merino, 2012, p.435), possibilitando uma visão sistêmica da situação que a organização se encontra.

O Modelo CDS tem por objetivo propiciar uma avaliação integrada das três dimensões e suas relações, quando utilizado nas etapas iniciais de um projeto e auxilia na compreensão das problemáticas e contingências existentes numa determinada situação (Merino, Gontijo, Merino, 2012). Neste contexto, o Modelo resulta num diagnóstico preliminar da situação, mas seu uso não se limita a este. O mesmo poderá ser aplicado em diferentes etapas, "permitindo visualizar e identificar as alternâncias sofridas pelos indicadores, na medida em que são incorporados e/ou retirados ao projeto elementos da sua configuração" (Merino, Gontijo, Merino, 2012, p.435-436).

4. Estudo de caso

4.1 Associação Ribeirão de Artesanato (ARA)

A ARA, composta por 16 artesãos do Distrito do Ribeirão da Ilha, na cidade de Florianópolis/Brasil, a ARA (Figura 4) tem como finalidade: a integração e a união de seus integrantes; o fomento ao desenvolvimento do artesanato e da produção artesanal, divulgando o trabalho dos artesãos; o estímulo à comercialização dos produtos de seus associados e a realização de pesquisa sobre o tema com o objetivo de criar melhores condições a seus membros; e o desenvolvimento de trabalhos visando suprir as necessidades dos associados, notadamente nas áreas: financeira, social, educacional, cultural e ecológica.

Fig. 4 Sede da associação, placas de sinalização externa e cartão de visita. Fonte: Aguiar (2013)

Entre os artesanatos desenvolvidos pela associação estão trabalhos com conchas, telas de pintura, maquetes, renda de bilro, balaios, lanternas de ostra, tarrafas em miniaturas e manualidades em geral.

4.2 Gestão de design na ARA

Para o desenvolvimento do estudo de caso foram seguidas as etapas da metodologia GODP, para a gestão de design propostas pelo NGD/UFSC (Merino, 2016) (Figura 5).

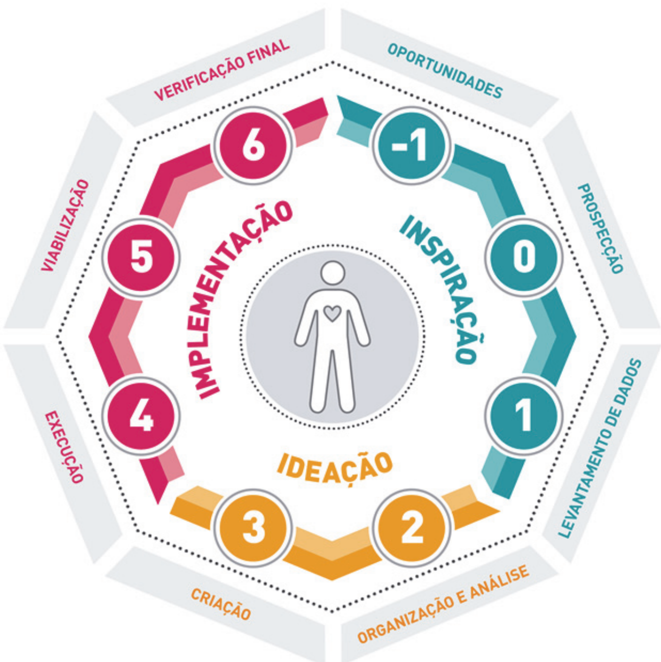

Fig. 5 GODP – Guia de Orientação para Desenvolvimento de Projetos. Fonte: Merino (2016)

Desenvolvido por Merino (2016), o GODP configura-se por 8 etapas que se fundamentam na coleta de informações pertinentes ao desenvolvimento da proposta, ao desenvolvimento criativo, a execução projetual, a viabilização e verificação final do produto (Merino, 2014),

Devido ao recorte dado ao artigo, serão apresentadas as etapas de -1 (Oportunidades), 0 (Prospecção), 1 (Levantamento de Dados) e 2 (Organização e Análise dos Dados).

As etapas -1 e 0 dizem respeito à identificação de oportunidades e prospecção, respectivamente. A oportunidade de desenvolvimento da pesquisa ocorreu por meio do NGD/UFSC em parceria com a OAB Cidadã[52], projeto desenvolvido pela Ordem dos Advogados do Brasil em Santa Catarina. A escolha do objeto de estudo, a ARA, deu-se a partir de demanda solicitada pela organização do projeto (Aguiar, Merino, Merino, Triska, 2015).

A partir da formalização do estudo de caso, iniciou-se a Etapa 1 (Levantamento de Dados), que corresponde ao mergulho do designer no contexto do projeto, visando sua compreensão (Melo, 2005). A etapa começou com observações sistemáticas na ARA, com o objetivo de compreender inicialmente a organização.

Realizaram-se também visitas a campo e observações sistemáticas em locais da cidade que ofereciam produtos similares, além de buscas online para identificação de organizações, eventos e feiras no setor do artesanato, nacional e internacionalmente. Pesquisas bibliográficas e documentais em relatórios sobre os setores do turismo, artesanato e de tendências de consumo também foram feitas.

Em seguida, realizou-se uma entrevista semiestruturada com a presidente da ARA, utilizando como base o modelo de formulário aplicado pelo SEBRAE para organizações ligadas ao setor do artesanato (MASCÊNE, 2010). Como resultado da entrevista, os pesquisadores desenvolveram um mapa mental[53] e um diagrama de *stakeholders* para auxiliar na compreensão inicial da ARA. Na Figura 6 pode-se visualizar as ferramentas utilizadas nas etapas 1 do GODP.

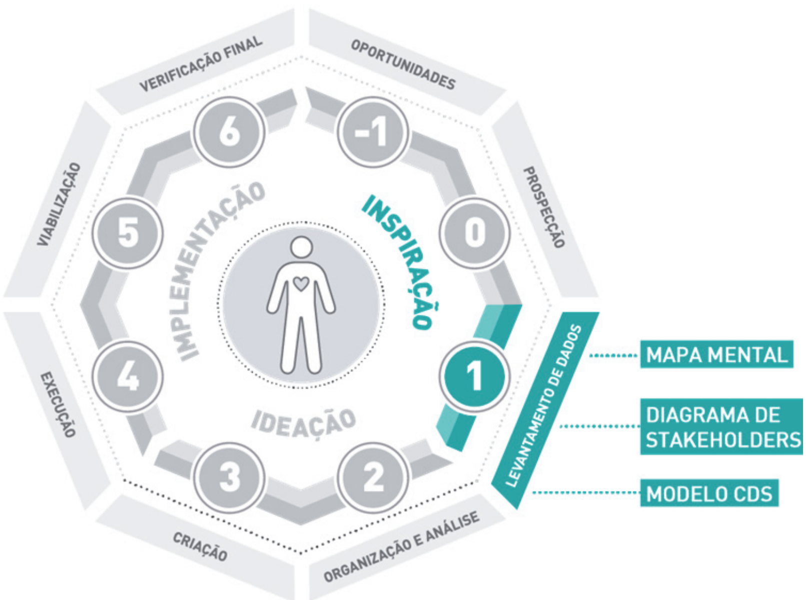

Fig. 6 Ferramentas utilizadas (diagrama de stakeholders, mapa mental e Modelo CDS de diagnóstico). Fonte: elaborado pelos autores com base em Merino (2016).

[52] A OAB Cidadã traz para perto da comunidade Advogados plenamente capacitados a informar, orientar, auxiliar e esclarecer dúvidas sobre os mais variados temas que afetam diretamente a vida das pessoas. Garante também, por meio de parceria, uma série de serviços que fortalecem o exercício pleno de cidadania (OAB/SC, 2016).

[53] Mapas mentais são, segundo Buzan (2005), ferramentas de ordenamento de pensamento, que ajudam na introdução e extração de informações do cérebro. Considerado o criador da técnica, o autor coloca que a ferramenta utiliza cores, linhas, símbolos, imagens e palavras que partem da ideia central.

O mapa mental foi escolhido por ser uma ferramenta que permite a organização de informações, possibilitando, por meio de suas ligações, uma visão geral de um assunto (Buzan, 2005). Para sua estruturação foram abordados 3 aspectos principais: (1) artesão, (2) produção e (3) associação, como pode ser observado na Figura 7 a seguir.

Fig. 7 Mapa mental da associação. Fonte: os autores (2016).

Em seguida, um diagrama de *stakeholders* foi construído (Figura 8), permitindo a compreensão dos contextos interno e externo no qual a associação se encontra, bem como suas relações.

Fig. 8 Diagrama dos stakeholders internos e externos. Fonte: os autores (2016).

Os *stakeholders* internos compreendem os próprios membros da ARA, sendo: presidente, vice-presidente, secretário, 2º secretário, tesoureiro, 2º tesoureiro, conselho fiscal; além dos demais associados. Nos *stakeholders* externos encontram-se a Paróquia Nossa Senhora da Lapa do Ribeirão da Ilha, que contribui para a associação com o empréstimo temporário do salão de festas da igreja; os moradores, destacando-se pescadores e rendeiras, que contribuem com a realização de atividades e eventos voltados para manter viva a tradição açoriana; os turistas, que influenciam diretamente no desempenho econômico da ARA; o comércio local (restaurantes e outras lojas), que contribuem para o estímulo ao turismo e como ponto de apoio e divulgação da associação; e, por fim, os fornecedores de matéria-prima, representados pelas empresas que vendem os materiais utilizados para produção dos artesanatos, além de outras que doam algumas sobras de tecido.

Para finalizar a etapa de levantamento de dados, um formulário foi aplicado com todos os associados com o objetivo de compreender a realidade da ARA sob o ponto de vista de cada integrante.

Em seguida, inciou-se a aplicação do Modelo CDS. Inicialmente, foram definidos os indicadores de cada dimensão (Competitividade, Diferenciação e Sustentabilidade), com base nas informações coletadas.

Para isso, as informações coletadas previamente foram sintetizadas em um quadro (Quadro 1). A partir disso, foi possível definir os indicadores para cada uma das três dimensões.

Quadro 1: Aspectos observados e respectivos indicadores para aplicação no Modelo CDS.

ASPECTOS OBSERVADOS	**INDICADORES**	**DIMENSÕES**
A identidade visual e suas aplicações (sinalização, etiquetas e cartões de visita) não são padronizadas	Identidade	**D**iferenciação
A divulgação da associação e de seus produtos inexiste	Identidade / Mercado	**D**iferenciação / **C**ompetitividade
A comercialização dos produtos é baixa	Econômico	**S**ustentabilidade
Os materiais gráficos utilizados não valorizaram aspectos culturais locais	Identidade	**D**iferenciação
O planejamento e controle de produção inexistem	Produção	**C**ompetitividade
Planejamento a curto, médio e longo prazo da associação inexiste	Econômico / Organizacional	**S**ustentabilidade
A capacitação (cursos, treinamentos) dos associados inexiste	Qualidade	**D**iferenciação
A valorização da cultural local por meio da utilização de matéria-prima e técnicas tradicionais da cultura nos produtos é baixa	Produção / Produtos / Socioambiental	**C**ompetitividade / **D**iferenciação / **S**ustentabilidade
Não há um portfólio de produtos definido	Produtos	**D**iferenciação

O desenvolvimento das técnicas tradicionais é escasso, não havendo também o repasse das técnicas para outras gerações	Qualidade	**D**iferenciação
Busca por referências de outros grupos e produtos é baixa	Produtos / Qualidade	**D**iferenciação
Conhecimento sobre a associação, seu objetivo e razão de existir não estão alinhados entre os membros	Organizacional	**S**ustentabilidade
Dificuldades na precificação, comercialização e geração de renda	Preço Mercado Econômico	**C**ompetitividade / **C**ompetitividade / **S**ustentabilidade
Utilização de materiais retirados do meio ambiente no Ribeirão da Ilha	Socioambiental	**S**ustentabilidade
A sede atual, único local de comercialização dos produtos e contato com os consumidores, não pertence à associação	Mercado	**C**ompetitividade

Fonte: elaborado pelos autores com base em Aguiar (2013).

Na elaboração do Quadro 1 percebeu-se a existência de diversas potencialidades e fragilidades, sendo algumas diretamente relacionadas ao design, enquanto outras abrangiam demais áreas do conhecimento.

Foi possível também notar que alguns dos fatores observados influenciavam em mais de um indicador. Isso mostra que um indicador pode influenciar, direta ou indiretamente, outros indicadores e, consequentemente, outras dimensões.

O Modelo CDS com os indicadores definidos para este estudo de caso pode ser visualizado na figura 9 abaixo.

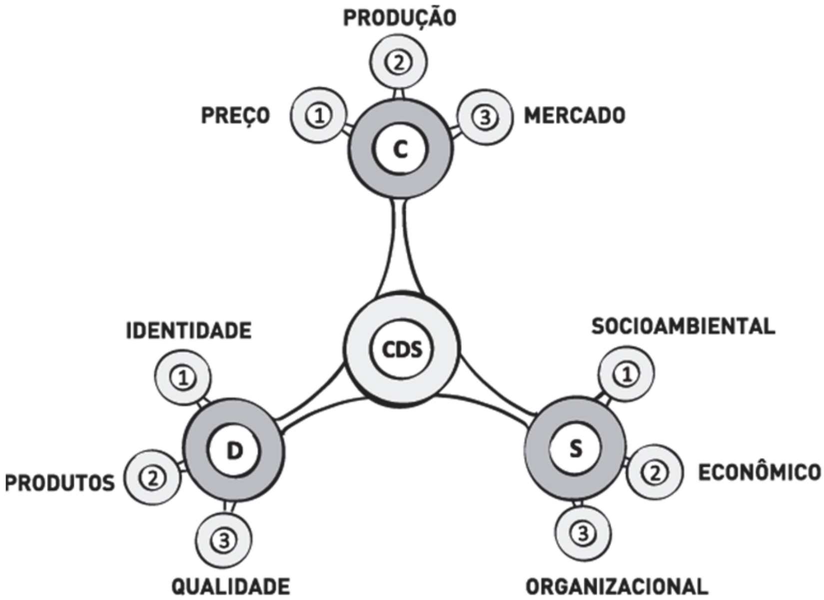

Fig. 9 Indicadores do Modelo CDS definidos para ARA. Fonte: os autores (2016)

Após definidos os indicadores, iniciou-se seu processo de avaliação. Para isso, foram definidos critérios e perguntas de aferição, com respectivas notas para cada resposta. A mensuração foi realizada por meio da Escala Likert (Figura 10), que permite a quantificação das informações qualitativas, tornando o processo de avaliação mais claro.

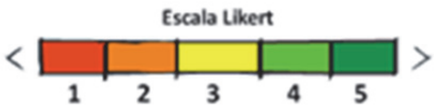

Fig. 10 Escala de mensuração dos indicadores do modelo CDS. Fonte: Merino (2010, p.59).

As respostas das perguntas foram organizadas em nove quadros, feitos para cada um dos indicadores. Um exemplo de como isso foi feito pode ser observado no Quadro 2 a seguir, onde o indicador Identidade (dimensão: Diferenciação) é apresentado.

Quadro 2: Mensuração da dimensão Diferenciação – indicador Identidade.

Dimensão: DIFERENCIAÇÃO				
Indicador	**Critérios**	**Perguntas Aferição**	**Opções de resposta**	**Resposta**
IDENTIDADE	**IDENTIFICAÇÃO**	A associação possui forma própria e padronizada de identificação (marca, etiquetas, embalagens, divulgação)?	[5] Sim, possui sistema de identidade visual completo [3] Parcialmente, possui apenas a assinatura visual [1] Não possui	[1]
		Os materiais gráficos utilizados informam características da produção, dos artesãos e dos produtos?	[5] Informam claramente características da produção, dos artesãos e dos produtos [3] Informam pouco sobre características da produção, dos artesãos e dos produtos [1] Não informam sobre características da produção, dos artesãos e dos produtos	[3]
	VALORIZAÇÃO	Os materiais gráficos utilizados para identificação valorizam a ARA, remetendo à associação, à atividade artesanal e ao contexto cultural no qual está inserida?	[5] Sim, a identificação valoriza a ARA ao fazer referência à associação, à atividade e ao contexto cultural [3] Parcialmente, a identificação remete apenas à associação, à atividade artesanal ou ao contexto cultural [1] Não remete à atividade, nem ao contexto cultural	[3]
	DIVULGAÇÃO	A associação possui formas diversificadas para divulgação (site, redes sociais, folders, portais)?	[5] Sempre [3] Parcialmente [1] Não	[1]

Fonte: Adaptado de Aguiar (2013, p.139).

Após elaborados os nove quadros de avaliação, foi possível mensurar os indicadores e aplicá-los no Modelo CDS, conforme visualizado na Figura 11 a seguir.

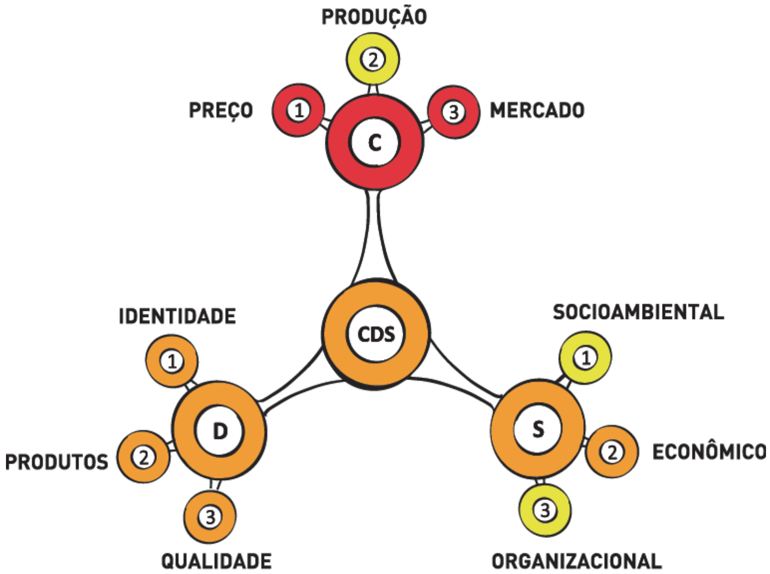

Fig. 11 Mensuração global dos indicadores. Fonte: Aguiar, Merino, Merino, Triska (2015).

A aplicação do Modelo permitiu que a síntese das informações obtidas no diagnóstico fossem apresentadas de forma gráfica, contribuindo para a visualização e compreensão do estágio de desenvolvimento da associação. A partir disso, foram definidos objetivos e estratégias de gestão de design, de modo a impulsionar os pontos fortes identificados e amenizar as fragilidades.

5. Resultados

A partir do diagnóstico das necessidades da ARA, foram definidos os seguintes objetivos de gestão de design, visando atender os objetivos organizacionais:

1) Promover o resgate e a valorização cultural;

2) Garantir a qualidade dos produtos;

3) Fortalecer a imagem da associação;

4) Proporcionar a sustentabilidade econômica;

5) Consolidar a gestão interna.

Para cada objetivo foram definidas estratégias, conforme pode ser visualizado na figura 12. De acordo com Gimeno (2000) a estratégia trata-se de uma previsão de como a empresa alcança seus objetivos em função dos recursos disponíveis e das características do ambiente em que atua.

Como exemplo, pode-se citar o objetivo de promover o resgate e a valorização cultural, que visa atender, principalmente, as fragilidades identificadas nos indicadores de produto, identidade, produção. Para este objetivo foram sugeridas estratégias como:

- Desenvolvimento da identidade visual, ressaltando nas representações gráficas, por meio de formas e cores, as características culturais locais;

- Realização de cursos abordando as técnicas tradicionais da cultura; treinamentos sobre a cultura local para os associados;
- Desenvolvimento de etiquetas com informações da história daquele produto (produtor, técnica e materiais utilizados);
- Estruturação do processo de desenvolvimento de produtos, considerando pesquisas de referência cultural, utilização de materiais locais e de elementos da cultura açoriana; entre outros.

Algumas estratégias mencionadas acima também contemplam outros objetivos, visto que, devido ao enfoque sistêmico e à visualização macro proporcionada pela gestão de design, uma ação acaba interferindo também em outros aspectos. Pode-se citar a realização de cursos e treinamentos das técnicas, que também contribui para a garantia da qualidade dos produtos uma vez que permite aos artesãos conhecerem e aperfeiçoarem sua prática, fortalecendo também a imagem da ARA pelo reconhecimento da qualidade de seus produtos.

Fig. 12 Objetivos e respectivas estratégias de gestão de design. Fonte: os autores (2016).

Para atuação em curto prazo, a estratégia de desenvolvimento da identidade visual foi priorizada devido à necessidade de identificação organizacional, visto que "uma adequada identificação da empresa é uma condição necessária para uma fluida relação entre empresa e cliente" (Gimeno, 2000, p.237).

Fig. 13 Identidade visual desenvolvida para a ARA: cartão de visita, tags e etiquetas para embalagem dos produtos, sacola e cadernos artesanais. Fonte: acervo NGD (2016).

A figura 13 acima ilustra o primeiro resultado da gestão de design com o desenvolvimento da marca gráfica e aplicações de papelaria, *tags* e etiquetas, sacola e cadernos artesanais.

6. Considerações Finais

A gestão de design tem se destacado como meio condutor de novas estratégias nas organizações. No entanto, ainda percebe-se certa dificuldade na sua implantação por parte da organização, que muitas vezes não consegue visualizar a contribuição da gestão de design. Diante deste cenário, o diagnóstico organizacional pode contribuir para a gestão de design ao possibilitar o conhecimento profundo da organização, a análise do cenário no qual se encontra, proporcionando uma atuação com embasamento em dados reais para o trabalho do designer.

A partir do diagnóstico, o profissional poderá avaliar a situação e identificar os pontos de intervenção, propondo estratégias coerentes com os objetivos organizacionais e as necessidades verificadas. Vale ressaltar que o diagnóstico de cada organização é particular, assim como o processo de gestão de design, pois cada instituição possui características próprias.

Destaca-se o Modelo CDS, uma ferramenta utilizada na gestão de design para diagnosticar o estágio de desenvolvimento de uma organização. A ferramenta contribui no sentido de identificar os principais aspectos a serem observados em cada empreendimento e facilita, por meio de sua representação gráfica, a visualização deste estágio. Com o estudo de caso realizado com a ARA, foi possível avaliar a situação da associação para que, a partir disso, fossem propostos objetivos e estratégias de design. Com conhecimento de suas reais necessidades, o designer consegue atuar de forma estratégica, facilitando a tomada de decisão buscando amenizando as fragilidades e alavancando os pontos fortes identificados.

A utilização de outros recursos, como os diagramas, mapas mentais, observações e entrevistas, também podem auxiliar o profissional no diagnóstico de gestão de design. O diagrama de *stakeholders* contribuiu para compreender os diversos atores envolvidos na organização (internos e externos), bem como as relações existentes entre eles, facilitando a compreensão de suas relações diretas e indiretas. A construção do mapa mental permitiu obter uma visão geral da associação e entender seu contexto.

No setor do artesanato ressalta-se a falta de visão estratégica do setor. Nesse sentido, a gestão, com sua característica sistêmica, auxilia estes artesãos a pensar sua atividade de forma estratégica, ampliando seu olhar além da prática manual (operacional), para que aspectos de mercado, tendências de consumo, turismo, entre outros, também sejam considerados em seu planejamento e gestão.

Por ser um setor, em muitos casos, ainda distante de questões relacionadas ao design, inovação e gestão, a inserção da gestão de design deve acontecer de forma gradual. Projetos que mostrem, na prática, os resultados da ação do design, como a otimização de processos e redução de tempo e custos para produção dos artesanatos, ou a identificação e comunicação podem ser priorizados.

7. Referências

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Desarrollo de proceso para elaboración de horma personalizada mediante el uso de herramientas de manufactura flexible. Una visión sistémica.

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Resumen

El presente proyecto busca la generación de un nuevo sistema para el desarrollo de componentes en la elaboración de zapatos mediante la implementación de sistemas computacionales para el diseño, desarrollo, evaluación y fabricación del producto. Particularmente se busca el desarrollo de hormas para menores con Malformaciones Congénitas (MC), que permita a través de su elaboración, la eventual confección de calzado personalizado ajustado a la morfología de las extremidades. El objetivo e intención del presente proyecto, busca atender la malformación de pie equino varo aducto congénito (PEVAC); alteración que compromete el eje transversal del pie, permitiendo con ello, coadyuvar a las técnicas terapéuticas convencionales para el tratamiento de este tipo de anomalías estructurales y/o funcionales.

La metodología utilizada para tal fin, se basa en la aplicación de las herramientas de manufactura flexible (escáner 3D, digitalizador, software CAD, CAE e impresión 3D) para el desarrollo de productos industriales. El resultado obtenido, es un par de hormas adecuadas a la malformación referida, generando una posibilidad importante de abrir un nicho de mercado en el desarrollo y comercialización de este tipo de insumos que aportan valor a un sector industrial todavía tradicional; método y producto que permiten mejorar la calidad de vida de las personas y su inclusión en la sociedad.

Palabras clave: *Hormas calzado, impresión 3d, pié equino varo abducto congénito.*

Abstract

This project aims to create a new system for the development of components in the production of shoes by implementing computer systems for the design, development, testing and manufacturing. Particularly sought is the development of lasts for children with Congenital Malformations (MC), which through its elaboration, allows eventually the making of custom shoes adjusted to the morphology of the extremities. The purpose and intent of this project seeks to address the malformation of congenital clubfoot adduct; alteration compromising the transverse axis of the foot, thereby permitting, contribute to conventional therapeutic techniques for the treatment of this type of structural anomalies and functionality.

The methodology used for this purpose is based on the implementation of flexible manufacturing tools (3D scanner, digitiser, software CAD, CAE and 3D printing) for the development of industrial products. The result is a pair of appropriate malformation referred lasts, generating a significant possibility of opening a niche in the development and marketing of this type of inputs that add value to a still traditional industrial sector; method and product that improve the quality of life of people and their inclusion in society.

Key words: *Shoe lasts, 3D printing, clubfoot*

1. Estado del arte

Desde hace cientos de años, las hormas han servido como réplica del pie humano para la elaboración de calzado, ya sea de madera o de plástico, las hormas tienen la finalidad de sustituir el pie durante la fabricación del calzado para servir como superficie de trabajo, sobre la cual, se agregan y ensamblan componentes que permitirán dar forma y estilo al mismo.

El segundo objetivo consiste en reflejar la orientación de la moda y los requisitos estéticos: es decir, mostrar una forma perfecta. A partir del modelo de zapato elegido, las hormas definen el volumen interior y la forma exterior del zapato elaborado, de acuerdo a las medidas que se han tomado del pie y en base a la morfología que éstos tengan.

Hasta hace algunas décadas, la fabricación de zapatos para cualquier tipología de persona se podría llevar a cabo de manera personalizada; los artesanos de calzado tenían la capacidad y experiencia para llevar a cabo las adecuaciones de hormas para realizar una copia abstracta del pie humano, elemento cuantitativo que suponía un alto valor agregado, ya que los zapatos una vez confeccionados calzaban perfectamente en el pie del cliente, cualidad que le confería al artesano una ventaja competitiva singular por encima de los fabricantes de calzado estandarizado.

El sector del calzado está compuesto por diferentes tipos de clientes y usuarios que tienen diversas necesidades, las cuales se convierten finalmente en criterios de diseño y producción. Tradicionalmente, estos grupos de criterios han tratado de solucionar las necesidades de los segmentos de la población más amplios, dejando de lado las necesidades de grupos de personas quienes por alguna razón, han nacido con alguna malformación que les impide entrar en los estándares de un calzado convencional. La fabricación de productos personalizados se ha configurado como la fuerza impulsora para muchas industrias, especialmente para las relacionadas con la moda, donde se están intentando implementar varias alternativas y métodos para abordar la personalización en masa como es el caso de la empresa Adidas (Adidas, 2015) con sus runner deportivos impresos en 3D. Sin embargo, este tipo de productos, sigue privilegiando los pies "sanos" marginando a la población que cuenta con una deformación.

La fabricación convencional de hormas se realiza en principio mediante la configuración de las características volumétricas y dimensionales a través de software de diseño asistido por computadora (CAD por sus siglas en inglés), información que es procesada por un software de manufactura asistida por computadora (CAM por sus siglas en inglés) para la generación del código "G", fichero electrónico que describirá las secuencias de operación de equipos de control numérico por computadora (CNC) para la operación de equipos de desbaste, las cuales llevarán cabo el proceso de transformación física de los bloques de poliestireno de alta densidad para la obtención de la horma. - CAD)

Las herramientas de manufactura flexible (HMF), entendidas desde el punto de vista del uso de tecnologías sistémicas que permiten la generación de productos complejos y altamente personalizados, han sido incorporadas en sectores no convencionales como las ciencias médicas, obteniendo resultados importantes en los campos de las prótesis y ortesis a través del uso de escáner tridimensionales y digitalizadores, los cuales permiten la obtención de modelos virtuales de geometrías corporales, información que a través de su edición por sistemas CAD, permiten la obtención de ficheros electrónicos imprimibles en sistemas de manufactura aditiva o prototipado rápido (PR); equipos de impresión en 3D que de acuerdo a los parámetros de calidad y tipo de material, generan productos fiables para el uso corporal cotidiano.

El pie equino varo aducto congénito (PEVAC), es una malformación musculo esquelética común. Ciertamente hay factores etiológicos que no han sido bien entendidos. (Matthew B. Dobbs, 2009) Se sabe que puede ser multifactorial y no existen reportes del padecimiento de manera idiopática en productos menores a las siete semanas de gestación (Vázquez 1987). En su gran mayoría se presentan de manera esporádica, sin embargo existen elementos asociados que se relacionan con la deformidad y que son bien conocidos (historia familiar, genética, factores estacionales, factores mecánicos intrauterinos, miogénesis anormal, causas neuromusculares entre otras) (Staheli, 2006)

El PEVAC es de las malformaciones musculo esqueléticas más comunes; los reportes de prevalencia van desde 0.7 hasta 6.8 por cada 1,000 nacidos vivos. Tomando como base la tasa de nacimientos en México, se estima que al año hay 5,600 nuevos casos de esta deformidad (Torres, 2010). Los problemas ortopédicos del pie en este tipo de niños difícilmente son devueltos y recuperados a su posición y/o forma natural, obligando a usar un calzado que permita además de la protección, un soporte adecuado que posibilite emprender la marcha con el menor daño en la estructura del pie.

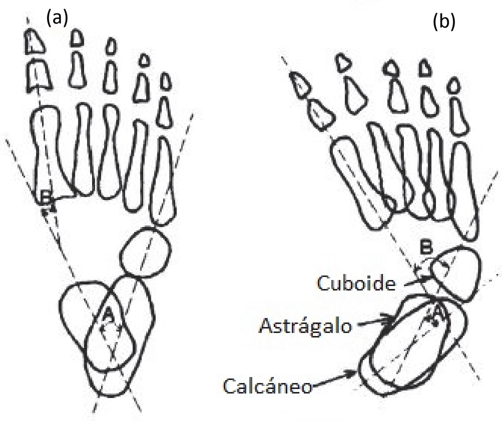

Fig. 1 Vista superior (a) pie normal, (b) pie deforme.
Fuente: E. Vijayaragavan (2014)

2. Material y métodos

Para el desarrollo del proyecto se llevaron a cabo investigación de tipo documental y de campo, en las que se obtuvo información de tipo cuantitativa respecto a las características a cumplir por parte de la horma una vez impresa, y en segundo término, en relación al padecimiento PEVAC sobre un caso real: niña de 9 años con PEVAC que ha sido intervenida quirúrgicamente para la extensión de su tendón de Aquiles.

Fig. 2 Método de trabajo. Fuente: Elaboración propia (2016)

Referente a la investigación de campo, se identificaron los esfuerzos y tensiones de la horma durante el proceso de fabricación del calzado en la empresa Diseños y accesorios S. A. de C.V., empresa de tamaño mediano (245 trabajadores) ubicada en la Cd. De Guadalajara Jalisco, México, cuya fabricación promedio es de 2,000 – 2,500 pares semanales.

Los esfuerzos se documentaron en base a las lecturas de cada uno de los equipos y procesos más significativos que se emplean en la fabricación del calzado, mismos que someten a la horma a diversos esfuerzos y compresiones durante el armado de sus componentes de acuerdo a como se muestra en la figura no. 3.

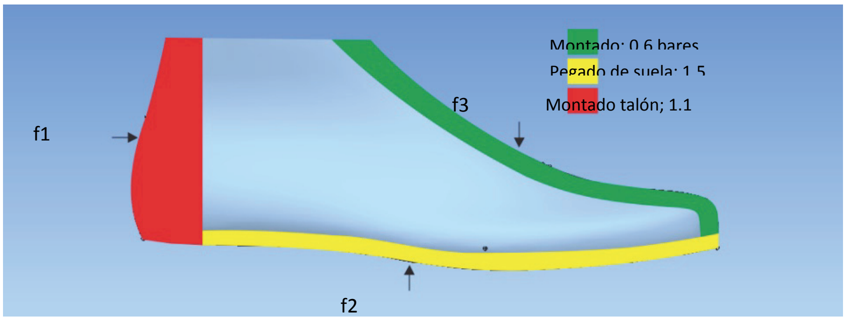

Fig. 3 Distribución de esfuerzos por proceso.
Fuente: Elaboración propia (2016)

Respecto a la digitalización de los pies, se generó un molde elaborado por la superposición de capas de vendas de algodón recubierta de una capa de yeso grado médico para cada pie tal como se muestra en la figura número 4. Una vez fraguado el molde y retirado del pie se vertió sulfato de calcio (yeso cerámico) para la obtención de las réplicas.

Fig. 4 Moldes de yeso cerámico. Fuente: Elaboración propia (2016)

Posteriormente fueron sometidos al proceso de digitalización mediante el uso de un brazo digitalizador marca MicroScribe con una precisión de +/-0.0508 mm. La captura de la geometría se realizó mediante la implementación de un software CAD Rhinoceros versión 5.0 tal como se muestra en la figura número 5.

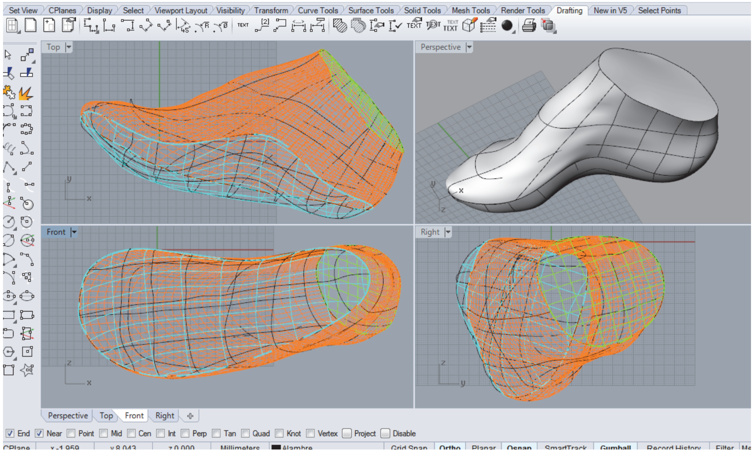

Fig. 5 Digitalización del pie. Vistas generales. Rhino V 5.0. Fuente: Elaboración propia (2016)

A partir de la obtención de la geometría del pie se desarrolló la horma personalizada en base a la utilización de método AK64 a través del cual se determinaron los siguientes parámetros para la configuración de la horma: longitud total (talla), recio, cintura, empeine, ancho de plantilla interno, ancho de plantilla externo, ángulo de dedo gordo, ángulo de dedo chico, ángulo de talón y grueso de punta. En referencia al spring (altura de la punta respecto al suelo) y al tipo de punta se consideraron en base a la tendencia actual.

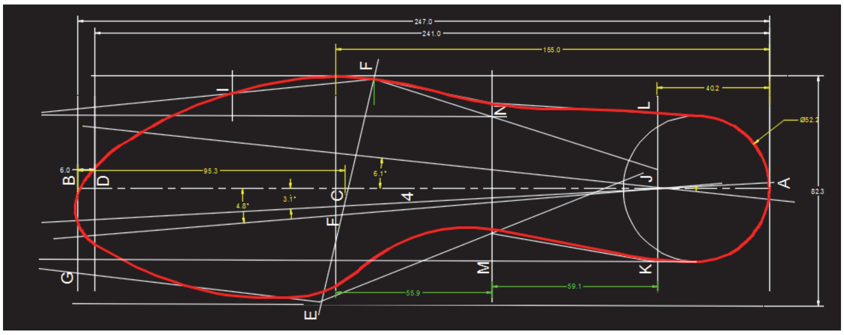

Fig. 6 Desarrollo de planta de horma mediante la aplicación de método AK64. AutoCad 2016 – Autodesk.. Fuente: Elaboración propia (2016)

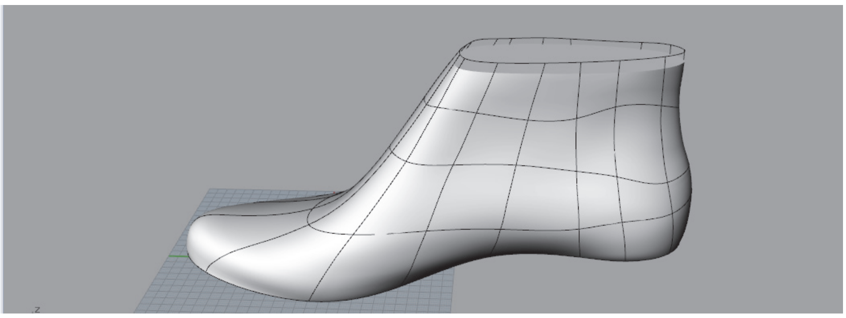

Fig. 7 Desarrollo volumétrico de horma en Rhino V 5.0. Fuente: Elaboración propia (2016)

La factibilidad técnica de la horma se comprobó mediante la elaboración de una simulación de esfuerzos a través del uso de módulo de software CAE de análisis por elemento finito (FEA por sus siglas en inglés) considerando los esfuerzos a los que se somete la horma durante las distintas fases de su proceso de elaboración. Para tal efecto se consideró una estructura interna de tipo romboide de 10mm de lado con espesor de pared de 0.5 mm y una capa exterior de 0.5 mm. El material considerado fue el acrílonitrilo butadieno estireno (ABS) con un módulo de tracción de 2.1 – 2.4 GPa. Los esfuerzos tangenciales a los que se sometió la horma fueron 15 N dando como resultados la concentración de esfuerzos en sus zonas con mayor tensión 1.5 Mpa., los cuales están por debajo del módulo de plasticidad del material.

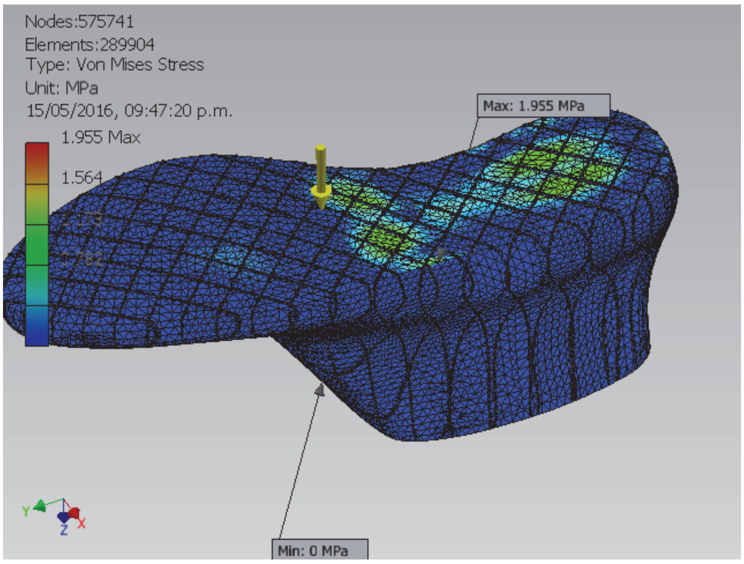

Fig. 8 Resultados de evaluación FEA en Inventor 2016- Autodesk. Fuente: Elaboración propia (2016)

La impresión de la horma se realizó mediante la utilización de un equipo de impresión 3D de modelado por deposición fundida (FDM por sus siglas in inglés) marca Airwolf, con velocidad de impresión de 25 mm/s, temperatura de cabezal de 240°C y de la cama de impresión de 115°C. El espesor de capa de .25 mm. y un espesor de pared de 0.5 mm. El tiempo de elaboración fue de 7.3 horas consumiendo un total de 144 gramos de material.

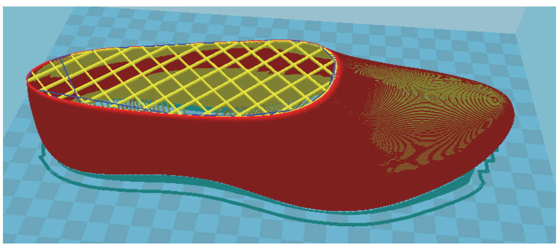

Fig. 9 Representación para impresión 3D. CURA V2.0 Fuente: Elaboración propia (2016)

Fig.10 Horma impresa en 3D. Fuente: Elaboración propia (2016)

3. Resultados

Obtención de par de hormas personalizadas para niña de 9 años con PEVAC, elaboradas de polímero ABS mediante el uso de impresión 3D, cuya estructura y características técnicas del material, permitirá su uso para la eventual fabricación de calzado en una empresa del ramo con equipos industriales con presiones de hasta 1.5 Bares.

4. Conclusiones

Una vez seleccionado el tipo de diseño de horma en base a las preferencias estéticas de la menor atendida, se procedió a la adecuación de la geometría en base a las dimensiones de sus pies. En este sentido, para el desarrollo de la geometría de la horma, sería en extremo útil la existencia de un sistema como el equipo YETI 3D scanner de la marca VORUM (VORUM, 2016) que permitiera la captura de las dimensiones de las extremidades con PEVAC adaptándolas a las hormas ya existentes, con la finalidad de generar con mayor rapidez el fichero para impresión en 3D. De esta manera se podrían potencializar dos herramientas para la generación más expedita de las hormas atacando a un nicho de mercado hoy no atendido.

5. Trabajos futuros

A partir de la obtención de la geometría del pie de la menor con PEVAC para la fabricación de su horma personalizada, hay la posibilidad de llevar a cabo un proceso similar para la elaboración de plantillas, ya que en la actualidad, hay materiales imprimibles en 3D con las características de flexibilidad y comodidad que permitirían su uso cotidiano.

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El modelado físico del espacio de diseño concurrente como recurso didáctico para el análisis, exploración y mediación entre lo abstracto y concreto.

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Resumen

Las metodologías de diseño de productos orientadas a potenciar la creatividad hacia la innovación requieren apoyarse en métodos y herramientas para pasar de la etapa divergente de análisis a una convergente de síntesis que se presenta al momento de abordar el diseño conceptual. El modelo simplificado para abordar el diseño conceptual planteado por Hernandis & Briede (2009), permite modelar el espacio del diseño del producto desde una perspectiva teórica , mapeando e integrando los requerimientos y condicionantes a tener en cuenta en esta etapa de desarrollo y servir como guía de referencia, a través de un esquema visual integral, que sirve como guía o mapa teórico al momento de configurar y caracterizar la propuesta de diseño conceptual. Este proceso, constituye un ejercicio cognitivo, que requiere un alto grado de abstracción que muchas veces dificulta y desalienta a los estudiantes, ya que no son capaces de alcanzar a identificar sus ventajas y mas aún conectarlas con la aplicación real.

Como estudio de caso, en el diseño y desarrollo de productos abordado por el Taller de Diseño Centrado en el Usuario [DCU] de tercer año de la carrera de diseño industrial de la Universidad del Bío-Bío, se ha implementado la metodología sistémica a modo de guiar el proceso y la toma de decisiones en el modelado conceptual. Para lograrlo se aplicó la secuencia metodológica de Hernandis & Briede (2009), con la cual, a la hora de modelar el espacio de diseño, los alumnos además de esquematizarlo en una lámina, lo han maquetado tridimensionalmente. Este ejercicio permitió reforzar el proceso de análisis y evidenciar la tensión entre la representación teórica y la representación física gracias al tiempo de construcción y a la representación de las cualidades geométricamente. Esto permitió a los alumnos entender la conexión entre el modelado teórico y su aplicación en el diseño final, la desagregación geométrica de volumen, superficie y límite de contorno y su traducción a la dimensión concreta y paramétrica del producto. El modelo físico del espacio del diseño puede estimular y apoyar la exploración de alternativas como recurso mediador de los atributos teóricos y su resolución tangible en el plano del producto. Se constata que incluir esta etapa facilita el "modelado del espacio del diseño" así como la gestión e integración de variables y atributos del producto antes de generar la propuesta de diseño.

Palabras Clave: *Diseño Conceptual, Modelado Concurrente, Maqueta, Espacio de Diseño, Educación en Diseño.*

Abstract

Product design methodologies supporting creativity and innovation require tools and methods that bridge divergent stages of analysis with concurrent stages of synthesis during conceptual design. The simplified model for conceptual design presented by Hernandis & Briede (2009) works from a theoretical perspective, allowing designers to model the design space of a given product by mapping and integrating diverse requirements and conditions. The resulting reference guide or theoretical map presents a visual, integrated framework for configuring and characterizing the conceptual design proposal. This is, above all, a cognitive exercise. It requires a high level of abstraction, which may challenge and discourge design students who are unable to identity the benefits of the task at hand and apply it to real-world situations.

This paper presents a case study of the User-centred Design (UCD) Workshop for third-year industrial design students at the Universidad del Bío-Bío. A systematic methodology for product design and development was implemented in order to guide the process of design and decision-making during conceptual modelling. Specifically, the sequential methodology proposed by Hernandis & Briede (2009) was applied. Here, students were asked to outline the design space on a sheet of paper and then create a three-dimensional model. This exercise ultimately strengthened students' ability to analyse and articulate tensions between the theoretical representation and the physical representation of a product. This was aided by the time allotted for construction and the task of geometric modelling. Overall, the activity provided students with a greater understanding of the relationship between theoretical modelling and its application to design, the geometric disaggregation of volume, surface area and contour limits, and its application to the concrete dimensions and parameters of a product. Physical modelling of the design space may help to encourage and support exploration of alternative approaches to design, thereby bridging the gap between theoretical product attributes and the final, tangible product solution. Results confirm that this stage enables the "modelling of the design space" as well as the development and integration of product attributes and other variables prior to developing a design proposal.

Keywords: *Conceptual Design, Concurrent Modelling, Model, Design Space, Design Education.*

1. Introducción

La relación entre la educación superior y el mercado laboral no es evidente en nuestro contexto, por lo que los alumnos en su proceso de enseñanza aprendizaje no desarrollan las competencias que le permitan insertarse de manera efectiva en el campo laboral y reconocer las particularidades de su entorno. En el caso del diseño, la enseñanza de éste se ha basado tradicionalmente a través de una metodología proyectual (Mabardi ,2012), donde la reflexión durante la práctica (Schon,1983) ocurre en un contexto de aprendizaje experiencial.

Por otro lado, el trabajo en proyectos ha sido ampliamente utilizado en estos programas formativos para ayudar a los alumnos a integrar, aplicar y expandir los conocimientos adquiridos en clases teóricas en su curriculum (Dym et al., 2005).

Por lo anterior, la carrera de Diseño Industrial en la Universidad del Bío-Bío en Chile, ha incorporado como estrategia en su proceso formativo el aprendizaje a partir del desarrollo de proyectos con encargos definidos, a fin de promover la formación de las competencias esperadas en el programa de estudio (Ballerini y otros. 2009) con una combinación de las habilidades, y del conocimiento necesario para realizar una asignación particular (SDE, 2001). Esto permite construir nuevo conocimiento, para satisfacer el encargo asignado (Voorhees, 2001; Walter, 2000).

El aprendizaje por proyectos es coincidente con el enfoque de aprendizaje por competencias, que busca facilitar la inserción de los estudiantes en el mundo laboral, permitiéndoles experimentar, a lo largo de los cinco años de carrera, diversos niveles y tipos de intervenciones similares a las del mundo laboral, avanzando por diversos énfasis (observación, producción, usuario, negocio), además de conocer y desarrollar la capacidad de interacción social desde su profesión, permitiéndoles desarrollar las competencias para responder a las nuevas necesidades del entorno (Barberá et al., 2008).

2. Contextualización metodológica

El diseño centrado en el usuario, ubica al ser humano como centro, inicio y fin del proceso de diseño [17]. En contexto específicos, como el diseño de las aplicaciones web, considera al usuario un sujeto clave al momento de evaluar, sugerir y hasta diseñar parte de las aplicaciones [18]. Si lo llevamos al diseño de productos existen variados métodos para registrar, sistematizar y utilizar la voz del usuario [19].

El presente trabajo documenta parte de la experiencia, específicamente el diagnóstico, en el Taller "Diseño Centrado en el Usuario" [DCU], parte del proceso formativo de la carrera de Diseño Industrial de la Universidad del Bío Bío, cuyo enfoque metodológico y apuesta busca responder a las características específicas contexto y asumir el rol social del diseño, explorando posibles áreas de desempeño a partir del estudio de comunidades vulnerables y necesitadas (Briede et al. 2011). En este taller se desarrolla la metodología DCU, cuyo énfasis es diseñar un producto, basándose en requerimientos y necesidades de un usuario real en su contexto igualmente real (Lim et al., 2012). Para ello se implementa un enfoque participativo (referencia) que busca integrar activamente al individuo en cuestión, durante el proceso de diseño cambiando del paradigma de diseñar "*para la gente*" a diseñar "*con la gente*" .

Se busca abordar una temática altamente relevante para la comunidad vulnerable y que es solicitada por los miembros de ésta. En la propuesta de diseño debe atender a la problemática social presente que emerge, con una mirada contextualizadora que considere el contexto a nivel país y regional, abordando la estrategia y enfoque de diseño inclusivo (Coleman et al., 2007), a fin de considerar y ser capaz de trabajar con contextos en riesgo social de nuestro país..

En la experiencia que se documenta en este estudio, es el "emprendimiento callejero" la temática y contexto de estudio abordado, enfocándose en el estudio del fenómeno cada vez en aumento de vendedores ambulantes, no convencionales que buscan acceder a un ingreso, vendiendo una diversidad de productos manufacturados, tales como artesanías, alimentos, joyas, etc. Estos trabajadores, son parte del grupo de trabajadores que pertenecen a la economía informal, que se caracteriza por carecer de contrato, dedicarse a actividades de subsistencia y carecer de protecciones jurídicas y reglamentarias, lo que los convierte en trabajadores de alta vulnerabilidad (Moyano, Castillo y Lizana, 2008)

El objetivo principal de este taller fue aplicar la metodología de diseño centrada en el usuario para diseñar un producto que respondiera a las necesidades de este grupo de trabajadores, contando como objetivos específicos: 1) Comprender y aplicar métodos DCU en el diseño de un producto, 2) Integrar al usuario en el desarrollo del proyecto tanto en las de definición del problema como en el proceso de diseño como proceso de ideación, selección y co-creación, y 3) Comprender, valorar y vivenciar el rol social del diseño ejerciéndolo con responsabilidad social.

3. Material y Método

El presente trabajo documenta los resultados de la eplicación del enfoque sistémico en el Taller de Diseño Centrado en el Usuario [DCU] durante la etapa de modelado conceptual. La investigación documenta la implementación de este enfoque durante la etapa de diseño conceptual del taller [DCU] (Briede et al., 2014). En este, se consideró el desarrollo de modelos conceptuales para el análisis desagregado del producto en los subsistemas fundamentals de forma, función y ergonomía (Hernandis y Briede, 2009). En la siguiente tabla se puede observar el momento, dentro de la secuencia de actividades del taller, en que se aplicó la metodología.

Tabla 1. Secuencia de Etapas abordadas en el taller. Fuente: Elaboración Propia

Etapa	**Métodos y Herramientas**
Inmersión	Observación
Invitación	Entrevista informal
Observación del Contexto	Observación /Perfil de Usuario. Secuencia Diaria.
Enfocar Problema	Card Sorting/Jerarquización
Diseño Conceptual	Propuesta Conceptual **Métodología Sistémica**
Validación y Testeo	Prototipo, Check list, Entrevistas.

3.1 Productos esperados de la actividad:

El taller [DCU] del año 2013 abordó la problemática del microemprendimiento callejero como foco de estudio. En dicha occasion el taller se dividió en grupos formados por 3 a 4 estudiantes y así poder abordar las etapas del proyecto en cuestión. Para ilustrar la aplicación de las fases claves del enfoque propuesto se utilizará el proyecto desarrollado por las alumnas Maureen Muñoz ,Carmen Pereira y Melissa Quezada.

Tema: Implementación objetual para apoyo de microemprendimientos.

Caso: Exhibición de ponchos en paredes de material ligero.

Propuesta Conceptual: Exhibidor de sobreposición radial para el almacenaje colgado de ponchos en tiendas de material ligero.

Objetivo General: Mejorar la exhibición de ponchos en tiendas de material ligero.

Objetivos Específicos:

- Generar orden en el almacenamiento de ponchos.

- Mejorar la visualización de cada poncho.

- Lograr que la exhibición de los ponchos sea completa, de tal modo que salga del exhibidor sólo al momento de prueba.

Estudio del Contexto y Observaciones:

Fig. 1 Observaciones de Contexto Proyecto Colgador. Fuente: Maureen Muñoz ,Carmen Pereira y Melissa Quezada (2013).

La realización de la etapa de diseño conceptual considerando el enfoque sistémico, implicaba la realización de los siguientes productos:

Análisis del Estado del Arte: se busca realizar un estudio de mercado respecto a los productos y tipologías como colgadores, tipo de prendas, ponchos, etc.

A través de una matriz que considera evaluar los aspectos atingentes a la forma, función y ergonomía pero de forma desagregada, considerando además por cada uno de ellos las ventajas y desventajas que pueden presentar.

	Forma		Función		Ergonomía	
Propuesta ganadora del DATUM	Ventaja	Desventaja	Ventaja	Desventaja	Ventaja	Desventaja
	-Mayor cantidad de almacenaje. -Aprovechamiento de espacios destinados para la exhibición.	- Condiciona que el poncho se tenga que descolgar para ser exhibido por completo.	-Mediante lo radial se puede exhibir de manera más completa el poncho.	-Al exhibir un solo poncho la visualización de éste es de manera horizontal, no se percibe la caída del poncho.	-Movimiento radial da fluidez al momento de exhibir un poncho.	-Los colgadores a mayor altura hacen aumentar el esfuerzo físico del usuario al exhibir los ponchos.
	Permite ser ubicado en toda el área del techo.	-El tamaño del exhibidor permite poca cantidad de ponchos exhibidos.	-Optimización de los espacios al estar adosado al techo.	-El poncho no se exhibe de manera frontal.	-La altura del exhibidor está al alcance del usuario.	Colgadores se desmontan al exhibir los ponchos, produciendo un sobreesfuerzo físico del usuario.
	-La cantidad de colgadores se puede adaptar a la cantidad de ponchos que se desea exhibir.	-La forma del colgador hace difícil el montaje y desmontaje del poncho.	- La materialidad flexible del cordón permite una exhibición completa, sin la necesidad de descolgar.	-El sistema retráctil interno no es de fácil mantención.	-El colgador se regula a la altura requerida.	Al quitar o poner los colgadores se produce un sobreesfuerzo físico del usuario.
	-Estructura ligera. -Optimización de espacio en uso y desuso.	-El soporte de exhibición condiciona la forma de los ponchos	-Lo regulable permite la personalización de la exhibición de los ponchos.	-Es de difícil mantención. El poncho no se exhibe completamente.	La altura se puede regular, permitiendo que al exhibir, colgar y descolgar el poncho se produzca un movimiento más óptimo.	-El poncho debe ser desmontado para su exhibición completa.
	- El exhibidor permite ser adosado a la pared a la altura requerida.	- El soporte de exhibición condiciona la forma de los ponchos. -Poca cantidad de soportes para la exhibición.	-La movilidad y verticalidad permite la exhibición de todos los ponchos, sin descolgarlos.	-Al exhibir los primeros ponchos se deben correr todos los de encima.	- El acto de colgar y descolgar es ágil. -La altura del exhibidor estará acorde a la altura del usuario.	- Al exhibir los ponchos se debe descolgar y colgar muchas veces, produciendo un acto repetitivo.

Fig. 2 Análisis del estado del arte. Fuente: Maureen Muñoz ,Carmen Pereira y Melissa Quezada (2013).

Ajuste de propuesta conceptual (opcional): En base al análisis del estado del arte y los productos existentes se ajusta la propuesta conceptual si llegara a ser necesario para que sea coherente y que constituya un aporte y novedad al contexto de la problemática.

Definición de modelos conceptuales. Considerando la propuesta conceptual y los atributos seleccionados del estado del arte se procede a definir los atributos y características del producto desagregadamente en forma, función y ergonomía y luego asociarlos a tres tipologías de representaciones geométricas:Volumenes, Superficies y Limites de Contorno.

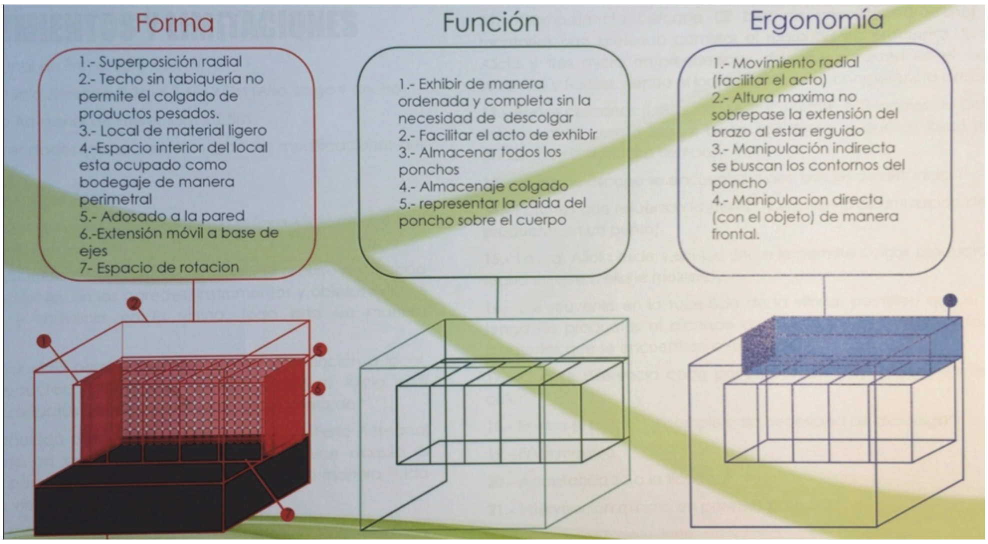

Fig. 3 Modelos Conceptuales. Fuente: Maureen Muñoz ,Carmen Pereira y Melissa Quezada (2013).

3.2. Integración del espacio del diseño

El proceso se inicia valorando cada atributos de cada subsistema (forma,función y ergonomía) y las correlaciones que entre estos pueda existir. Junto con eso se esquematiza la integración en una representación análoga del espacio del diseño donde se van representando las geometrías principales de los atributos seleccionados.

En este caso particular, como siguiente etapa los estudiantes tuvieron que construir una maqueta del espacio del diseño. Esta maqueta en baja fidelidad buscaba representar físicamente las geometrías representantes de los atributos fundamentales del producto: Volúmenes, Superficies y limites de contornos de la forma, función y ergonomía). Este insumo tangible, les facilitó la identificación de los atributos y de sus posibles consecuencias y efectos dentro de la propuesta de diseño.

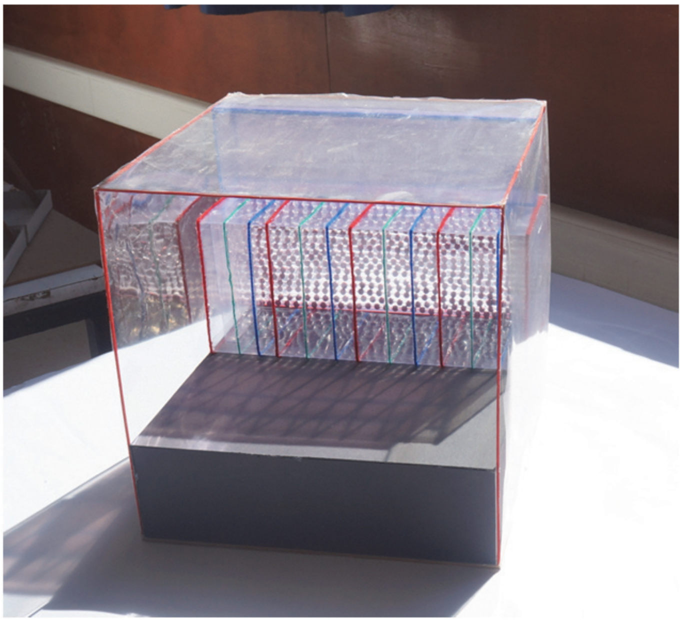

Fig. 4 Maqueta Espacio del Diseño Fuente: Maureen Muñoz ,Carmen Pereira y Melissa Quezada (2013).

3.3. Desarrollo Formal y Propuesta Final

Considerando la modelación del espacio del diseño así como los objetivos y requerimientos se procedió a explorar las posibles formas y configuraciones del producto tal como se puede observar en las figuras 5 y 6. Considerando la opinión y retroalimentación del usuario dentro de la elección, desarrollo y refinamiento de la propuesta de diseño.

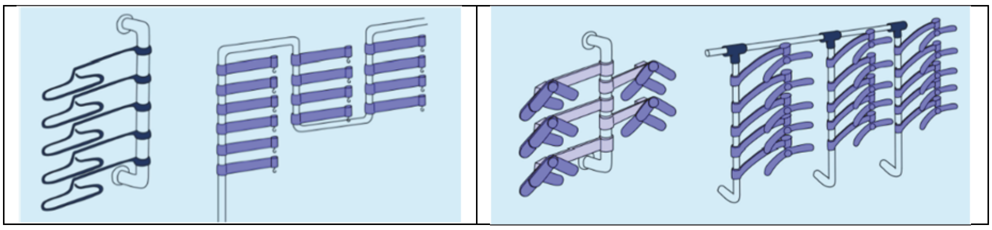

Fig. 5 Desarrollo Formal. Fuente: Maureen Muñoz ,Carmen Pereira y Melissa Quezada (2013).

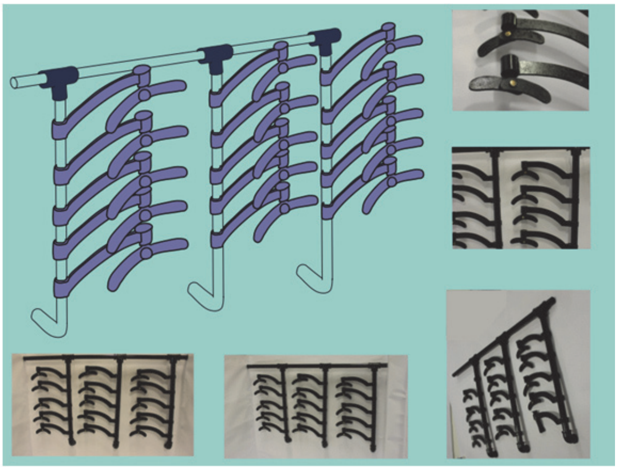

Figura 6. Prototipo de propuesta de diseño. Fuente: Maureen Muñoz ,Carmen Pereira y Melissa Quezada (2013).

3.4. Estudio

Para caracterizar los resultados de la implementación del enfoque sistémico en la etapa de diseño conceptual se realizó un estudio de alcance descriptivo, con una orientación exploratoria, mediante un análisis pre-experimental. Para recolectar los datos se aplicaron diferentes encuestas al final del taller, donde se evaluó la percepción de los estudiantes participantes respecto a la aplicación del enfoque sistémico en el diseño y desarrollo de productos.

La encuesta fue aplicada a 15 estudiantes de 3er año de la carrera de Diseño Industrial de la Universidad del Bío Bío, la única universidad estatal de la ciudad de Concepción, Chile. Estos alumnos cursaban el taller [DCU] como parte de sus asignaturas obligatorias. Fueron seleccionados mediante muestreo no probabilístico por accesibilidad y representan el 54,3 % de los estudiantes que cursaron la asignatura.

El cuestionario aplicado en el proceso de encuesta incluía dos partes, una centrada en la percepción de la metodología sistémica y su utilidad en el proceso de diseño, y la segunda referida a la utilidad específica de dos herramientas empleadas durante la actividad: la representación de atributo en forma de geometrías y la construcción de una maqueta tridimensional. La encuesta presentaba nueve preguntas, seis de la primera parte y tres de la segunda parte del cuestionario, exhibiendo afirmaciones sobre el funcionamiento de la actividad. Para responder, los estudiantes debían emplear una escala Likert de cinco alternativas (1: Muy en desacuerdo; 2: En desacuerdo; 3:Indiferente; 4: De acuerdo; 5: Muy de acuerdo), según su percepción sobre lo vivenciado, Tabla 2. El cuestionario pasó previamente por juicio de expertos.

Tabla 2. Cuestionario utilizado en la encuesta de percepción

	1	2	3	4	5
1. Aplicar la metodología sistémica me facilitó el proceso de análisis del producto a diseñar.					
2. El análisis desagregado de las variables en forma, función y ergonomía me permitió identificar aspectos claves del producto.					
3. La metodología sistémica me permitió llevar un registro del proceso que permita fundamentar las decisiones.					
4. El modelo sistémico me ofreció una referencia teórica con los requerimientos y aspectos a tener en consideración al momento de generar la propuesta de diseño formal					
5. El análisis me permitió diferenciar los atributos o variables asociados a forma, función y ergonomía					
6. La metodología sistémica me ayudo a comprender mejor el problema					
I. Representación del Espacio del Diseño:					
1. La representación de los atributos en forma de geometrías me permitieron comprender la relación entre los atributos identificados dentro del espacio.					
2. Construir la maqueta tridimensional me permitió identificar la implicancia en el contexto real de los atributos estudiados.					
3. La maqueta del espacio de diseño fue un insumo que facilitó la comunicación y colaboración con los miembros del equipo.					

4. Resultados

En el siguiente apartado se exhiben los resultados obtenidos a partir de las opiniones y percepciones de los estudiantes con respecto a la contribución del uso de la metodología sistemática y la realización de la maqueta del espacio del diseño en la solución final de diseño.

A continuación se detallan los resultados según los siguientes apartados:

4.1. Evaluación global de la metodología sistémica:

En cuanto al uso de la metodología sistémica, un 40% de los estudiantes está de acuerdo con que aplicar la metodología sistémica facilita el proceso de análisis del producto a diseñar, seguido por un 33% que está muy de acuerdo con la aplicación de la metodología sistémica, Figura 7.

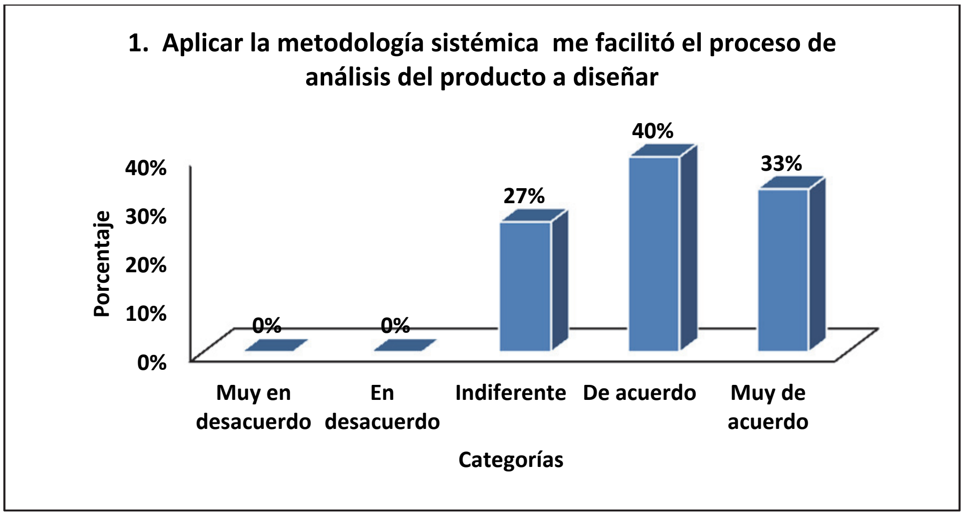

Figura 7. Evaluación de la utilidad de la metodología sistémica para facilitar el proceso de análisis del producto a diseñar.

Por otro lado, un 53% de los encuestados está muy de acuerdo con que el análisis de las variables en forma, función y ergonomía permite identificar aspectos claves del producto. Sin embargo, un 13% de los encuestados se reportó indiferente y un 7% se considera en desacuerdo, Figura 8.

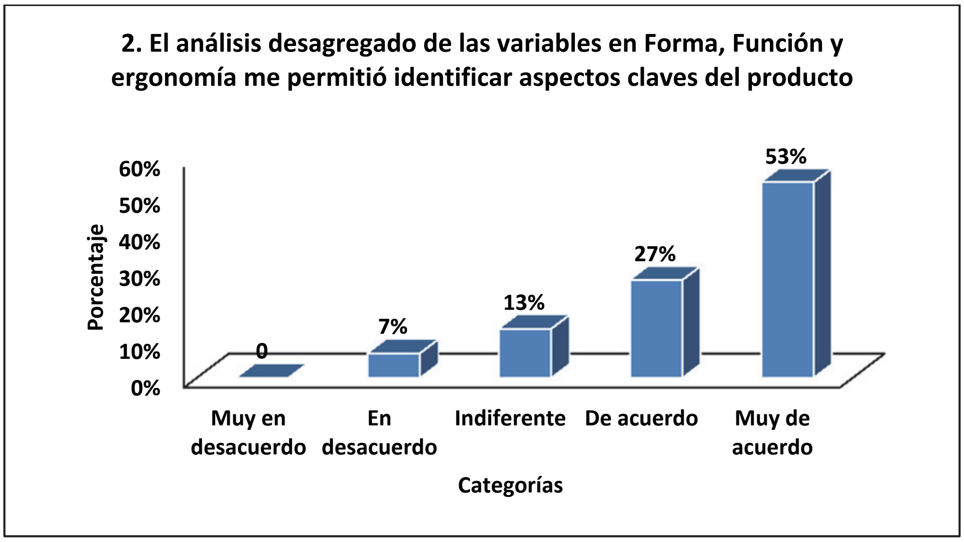

Figura 8. Evaluación de la utilidad del análisis para identificar aspectos clave del producto diseñado.

En cuanto a si la metodología sistemática permite registrar el proceso de cara a una toma de decisiones fundamentadas, un 74% de las respuestas de los ex alumnos del curso se encuentra en las categorías de acuerdo o muy de acuerdo, Figura 9.

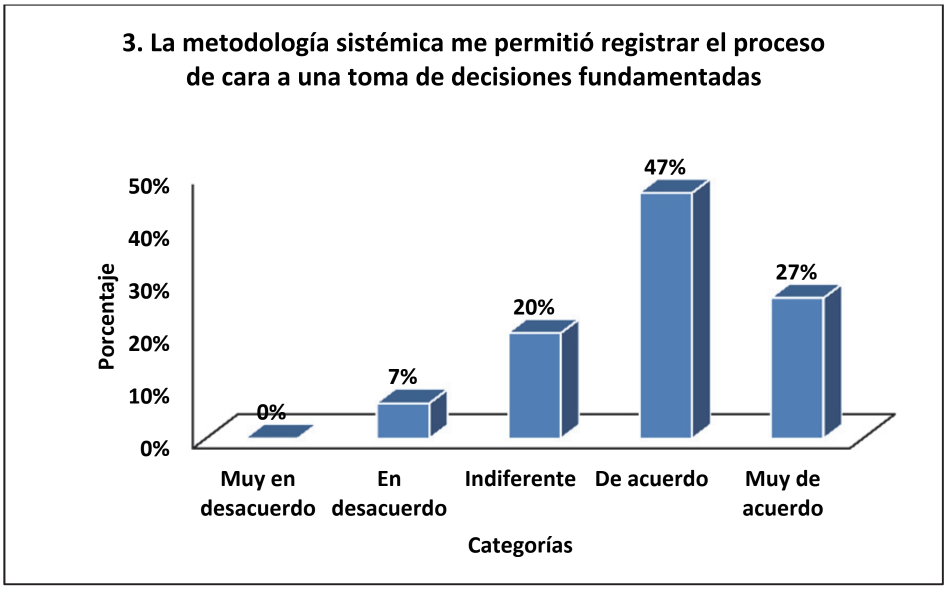

Figura 9. Evaluación de la utilidad de la metodología sisémica para registrar el proceso y fundamentar la toma de decisiones.

El 83% de los estudiantes está de acuerdo o muy de acuerdo en que el modelo sistemático ofrece una referencia teórica con los requerimientos y aspectos a tener en consideración al momento de generar el diseño conceptual, Figura 10.

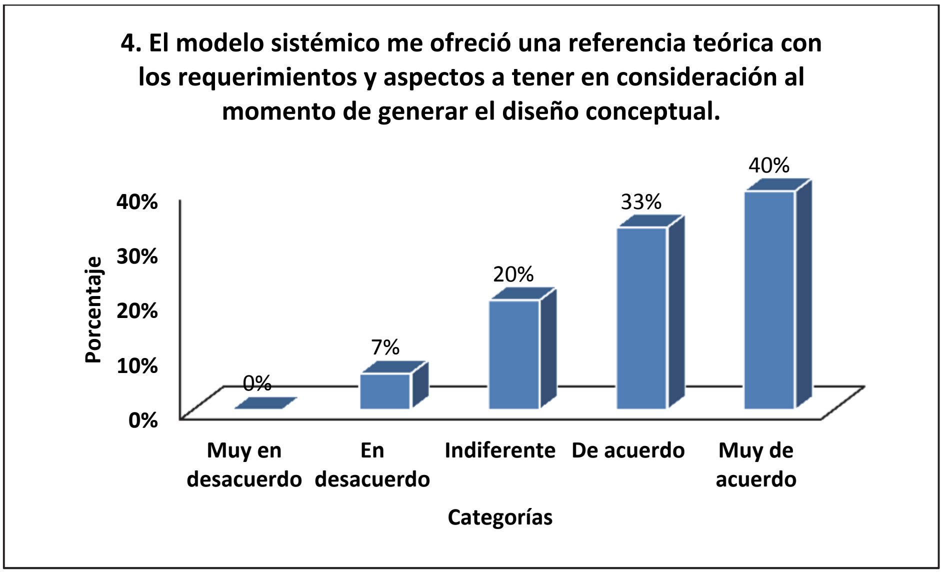

Figura 10. Evaluación de la utilidad de la metodología sistémica para ofrecer una referencia teórica.

El 69% de los encuestados encuentra que el análisis permite diferenciar los atributos o variables asociadas a forma, función y ergonomía y un 15% que esta acuerdo con esta afirmación, Figura 11.

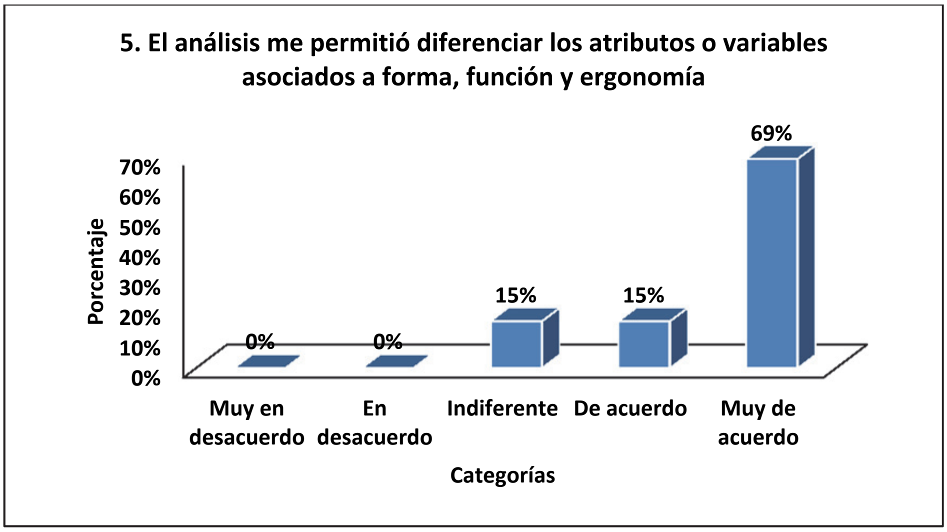

Figura 11. Evaluación de la utilidad de la metodología sistémica para diferenciar atributos asociados a forma, función y ergonomía.

Un 69% de las respuestas de quienes cursaron la asignatura estuvieron de acuerdo o muy de acuerdo en que la metodología sistemática ayuda a comprender mejor el problema, Figura 12.

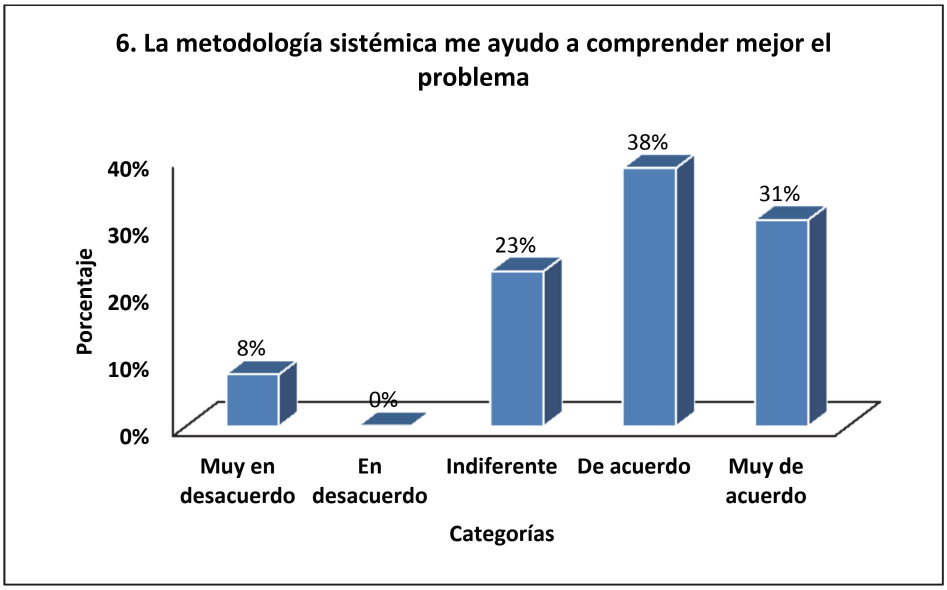

Figura 12. Evaluación de la utilidad de la metodología sistémica para comprender mejor el problema.

4.2. Evaluación de herramientas específicas.

La segunda parte del cuestionario estuvo referida a la percepción de herramientas específicas: puntualmente el uso de representación de geometrías para comprender la relación entre atributos identificados dentro del espacio; el empleo de maquetas tridimensionales para identificar la implicancia de los atributos empleados; el uso de la maqueda del espacio de diseño como insumo para facilitar la comunicación y la colaboración, y su aporte para explorar diversos modos y configuraciones de los atributos.

En el primer caso, un 73% de los estudiantes estuvo muy de acuerdo o de acuerdo con que la representación de los atributos en forma de geometrías permite comprender la relación entre los atributos identificados dentro del espacio, Figura 13.

Representación del Espacio de Diseño

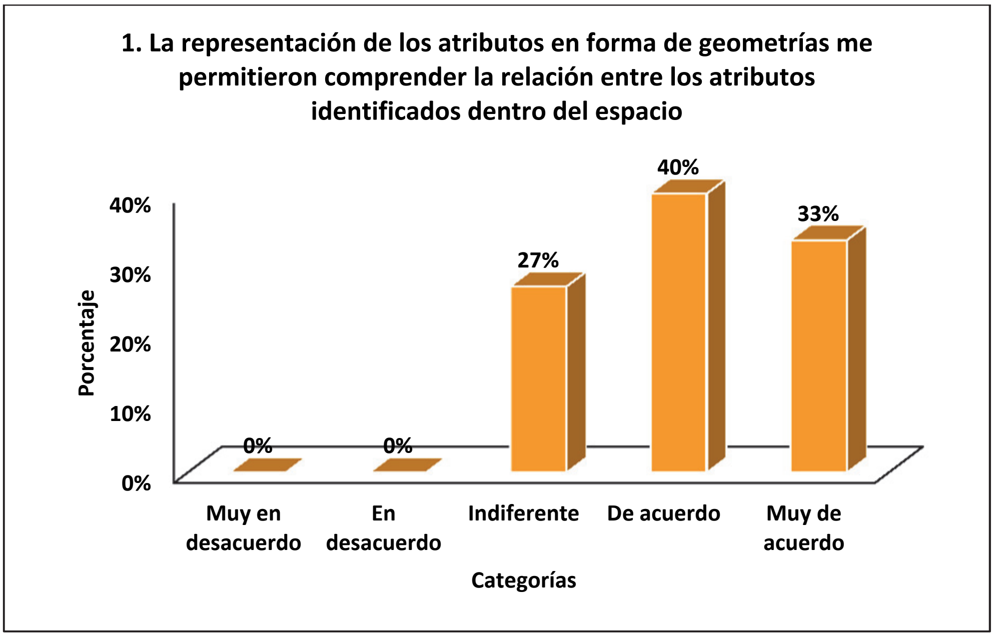

Figura 13. Evaluación de la utilidad del uso de formas de geometría para comprender la relación entre atributos identificados.

En la segunda agirmación, un 83% de los ex alumnos se mostró de acuerdo o muy de acuerdo en que construir la maqueta tridimensional permite identificar la implicancia en el contexto real de los atributos estudiados, Figura 14.

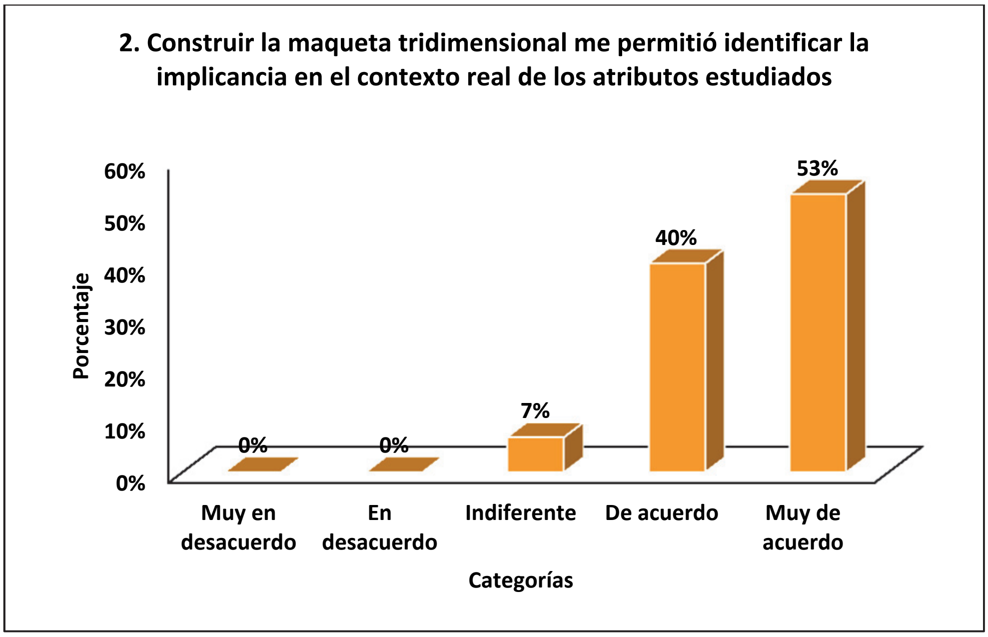

Figura 14. Evaluación de la utilidad de la maqueta tridimensional para identificar la implicancia de los atributos en el contexto.

Y finalmente, un 67% de los jóvenes está de acuerdo o muy de acuerdo en que la maqueta del espacio de diseño fue un insumo que facilitó la comunicación y colaboración con los miembros del equipo, aunque 33% se mostró indiferente ante esta afirmación, Figura 15

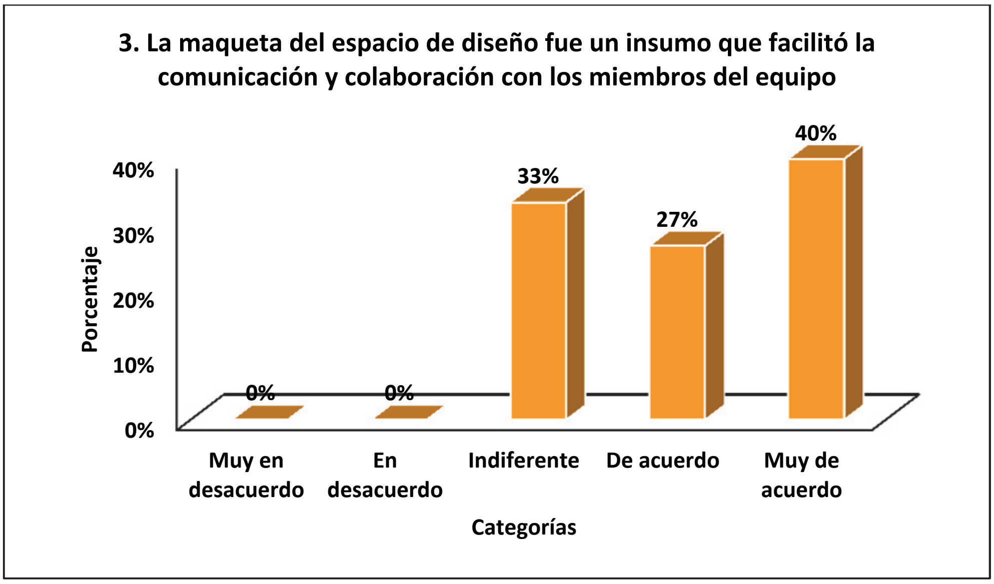

Figura 15. Evaluación de la utilidad de la maqueta tridimensional para facilitar la comunicación y colaboración dentro del equipo.

A la luz de los resultados y a la experiencia de dicha actividad, se plantea en la siguiente figura la secuencia de la desagregacion sistémica y su relación con las representaciones de diseño.Evidenciando los tipos de representaciones que se utilizan en cada una de sus fases**.** Considerando la construcción de la maqueta en baja fidelidad dentro de la exploracion y definición del espacio del diseño.

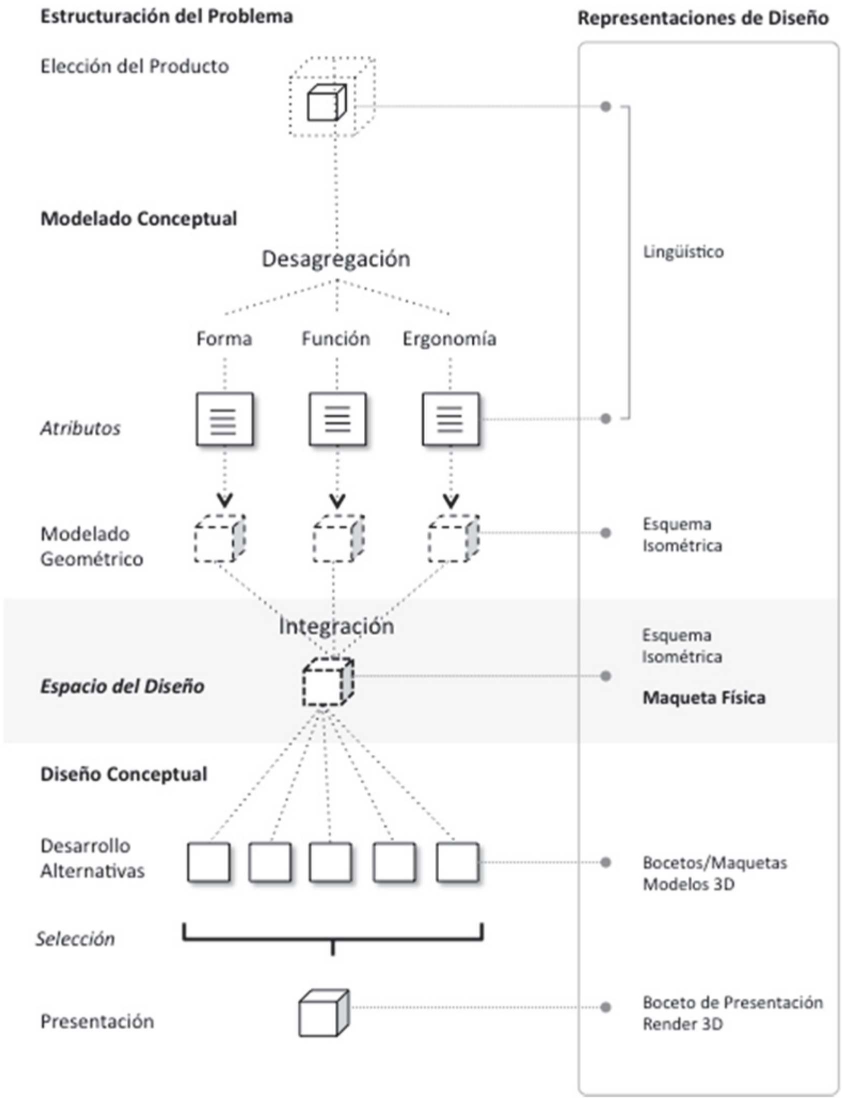

Fig. 16 Secuencia Aplicación Modelado Sistémico. Fuente: Elaboración Propia basada en Briede et al. 2014

5. Conclusiones

La metodología sistémica, permite el análisis detallado de tres variables fundamentales de un producto de diseño (forma, función y ergonomía), que al separarlos facilita notoriamente la evaluación y jerarquización de sus condicionantes, relacionándolas además, con el potencial comportamiento que el usuario espera del objeto en cuestión, esto aparece claramente reconocido por la mayoría de los estudiantes que participaron de la experiencia.

Pero también en paralelo, otra ventaja es que establece los criterios teóricos o experienciales sobre los que se fundamentan dichas jerarquizaciones, lo que racionaliza su puesta en valor.

Por otra parte, la representación del Espacio de Diseño permite relacionar dichas jerarquías y argumentos a su dimensión tangible, concentrando la atención del diseñador en aquellos conceptos relevantes, evidenciando de esta manera aquellas variables del diseño formal que serán coherentes con los conceptos y su respectiva argumentación lógica de valor que sobre lo esperado del producto. Este último punto resulta ser uno de los más importantes de la propuesta metodológica, porque verbalizar un discurso en relación a su formalidad de manera coherente, implica una internalización clave y esencial que demuestra la transferencia de un conocimiento abstracto a una apuesta tangible y fundamentada. Esta transferencia será aplicable al mundo laboral, como una estrategia argumentativa que el diseñador requerirá siempre, ya sea para ofrecer su producto, como para resolver en distintos ámbitos, las soluciones más apropiadas a las diversas problemáticas y contextos.

Finalmente, en cuanto a las herramientas específicas, tanto las representaciones geométricas como la maqueta fueron muy bien evaluadas, aunque un 27% se reportó indiferente al impacto de las primeras en comprender los atributos identificados dentro del espacio y un 33% pensó lo mismo en cuanto a la utilidad de las maquetas para favorecer la comunicación y colaboración. Pese a esto, un 93% de los encuestados consideró que éstas últimas permitían identificar la implicancia de los atributos en el contexto real, por lo que demuestran su utilidad para estos fines, llevando a cuestionarse de qué forma podría potenciarse también su utilidad comunicativa.

Pese a esto, existe un grupo minoritarío de estudiantes que mostraron su desacuerdo con que la metodología ayudaba a identificar aspectos clave del producto, permitía el registro del proceso, aportaba una referencia teórica y permitía comprender mejor el problema. Si bien estos alumnos nunca representaban más de un 8% cabe cuestionarse si se debe a estudiantes que no lograron realizar una adecuada implementación de estas herramientas o, por el contrario, identificaron debilidades en la implementación de la misma. Por este motivo, para futuras instancias, se sugiere realizar integrar herramientas cualitativas como entrevistas o grupos focales que permitan obtener una visión más experiencial y procesual de la implementación de estas herramientas.

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Estratégias de design em ecossistemas criativos de inovação social

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Resumo

A inovação social depende de um processo de mudança sistêmica. Para obtê-la, é necessário desafiar nossos modos insustentáveis de vida e, sobretudo, elaborar processos de aprendizagem social que ativem a capacidade imanente nos ecossistemas criativos de desenvolver soluções inovadoras que transformem a sociedade em prol do bem-estar coletivo. Ecossistemas criativos podem ser definidos como organizações sociais em interação, produtoras de múltiplas conexões, complexas e dinâmicas, que permitem sua existência e evolução sustentável. O design se insere nos ecossistemas criativos propondo seus processos para o desenvolvimento de dispositivos sócio-técnicos de transformação do mundo: produtos, serviços, sistemas produto-serviço, mas também tecnologias sociais que auxiliam as dinâmicas de governo, organização e transformação que ocorrem na, para e/ou pela sociedade. O artigo tem como objetivo identificar estratégias de design a serem praticadas em ecossistemas criativos de inovação social. Para tanto, o artigo inicia apresentando o conceito de inovação social e algumas estratégias praticadas para procura-la como, por exemplo, as estratégias de criação por meio de toolkits, de difusão de modelos de negócios por meio de formats padronizados ou de franchising, de crescimento orgânico ou, ainda, de programas institucionais de apoio à inovação. Logo, usando a perspectiva ecossistema, o artigo evolui o processo de inovação dirigida pelo design proposto por Roberto Verganti, direcionando-o à inovação social. Por fim, evidencia mais dois processos que se entrelaçam ao de inovação social dirigida pelo design, ou seja, o processo de infrastructuring e o de seeding. O processo de infrastructuring visa ao desenvolvimento e à prática de relações entre os atores de um ecossistema, de forma a constituir um enredo social que habilite a atividade projetual dos designers e do ecossistema como um todo. O processo de seeding visa à elaboração de sementes de inovações sociais desenvolvidas em um ecossistema, de forma a permitir sua disseminação e crescimento autônomo no mesmo ecossistema ou em outros ecossistemas.

Palavras chave: *Design estratégico, Inovação social, Ecossistemas criativos, Infrastructuring, Seeding.*

Abstract

Social innovation depends on a process of systemic change. In order to achieve it, unsustainable ways of life have to be challenged, and social learning processes promoted. The latter must be able to catalyze creative ecosystems' immanent capacity of developing innovative solutions able to transform society towards collective wellbeing. Creative ecosystems are interactive social organizations that produce multiple, complex and dynamic connections which allow their own existence and sustainable development. Design contributes to this framework by applying it processes for development of socio-technical devices for world transformation: products, services, product-service systems, but also social technologies that support government dynamics, as well as the organizing and transforming ones that take place in, to or by society. This paper aims at identifying which design strategies can be applied in creative ecosystems of social innovation. Thus, firstly the authors present the concept of social innovation and some strategies for fostering it, i.e. strategies based on toolkits, strategies for the diffusion of business models based on standardized formats or franchising, strategies of organic growth, or even institutional support innovation programs. Therefore, through an ecosystem perspective, the paper evolves the design-driven innovation process proposed by Roberto Verganti, redirecting it towards social innovation. Finally, it highlights two processes that are interwoven with the one of design-driven social innovation, i.e. the processes of infrastructuring and seeding. Infrastructuring is about the development and practice of relations among the actors of an ecosystem aiming at fostering a social scenario that enables the design activity of the ecosystem as a whole. On the other hand, seeding aims at the creating seeds of the social innovations developed within the ecosystem, thus fostering their diffusion and autonomous growth there or in other ecosystems.

Keywords: *Strategic Design, Social Innovation, Creative Ecosystem, Infrastructuring, Seeding.*

1. Introdução

O presente artigo apresenta a compreensão de que a inovação social depende de um processo de mudança sistêmica, e que para isso é necessário não apenas criar descontinuidades nos modos insustentáveis de vida, mas, sobretudo, por meio de um processo de aprendizagem social, ativar ecossistemas criativos nos quais seja imanente a capacidade de desenvolver soluções inovadoras que transformem a sociedade em prol do bem-estar coletivo. A perspectiva ecossistêmica é fundamental para gerar a inovação necessária para alcançar as mudanças desejadas no contexto social. Ecossistemas criativos podem ser definidos como organismos sociais em interação, com capacidade de adaptação e sustentabilidade e produtores de múltiplas conexões, complexas e dinâmicas, que desenvolvem processos criativos para a transformação do mundo.

Nesse processo criativo, cabe destacar o papel do design. A atividade de design é definida como um processo criativo que visa ao desenvolvimento de dispositivos sócio-técnicos (sistemas produtos-serviços, mas também processos e até modelos de negócios) para a transformação do mundo (Franzato *et al.* 2015). Ainda, compreendemos a necessidade de que essa transformação conserve e crie condições favoráveis para que haja a possibilidade de novas transformações no futuro. Ao considerar sustentabilidade e inovação social entre os objetivos do design, incluímos entre os dispositivos sócio-técnicos elaborados por ele, as tecnologias sociais que são desenvolvidas para auxiliar os processos de governo, organização e transformação que ocorrem na, para e/ou pela sociedade. Isso insere a atividade de design no âmbito de um processo de aprendizagem social que leve a uma nova ideia de bem-estar e que estimule praticas nesta perspectiva.

O design é caracterizado pela sua dimensão processual. Os processos criativos considerados são praticados por relações ecossistêmicas que envolvem designers, profissionais da produção cultural e tecnológica, o tecido organizacional e institucional e os cidadãos. Neste contexto, cabe ressaltar a relevância de uma abordagem de design estratégico que desenvolve estratégias para orientar a ação projetual e a ação organizacional em direção à inovação e a sustentabilidade. O processo de design estratégico é desenvolvido no âmbito das múltiplas relações instauradas na ação projetual do ecossistema de atuação: o meio organizacional, o mercado, a sociedade e o meio ambiente. Neste processo, as competências técnicas de design se transformam em uma plataforma transdisciplinar que sustenta a colaboração dialógica desse conjunto de atores e a construção coletiva das estratégias organizacionais para a geração, sustentação e disseminação das inovações sociais (Franzato *et al.*, 2015).

No âmbito da inovação social, diferentes perspectivas teóricas têm até hoje apontado caminhos para sua promoção, sustentação e disseminação (Manzini, 2008; Murray *et al.*, 2010; Pulford *et al.*, 2014). Porém, como se apresentará ao longo do presente artigo, ainda são necessários estudos voltados a compreensão de como superar os desafios ligados a sustentação dos processos de inovação social no longo prazo, a como alimentá-los, faze-los crescer em escala e difundi-los. Neste sentido, recentes pesquisas apontam possíveis formas de disseminação, mas ao mesmo tempo não descrevem como organizar e implementar a mudança de forma sistêmica, sobretudo a nível contextual e processual. Pelas características acima explicitadas, acredita-se que uma abordagem de design estratégico possa contribuir nesta direção.

2. Inovação Social

Inovação social neste artigo, refere-se a um processo de criação de novos dispositivos sócio-técnicos capazes de promover mudanças no contexto sociocultural, mudanças essas que possam desenvolver capital humano e social ao mesmo tempo que preservam o capital natural e que geram capital econômico para que se sustentem no tempo. O cerne da inovação social está na sua capacidade de geração de valor social, ou seja, no reconhecimento coletivo do benefício de um recurso para o conjunto de atores sociais. Assim, o valor das soluções é gerado nas relações sociais, nos benefícios que proporcionam para a coletividade, ou seja, ao estimular: a sensação de pertencimento das pessoas que serão afetadas pela nova solução; a responsabilidade social das organizações que a oferecem; a reciprocidade das relações entre os membros de um ecossistema e a sociedade; por fim, a viver uma vida significativa, que promova o bem-estar coletivo (Ouden, 2012).

Portanto, inovações sociais são resultantes de um processo de desenvolvimento aberto que envolve a participação de uma diversidade de atores. Esta participação é fundamental, enquanto o processo é reconhecido como um processo de aprendizagem, de construção social que tem por objetivo maior transformar aqueles que dele participam (Mulgan, 2007; Murray *et al.*, 2010).

Os principais desafios desse processo estão ligados a encontrar formas de sustentar as novas soluções ao longo do tempo, faze-las crescer, ganhar escala e serem difundidas a ponto de gerar mudanças sistêmicas (Manzini, 2008; Murray *et al.*, 2010). Murray *et al.* (2010) apontam como caminhos para essa sustentação: o projeto de modelos de negócio e governança que prevejam fontes de financiamento; e a estruturação de redes para a geração de capital relacional que é um modo de criar fontes de resiliência para os momentos mais difíceis da organização. Quando esses modelos se tornarem sustentáveis, deve-se encontrar formas de difundi-los. Mulgan *et al.* (2007, p. 24) identificam cinco tipos de padrões de crescimento e replicação como modo de disseminar as inovações sociais e obter ganhos de escala:

1. **Princípios e ideias gerais** que se difundem através da promoção e a persuasão de um movimento (por exemplo, a ideia da cooperativa de consumidores);
2. **Princípios e ideias projetuais** que incorporam e evoluem o padrão anterior e se difundem espontaneamente por meio das redes profissionais e outros tipos de redes (por exemplo, os doze passos do programa dos alcoolistas anônimos);
3. **Programas específicos** que incorporam e evoluem os padrões anteriores e se difundem programaticamente por meio das redes profissionais e outros tipos de redes, recebendo auxílios econômicos e/ou técnicos (por exemplo, os programas de tratamentos dos toxicodependentes de heroína com o uso de metadona);
4. **Estratégias de *franchising*** que incorporam e evoluem os padrões anteriores e se difundem por meio de uma organização que fornece suporte técnico aos franquiados e garante sua qualidade (por exemplo, o crescimento do banco Grameen, voltado à financiar os pequenos empreendimentos, no Bangladesh);
5. **Estratégias de crescimento orgânico** que incorporam e evoluem os padrões anteriores e se difundem através do crescimento orgânico de uma organização singular com uma governança comum (por exemplo, Amnesty International).

Nesta direção, Manzini (2008) sintetiza três dinâmicas de difusão de inovações sociais: o *toolkit*, o *format* e, novamente, o *franchising*. O *toolkit* é um *format*o mais livre: é um conjunto de instrumentos tangíveis e intangíveis concebido e produzido para simplificar uma tarefa específica, no qual o produtor não assume nenhuma responsabilidade sobre os resultados finais de uso. O *toolkit* é equivalente aos tipos 1 e 2 propostos por Mulgan (2007). O *format*, equivalente ao tipo 3, consiste em uma lista de procedimentos e indicações passo a passo do que é necessário fazer para replicar a solução em contextos diferentes, dando aos compradores, o direito de reproduzir o programa original e adaptá-lo as necessidades locais. E o *franchising*, equivalente ao tipo 4, é um conjunto de procedimentos e ferramentas de comunicação que habilita empreendedores locais a começarem suas atividades comerciais, amparados pela reputação da empresa franqueadora. Esta fornece aos franqueados um conjunto de instrumentos e exige deles o respeito a uma série de procedimentos e padrões de qualidade.

Entendemos que estas propostas podem ser consideradas como modelos de processos focados em sustentar e difundir inovações sociais. Embora esses estudos apontem modos possíveis de disseminação, não apontam caminhos de como organizar a mudança sistêmica, considerando as dimensões contextuais e processuais da inovação social. Portanto, considerando a necessidade de difundir ideias promissoras e de adaptá-las as diferentes questões contextuais que podem emergir, entendemos que caminho para gerar formas mais sustentáveis de vida em sociedade, é a criação e o desenvolvimento de novos modelos de empreendimentos, negócios e organizações capazes de favorecer a mudança no contexto sociocultural em prol do bem-estar coletivo e em diálogo com às dinâmicas e as características locais. Faz-se necessário outro olhar para a geração de valor. Um olhar que favoreça todos os atores envolvidos no ecossistema de uma nova solução, mais do que indivíduos em particular. Acreditamos que uma visão ecossistêmica seja o meio para gerar soluções para problemas complexos, soluções que gerem valor social por meio da recombinação criativa das tecnologias existentes na produção de novos significados. A partir dessa compreensão, entendemos que o design pode contribuir para o processo de desenvolvimento de inovações sociais por meio da criação de dispositivos sócio-técnicos que em seu cerne, considerem os elementos necessários para o seu crescimento e difusão, sendo assim capazes de transformar o mundo.

Ferrara (2012; p. 240) afirma que "a eficácia da inovação social é conectada operacionalmente à inovação tecnológica, e a inovação de negócios para seu sucesso e propagação", identificando o design como o elemento capaz de conectar esses três tipos de inovação de maneira imbricada. Assim nossa proposta para alcançar esse objetivo é trabalhar de forma integral e ecossistêmica, para projetar um dispositivo sócio-técnico que, incorpore em sua proposição de valor tanto a inovação social, quanto a tecnológica e de negócios. Dessa reflexão, aproximamos aqui os modelos de inovação dirigida pelo design que consideram a rede projetual, resultante da inteligência coletiva, para desenvolver coletivamente novas soluções que incorporem os significados culturais dispersos.

Autores da área da gestão reconhecem a possibilidade da liderança do design no processo de inovação em contextos econômicos (Verganti, 2009). Acreditamos que o design também possa contribuir com a ativação e a liderança do processo de criatividade coletiva de modo a encorajar a inovação e a disponibilidade de troca entre os atores do ecossistema e configurar novas propostas de valor social. Assim, propomos a inovação social dirigida pelo design seja um processo de desenvolvimento de inovações sociais liderado pelas competências de design e voltado para a infraestruturação do enredo social e a disseminação das inovações sociais desenvolvidas.

2.1. Inovação social dirigida pelo design

Buscamos no trabalho de Verganti (2009) as bases para a proposição de um processo de inovação social dirigida pelo design. O autor identifica os processos de inovação radical de significados dirigidos pelo design em empresas que propõem uma visão de como os contextos de vida – socioculturais e tecnológicos – poderiam evoluir para melhorar a qualidade de vida. Trata-se de empresas que fazem uma exploração mais ampla do contexto sociocultural e tecnológico. Ao fazer isso reconhecem que são vários os agentes que possuem interesses comuns sobre o contexto de vida, e que o diálogo entre eles – internos e externos à organização e chamados pelo autor de intérpretes: empresas em outras indústrias que querem atingir os mesmos clientes, fornecedores de novas tecnologias, pesquisadores, designers e artistas –, é o elemento central de um processo de inovação dirigido pelo design. O autor descreve essa exploração como um processo pesquisa coletiva difuso, organizado em rede, e relacionado a possíveis significados para as coisas, e a denomina como "o discurso de design". Nessa perspectiva, as empresas não se utilizam de tendências existentes e definidas, mas recorrem a um processo orgânico e colaborativo de análise das informações trazidas pelos intérpretes para compreender os contextos possíveis. Tal discurso considera a compreensão do contexto sociocultural da vida das pessoas, promovendo trocas de conhecimento entre os atores de diferentes formas: obras de arte, estudos, palestras, protótipos e produtos. O objetivo dessa abordagem é criar propostas para modificar um cenário, visões de um futuro possível. A intenção do discurso é "seduzir, moldar os modelos socioculturais e influenciar as aspirações e desejos das pessoas" (Verganti, 2009, p. 192).

No âmbito da criação de valor social, o discurso de design e o processo de pesquisa coletivo difuso se ampliam e transformam. No caso de inovações sociais, a troca de valor não ocorre diretamente entre um cliente e uma organização, mas inclui outros stakeholders que fazem parte do sistema. De fato, como aponta Bignetti (2011), os processos de configuração de proposições de valor de inovações sociais distinguem-se dos processos tradicionais de inovação pela sua abertura e cooperação com a comunidade para resolver questões de cunho social. O processo de inovações sociais valoriza o conhecimento tácito presente nas pessoas da comunidade, envolvendo-as ao longo do processo, iniciando pela concepção, passando pelo desenvolvimento e chegando à aplicação. As pessoas são consideradas como possuidoras de capacidades que devem ser estimuladas para promover o bem-estar ativo e reforçar o tecido social (Manzini, 2008).

A partir dessa compreensão surge o questionamento: haveria uma rede de intérpretes da inovação social? Como ativar o discurso de design dessa rede? Como esta seria composta?

Seguindo a proposta de Verganti (2009) a rede de interpretes da inovação social seria formada por atores ligados a produção cultural e a produção de tecnologias que buscam novos significados para o uso da tecnologia na promoção do bem-estar coletivo. No âmbito das inovações sociais, seguindo a proposição de Bignetti (2011) e Manzini (2008), devemos considerar a participação de uma multiplicidade de atores sociais na inovação e incluir as pessoas, que estão inseridas nesses contextos socioculturais como intérpretes relevantes dessa rede, por serem especialistas na experiência cotidiana em tais contextos (figura 1).

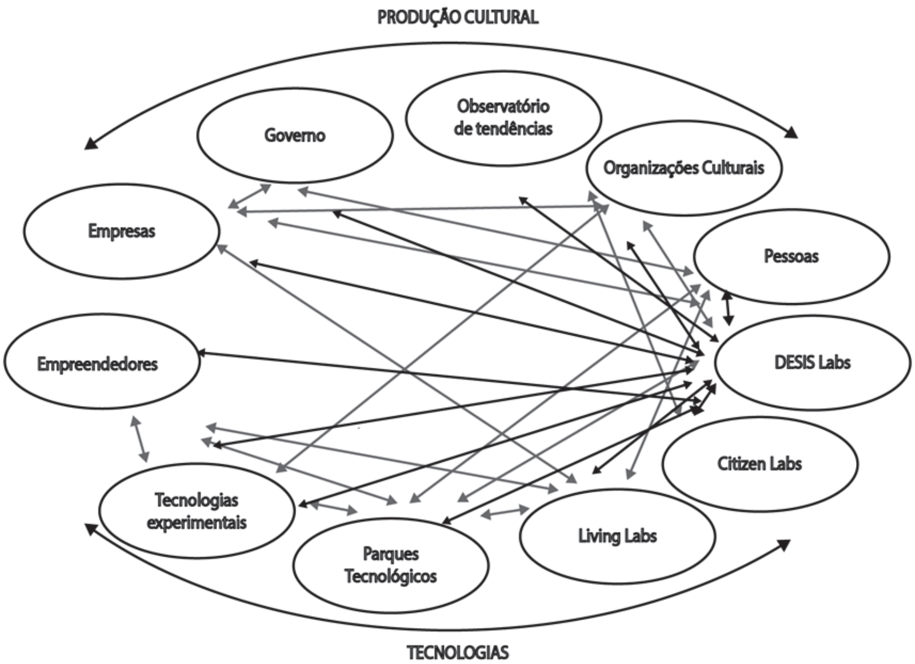

Fig. 1. Ecossistema criativo: rede de intérpretes do contexto sociocultural

Neste sentido, buscamos elucidar o questionamento acima ilustrando com o caso da Rede Design para a Inovação Social e Sustentabilidade (DESIS). A Rede DESIS é formada por uma constelação de laboratórios experimentais autônomos, mas interconectados, formado por um grupo de professores, pesquisadores e estudantes de uma Escola de Design encarregados de promover a inovação social. Os laboratórios da rede estabelecem parcerias com empresas, organizações sem fins lucrativos, fundações e agências do governo para identificar, projetar e disseminar casos de inovação social, ou seja, se conectam a outros intérpretes da inovação social. A visão que une a rede é a compreensão de que os recursos sociais difusos são o principal motor da mudança e podem se tornar poderosos promotores de modos de produção e vida sustentáveis. Para tanto, desenvolvem pesquisas para identificar soluções criativas para resolver questões cotidianas ligadas a sustentabilidade e ao bem-estar coletivo, desenvolvidas por pessoas comuns.

A visão da rede é que a comunidade de design em geral e as Escolas de Design em particular podem desempenhar um papel fundamental na difusão desses sinais como forças motrizes das mudanças sustentáveis para a inovação social. O objetivo da rede é usar o conhecimento de design para co-criar cenários, soluções e comunicações socialmente relevantes, com parceiros locais, regionais e globais, estimulando o desenvolvimento de inovações sociais.

Podemos dizer que essas soluções, identificadas como sementes para a inovação social, estão alinhadas à proposta de inovação de Verganti (2009), em que um "discurso sedutor" é produzido para incentivar a mudança dos modelos socioculturais rumo à inovação social e à sustentabilidade. A exposição "Sustainable Everyday" na Triennale di Milano (Jégou, Manzini, 2003) e os DESIS Showcases são exemplos de discursos de design produzidos por essa rede de intérpretes, liderados pelo design, para a criação de novas propostas de bem-estar sustentável, seja por meio de protótipos de soluções, produtos, seja por meio de estudos e palestras.

Como mostra este caso, na proposta de inovação social dirigida pelo design, o designer adquire a função de ativar o discurso projetual de uma rede intérpretes, através de suas capacidades de imaginar e influenciar comportamentos, trazendo seu ponto de vista profissional criativo, transformando os sinais do presente em uma mudança de paradigma para o futuro. Nessa proposta, caberá ao designer criar as ferramentas para favorecer um discurso projetual e dar forma as ideias que emergem do grupo (Sanders, Stappers, 2008).

Em síntese pessoas e organizações que queiram desenvolver inovações culturais e sociais podem encontrar no designer um agente capaz de: ativar a rede de interpretes, configurar equipes interdisciplinares, criar instrumentos que possibilitam a ideação coletiva, estimular as relações e as discussões projetuais por meio de propostas provocativas. Portanto, podemos propor que os processos de inovação social dirigidos pelo design são co-criativos e liderados pelo designer, para promover a o diálogo projetual fundamentado na cooperação dialógica visando desenvolver relações entre os atores do ecossistema criativo (Franzato *et al.*, 2015).

Deste ponto, o design estratégico é uma abordagem adequada para tal fim. É uma abordagem que privilegia o co-design, ou seja, a colaboração criativa entre designers e não designers, entre especialistas e pessoas comuns, em um percurso projetual, que resulta, naturalmente, em soluções mais efetivas, mais apropriadas e mais desejáveis. Portanto o design estratégico se torna fundamental no cenário da inovação social dirigida pelo design, uma vez que permite que uma gama de stakeholders, de diferentes disciplinas, colaborem criativamente no desenvolvimento de soluções.

De fato, a participação da multiplicidade de atores sociais na construção das inovações e a busca por novas formas de bem-estar são características centrais das inovações sociais dirigidas pelo design. Isso porque, como apresentado, para que as soluções possam gerar novos sistemas de produção ou até mesmo novos modelos econômicos, na perspectiva de promover uma ideia de bem-estar que esteja desvinculada do consumo de produtos, elas precisam estar vinculadas aos bens comuns locais, aos contextos de vida (ambiente físico e social) e ao valor do tempo lento e contemplativo. E isso só pode acontecer por meio de novas formas de se relacionar, de dialogar e discutir constantemente, buscando desenvolver estas propostas sedutoras e provocativas. Neste sentido, em uma perspectiva de design estratégico, considerando a necessidade de gerar, disseminar e provocar mudanças sistêmicas, dois processos são essenciais: o de estimular as relações e as discussões projetuais, definido aqui como *infrastructuring*, e o de desenvolver e difundir propostas provocativas, definido aqui como *seeding*, apresentados a seguir.

3. “Infrastructuring” para a inovação social

A proposta de inovação social dirigida pelo design para criar, sustentar e difundir inovações sociais, se diferencia das de Manzini (2008), Murray *et al.* (2010) e Pulford *et al.* (2014), por apresentar uma abordagem à mudança mais ecossistêmica e integral – considera de fato também as dimensões contextuais e processuais da inovação social.

Como apontado anteriormente a articulação entre mudança social, novas formas de empreendimentos sociais – que a estimulariam – e novas formas de negócios para disseminar estes últimos se faz necessária. Ou seja, os projetistas não têm que atuar só no nível de cada inovação, mas devem pensar de forma mais abrangente em como coordenar e articular esses novos empreendimentos e novas formas de negócios com a mudança sistêmica desejada para a sociedade. Para tanto, ao considerar também que a mudança a ser perseguida encontra sua força na relevância da dimensão relacional das inovações sociais, emerge a relevância de um processo que atue no desenvolvimento constante do enredo social. De acordo com o conceito de *infrastructuring*, recentemente discutido no âmbito do design, considera-se que o design possa atuar de modo a estimular relações e discussões produtivas da rede de intérpretes do social para continuamente adaptar as soluções às mudanças contextuais. Em uma proposta de inovação social dirigida pelo design o processo de *infrastructuring*, apresentado a seguir, é central.

Vários foram os autores que trabalharam esse conceito, mas o que interessa aos fins deste artigo, é sua definição contextualizada no âmbito de projetos com comunidades que visam a constituição de uma sociedade mais democrática (Björgvinsson *et al.,* 2010; Ehn, 2008; Hillgren *et al.,* 2011). Considerando a ação do designer, e as características das comunidades e dos processos a serem promovidos, Ehn (2008) conceitualizou *infrastructuring* como projetar possibilidades de design futuras. Ele afirma a relevância do designer focar seu trabalho no desenvolvimento de estratégias projetuais (design for design) que visem criar infraestruturas flexíveis e abertas para um pós-design (design after design) não planejado, ou seja, que permitam ações criativas e projetuais futuras. Hillgren *et al.* (2011) definem o processo de *infrastructuring* como: processo contínuo e aberto de construção de relações entre diferentes atores (feito com tempo e recursos variáveis) que visa constituir uma estrutura de design aberta, sem prazos e objetivos específicos, e que tem como fim último o de constituir e alimentar esses. Esta definição reforça a natureza processual do *infrastructuring*. O papel do projetista não é mais o projeto de uma solução especifica, mas se torna o projeto do processo. A *–ing form* aponta de fato a relevância da dimensão processual, e a natureza mais flexível e dinâmica da ação dos projetistas.

Assim, emerge a necessidade de *infrastructuring* como de uma abordagem focada no processo (Manzini, 2015). O entendimento de Ehn e colegas que consideram o *infrastructuring* como um processo constante relativo a criação de infraestruturas flexíveis e abertas para um design after design, não é mais suficiente. Trata-se ao invés de afirmar o processo como processo. Ou seja, o designer contribui para inovação social por meio do mesmo processo de design: é por e nele mesmo que a inovação e a mudança acontecem, e que são estimuladas relações e formas de interagir projetuais. Trata-se, portanto de um processo constante, aberto e sem fim que ao acontecer gera e alimenta constantemente o contexto desejado e as possibilidades de outros processos que visem mudanças sociais acontecerem, tornando-se esta uma característica do contexto em si. Desta forma são consideradas as dimensões contextuais e processuais da inovação social: os projetistas agem para promover uma mudança contextual, ou seja, não atuam mais (ou não só) no nível do projeto, mas no do processo de constituição e evolução de um determinado contexto.

É importante observar que no âmbito da contribuição do design para promover processos de inovação social, tem recentemente sido apontada a relevância da infraestrutura relacional de um contexto, isso a partir das características intrínsecas relacionais relevantes da mesma inovação social. De fato, para o designer ativar o discurso projetual, ele precisa estimular relações projetuais, visto que o cerne da inovação social tem a transição do foco do bem-estar individual ao bem-estar coletivo, e isso acontece pela geração e difusão de novos comportamentos e relações sociais. Portanto, a dimensão relacional, se torna fundamental de ser trabalhada pelo e no processo de *infrastructuring*. Na perspectiva da inovação social, este tipo de relações produtivas são o elemento constitutivo mais relevante do contexto desejado.

Dindler e Iversen (2014) propõem que o design foque em desenvolvê-las e alimentá-las por meio do próprio processo de design. Na perspectiva de ecossistemas criativos de inovação social, estas relações precisam ser flexíveis e em constante redefinição. Em síntese, isso significa que o processo de *infrastructuring* gera e alimenta estes espaços por alimentar e renovar as relações que os constituem.

De acordo com Björgvinsson *et al.* (2010) e Hillgren *et al.* (2011), a participação do usuário no processo é fundamental: eles são interpretes fundamentais da rede por serem especialistas do cotidiano, e ao mesmo tempo porque no processo e pelo processo encontram-se as bases da participação futura das pessoas, que é um dos pontos-chave deste tipo de ação. O designer age para provocar relações que levem os diferentes atores a participar e a se relacionar de forma diferente, colaborando entre eles. Esta participação acontece por engajamento – provocado pelo designer – e gera engajamento futuro e de outras pessoas. De acordo com Dindler e Iversen (2014) o designer é habilitado a fazer isso porque possui e usa – ao longo do processo – uma habilidade relacional para o desenvolvimento e a transformação de relações pessoais e profissionais entre os diferentes atores envolvidos.

Assim, pode-se destacar que a abordagem de *infrastructuring* se distancia da dinâmica do *format*, pois nenhum resultado é planejado. A ação acontece a nível processual e por ações que agem diretamente na dimensão relacional, na perspectiva de favorecer o surgimento de oportunidades de projetos cujo desenvolvimento e resultado colaborem nesta direção. Também pode-se ressaltar a dimensão contextual do *infrastructuring* e a abrangência deste processo. Para que ocorra, é necessário um diálogo constante e constantemente atualizado. Esse tipo de processo não tem regras, não pode ser planejado e não pode ser ensinado na forma de um processo predefinido (Hillgren *et al.*, 2011). Finalmente, o processo de *infrastructuring*: não tem início, desenvolvimento, fim: a ação do design não tem previsão de término, nem é desejada. É o processo em si que é relevante.

Promover um ecossistema criativo para inovação social, porém não é em si suficiente para disseminar e alcançar a mudança sistêmica desejada: é necessário que na abordagem de design estratégico esteja incluído outro processo que permita aos ecossistemas criativos difundir as propostas sedutoras e provocativas de inovação social por eles gerada e por sua vez ativar outros ecossistemas criativos. O conceito de *seeding*, apresentado na próxima seção, se torna fundamental para entender como isso pode acontecer.

4. "Seeding" da inovação social

Na introdução, definimos o design como processo criativo que visa ao desenvolvimento de dispositivos sócio-técnicos para a transformação do mundo. Ao considerar a inovação social como objeto do design, os dispositivos sócio-técnicos que este design visa desenvolver, são evidentemente muito diferentes dos artefatos que o desenho industrial visa desenvolver. Precisam ser dispositivos tecnológicos, processuais, organizacionais e sócio-culturais que já em si incorporem estratégias de difusão para geração e sustentação de ecossistemas criativos de inovação social.

Como foi mencionado, Murray *et al.* (2010) apontam que a replicação e a adaptação são as mais frequentes formas de difusão das inovações sociais e, nesta mesma direção, Manzini (2008) inclui *toolkit*, *franchising* e *format* entre as estratégias do design para a inovação social. Estes mesmos autores, porém, sublinham que uma das questões atuais mais relevantes é permitir que as inovações sociais se adaptem aos diversos contextos, evoluindo em novas formas. Replicação, na forma de *franchising* e *format*, é uma estratégia de difusão tradicional. Por outro lado a ideia de adaptação (Murray *et al.*, 2010) e de *toolkit* (Manzini, 2008) apresentam um potencial caminho para difusão, mas como apresentado, precisam ser evoluídos a fim de entender a forma de implementação.

Neste sentido, o trabalho de Elisa Giaccardi (2005) se torna útil para superar a contradição acima apontada do conceito de replicação, que remete à produção em série, e assim chegar a novas estratégias para difundir a inovação social. A autora operou uma ampla revisão da literatura sobre metadesign. Para repercorrer resumidamente suas etapas, podemos partir do design generativo. Trata-se de um método de design que não visa desenvolver artefatos finais, mas sim processos que, quando inicializados, entregam artefatos finais. Entre os resultados de design generativo podemos incluir códigos informáticos que, a partir de um conjunto de variáveis, uma inteligência artificial pode operar para entregar um projeto de um artefato gráfico ou até mesmo de um produto industrial ou de uma arquitetura. Isso mostra, portanto, como, estes códigos possam ser compreendidos como “sementes” para o projeto de artefatos finais, a inovação é imanente neles. O metadesigner – ou seja, o designer que opera no âmbito do metadesign – não projeta o artefato final, mas a semente para o projeto de artefatos finais.

Enquanto o *franchising* e o *format* permitem replicar exemplares idênticos a um dado modelo, o processamento do código pela máquina garante a elaboração de exemplares diferentes a partir de conjunto de variáveis diferentes. No âmbito do discurso até aqui desenvolvido, isso significa que se designers atuarem por meio de sementes - códigos de inovação social -, a alteração das variáveis contextuais, permitiria a obtenção de versões adaptadas de uma inovação social codificada.

Porém isso não resolve a contradição em questão. De fato, para resolve-la precisaria considerar que o social seja um ambiente controlado como o da máquina. Entretanto, neste caso teria a contradição posta pelo conflito entre tecnocracia e democracia: é possível aceitar soluções inovadoras predeterminadas e impostas por um código? Neste sentido, é importante citar a possibilidade do código aberto às intervenções da comunidade de usuários, o código que “os usuários possuem a liberdade de executar, copiar, distribuir, estudar, mudar e melhorar” (Free Software Foundation, 2015, s. p.).

A partir disso entende-se a relevância de processos de inovação social orientadas pelo design que visem não só a geração de ecossistemas - baseados em novas formas de se relacionar e onde aconteçam constantemente discussões sobre questões localmente relevantes - mas que também visem ao desenvolvimento de sementes de dispositivos tecnológicos, processuais, organizacionais e socioculturais, que são sustentáveis e objetivam alcançar objetivos socialmente reconhecidos de novas formas.

Por sua vez, uma vez que essas sementes germinam, exploram a organização em rede para se difundirem de maneira rizomática, seguindo a metáfora de Deleuze e Guattari (1987). Ou seja, explorando as conexões possíveis na rede global de colaborações projetuais entre indivíduos e organizações, acabam sendo elaboradas em um contexto e evoluídas em inúmeras variantes em outros contextos. Chamamos de *seeding* esta dinâmica de difusão projetual que tem a potencialidade de gerar inovação: as ideias inovadoras (seeds) se difundem de um contexto para outro através das redes de intérpretes, consequentemente são praticadas por meio de processos de projeto em rede, de acordo com as dinâmicas chave dos contextos desejados, e assim são reinterpretadas, transformadas e renovadas para que possam ser finalmente implementadas nos diversos contextos. E para que, assim por diante, continuem se difundindo.

Aponta-se que nestes percursos projetuais, a semente, o dispositivo sócio-técnico e a inovação imanentes nela, podem evoluir radicalmente. Não apenas se adaptam aos contextos, mas podem e, aliás, devem ser interpretados autonomamente, transformados e usados nas maneiras mais diferentes, e assim evoluir. Determinante é, portanto, o alinhamento com a metáfora computacional do código aberto: à abertura da semente e de seus efeitos é uma das suas características essenciais.

5. Considerações Finais

No quadro delineado, a organização em rede emerge como uma das principais formas organizacionais que embasam os processos de inovação dirigida pelo design também, e talvez especialmente, no âmbito social. Os processos criativos ocorrem nas e pelas redes que os atores sociais integram e nas quais agem, e contribuem para o desenvolvimento das mesmas. O design se integra no processo de *infrastructuring* do social, sendo, ao mesmo tempo, seu catalizador e efeito. De fato, tais processos são impulsionados e acelerados nas e pelas redes dos especialistas e dos demais atores – todos, sem distinção, são interpretes locais – que concorrem à elaboração do discurso do design. Se o *infrastructuring* ativa e alimenta a rede de interpretes, esta, por sua vez, alimenta um discurso de design local e gera propostas que podem ativa-lo em outros lugares.

Não estamos com isso, porém, delimitando com precisão cada ecossistema criativo. As relações e interações ativadas e sustentadas embora concentrem-se em um ecossistema criativo especifico, cerne da ação de cada designer, o extrapolam também. Desta forma há um enredo inter-ecossistêmico. Esta não é só uma característica das redes, mas o é especialmente nas redes da inovação dirigida pelo design (ou, por extensão, as redes que artificialmente evidenciamos e atribuímos à inovação dirigida pelo design) que são ricas em relações e interações inter-ecossistêmicas.

O entendimento deste enredo de relações e interações ecossistêmicas e inter-ecossistêmicas que sustentam a inovação e ainda mais processos de inovação social, faz com que o enfoque do design se desloque do projeto de dispositivos sócio-técnicos para o enredo do processo projetual com os demais processos que concorrem à aprendizagem e à inovação social, especialmente com processos ligados à organização em rede dos indivíduos e das organizações. Assim, o processo de design é considerado e desenvolvido no âmbito das múltiplas relações ecossistêmicas instauradas na ação projetual. Eis, a relevância do design estratégico atuar para ativar e sustentar estes ecossistemas criativos, pois o design estratégico permite e promove processos de estruturação de relações ecossistêmicas e de sua prática projetual. O efeito mais significativo do design estratégico é a organização e a contínua reorganização das relações e das atividades que são desenvolvidas no ecossistema das empresas públicas e privadas, das ONGs, demais organizações, e de todos os atores e intérpretes locais. Não é possível prescindir deste tipo de trabalho na inovação social orientada para o design, uma vez que é contextualizado nos processos de aprendizagem e de inovação social, constituindo a base para o *seeding* de oportunidades projetuais e sua prática.

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Aplicación del Método Sistémico al Diseño de un Modelo Conceptual para Sistemas Integrales de Gestión QHSE3+ en PYMES

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Resumen

La alta vulnerabilidad y el elevado porcentaje de fracasos y cierres de las PYME, pone en evidencia la necesidad de diseñar un modelo que con un enfoque básico funcional e integral de riesgos y calidad, permita a los actores de las PYME conocer, apropiar y aplicar las Buenas Prácticas en los ciclos de Planificación, Operación, Control y Mejora de sus productos, procesos y negocios. Los autores presentan en este documento el enfoque y la aplicación del Método Sistémico en el Diseño de un Modelo Conceptual para los Sistemas de Gestión Integral de las PYMEs, configurado a partir de la conjugación de las Buenas Prácticas relacionadas con:

i) *El Ciclo de Gestión de Riesgos Estratégicos y Operacionales,*

ii) *La Efectividad en el Manejo de los Procesos Directivos, de la Cadena de Valor y de Apoyo.*

iii) *El éxito sostenible del negocio PYME, entendido desde la eco eficiencia, la competitividad y la rentabilidad.*

*Las Buenas Prácticas se direccionan desde el cuerpo del conocimiento contenido en la familia de normas (ISO 31000:2009)"Risk Management. Principles and Guidelines", al igual que en los referenciales para la Gestión de Calidad **Q**(ISO 9001:2015), Salud y Seguridad **HS**(ISO DIS 45000:2016), Gestión Ambiental **E**(ISO 14001:2015), Gestión para la Eficiencia Energética **E2**(ISO 50001:2011); y de otras componentes de riesgo, ligadas a la conformación del acrónimo **QHSE3+**, asociado a la integración de las iniciales en ingles señaladas en negrita previamente, según se requiera.*

El modelo ha sido objeto de realimentación y de una validación preliminar mediante su aplicación en varias PYME del Caribe Colombiano, desde actividades de consultoría, y con grupos de investigación en asignaturas de Posgrado.

Los resultados obtenidos permiten:

i) *Ratificar la utilidad e importancia de poner a disposición de los emprendedores un Modelo con Instrumentos Básicos para la Planificación y la Gestión Integral de Riesgos de afectación de la Calidad, la Salud y la Seguridad, el Medio Ambiente,*

los Recursos y el Desempeño Energéticos, al igual que otras componentes particulares de riesgos aplicables al tema particular de cada negocio PYME.

ii) *Destacar el beneficio asociado a disponer de instrumentos sencillos de Gestión Integral de Riesgos QHSE3+ que contribuyan en el éxito sostenible y la competitividad de los negocios PYME.*

iii) *Demostrar con valoraciones específicas, que mediante la aplicación del Modelo y sus instrumentos de Planificación y Operación, es posible traducir el éxito sostenible, en la disminución de la vulnerabilidad estratégica global y de cada proceso, con magnitudes entre el 15% y el 37%, que pueden llegar a representar cifras mayores de reducción de costos, en la medida en que se apropien e institucionalicen los métodos y sus principios asociados.*

Palabras clave: *diseño, método sistémico, sistema integral de gestión, modelo conceptual, éxito sostenible, buenas prácticas.*

Abstract

The high vulnerability and the high percentage of failures and closures of SMEs, reveal the need to develop a working model which should begin with a basic Integral and functional approach of risk and quality, and with easy application tools, that allow the SME's characters know, adopt and apply good practices in Planning cycles, operation, control and improvement of products, processes and businesses.

The authors present in this paper the focus and application of Systemic Method in Designing a Conceptual Model for Integrated Systems Management SMEs, configured from the combination of Good Practices related to:

i) The Management Cycle Strategic and Operational Risks,

ii) Effectiveness of the Governing Process Management, Value Chain and Support Services.

iii) Sustainable business success SMEs understood from the eco-efficiency, competitiveness and profitability.

*These good practices are addressed from the body of knowledge contained in the standards family (ISO 31000:2009)"Risk Management. Principles and Guidelines", as in the standard for Quality Management **Q**(ISO 9001: 2015), Health and Safety **HS**(ISO DIS 45000: 2016), Environmental Management **E**(ISO 14001: 2015), Energy Efficiency **E2**(ISO 50001: 2011); and other risk components, linked to the formation of Acronym QHSE3+, - associated with the integration of english initials previously indicated in bold, as required.The model and instruments associated have been object of feedback and validation through its application in several SME's, since the consulting activities, and with research trams in postgraduate courses from Universidad del Norte, in Barranquilla.*

The results allow:

i) *To confirm the usefulness and importance of making available to entrepreneurs with a model with Basic Instruments for Planning and Integrated Risk Management affectation of Quality, Health and Safety, Environment, Resources and Energy Performance , like other individual risk components applicable to the particular theme of each business SMEs.*

ii) *Highlight the benefits associated with simple tools that have implemented the Integrated Risk Management* ***QHSE3+*** *contribute to the strategic perspective of sustainable success and competitiveness of the SME business.*

iii) *Demonstrate with specific assessments, that by applying the Model and its instruments of planning and operation, it is possible to translate sustainable success in reducing global strategic vulnerability and each process, with magnitudes between 15% and 37 %, which may account for higher numbers of cost reduction, to the extent that ownership and institutionalize methods and its associated principles.*

Keywords: *design, systemic method, integrated management system, conceptual model, sustainable success, good practices.*

1. Introducción

En todo el mundo es evidente la necesidad estratégica de fortalecer el núcleo de desarrollo y la gestión efectiva de los negocios que conforman el músculo empresarial y social más importante del planeta: las PYMEs, que además soportan una componente clave en la estrategia de crecimiento, racionalización de costos y desarrollo de muchos sectores de la economía: La Tercerización y la Especialización.

En contravía, se destaca la dura realidad de las estadísticas frías y contundentes, que nos señalan que mas del 80% de las PYME de los cinco continentes, se siguen cerrando por bancarrota antes de superar sus 5 años de existencia.

Las causas y consecuencias asociadas a esta situación, que pueden observarse en la Figura 1, estructurada mediante la aplicación del enfoque de la Metodología del Marco Lógico para Proyectos, (NACIONES UNIDAS - CEPAL, 2005), ponen de manifiesto la necesidad de desarrollar un modelo básico de trabajo para la gestión, que a partir de un enfoque integral básico, y con herramientas de fácil aplicación, permita a los actores de las PYME conocer, apropiar y aplicar Buenas Prácticas en los ciclos que tienen lugar durante la configuración, planificación desarrollo y consolidación de sus Proyectos de Emprendimiento y creación de PYMES, para garantizar el éxito sostenible de sus empresas.

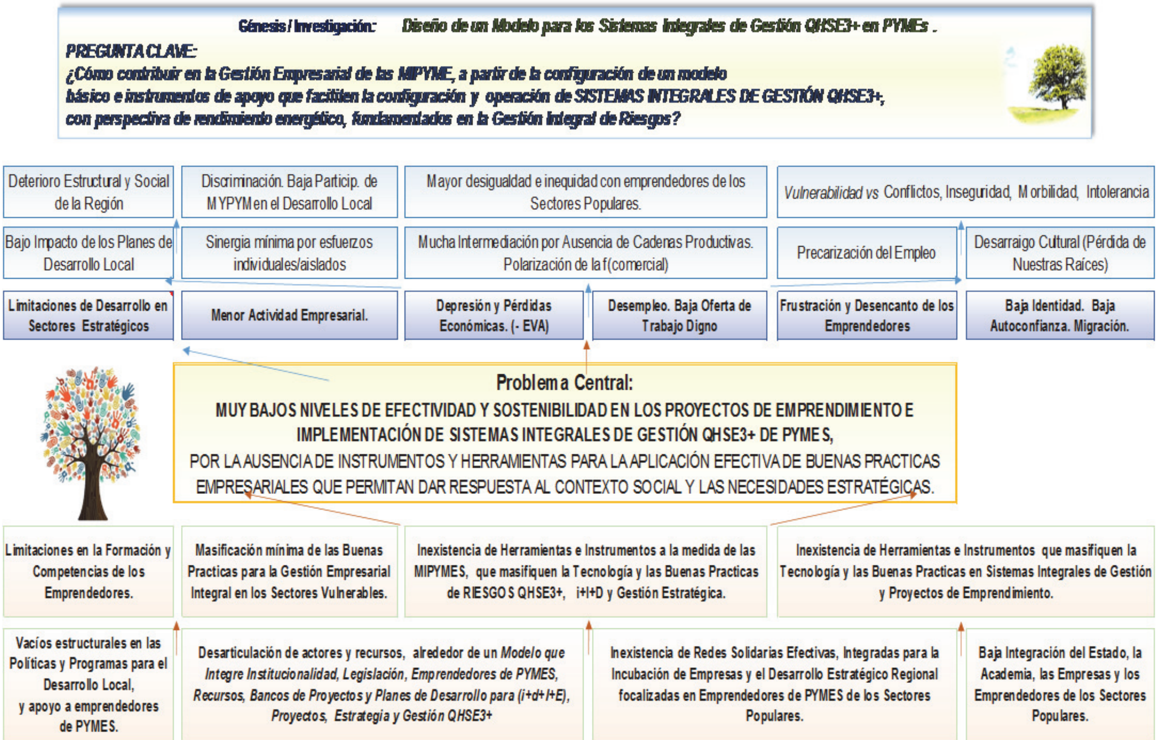

Fig. 1 Aplicación de la Metodología del Marco Lógico al Problema Objeto de la Investigación. Fuente: Realización de los Autores.

2. Problemática y Objetivo.

No obstante el desarrollo de los Programas de los Gobiernos de las diferentes latitudes, y los incentivos financieros que amplian los criterios de clasificación de las PYME para posibilitar un mayor acceso a los beneficios, como por ejemplo la aplicación flexible de la Recomendación C 2003 1422 (CEE, 2003), la dura realidad es que son demasiadas las barreras que desafían al espíritu emprendedor y a sus proyectos de construir y hacer empresa:

a) Las dificultades normales asociadas a tener un buen equipo de socios o un buen socio estable en el ámbito emocional, técnico, administrativo y financiero,

b) Las restricciones y limitaciones propias del mundo de hoy, en cuanto a los recursos más escasos y más costosos, la agudización de problemas ambientales como el acceso continuo al agua, la energía, los recursos naturales, o el calentamiento global, entre otros,

c) Las dificultades propias del mercado en su naturaleza puntual de oferta-demanda-rentabilidad, exclusivamente focalizada en el retorno del activo, y no en la generación integral de valor,

d) El vértigo del cambio externo en los intereses, gustos y necesidades de los clientes y el mercado, los proveedores, la legislación, la tecnología y a veces también las condiciones geopolíticas y macroeconómicas del entorno,

e) El imperativo del cambio interno de procesos, cultura y talentos para poder estar a tono y responder cuándo y cómo debe ser, a las condiciones y demanda del mercado,

f) El costo del dinero, y las dificultades para lograr el fondeo de proyectos de emprendimiento, bajo tasas que no sean de usura, o que como mínimo esten por debajo de los niveles de rentabilidad después de impuestos, depreciaciones y otros deducibles.

g) Las limitaciones desde el punto de vista de competencias, experiencia, organización y métodos de administración de los Negocios y Proyectos PYME.

Con esta complejidad, el camino de la solución está determinado por el desarrollo de las competencias de los actores de los Proyectos PYME, y la aplicación de herramientas y enfoques que permitan tener una visión y un manejo integral y holístico del Negocio y de los Proyectos de Emprendimiento, fundamentado en la visualización y aplicación de las Buenas Prácticas, entendidas como las medidas de prevención y control que deben adoptar los emprendedores para reducir la vulnerabilidad ante el enjambre de riesgos, y soportar la toma de decisiones fundamentada en la inteligencia que permite conocer, y comprender qué está pasando, y prever qué puede ocurrir en los Proyectos de emprendimiento y en la operación e interacción del Negocio PYME con su entorno y contexto.

El objetivo del trabajo que describe este documento, tiene que ver precisamente con el aporte al esfuerzo emprendedor y el éxito sostenible de las PYMEs, a partir de la Aplicación del Método Sistémico al Diseño y Configuración de un Modelo Básico para la Planificación, Operación, Realimentación y Mejora de los Sistemas Integrales de Gestión, fundamentado en la Gestión Integral de Riesgos (Poveda Orjuela, et al., 2015-A), y en la aplicación de las Buenas Prácticas contenidas en las Normas Internacionales relacionadas con las componentes QHSE3+.

3. Metodología para el Diseño y Configuración del Modelo propuesto.

En el desarrollo de la investigación se conjuga la metodología de Investigación Aplicada, con la Investigación Cualitativa y Cuantitativa, requeridas para abordar, definir el problema, investigar, comprobar y/o rechazar/reformular las hipótesis que fundamentan el modelo conceptual, a partir del acercamiento retrospectivo al problema y el estudio de casos individuales, mediante diagnósticos, sondeos y observación directa.

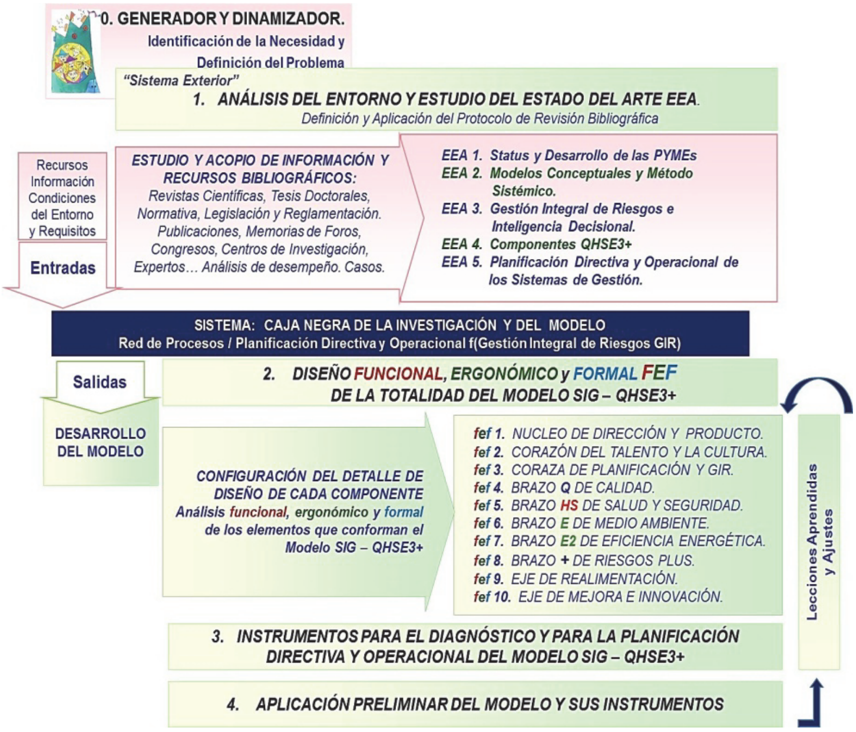

Fig.2 Metodología de la Investigación Aplicada para el desarrollo del Modelo SIG – QHSE3+. Fuente: Realización de los Autores.

Como se puede apreciar en la figura 2, una vez determinada la necesidad e identificado el problema, la metodología empleada considera las cuatro fases básicas, ligadas al flujo de la Investigación, que se enuncian a continuación:

3.1. Definición y Aplicación del Protocolo de Revisión del Estado del Arte:

El proceso de Revisión Bibliográfica para el Estudio del Estado del Arte, ha considerado la investigación, a partir de la definición de los cinco bloques que se relacionan a continuación, mediante la definición de temas, subtemas y preguntas y palabras clave que nos permiten determinar qué nos interesa en términos de bases de datos y criterios para seleccionar fuentes ligadas a artículos de revistas científicas, tesis doctorales y de magister, publicaciones reconocidas, entre otros:

3.1.1. Estudio del Estado del Arte propio del estatus y desarrollo de las PYMEs.

3.1.2. Estudio del Estado del Arte correspondiente a las Metodologías de Diseño de Modelos Conceptuales y su correlación con el Método Sistémico.

3.1.3. Estudio del Estado del Arte en cuanto a la Gestión Integral de Riesgos, la Inteligencia Decisional, y su aplicación en PYMEs.

3.1.4. Estudio del Estado del Arte en cuanto al Desarrollo de las Componentes de los Sistemas de Gestión QHSE3+: Calidad, Salud y Seguridad, Gestión Ambiental y Eficiencia Energética, al igual que de otros referenciales aplicables, teniendo en cuenta los programas y proyectos de las Comisiones Técnicas de ISO TC, generadoras de las familias de normas internacionales ISO 9000, ISO 45000, ISO 14000, ISO 50000 e ISO 31000.

3.1.5. Estudio del Estado del Arte en cuanto al Desarrollo de la Gestión de Planificación Directiva y Planificación Operacional en los Sistemas de Gestión, y su aplicación en las PYMEs

3.2. Configuración del Modelo SIG – QHSE3+

La configuración del Modelo se realiza de manera global y particular para sus 10 componentes principales, adecuando los desarrollos del Diseño Sistémico que lidera Bernabé Hernandis Ortuño (Hernandis Ortuño & Briede Westermeyer, 2009) y la Red para el Diseño Sistémico RIS, al caso particular del diseño de un Modelo de Sistemas Integrales de Gestión.

En primera instancia se observa el Sistema como un todo ligado a cada empresa PYME, que tiene unas entradas en términos de recursos, información, condiciones del entorno y requisitos, que se incorporan a la red de procesos de la PYME y generan resultados de negocio, a partir de una Planificación Directiva y Operacional asociadas al Direccionamiento Estratégicoy y a la Gestión Integral de Riesgos. Bajo este enfoque se considera un análisis en cuanto al diseño Estructural, Funcional y Ergonómico (EFE), sobre el Sistema en su globalidad, que posteriormente tiene una réplica en los mismos temas (efe_i) para cada una de las siguientes componentes que lo integran:

a. **Núcleo de Dirección**: Direccionamiento y Estrategia para el Éxito Sostenible, en integración y simbiósis con la Gestión del Core del Negocio, asociada al Desarrollo de los Productos y Servicios que caracterizan y diferencian la PYME.

b. **Corazón del Talento y la Cultura:** Gestión de la Cultura, el Desarrollo Organizacional y el Conocimiento. Desarrollo de Competencias. Fortalecimiento del Sentido Social y Humano del Proyecto de Emprendimiento PYME.

c. **Coraza de Planificación Operacional, Inteligencia y Riesgos:** Este componente correlaciona la Inteligencia y la Gestión Integral de Riesgos con la Planificación Operacional QHSE3+ de los procesos.

A continuación, los componentes ***d*** al ***h*** conforman los ***Brazos del Modelo*** y corresponden a la aplicación de la Planificación Operacional en términos de Buenas Practicas, que le competen a cada uno de los componentes QHSE3, teniendo en cuenta la Estructura de Alto Nivel (HLE por sus iniciales en inglés), definida por ISO para todas las normas sobre Sistemas de Gestión a partir de los procesos de revisión iniciados en el año 2013, que generaron las versiones actualizadas de ISO 9001:2015, ISO 14001:2015 e ISO 45001, en curso de desarrollo para el año 2016.

d. **Componente Q - 9k**(ISO 9001)**:** Componente correspondiente al Control Operacional aplicado a las Buenas Prácticas asociadas a la Gestión de Calidad de productos, servicios y procesos, focalizadas hacia la prevención de las fallas y no conformidades de sus especificaciones.

e. **Componente HS - 45k**(ISO 45001)**:** Componente correspondiente al Control Operacional aplicado a las Buenas Prácticas asociadas a la Gestión de Salud y Seguridad, focalizadas hacia la prevención de accidentes de trabajo y enfermedades profesionales.

f. **Componente E - 14k**(ISO 14001)**:** Componente correspondiente al Control Operacional aplicado a las Buenas Prácticas asociadas a la Gestión Ambiental, que se focaliza en la prevención de la contaminación.

g. **Componente E2 – 50K**(ISO 50001): Componente correspondiente a la Gestión para la Eficiencia Energética, focalizado en la prevención de los riesgos de uso no racional e ineficiente de los recursos energéticos.

h. **Componente Plus (+):** Tiene en cuenta el manejo de otro tipo de riesgos específicos que dependiendo del tipo de PYME deben incluirse, como por ejemplo: Riesgos de Inocuidad, de Seguridad de la Información, de Contrabando, Narcotráfico o Comercio ilegal, entre otros.

Los dos últimos componentes del modelo tienen que ver con los elementos que cierran el Ciclo PHVA *(**P**lanear, **H**acer, **V**erificar / Realimentar, y **A**ctuar en consecuencia / Mantener, Corregir, Prevenir, Mejorar),* propio del contexto integral de calidad de todas las empresas PYME:

- ***i.*** **Eje de Realimentación**: Tiene un alcance que cubre la totalidad de componentes del Sistema y considera los aspectos relacionados con Auditoría, Gestión de Indicadores, Seguimiento, Medición, Evaluación y Análisis, Supervisión, Peticiones, Quejas, Reclamos y Gestión de las Voces de los Grupos de Interés.
- ***j.*** **Eje de Mejora e Innovación:** Integra la Gestión de Acciones de Corrección, Tratamiento y Respuesta a No Conformidades e Incidentes, Mejora e Innovación.

3.3. Configuración de los Instrumentos de Diagnósis y Planificación Directiva y Operacional para el Modelo SIG – QHSE 3+

En esta fase del flujo de investigación se diseñan los Instrumentos que operacionalizan el modelo para su particularización en términos de Diagnóstico y Planificación, para la configuración efectiva y particularizada del modelo, en función de las características propias de cada PYME.

3.4. Aplicación y Validación Preliminar de los Instrumentos del Modelo.

La Validación Preliminar del Modelo tiene en cuenta la aplicación inicial de los Instrumentos de Diagnóstico y Planificación del Modelo y la observación de su pertinencia y beneficios, para la formulación de conclusiones, la declaración de lecciones aprendidas y la proyección de futuras investigaciones.

4. Revisión Bibliográfica. Aplicación del Protocolo de Estudio del Estado del Arte (E2A).

Con la aplicación del Protocolo, se desarrollaron las componentes del Estudio del Estado del Arte. De esta manera se obtuvieron las siguientes conclusiones.

4.1. E2A-1. Estudio del Estado del Arte de las PYMEs:

No obstante que los Programas de Gobierno y los Planes de Desarrollo de la mayoría de países de occidente tienen en cuenta Desarrollos en Competitividad, Premios y Planes de Incentivos, Programas de Formación, y Planes de Apoyo al Emprendimiento, como se observa en los estudios y las estadísticas del los Ministerios de Desarrollo y Cámaras de Comercio de muchos países de Europa y América, las cifras asociadas al cierre de las PYME se mantienen, y el desarrollo de sus competencias es más limitado en los países en vía de desarrollo, donde además las PYMEs tienen que afrontar una carga fiscal impositiva demasiado alta.

Si bien las condiciones de crisis del petróleo, al igual que la problemática climática y sus implicaciones en las restricciones económicas del mundo en la última década han hecho disminuir el presupuesto asignado, de todas maneras existen varios proyectos de estado, tesis de grado y programas de desarrollo, que desde el sector académico y las organizaciones gremiales aún trazan líneas maestras, para contribuir en la sostenibilidad, el crecimiento y el éxito sostenible de las PYMEs.

Este es el caso de los estudios de (Marcelino-Sádaba, et al., 2014), y (Del Caño & De La Cruz, 2002), por sus trabajos en materia de Riesgos para estas organizaciones, como de (Gomez y Rialp, 2008), (Madrid y García, 2008), (Rabentino 2005) y (Zornoza, 2000), quienes en sus investigaciones muestran los desafíos, el imperativo y las tendencias del presente y futuro de las PYMEs, como se ha resumido en el anterior párrafo.

4.2. E2A-2. Estudio del Estado del Arte del Diseño de Modelos Conceptuales y su correlación con el Método Sistémico.

El Diseño de Modelos Conceptuales y la aplicación de la Sistémica y la Ingeniería Concurrente para su enfoque en todo tipo de productos, servicios, organismos y sistemas se ha venido desarrollando a partir de los desarrollos de la Teoría General de Sistemas (Bertalanffy, 1975) y posteriormente con escuelas particulares de diseño que han integrado el diseño gráfico con el diseño en sus componentes funcional, ergonómico y formal, y a partir del enfoque sistémico, el diseño para estos tres componentes, modelando sobre objetivos de explotación, gestión, evolución y mutación. Este es el caso particular de la Red Latina de Diseño, que liderada por Bernabé Hernándis Ortuño (Cardozo J., Hernandis B., et al, 2015) y desde la revista *rdis "revista de la **red** internacional de investigación en **dis**eño",* ha venido integrando los trabajos y esfuerzos de las escuelas de diseño y los investigadores de Argentina, Brasil, Chile, Colombia, España, Italia, México y Venezuela, entre otros.

4.3. E2A-3. Estudio del Estado del Arte de la Gestión Integral de Riesgos.

En su componente de Inteligencia y Gestión Integral de Riesgos, el modelo se ha fundamentado en los desarrollos de las últimas dos décadas que ha liderado la escuela australiana y neozelandesa, a través de los Comités de Normalización de AS/NZ e ISO, quienes dinamizaron el desarrollo de la norma ISO 31000:2009, *"Administración Integral de Riesgos*", y las demás normas que integran su familia, en temas ligados a la estimación del riesgo, los indicadores, la auditoría y los indicadores para la gestión del riesgo. Esta dinámica se complementa con el Enfoque de Inteligencia del Departamento de Seguridad Nacional Norteamericano y de la Policía de las Américas (USA - DHL, 2010), y con los desarrollos en materia de Control Interno desde el modelo del *"Committee of Sponsoring Organizations of the Treadway Commission"* (COSO).

4.4. E2A-4. Estudio del Estado del Arte de la Gestión QHSE3+

Esta componente del E2A se nutre de los desarrollos de las familias de Normas ISO 9000, desde el Comité ISO TC 176; ISO 45000, con el Comité PC 283; ISO 45000 con el Comité TC 207 e ISO 50000 bajo el Comité TC 242. Desde cada una de estas comisiones, y bajo un Plan de Desarrollo particular de cada una se van jalonando los desarrollos en estos temas.

4.5. E2A-5. Estudio del Estado del Arte de la Gestión de Planificación Directiva y la Planificación Operacional en las PYMEs

Los desarrollos de las Escuelas de Negocios y Administración en Materia de Planificación Directiva y Estratégica, al igual que el enfoque de procesos y su aplicación en transversal en cuanto a definición de procesos, especificaciones y controles constituyen los elementos de Planificación que nutren en el modelo, bajo el desafío del éxito sostenible para las PYME.

5. Desarrollo. Argumentación y Resultados Obtenidos

5.1. El Modelo SIG – QHSE3+:

En la figura 3 se observa el modelo configurado, en el que se articulan los componentes descritos en la sección 3, que tiene una ***Estrella*** como *Núcleo de Dirección,* seguido del ***Corazón*** que representa el *Talento y la Cultura*, con una ***Coraza*** de tres capas que reúnen la *Inteligencia,* la *Gestión de Riesgos* y la *Planificación Operacional.* A continuación, el modelo plantea 5 ***Brazos***, *para las componentes QHSE3+, y su estructura culmina con dos **Ejes de Dinámica,*** que corresponden al *Eje de Realimentación* y el *Eje de Mejora e Innovación.*

Desde un punto de vista general se destaca que para el Modelo se ha considerado el estudio de las componentes de Diseño Funcional, Ergonómico y de Forma (FEF), al tiempo que, de manera particular para cada uno de los diez elementos señalados en el párrafo anterior (fef), se hace la réplica de este análisis, destacando el enfoque sistémico y la determinación de entradas, procesos relacionados, salidas y métricas ligadas a sus objetivos.

5.2. Los Instrumentos de Diagnósis y Planificación.

Una vez realizado el diseño gráfico y Funcional/Estructural, Ergonómico y Formal del Sistema Integral de Gestión SIG-QHSE3+, se ha procedido a configurar varios instrumentos básicos que facilitan su configuración, comprensión y puesta a punto para la operación. Estos instrumentos se dividen básicamente en dos bloques:

5.2.1 Instrumentos para la comprensión y el Diagnóstico del SIG-QHSE3+,

Estos instrumentos están reunidos como un libro Excel que plantea una hoja Excel para cada uno de los 7 Principios Universales de Gestión Integral: **a)** Enfoque en las Partes Interesadas, **b)** Liderazgo Gerencial, **c)** Humanización y Desarrollo del Talento, **d)** Enfoque de Procesos, **e)** Enfoque Basado en Hechos para la toma de decisiones, **f)** Relaciones mutuamente beneficiosas con los grupos de interés, y **g)** Mejora Continua.

En cada una de las hojas y para cada principio se realiza una calificación de 10 preguntas que cubren el ciclo PHVA aplicado a los riesgos Q(ISO 9001/Calidad), HS(ISO 45000/Salud y Seguridad), E(ISO 14001/Gestión Ambiental, y E2(ISO 50001/Eficiencia Energética).

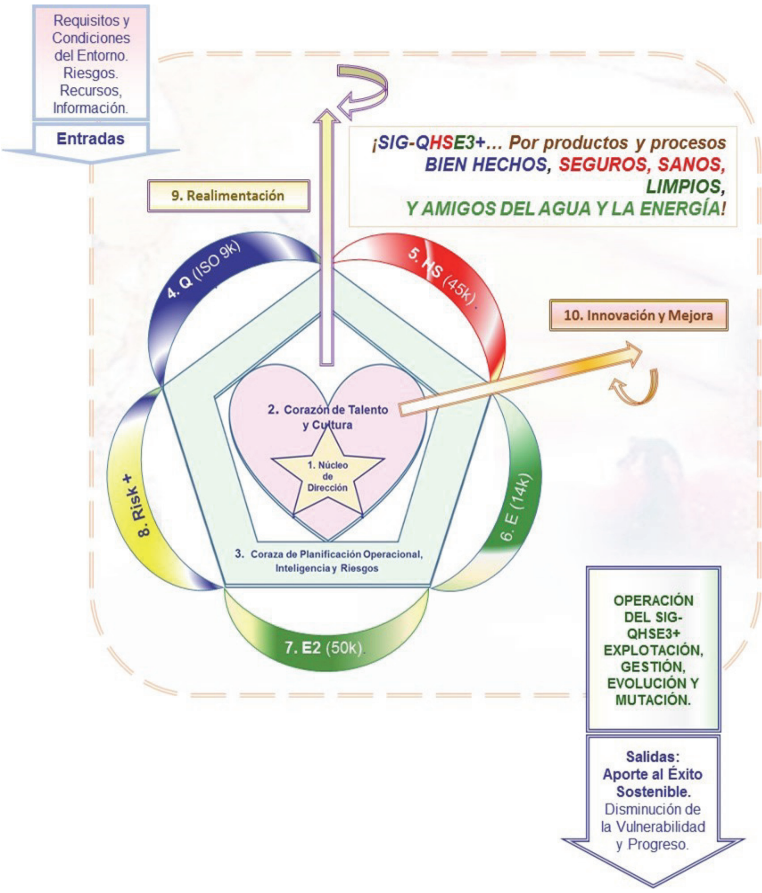

Fig. 3 Boceto de Representación del Modelo SIG – QHSE3+. Fuente: Poveda Orjuela (2016).

Se deja abierta la posibilidad de formular una o varias columnas adicionales para referenciales ligados a especificaciones adicionales que apliquen según la naturaleza de los productos, los procesos y las empresas relacionadas.

La aplicación de estos instrumentos permite obtener una línea base y establecer prioridades particulares para la configuración detallada del modelo.

5.2.2 Instrumentos para la Planificación Directiva.

Estos instrumentos permiten soportar la Planificación Directiva del Sistema y del Negocio, a partir de la definición del contexto vs los productos o servicios clave de las PYME, la definición del Modelo de Negocio, los propósitos y objetivos estratégicos, los riesgos críticos del negocio bajo un análisis de motricidad, dependencia que aplica el enfoque de la escuela Prospectiva (Godet, 2000), en conjugación con el análisis clásico de importancia y gobernabilidad, para formular posteriormente los proyectos y medidas de administración de estos riesgos, y la Política Integral de Gestión SIG-QHSE3+,

5.2.3 Instrumentos para la Planificación Operacional y la Gestión Integral de Riesgos QHSE3+

El enfoque de procesos se materializa en el modelo a partir de la Planificación de su secuencia, la identificación de riesgos en cada una de sus componentes QHSE3+, y la definición de medidas integrales de prevención, control, medición y seguimiento por cada proceso. En este punto se centra la Gestión del Modelo en cuanto al Pensamiento Integral basado en riesgos.

El enfoque de la Planificación Operacional puede considerar la formulación de Planes particulares QHSE3+ en la configuración de Proyectos Clave, o bien en la Planificación, Diseño y Desarrollo de Productos y Servicios bajo el enfoque i+d+D+I, según sea el caso.

6. Conclusiones

Con la aplicación de las líneas metodológicas expuestas de manera general en las anteriores secciones, se logró poner al servicio de los emprendedores de las PYMEs un Modelo Integral para los Sistemas Integrales de Gestion que mediante Instrumentos montados sobre hojas electrónicas básicas, permite llenar el vacío actual en este sentido y complementar los pocos instrumentos específicamente diseñados para las PYMEs que se encuentran disponibles para el público en general, entre los que se destacan principalmente los trabajos de (Marcelino-Sádaba, et al., 2014), y (Del Caño & De La Cruz, 2002), que aplican para el caso particular de Gestión de Riesgos en Proyectos para el sector de la construcción, pero no tienen en cuenta la visión integral SIG-QHSE3+, ni la problemática de los Sistemas de Gestión de las PYMEs.

Se plantean a continuación, a título de conclusión general, los puntos de innovación, los aportes, y los logros específicos generados:

a) *La apropiación, particularización y validación de un modelo de trabajo sencillo que facilita aplicar en cada PYME los ciclos y etapas para la configuración y operación de los SIG-QHSE3+, bajo un enfoque de Prevención fundamentado en la aplicación de las Buenas Prácticas y la Inteligencia de la Información para la Toma de Decisiones acertadas.*

b) *El desarrollo y validación de Instrumentos de Comprensión y Diagnóstico del ámbito del SIG, que soportan también la particularización de su configuración, al tiempo que su Planificación Directiva y Operacional focalizada en los negocios PYME.*

***c)** La aplicación sistemática e integral (QHSE3+,) del Pensamiento Basado en Riesgos desde el análisis del problema y las necesidades asociadas, en la estructuración de los Bancos de Ideas, de Conceptos y en la Administración del Portafolio de Proyectos, al igual que en el ciclo transversal de Direccionamiento Estratégico, Enfoque de Procesos y Operación de los negocios PYME.*

***d)** La incorporación del análisis de Motricidad y Dependencia, como herramienta para soportar las decisiones en cuanto a la priorización de los frentes preventivos de acción ante riesgos y problemas, y como instrumento de análisis de las prioridades que tienen en campo los diferentes elementos directivos y operacionales de los negocios PYME.*

***e)** La focalización en mapas de riesgos y la incorporación del Pensamiento Basado en Riesgos a la cotidianidad operacional y estratégica de los directivos, responsables de la gestión del emprendimiento y los procesos de las PYME, cuando al lograr disminuciones porcentuales de vulnerabilidad del riesgo general entre el 15% y el 37%, que pueden llegar a representar cifras mayores de reducción de costos; entienden y apropian la ecuación (1):*

CALIDAD INTEGRAL = APLICACIÓN DE BUENAS PRÁCTICAS = GESTIÓN DE RIESGOS = % DISM. DE LA VULNERABILIDAD = %DISMIN. COSTOS

$$\%DismVul = \left[\sum_{i=1}^{n} (Po_i).(Go_i) - \sum_{i=1}^{n} (Pf_i).(Gf_i) \right] / \left[\sum_{i=1}^{n} (Po_i).(Go_i) \right] \qquad (1)$$

Donde DismVul corresponde al porcentaje de Disminución de la Vulnerabilidad, luego de aplicar las Buenas Prácticas, Poi y Goi representan la valoración inicial de la Posibilidad y la Gravedad de cada riesgo, en tanto que Pfi y Gfi corresponden a la Posibilidad y Gravedad finales, después de haber puesto en aplicación las medidas de prevención asociadas a las Buenas Prácticas.

***f)** La apertura y generación de campos para nuevas investigaciones y proyectos PYME con herramientas sectoriales para los diferentes tipos de empresas PYME y proyectos de desarrollo de nuevos productos y negocios, emprendimiento, inversiones y desarrollo urbano, social, tecnológico e industrial.*

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O Uso do Dispositivo IdThink no Compartilhamento de Conhecimento

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Resumo

A sociedade está mudando, deixando o velho paradigm de trabalho para um novo que mais dinâmico e complexo. Neste contexto a maneira que as pessoas consomem mudou. Para sobreviver este cenário as organizações tiveram que inovar, mas não somente inovar baseado nos comportamentos dos atuais consumidores, mas inovar baseado em pessoas que ainda não existem e suas relações, para tanto as organizações tiveram que adotar a inovação impulsionada pelo design, a qual traz avanços lidando com conhecimento de códigos visuais e significados. Este artigo pretende demonstrar como o modelo de Gestão Estratégica Integradora de Design atualizado (GEiDa), o qual trata o design como conhecimento e adota o design thinking, pode levar as organizações a adotar a inovação radical e incremental por meio da inovação impulsionada pelo design. Para tanto este irá discursar sobre a inovação impulsionada pelo design, design thinking, e apresentar o modelo conceitual GEiDa. Este artigo trabalhou com o delineamento ex-post-facto utilizando etnografia como estratégia, por meio da observação não participante. Depois da aplicação do modelo ficou evidente que por meio da aplicação do design thinking o modelo será capaz de auxiliar as organizações a alcançarem a inovação incremental e radical pela inovação impulsionada pelo Design.

Palavras-Chave: *Inovação Impulsionada pelo Design; Codigos visuais; Design Thinking; Gestão do Design*

Abstract

Considering that the great advantage of an organization today is the knowledge it has, and how it manages this knowledge, this article reports the application of the IDThink device in a fashion organization's manufacturing sector for its validation. This device applies knowledge management through the skills and attitudes of the design thinker. The device shown here is to assist the process of innovation in organizations by using some design *thinkers skills in the knowledge explicitation and externalization. To Brown (2009) design thinking begins with the skills that designers have learned over time as: To align the human being´s needs with the technological resources available in the organization; Intuition; The ability to recognize patterns; Build ideas that have both emotional significance and functional; The ability to question their surroundings and be empathetic and; The ability to express otherwise than in words or symbols. This last is one of the most important designer skills. The designer uses the drawing process also as a critical process, as discovery. He uses drawing as a means of materializing, imagination, or discovery of something that he cannot built in his mind, and as a mean of communication with others, facilitating collaboration on projects. The IDThink device is an external, temporary repository for ideas, with which the designer interacts, and this externalization supports the necessary dialogue that it has between the problem and the solution, which minimizes the cognitive stress when dealing with quantities and complexities of knowledge to be process internally. The identification of concepts and their positioned graphical representation facilitates decision-making, the sharing of knowledge of everyone involved in the organization management, and observation of systemic functioning of the company, focusing on indicators that it judged suitable. The use of visual codes, which will be available throughout the process, allows the team to navigate the process without losing their train of thought. Also allows us to observe the evolution of the environment and its influence in the organization to assist in corrective actions. The nature of the research was exploratory, with lineation by ex-post-fact, using a strategy of ethnography, through non-participant interviews and observation. After applying, the researchers understood the need to adapt the External System of the IDThink device so that it includes an amount of knowledge needed to the visualization of the organization's management and / or the development of new products.*

Keywords: *Knowledge Management, Design Thinking, external repository, visual codes.*

1. Introdução

O dispositivo aplicado promove mudanças organizacionais pela inserção da Gestão do Conhecimento, que preserva as características da organização, a lógica de produção, o respeito à diversidade cultural, e também coopera para que haja a inserção do produto na lógica empresarial por meio do entendimento mercadológico, gerenciadas pelos design thinkers.

O design thinker traduz observações em insigths e insights em produtos e serviços. Não só os designers podem ser design thinkers, mas aqueles que têm as mesmas experiências e habilidades integrativas e holísticas do design thinker, (nas organizações, nas sociedades e na vida). Sabe-se que o acúmulo de experiências durante a vida possibilita aguçar a sensibilidade e habilidades.

O design thinker extrai conhecimentos (tácito, cultural, objetivo e explícito) das organizações (Demarchi, Fornasier, Martins, 2013), codifica-os e gera conhecimento organizacional para produzir o conhecimento objetivo, agregando valor aos produtos e contribuindo para torná-los mais competitivos. Por meio da etnografia e utilizando sua habilidade empática o design Thinker extrai os conhecimentos da organização, no entanto, para poder lidas com a carga cognitiva gerada e refletir sobre as informações e conhecimentos coletados o design Thinker coloca em prática outra de suas habilidades a de visual thinker.

Este artigo relata a aplicação do dispositivo IDThink, que permite visualizar o plano de empresa sobre um suporte material, a partir da representação gráfica dos vários conhecimentos atribuídos a organização, em uma organização do setor de confecção para sua validação.

Portanto este dispositivo é um repositório externo e temporário para ideias, com o qual o design thinker e a equipe interage, e essa externalização suporta o diálogo necessário que o indivíduo tem entre o problema e a solução, o que minimiza o estresse cognitivo ao tratar com quantidades e complexidades de conhecimentos a serem processados internamente. Utilizando a habilidade de Design Thinker o agente de design alimenta este repositório externo com a síntese dos conhecimentos levantados utilizando códigos visuais diversos.

O Dispositivo facilita a visualização do seguimento contínuo dos objetivos da empresa, auxilia a visualização do problema de maneira global, por meio de um processo gráfico que garante retroalimentações tanto nas estruturas disponíveis, quanto nos recursos humanos e materiais, assim como facilita a visualização das ações e fluxos de informações correspondentes as decisões necessárias para a produção de produtos e serviços. O dispositivo demonstra também quais são as habilidades e as atitudes de design thinker que o gestor deve ter em cada etapa, o que facilita a aplicação da gestão do conhecimento na organização.

O dispositivo utiliza os conceitos do Modelo Sistêmico de Hernandis (2003) agregado de conceitos proposto na Gestão Estratégica Integradora de Design Aprimorado (GeIDa) de Demarchi, Fornasier e Martins (2013), sendo estes modelos baseados na gestão do conhecimento.

2. Gestão do conhecimento

O modelo GeIDa (Demarchi, Fornasier e Martins, 2013), adota a segunda fase da gestão do conhecimento considerando o modelo de Mark W. McElroy (apud Firestone e McElroy, 2003), construído pelo trabalho conjunto com o Knowledge Management Consortium International (KMCI). A Nova Gestão do conhecimento que presumia os conhecimentos valiosos não estavam a disposição prontos para serem coletados. De fato muitas vezes a organização não sabe, os conhecimentos que possue, portanto devem ser extraídos para depois serem sintetizados e codificados em um novo conhecimento.

De acordo com os autores um importante aspecto da NGC é o reconhecimento de que organizações são permeadas de um fenômeno do sistema adaptativo complexo. Nesse contexto, a gestão do conhecimento baseia-se na utilização deste sistema para a adaptação organizacional, que possibilita e reforça a auto-organização e processa o conhecimento para atingir uma acelerada inovação sustentável. Lembrando que o modelo de McElroy (2003, p. 5), apresenta o conhecimento como algo produzido por "sistemas sociais humanos, que fazemos isso por meio de processos individuais e por compartilhamento que regularmente acontece entre os seres humanos".

O dispositivo descrito neste artigo, adota a NGC, e consequentemente visa a interdependência da produção e da integração do conhecimento, apesar de neste momento, o dispositivo apresenta somente a produção do conhecimento, mas será ampliado.

O Modelo Sistêmico (Hernandis, 2003) é um aparato que gestiona dados, informação e conhecimento. Convêm reforçar que basicamente os dados são provenientes quando ocorre a definição dos componentes do sistema exterior por meio das variáveis de entrada. Neste ponto é oportuno destacar a importância da abordagem sistêmica para potencializar a compreensão integral do processo de gestão do conhecimento. Como assinala Cross (2011), a perspectiva é contextual e, portanto, não só a análise da estrutura como também a qualidade do sistema estudado e suas interações, aspectos que são essenciais para este projeto. Portanto, a gestão de dados, informação e conhecimentos articulam-se com conceitos fundamentais associados a noção de análise sistêmica como a proposta por Joel de Rosnay (1979), que "[...]consiste em definir os limites do sistema a modelar; em identificar os elementos importantes e os tipos de interações entre estes elementos; depois, em determinar os enlaces que os integraram em um todo organizado" (p.85).

A contribuição proposta do Modelo Sistêmico será justamente no processo de extração do conhecimento, assim o modelo trabalha com dados, informações e conhecimentos, considerando os conhecimentos explicitados (objetivo e explícito) e conhecimentos não explicitáveis (conhecimento tácito e cultural) estudados por Demarchi, Fornasier e Martins (2010).

O conhecimento objetivo é o conteúdo lógico de nossas teorias, conjecturas e suposições explicitados em procedimentos aparentes nos produtos, tecnologia, arte, arquitetura, linguagem escrita e falada, mitos, rituais e histórias, enfim são os fenômenos que alguém vê, ouve e sente, quando depara-se com um novo grupo, ou com uma cultura não familiar. O conhecimento explícito está na linguagem formal, em afirmações gramaticais, expressões matemáticas, especificações, e manuais sendo transmitido, formal e facilmente entre os sujeitos.

O conhecimento tácito é compartilhado a partir de exemplos ou demonstrações, quando se trata da experiência "do fazer" é difícil de ser verbalizado ou explicitado, pois é o conhecimento pessoal incorporado à experiência individual e envolve fatores intangíveis como as crenças pessoais, perspectivas e sistemas de valores. Muitas vezes pode ser somente compartilhado por meio de discurso como: analogias, metáforas e compartilhamento de histórias. Apesar de o conhecimento tácito ter característica pessoal, as organizações possuem conhecimento tácito em torno de práticas que a tornam diferentes entre si.

Conhecimento cultural está expresso nas crenças, normas e pressupostos usados para dar valor e importância a novos conhecimentos e informações, não é codificado, mas divulgado por vínculos e relacionamentos que ligam um grupo, e que por meio da linguagem constrói-se o sistema que articula com outros sujeitos. As crenças são sustentadas como verdades, porque são construídas por determinadas referências da realidade a partir de aceitações anteriores formuladas pelo grupo.

À medida que estes conhecimentos são explicitados, vão sendo anexados ao produto proposto a partir de dois quadros, que facilitam a visualização da externalização do conhecimento. Demarchi, Fornasier e Martins (2010) a definem como a ação de extrair os conhecimentos explícitos e culturais do ambiente, que se articulam com as necessidades latentes do sujeito (conhecimento subjetivo), pois ao compartilhar um conhecimento, o sujeito adquire outro conhecimento, ou muda as crenças e valores enraizados.

A partir da relação dos cinco conhecimentos pode-se produzir um novo conhecimento. Observa-se que três dos conhecimentos apresentados anteriormente não podem ser explicitados. O conhecimento tácito e o conhecimento cultural podem ser compartilhados, mas não externalizados; e o conhecimento subjetivo não é nem explicitado, nem compartilhado, é somente alterado quando ocorrem as relações de sociabilidade, o que justifica a dificuldade em extrair os conhecimentos, e coloca em xeque o entendimento de Nonaka e Takeuchi (1997) de que o conhecimento está pronto para ser trabalhado.

Para poder utilizar os conhecimentos durante o processo de design, deve ocorrer o processo de aprendizagem. Aprende-se por meio de um processo que inclui o conhecimento investigado, associando-o ao saber como fazer algo, e ao saber que este algo é feito desta ou daquela maneira, ou seja, da teoria e da prática, numa ação sistêmica. Este ciclo ocorre durante a conversão do conhecimento, pois o designer precisa aprender para poder sintetizá-lo e convertê-lo em outra linguagem.

Para produzir um novo conhecimento é necessário fazer a sua extração e conversão pela interação dos cinco conhecimentos articulados em quatro possíveis modos de conversão, os quatro Es do Processo de Produção do Conhecimento definido por Demarchi (2011)..

A Externalização é conseguida pelo compartilhamento de experiências. Esta fase é muito importante para o agente de design, e provavelmente a que ele tem maior dificuldade, pois necessita tirar das pessoas o que sabem e querem que seja importante para o trabalho, considerando que nem elas mesmas sabem que sabem, ou o que querem, "ajudar as pessoas a articularem as novas necessidades que eles podem nem saber que têm" (Brown, 2009, 40) é um desafio que pode ser solucionado utilizando as habilidades dos design thinkers. O agente de design é ajudado por algumas ferramentas, como ir ao campo observar o comportamento das pessoas enquanto elas agem, o que proporciona pistas valiosas sobre uma lista de necessidades insatisfeitas.

Na Explicitação se torna necessária para que o agente de design consiga trabalhar com a carga cognitiva gerada pela grande quantidade de conhecimentos externalizados que o individo deve lidar. Neste modo o agente necessita sintetizar os conhecimentos e converte-los em códigos visuais para facilitar a socialização dos conhecimentos. O individuo normalmente incentiva a socialização a partir de metáfora e/ou analogia, importantes para a criação de uma rede conceitual, como também: contação de histórias (storytelling- metáforas para externalizar conceitos e transmitir ideias ou eventos); e o pensamento visual (visual thinking - para explicitar conceitos). Após, sintetiza as observações que serão agrupadas e a partir delas formularão outros conhecimentos, por meio da redução do conhecimento, a primeira do Processo de Produção do Conhecimento.

Na Experimentação compartilha-se o conhecimento explicitado e recodificado, por meio das habilidades criativas e experimentais. Desmembram-se as ideias surgidas e se operacionalizam as visões explicitadas conseguidas pelas pesquisas qualitativas, quantitativas, e na construção de protótipos. Eles são utilizados como modelo, como uma representação física ou matemática de um objeto, ou pode ser ainda "qualquer coisa tangível que nos deixe explorar uma ideia, avaliá-la e levá-la adiante" (Brown, 2009, p.92). Portanto, a experimentação é o processo de sistematização de conceitos em um sistema de conhecimento.

A Estratégia é o processo de redução progressiva para chegar a uma alternativa de aplicação estratégica formada pelo conhecimento explicitado. Está relacionada ao "aprender fazendo", já que "para que o conhecimento tácito torne-se explícito, é necessária a verbalização e diagramação do conhecimento sob a forma de documentos, manuais ou histórias orais"(Nonaka e Takeuchi, 1997, p.78)

O produto aqui aplicado é um dispositivo de explicitação de conhecimentos adquiridos do sistema exterior e que entram no modelo por meio de variáveis de entrada. No entanto, essas variáveis também contêm conhecimentos não explicitados, sendo necessária a realização da extração do conhecimento em uma etapa anterior que se materializa no modelo proposto no primeiro quadro que orienta o agente de design a colocar em prática os conceitos de design thinking, assim como as habilidades inerentes ao design thinker, principalmente a habilidade de visual thinking para que o processo de colaboração aconteça.

3. Design Thinking, Inovação e o IdThink

De acordo com Visser, Faems, Visscher, e Weerd-Nederhof (2014) gerar inovação rrequer a execução com sucesso atividades explorativas e explotativas. Estas atividades desviam o foco da organização das rotinas existentes. Consiste em identificar novos recursos de informação e ou recombinar componentes de conhecimento existente em uma nova estrutura de conhecimento.

Segundo os autores, existem fortes evidencias de que indivíduos com perfil cognitivo intuitivo facilitam a execução de atividades de exploração. No trabalho indivíduo intuitivos tendem a ter uma perspectiva mais ampla na solução de problema. Eles normalmente lidam com a informação de vários pontos de vista, aumentando a probabilidade de gerar novas soluções para os problemas.

O que percebe-se é que níveis altos de pensamento intuitivos são requeridos no início do processo de desenvolvimento de novos produtos quando o foco é geração de alternativas e lidar com uma grande quantidade de conhecimentos e informações extraidos, no entanto isso se torna menos relevante nos estágios finais.

“O pensamento intuitivo permite que indivíduos rapidamente passem sobre uma grande quantidade de informação na tentativa de identificar novas conexões entre diferentes componentes do conhecimento.” (Visser, Faems, Visscher, e Weerd-Nederhof , 2014, p.1170). O processamento intuitivo é normalmente vinculado ao pensamento divergente. O processo intuitivo é inerente ao design Thinker.

O dispositivo aplicado e descrito neste artigo pretende auxiliar o processo de inovação nas organizações pelo uso de algumas habilidades do design Thinkers no momento da Explicitação e Externalização dos conhecimentos.

Dyer, Gregersen e Christensen (2011) concordam com os autores acima, para eles a inovação é desencadeada pela habilidade que esses inovadores possuem de ligar ideias (chamam essa habilidade cognitiva de pensamento associativo), no entanto inovadores não só pensam de maneira diferente, mas também agem de forma diferente. Alguns observam o mundo com uma intensidade maior que os indivíduos comuns. Outros criam network com outros indivíduos criando um grupo colaborativo, enquanto outros se engajam em ações experimentais. O que os autores afirmam é que a inovação e a criatividade não é só uma habilidade cognitiva, mas também uma questão de comportamento.

Os autores criaram um modelo que demonstra o DNA de inovadores para gerar ideias inovadoras, demonstrado na figura abaixo.

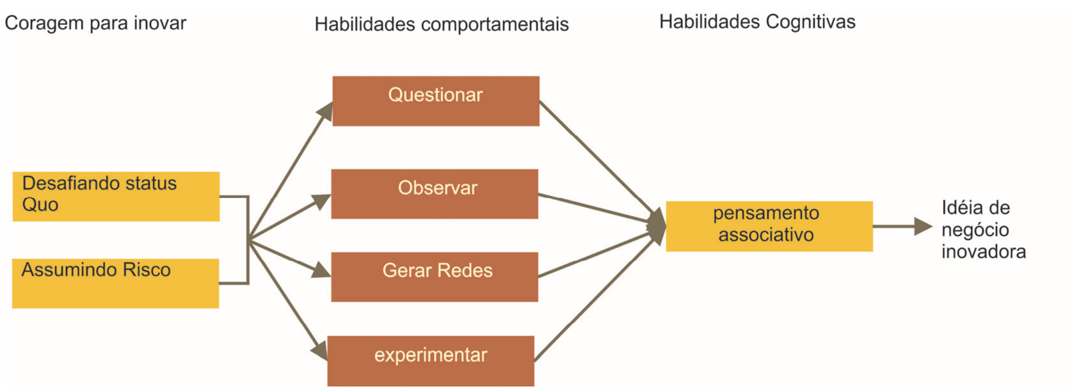

Fig. 1 Modelo de DNA de Innovadores. Fonte: adaptado de Dyer, Gregersen e Christensen (2011, p.27)

Observa-se que as habilidades comportamentais, e cognitivas dos inovadores são as mesmas do design-thinkers. Para Brown (2009) o design thinking inicia com as habilidades que os designers aprenderam no decorrer do tempo; como a de alinhar as necessidades dos seres humanos com o recurso tecnológico disponível na organização, na intuição, na habilidade de reconhecer padrões, construir ideias que tenham significado tanto emocional quanto funcional, na habilidade de questionar o entorno e ser empático, e a habilidade de expressar de outra maneira que não em palavras ou símbolos. Essa última uma das mais importantes habilidades do designer. Segundo Cross (2011, p.12) "O ato de desenhar parece clarear meus pensamentos."

Ainda segundo o autor, o processo do design, ao que parece, é difícil de conduzir por processos mentais puramente internos; o designer precisa interagir com uma representação externa.

Acontece que há um limite cognitivo para a quantidade de complexidade que pode ser manuseada internamente; esboçar fornece um depósito temporário e externo para ideias tentadas, e essa externalização suporta o diálogo que o designer tem entre o problema e a solução.

O designer utiliza o processo de desenho tanto como um processo de crítica como de descoberta. Ele utiliza o desenho como meio de materialização, imaginação, ou descoberta de algo que não pode ser construído na sua mente, e também como um meio de comunicação com os outros. De acordo com Cross (2011) nesses casos, o design se torna não somente um processo pessoal e cognitivo, mas um processo partilhado e social. Esse processo leva a outra habilidade que segundo Brown (2009) é a de trabalhar de forma interdisciplinar e de criar redes.

Os códigos visuais desenvolvidos pelos designer quando explicitando os conhecimento externalizados facilita a colaboração em projetos. O design thinker observa o ordinário e grava as suas observações e ideias visualmente; ele tem em si a habilidade de expressar suas ideias visualmente. A cultura do design thinking encoraja o protótipo, que não deixa de ser uma maneira de pensar visualmente. Para um design thinker, o protótipo não é só uma maneira de validar ideias finais, mas é também um processo de criação. A única premissa é que os protótipos precisam ser testáveis, mas não necessariamente físicos. De acordo com Brown (2009, p.231), protótipos podem ser "storyboards, cenários, filmes, e até um improviso teatral".

Praticantes do design thinking competentes geralmente sabem mais do que conseguem dizer. Eles exibem um tipo de saber-na-prática, em sua maioria, tácito. Ele identificou um processo cognitivo de reflexão-em-ação como a inteligência que guia o comportamento 'intuitivo' em contextos práticos de pensar-e-agir, algo como 'pensando sobre seus pés'. (thinking on your feet). Refletir-em-ação é um quadro experimental no qual o design thinker encontra uma maneira de ver a problemática nas mãos, ou seja, em forma de protótipos.

Pode-se observar a semelhança entre as habilidades e atributos do design thinker com o DNA de inovadores, o quadro abaixo gera essa relação.

Tabela 1. comparação entre as habilidades e atitudes do design thinker com o DNA do inovador

Habilidades e atitudes do design Thinker	Habilidades comportamentais do inovador	Habilidades Cognitivas do inovador	Coragem de inovar
Observação empática	Observação Questionar		
Colaborativa Integrativo	Criar rede		
Gerar protótipos	Experimental		
Criativo Visual thinkers		Pensamento associativo	
Trabalhar com a diferenciação			Desafiar o Status Quo
Visão de futuro Assumir risco			Assumir risco

Fonte: Demarchi, Fornasier, Ortuño e Marquina, 2014 p. 3231

O design Thinking pode auxiliar na inserção da inovação baseada em design utilizando todo o potencial do designer de identificar padrões e gerar ressignificações, por meio de códigos visuais, a partir da maior habilidade do designer o visual thinking.

4. IdThink: um dispositivo de extração e explicitação do conhecimento

ID-Think foi o nome dado ao dispositivo que é caracterizado como um produto empresarial de produção de conhecimento, tendo como objetivo auxiliar o processo de criação e planejamento de empresas, assim como para a análise, descrição, e detecção de problemas, para posterior correção de desvios de gestão empresarial.

Durante a modelagem do produto devem participar diretores, gestores, design thinkers, e pessoas diretamente envolvidas com a área ou empresa em questão. O processo é de cocriação, o que significa que todos deverão determinar os problemas da empresa/área planificando e determinando ações corretivas futuras, para que a empresa se adapte ao entorno e evolua. Como todo processo deve haver um líder, alguém com habilidades propícias para ajudar a realizar a externalização dos conhecimentos e que dirija as ações de preenchimento do modelo.

O produto constitui-se de dois quadros. O primeiro é o Sistema Exterior, o segundo é o Sistema de Empresa e abaixo do último existe uma faixa mais estreita, aonde serão colocados os objetivos já cumpridos, denominada de Faixa de Objetivos Cumpridos. Lembrando que o dispositivo auxilia no processo de criação e planejamento de empresas a partir das definições dos objetivos em cada um dos níveis empresarial e a partir deles define-se quem realizará o que, de que maneira, com o que e quando será realizado e o mesmo processo ocorre para ser validado.

Os dois quadros são imantados e possuem quadros específicos que facilitam a localização das ações a serem realizadas. A modelagem é induzida pela disposição destes quadros que serão preenchidos com os materiais incluídos na maleta do do dispositivo, como post its, marcadores, e fichas imantadas específicas com imagens ou com conceitos escritos.

O tabuleiro completo deve ficar pendurado a partir dos dois orifícios superiores, em qualquer local da organização no qual os participantes forem se reunir.

O Sistema Exterior é onde se copila toda a informação relativa ao entorno da empresa e se analisa mediante diversas ferramentas de transcendência da informação, gerando uma síntese mediante conceitos base, fotografias ou códigos visuais que constituem a informação fundamental da realidade da empresa

O Sistema Exterior alimenta o Sistema em Estudo com dados, informações e conhecimentos, Ortuño e Navarro (2000) definiram-no como sendo a caracterização do sistema aonde se localizará a atenção do pesquisador. Por isto que o segundo quadro imantado é constituído pelo subsistema de empresa. A organização, é formada por subsistema físico e pelos níveis de gerência que demonstram a ordem de prioridade, portanto, de preenchimento do sistema, de cima para baixo, começando pelos objetivos do nível de mutação.

A maneira lógica de preencher o Sistema em Estudo é do nível macro para o micro, sempre inicia pelo nível de Mutação, no qual o conselho administrativo, ou seja, os agentes responsáveis pela organização atuam diretamente, definem o conceito organizacional, e após determinam os objetivos de Mutação.

5. A aplicação

A Natureza da pesquisa foi exploratória, com delineamento pelo ex-post-facto, utilizando como estratégia a etnografia, por meio da entrevista e observação não participante.

A organização escolhida foi do setor de confecção e é situada na cidade de Londrina no Norte do Paraná – Brasil.

A A Polka Dotz é uma empresa jovem, extremamente feminina para as garotas que gostam de moda retro, com uma pitada de romance moderno, sem ser caricata. Valoriza os detalhes, transforma o novo e dá vida nova a antigos ideais.

A empresa trabalha com estampas exclusivas, e por conta de alguns problemas em anos passados está passando por uma fase difícil e necessitando compreender seu propósito e pensar em novos rumos.

O grupo da especialização em gestão de design da Universidade Estadual de Londrina, pegou o desafio para si e se propôs a utilizar o IdThink para a realização do diagnóstico e repensar os objetivos de curto e longo prazo da empresa.

O grupo iniciou com a externalização dos conhecimentos da organização para isso foi visitar a empresa e passou 4 horas conversando com a proprietária e vivenciando seus processos.

Após a visita, voltaram para a universidade, sentaram em grupo e primeiro discutiram o encontrado juntamente com a empresaria que participou de todo o processo, e depois começaram a preencher o IdThink em grupo. Os quadros foram colados em dois quadros grandes pois ainda não estavam atrelados aos quadros imantados e a pasta como demonstrado na imagem abaixo.

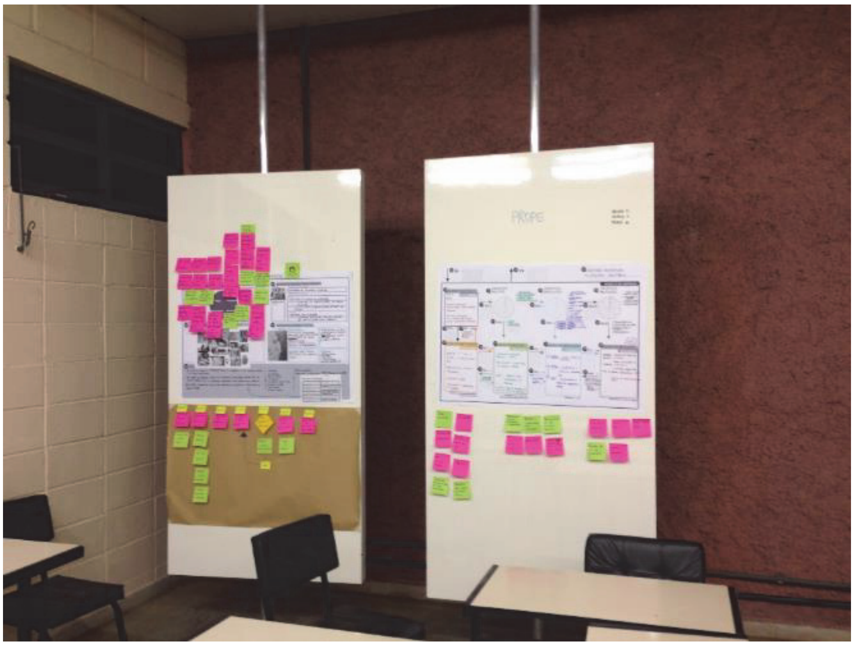

Fig. 2 quadros sendo preenchido após a visita na organização

Um dos primeiros problemas encontrados foi a falta de espaço para a colocação de informações importantes da empresa, como Missão, visão, valores, entre outras.

A outra dificuldade era como guardar estas informações após a realização da explicitação. Este problema já seria sanado com a pasta com os quadros imantados proposto pelo grupo de pesquisadores e com o site para que a informação fosse passada a limpo e armazenada na organização. O grupo apresentou os guadros a empresaria, a qual ficou surpresa com os encontrados. (fig 3 e fig 4).

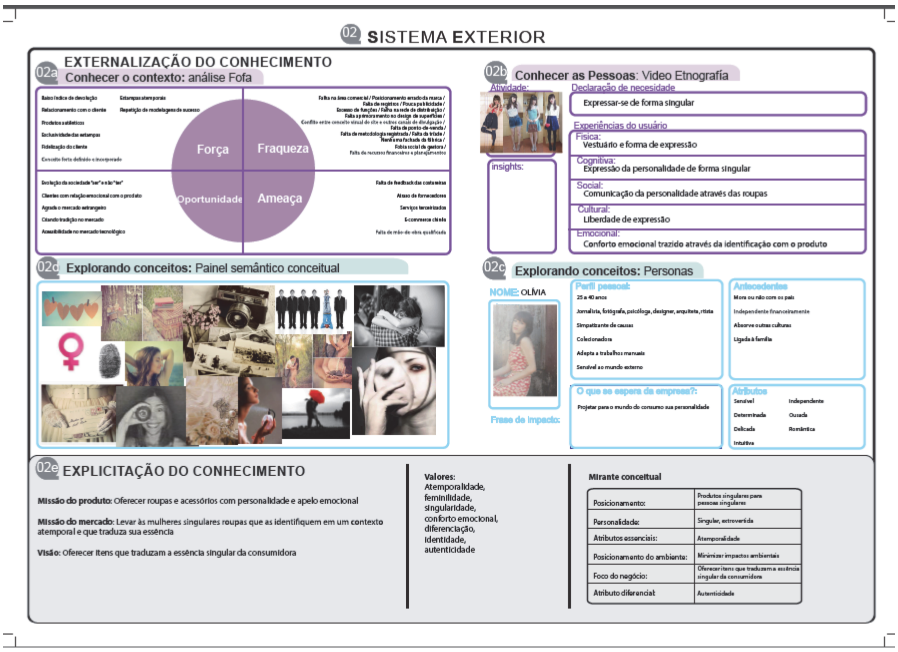

Fig. 3 Sistema exterior da organização

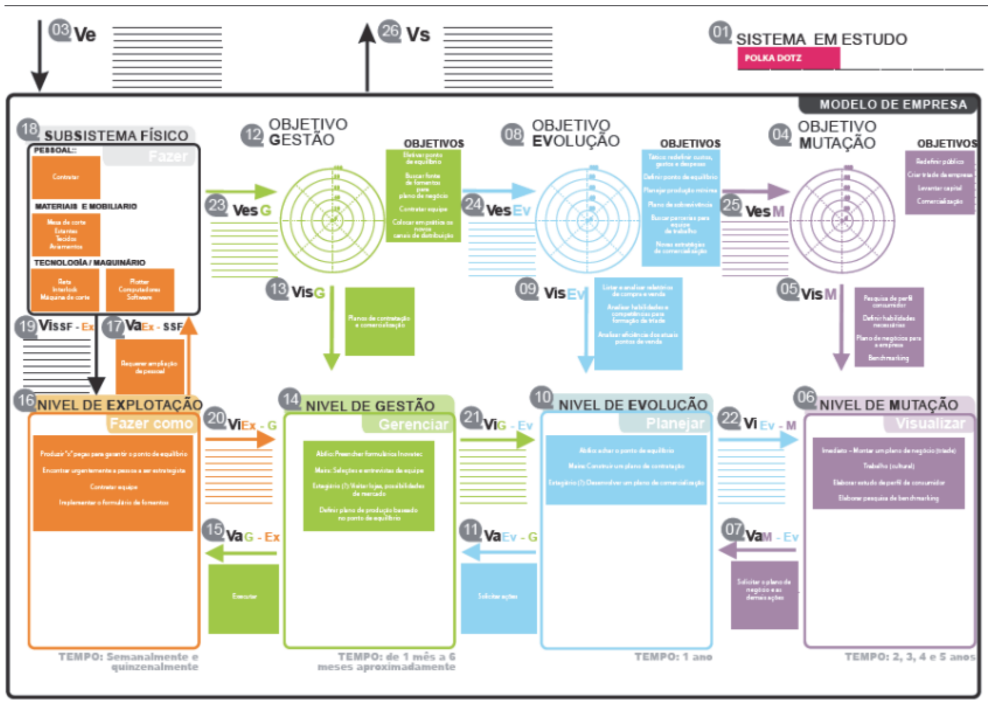

Fig. 4 Sistema de empresa

6. Conclusão

Após a utilização foi possível verificar que o dispositivo desenvolvido permite representar o problema de maneira global, permite visualizar pelo processo gráfico os pontos de retroalimentação de informação tanto dos recursos humanos e materiais, quanto das ações e fluxos de informações correspondentes às decisões necessárias para a produção de produtos e processos.

Também permite observar a evolução do entorno e sua influência na empresa para auxiliar nas ações corretoras.

A identificação de conceitos e sua representação gráfica posicionada por meio dos quadros preenchidos utilizando os post its, imagens imantadas, entre outros facilita a tomada de decisões e a observação do funcionamento global da empresa focando os indicadores que se julgam apropriados.

Pode-se observar que o dispositivo ID-Think é um depósito temporário e externo para ideias e síntese dos conhecimentos explicitados, com o qual o indivíduo precisa interagir, e essa externalização suporta o diálogo necessário que o indivíduo deve ter entre o problema e a solução, o que minimiza o estresse cognitivo ao tratar com quantidade e complexidade de conhecimentos a serem processados internamente. O dispositivo auxilia no processo colaborativo de definição de objetivos de curto e longo prazo da empresa.

Percebeu-se também a necessidade da pasta e a facilidade de manuseio que trará ao dispositivo possibilitando a utilização deste em qualquer situação.

No entanto pode-se perceber a necessidade de adaptação do sistema exterior do dispositivo IDThink, para que comporte a quantidade de conhecimentos necessários para a visualização da gestão da organização.

Percebeu-se também a necessidade de criar um sistema exterior único para empresa e para produto, para evitar retornos a organização e mais uma vez otimizar o processo.

Conversando com o grupo que utilizou o IDThink, pode-se concluir que o dispositivo otimiza o processo de gestão do conhecimento, enfatizando as habilidades e atitudes do design thinker, as quais são similares as habilidades cognitivas e comportamentais do inovador, auxiliando na implementação da inovação, a qual é essencial para a sobrevivência nas organizações em uma sociedade complexa.

7. Agradecimentos

Gostaríamos de agradecer à Universidade Estadual de Londrina a oportunidade de estarmos desenvolvendo essa pesquisa, disponibilizando tempo e local para tanto e a Capes que oferece apoio científico e financeiro.

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Emotional maps: neuro architecture and design applications

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Abstract

Neurophysiological measurements for emotional assessment have increased in Design and Architecture. Objective understanding of emotional states enables enormous opportunities to explain how environmental aspects affect persons. New methodologies must be developed to achieve a successful approach between Neuroscience and design areas, in order to consolidate this recent synergy. This paper contribute to delve into the concept of Emotional Maps (EM), which is a challenge for two reasons: the characterization of emotional states and the uncertain relation with maps illustrations.

In order to create an EM, Heart Rate Variability (HRV) was used to detect certain emotional states and Virtual Reality (VR) to generate an environment condition. The study was conducted by VR environment displayed in Head-mounted Display Oculus DK2. Sixteen persons participated in data acquisition by two tools: during environment exploration, a portable physiological device (Empatica E4) recorded HRV signal; and at the end of study, a Likert scale questionnaire collected emotional impressions.

HRV signal was time-frequency analyzed to detect activation levels. The statistical results prove that design guidelines used in environments evoked the stressful state sought, and that the physiological measure used are appropriate to be represented. The final result shows the possibility to mapping emotional states. This novel technique allows to quantify objectively a subjective experience and locate in specific place when occurs. Our technique supposes a contribution toward emotional states measurements applied to design and architecture.

Keywords: *Emotional Map; Heart Rate Variability; Virtual Reality; Parasympathetic reaction.*

1. Introducción

Actualmente, la investigación en diseño y arquitectura está explorando nuevas alternativas para comprender al usuario. En concreto, estas dos disciplinas se están interesando en como las señales fisiológicas pueden medir la respuesta emocional de las personas durante su interacción con productos o espacios. (Laparra-Hernández et al., 2009; Jacobsen, 2010; Reimann et al., 2010).

Existen varios estudios publicados cuyo objetivo es la detección emocional mediante equipamiento tecnológico para medir señales fisiológicas (Goshvarpour, Abbasi y Goshvarpour, 2015; Rojas et al., 2015). Estas tecnologías, muchas de las cuales provienen del área clínica, poseen nombres y metodologías propias para medir distintos aspectos fisiológicos de las personas. Las más populares dentro del área de la neurociencia aplicada a otros campos son: electrocardiograma (ECG), respuesta galvánica de la piel (GSR), electroencefalografía (EEG), magnetoencefalografía (MEG), variabilidad de la frecuencia cardiaca (HRV) y Eye-tracking (ET) (Demangeot y Broderick, 2010; Kable, 2011; Solnais et al.,2013).

En los ámbitos del diseño, la incorporación de estos sistemas de medición psicofisiológica han hecho que se comiencen a utilizar combinadamente métodos objetivos y subjetivos de adquirir la respuesta emocional del usuario (Ares y Deliza, 2010; Higuera et al., 2016; Marín-Morales et al., 2016; Monestina et al., 2014).

En este sentido, el concepto de Cartografía Emocional (o mapa emocional), introducido por Christian Nold (2009), es la representación racional y fisiológica de las emociones en un área o lugar específico. El comportamiento de un sujeto al moverse a través de áreas puede ser afectado por la información a su alrededor. Limitadamente, diseñadores y arquitectos han explorado este concepto con anterioridad, desarrollando distintitas estrategias para mapear la relación entre un espacio y las emociones (Litteman, 2012; Fischer et al., 2014; Amilant-Szary y Mekjajian, 2015). Sin embargo, la cartografía emocional requiere de métodos rigurosos para caracterizar las emocionales y representarlas adecuadamente sobre un mapa.

Una señal fisiológica que brinda una ventaja para cartografiar un estado emocional es el HRV, que se puede obtener por medición del volumen sanguíneo a través de la piel, y tiene correspondencia a la excitación o depresión en la actividad cardiaca. Existe una relación entre la señal de HRV y los sistemas simpático y parasimpático de las personas (Berntson y Cacioppo, 2004). Del análisis del HRV en el dominio de la frecuencia, se pueden extraer las bandas bajas (LF) y altas (HF) (Berntson et al., 1997). Aunque con el LF existe cierto debate sobre si refleja la actividad del sistema simpático, en cuanto al HF existe amplio consenso de que refleja la actividad cardiaca parasimpática de forma que incrementos de HF reflejan un mayor dominio por parte del sistema nervioso parasimpático (Billman, 2015), el cual es responsable de provocar o mantener un estado corporal de descanso actúando sobre el nivel de estrés del organismo disminuyéndolo (McCorry, 2007). De esta manera, se estima que mayores valores de la franja HF del HRV se relacionan con estados de mayor relajación o menor estrés.

Son varios los estudios que han utilizado la señal de HRV para observar la reacción positiva y negativa hacia ciertos estímulos (Rantanen et al., 2010; 2013) al mostrar una correlación entre los estados emocionales y la carga cognitiva que puede generar (Mann et al., 2015). De esta forma, en el presente experimento se utiliza la señal de HRV para extraer el estado emocional de los participantes y generar un mapa emocional.

El presente estudio pretende evaluar la capacidad de la señal del HRV para detectar estados emocionales generados por espacios arquitectónicos, así como la posibilidad de cartografiarlos posteriormente sobre plano.

En cuanto a la presentación de estímulos, se utilizó Realidad Virtual Inmersiva para presentar a los participantes del experimento los escenarios que debían generar emociones, ya que existe consenso en que ésta aporta una percepción más similar a la realidad que otros formatos tradicionales (Rodríguez et al., 2015; Rojas et al., 2015; López-Tarruella et al., 2016), permitiendo una mayor sensación de presencia física y, por tanto, facilitando la evocación de estados emocionales.

2. Materiales y métodos

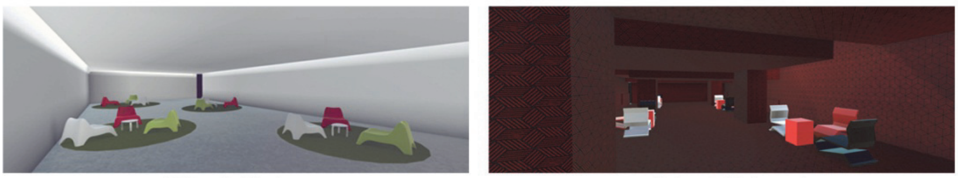
A continuación se describe cómo se realizó el estudio, atendiendo a los siguientes apartados: (2.1) participantes; (2.2) estímulos, (2.3) dispositivos; (2.4) procedimiento; y (2.5) análisis de datos.

2.1 Participantes

16 sujetos participaron en el estudio. De estos, 8 eran hombres y 8 mujeres. Sus edades estaban comprendidas entre 25 y 46 años (□: 30.25; σ: 5.89). Todos informaron tener una visión normal o corregida a normal y tener familiaridad con sistemas de VR. Previamente al inicio de las experiencias, todos firmaron el consentimiento de participación.

2.2 Estímulos

Para generar el estado emocional buscado se diseñó un interior arquitectónico preparado para ser explorado mediante VR. Éste consistió en dos estancias de uso ambiguo contiguas y conexas: una de ellas neutra y otra estresante (Fig. 1). Los criterios de diseño para evocar estrés se basaron en la bibliografía científica, como altura de techo (Meyers-Levy, & Zhu, 2007), forma de los contornos (Vartanian et al, 2013), o colores (Yildirim et al, 2011; Jalil et al, 2012). En cuanto a su implementación en VR, los diseños fueron modelados mediante SketchUp® (v2016) e importados en Unity 3D® (v5.3) para generar un formato compatible con el Head-Mounted Display Oculus DK2. El modelo resultante contenía 18.222 polígonos y 17 texturas.



Estancia Neutra   Estancia Estresante

Fig. 1 Estancias diseñadas para el experimento.

2.3 Dispositivos

La investigación hizo uso de los siguientes dispositivos. Por un lado, para reproducir el interior en VR se utilizó un ordenador de altas capacidades, un dispositivo de visualización de VR, y un dispositivo de navegación en VR. El ordenador contaba con un procesaor Core i5 (3.4 GHz), 8GB de RAM, y una tarjeta gráfica AMD RADEON r9-255 Series GPU (2 GB). El dispositivo de visualización elegido fue el casco de VR OCULUS DK2 (www.oculus.com), el cual cuenta con una resolución de 1920x1080 píxeles en una pantalla de 7 pulgadas. El dispositivo de navegación usado fue el gamepad LOGITECH GAMEPAD F310. Por otro lado, para registrar el HRV se recurrió a la plataforma multifisiológica E4 (EMPATICA©, www.empatica.com), la cual ofrece el tiempo entre latidos del corazón.

2.4 Procedimiento

Todos los participantes siguieron el mismo procedimiento:

(1) Fueron informados brevemente de las fases de la investigación y de que podían interrumpir el experimento en cualquier momento. Todos firmaron los consentimientos y ninguno interrumpió la investigación hasta el final.

(2) Tras la firma de consentimientos, fueron acompañados a la sala de investigación y situados frente al casco de VR, donde se les colocó el dispositivo de medición de HRV que registraba la actividad durante toda la experiencia.

(3) Antes de empezar la experiencia, fueron expuestos a un audio relajante que sirvió de línea base, con objeto de situarles en un estado emocional de inicio similar con respecto al cual poder comprar los datos de HRV de la experiencia.

(4) Empezaban la experiencia. Para evitar posibles efectos de la VR en la generación de estrés (Mon-Williams, Warm, & Rushton, 1993), la mitad de los usuarios realizaron el recorrido inverso; es decir: 8 sujetos -4 hombres y 4 mujeres- recorrieron el entorno desde la estancia estresante hasta la neutra, y los 8 sujetos restantes desde la neutra hasta la estresante (Fig. 2). Los participanes comenzaban en una de las estancias (Neutra o Estresante) con la instrucción de recorrer libremente el espacio hasta llegar al final de la sala contigua. Durante este recorrido, además de los datos de HRV, se recogieron datos de posición. Para ello, todos los movimientos en el escenario arquitectónico en VR eran continuamente registrados mediante un script funcionando bajo la plataforma gráfica.

(5) Al llegar al punto final, la experiencia terminaba y el participante respondía un cuestionario sobre el estado emocional basado en el marco de Russell, Weiss, & Mendelsohn (1989): nivel de bienestar, arousal, y estrés, en una escala tipo Likert de -2 a 2. Este cuestionario tuvo un doble propósito: validar el diseño de las estancias (Neutra y Estresante), y estudiar correlaciones entre la respuesta psicométrica y la fisilógica. Finalmente, en cuarto lugar, el participante completaba un cuestionario demográfico básico.

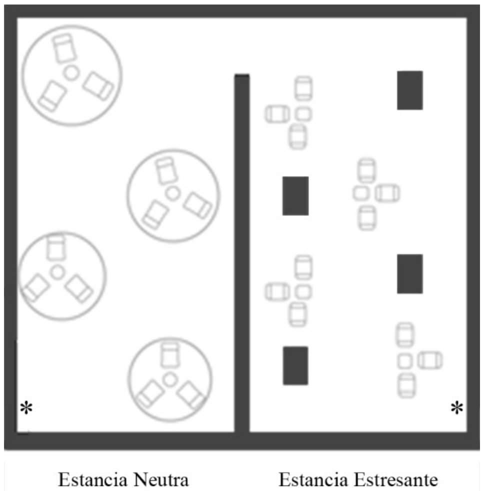


Fig. 2 Vista de planta del interior arquitectónico completo. Los asteriscos indican los punto de inicio/final de las experiencias.

2.5 Análisis

La señal HRV fue analizada mediante un toolbox de análisis avanzado (HRVAS V2014-03-21) funcionando bajo Matlab 2012a (www.mathworks.com). Se analizó en el dominio del tiempo-frecuencia, concretamente con el método de Burg (Rajendra et al., 2007). Esta elección se debió a que fue juzgado como el apropiado para satisfacer la naturaleza cartográfica: permite comprobar cómo evoluciona el espectro de frecuencia (que se puede asociar con determinados estados emocionales) en el tiempo (que ser puede asociar a una posición). De esta forma, se obtuvo el valor absoluto de las bandas cardíacas definidas para humanos (Camm et al., 1996), quedándonos en nuestro caso con la banda de alta frecuencia de la HRV (HF, 0.15–0.4 H) debido a que se relaciona con la actividad parasimpática (Berntson et al., 1997). Así, para cada instante de cada participante, se obtuvo un valor absoluto de la banda HF; que posteriormente fue exportado y sincronizado con las posiciones a las que correspondía, para elaborar una representación de mapa de calor.

Posteriomente las señales fisiológicas y posicionales fueron tratadas. En cuanto a la señal fisiológica, para controlar las variaciones entre sujetos, la señal HF del HRV fue unituarizado de 0 a 1 para cada sujeto. Se usó 0 como el el valor más bajo y 1 como el más alto, de la actividad parasimpática cardíaca. En cuanto a la señal posicional, para asegurar la calidad de la representación se llevaron a cabo dos decisiones: (1) si un mismo participante recorría más de una vez el mismo lugar, el valor representado en el mapa era el mayor; y (2) el mapa media de todos los participantes tenía el requisito de que al menos el 25% de la muestra (cuatro participantes) debía haber atravesado un punto para que éste fuese representado con su valor.

Los datos, tanto de cuestionario como los valores de HRV, se trataron estadísticamente con el software SPSS v.22.

En primer lugar se realizó un análisis descriptivo para detectar tendencias en los resultados. Los valores para cada variable se normalizaron a sus puntuaciones z de forma que simplificara su interpretación comparativa, tanto entre salas como entre conceptos valorados. En segundo lugar, se buscaron correlaciones entre las distintas variables mediante el coeficiente Rho de Spearman para muestras no paramétricas. Esto, además de revelar correspondencias entre la respuesta psicométrica y la fisiológica, permite validar el diseño de las salas. Por último, se buscaron diferencias significativas para las distintas variables mediante la prueba no paramétrica de los rangos con signo de Wilcoxon para dos muestras relacionadas.

3. Resultados

La Tabla 1 muestra las medias z-estandarizadas de las variables segmentadas por estímulo.

Tabla 1. Medias z-estandarizadas de las variables, segmentadas por sala

Sala		Bienestar	Activación	Estrés	HRV	*n*
Sala 1	**media**	0,83	-0,67	-0,85	0,486	*16*
	d.e.	*0,62*	*0,73*	*0,52*	*1,002*	
Sala 2	**media**	-0,83	0,67	0,85	-0,486	*16*
	d.e.	*0,45*	*0,75*	*0,49*	*0,757*	
Total	**media**	0,00	0,00	0,00	0,000	*32*
	d.e.	*1,00*	*1,00*	*1,00*	*1,000*	

El análisis de correlaciones (Tabla 2) confirma relaciones estadísticamente significativas entre las distintas salas y las variables valoradas mediante cuestionario en el nivel 0,01, así como entre salas y la respuesta psicofisiológica, en el nivel 0,025. Además se encuentra una relación inversa entre los valores de HF del HRV y la autoevaluación del estrés, para un nivel de significación inferior a 0,05.

Por otro lado, valores del coeficiente de Spearman superiores a 0,8 para la combinación "*sala 2*" y "*estrés*" permiten asumir que el diseño de estímulos es aceptable para el estudio desarrollado y que realmente se están midiendo dos estímulos percibidos como "estresantes" y "no estresantes" por los usuarios (Eisinga et al., 2013).

Tabla 2. Tabla de correlaciones entre variables mediante el coeficiente Rho de Spearman.

		Bienestar	Activación	Estrés	HRV
Sala 1	***Coef.***	,873	-,698	-,856	,457
	Sig.	*,000*	*,000*	*,000*	*,025*
Sala 2	***Coef.***	-,873	,698	,856	-,457
	Sig.	*,000*	*,000*	*,000*	*,025*
HRV	***Coef.***	,325	-,400	**-,415**	
	Sig.	*,122*	*,053*	***,044***	

Los resultados de la prueba de los rangos con signo de Wilcoxon (Tabla 3) para muestras pareadas no paramétricas confirma la existencia de diferencias significativas entre la "Sala 1" y la "Sala 2" para todas las variables evaluadas, con un nivel de significación inferior a 0,01.

Tabla 3. Prueba de Wilcoxon de contraste de hipótesis entre "Sala 1" y "Sala 2".

	Bienestar	Activación	Estrés	HRV
Z	-3,115	-2,736	-3,095	**-2,667**
Significación	,002	,006	,002	**,008**

Por último, el mapa de calor, obtenido por grafiado de los valores medios de HF del HRV en las distintas coordenadas espaciales de su adquisición, se muestra en la figura 3. Se muestran en rojo los valores más altos de HF, y en azul los valores más bajos. Las zonas en blanco no indican valores bajos sinó lugares donde no han pasado, al menos, cuatro participantes. Se ha de recordar que, contraintuitivamente, valores más altos de la banda HF (y por tanto más rojo) corresponden a valores más bajos de activación simpática y, por tanto, de estrés.

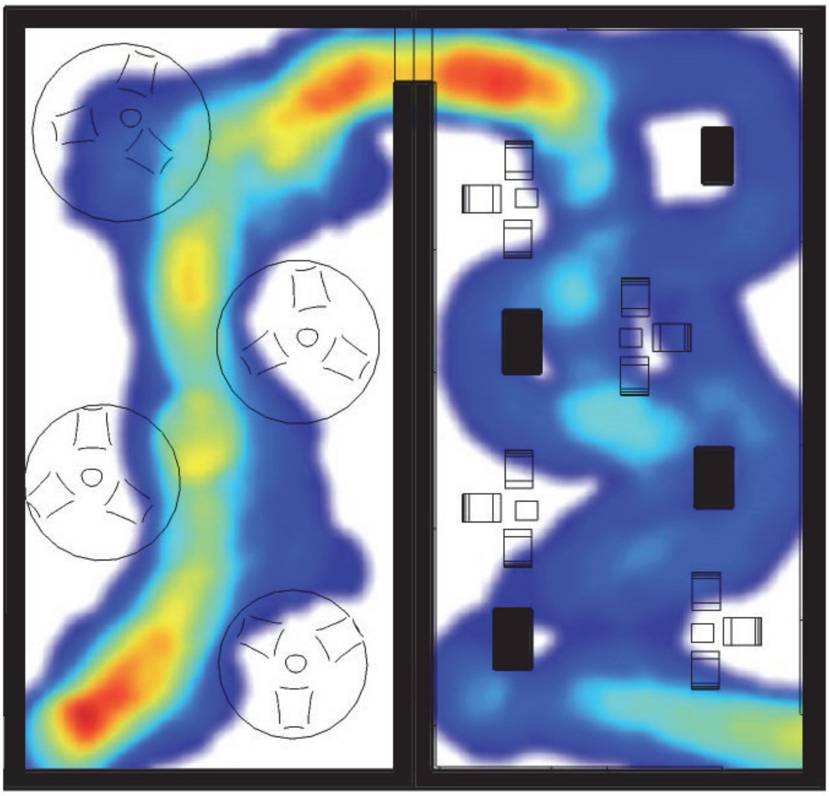


Fig. 3 Mapa emocional de la experiencia. Los tonos rojos indican mayor valor de la banda HF del HRV.

4. Discusión

En este estudio dos espacios, diseñados conforme a la evidencia científica, han sido capaces de provocar las respuestas emocionales esperadas en los participantes, tal como el cuestionario respalda. Posteriormente, ha sido posible el registro de la actividad cardiaca del usuario mientras se monitorizaba su recorrido dentro de un entorno de Realidad Virtual. Esta señal ha podido ser procesada para obtener una métrica psicofisiológica fiable que, mediante tratamiento estadístico, ha permitido encontrar diferencias en la respuesta orgánica del usuario ante los distintos espacios, encontrándose, además, una relación inversa entre los valores de la banda HF del HRV y el estrés autoevaluado.

Por otro lado, ha sido posible representar espacialmente los niveles de relajación / estrés generados por los espacios.

La medida de la variabilidad de la frecuencia cardiaca parece aportar información de interés en el área de la cartografía emocional pudiendo suponer una contribución a investigaciones previas como las de Nord (2009), Litteman (2012), Fischer et al. (2014) o Amilant-Szary & Mekjajian (2015).

Es preciso comentar que este es un estudio preliminar. Se utilizó una muestra relativamente reducida con el fin de definir una metodología para la realización de futuros estudios, lo que ha permitido encontrar y solventar dificultades propias de las técnicas empleadas; como pueda ser la variabilidad intersujeto de las señales fisiológicas, que ha requerido de un estudio de su tratamiento y normalización, y la estimación de tamaños muestrales para posteriores experimentos.

Por otro lado, en futuros estudios se considerarán desarrollos a nivel de diseño y de medición fisiológica. En cuanto al diseño, el escenario podría completarse para mejorar la cartografía: añadir una sala neutra, para comprobar la capacidad de la medición fisológica en entornos menos extremos; y dos salas de inicio y fin, la primera de las cuales para permitir al usuario adaptarse a la navegación en VR, y la última para evitar posibles efectos emocinales relacinados con hecho de terminar la tarea. En cuanto a la medición fisiológica, la incorporación de otras señales podría completar la información. En concreto, la Respuesta Electrodérmica (EDA) podría ser de gran utilidad al capturar la actividad del sistema simpático (Benedek & Kaernbach, 2010) de una forma poco invasiva y compatible con el HRV.

5. Conclusion

La experiencia aquí descrita revela que el HRV es una medida fisiológica apta para ser utilizada en cartografía emocional. Desde nuestro conocimiento, no existen estudios previos en que se utilicen, por lo que a pesar del carácter preliminar del estudio es una contribución substancial. Globalmente, la metodología propuesta permite la cuantificación objetiva de experiencias subjetivas a nivel tanto psicométrico como fisiológico, permitiendo esta última además localizarse en puntos concretos del espacio. Estas capacidades abren una serie de posibilidades a nivel de diseño.

6. Agradecimientos

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Design Thinking and its visual codes enhanced by the SiDMe Model as strategy for design driven innovation

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Abstract

The society is changing, leaving the old paradigm of work to a new one that is more dynamic and complex. In this context the way that the people consumes chance. In order to survive this scenery the companies has to innovate, but not only innovate based in the behaviours of the actual users, but innovate based in a person and its relations that do not exist yet, therefore the companies have to adopt the design driven innovation which brings advances dealing with knowledge of visual codes and meanings. This article aims to demonstrate how the model Strategic Integrator Design Management enhanced (SiDMe), which treat the design as a knowledge and adopt the design thinking, can lead companies to adopt incremental and radical innovation through design driven innovation. To do so it will discourse about the design driven innovation, design Thinking and present the SiDMe conceptual model. This research will work with the ex-post-facto delineation, using ethnography as a strategy, through the non-participant observation. After the application of the model it is evident that by the application of Design Thinking it will be able to help the companies to achieve incremental and radical innovation by the design driven innovation.

Keywords: *Design Driven Innovation; visual codes; Design Thinking; Design Management*

1. Introduction

Now a days, the design is recognized as an innovation strategy, because by all meaning it is an innovation activity. Consumers increasingly are in control of their own consumption, and are aware of the value (aesthetic, symbolic and emotional) of the product, which is transmitted by the design language (a combination of forms, signs, colours, materials - all that give meaning to a product) that has mobilized companies to employ efforts to define appropriate strategies (or suitability) of the design language to its products, as the design itself is seen as differentiation strategy as it is responsible for the form attributed to the brand, products and processes, which in turn equates to a proposition to be interpreted. Romanini (2008) found that articulate signs to reach pragmatic communicative effects is the essence of Design.

Among these strategies (including sort by signs) and innovative processes, an approach has gained space: design thinking. Brown (2009) states that the Design thinking benefits from the human ability to be intuitive, empathic, recognize patterns, develop ideas that have an emotional meaning as well as functional, and that be able to express themselves in medias beyond words or symbols (capacity forgotten by conventional resolution practices problems). It is a human proposed by the nature and not merely centred in humans.

Nowadays, to address this consumer/author at the speed that it requires, with its different way of thinking (its ability to choose, interpret, freely combine services, products and aesthetic), and whose meaning is relates to new values and experiments, manifested by behavior and suggested parameters and supported by new technologies (Morace, 2009). Organizations, eager for innovation, and despite its high cost and time investments, has taken the risk of adopting radical, or incremental innovation.

The technology driven innovation is often difficult to achieve, thus organizations start to look for the design driven innovation, in other words, focused on meaning.

Designers have expanded their action, leaving the traditional position of developing processes and products, which address issues like style and ergonomics, for a greater contribution in generating new concepts and management of the image (in the broad sense) around these concepts. For this, use the empathic observation skills to understand the consumer's requirements (users / authors / viewers) as well as it relations.

The Strategic Integrator Design Management enhanced (SiDMe) presented here is a conceptual model based on design thinking, that will assist the designer in its new role, enhancing its skills, becoming a tool for design driven innovation (Demarchi, A.P.P., Fornasier, C.B.R. & Martins, R.F.F. , 2013).

2. Innovation

Terra et al. (2007) claims that "innovation means having a new idea or, apply the idea to others in a way that is original and effectively". But not only: it is a new idea combined with implementation, or successfully exploitation of new ideas.

There are many kinds of innovation. The classifications vary according to the object of innovation. In this papers we will adopt the classifications of Higgins coated by Xavier (2014) that specified tree levels of innovations: Incremental, Semi radical and Radical.

- Incremental innovation is prevalent in most companies. It is small and practical changes that can be applied in business models, products or services.
- Semi radical: compared to incremental innovations, this can leverage major changes involving changes in the business model or on the company's technology.
- Radical: consists of changes in the business model and technology of the company and usually cause significant changes in the market. It is possible that radical innovation is followed by other levels of innovations that cause improvement in the product.

Another classification of innovation, stated by Chesbrough (2012), is related to this paper is the one that differentiate the close and open innovation:

- The closed innovation is an approach that is fundamentally focused inward, and well suited to early 20th-century paradigms.
- Open innovation is the paradigm that assumes "that companies can and should use external ideas in the same way that use internal ideas, and internal and external paths to market" (Terra, 2007). This classification adapts to 21st century paradigms.

In the 21st Century the ideas cannot remain in stock on the shelf, because it will end up leaking to the larger environment. It need this larger environment to co-create, and be brought back to the organization to be transformed into new products and services. It is observed that the knowledge they're not centralized in research facilities, but are groupings of varied knowledge distributed throughout scenario.

Therefore, companies are practicing new opportunities for innovation. The 21st century is the century of open innovation, so we will demonstrate a model that through the co-creation (emphasizing the open innovation) generate radical and incremental design driven innovation based on Design Thinking.

2.1. Technology driven innovation X Design Driven innovation

Having introduced some basic concepts of innovation, we can now understand the concept technological and meaning innovation. Technology driven innovation brings technological advancement, uses technological knowledge. Meaning driven Innovation is based on the meanings, uses knowledge of languages and meanings, the design is comfortable with these knowledge.

Norman and Verganti (2012) claims that the organizations in this century seek either incremental or radical innovations. They affirm that usually the radical innovation is achieved by the technological knowledge, however it is costly and take too long to develop a radical innovation by technological knowledge. In a complex society, where the time and space change so rapidly we don’t have room for that.

The author’s suggest a two dimension model that demonstrate how an organization can achieve radical innovation using the meaning and languages knowledge. The figure 1 below demonstrate this model.

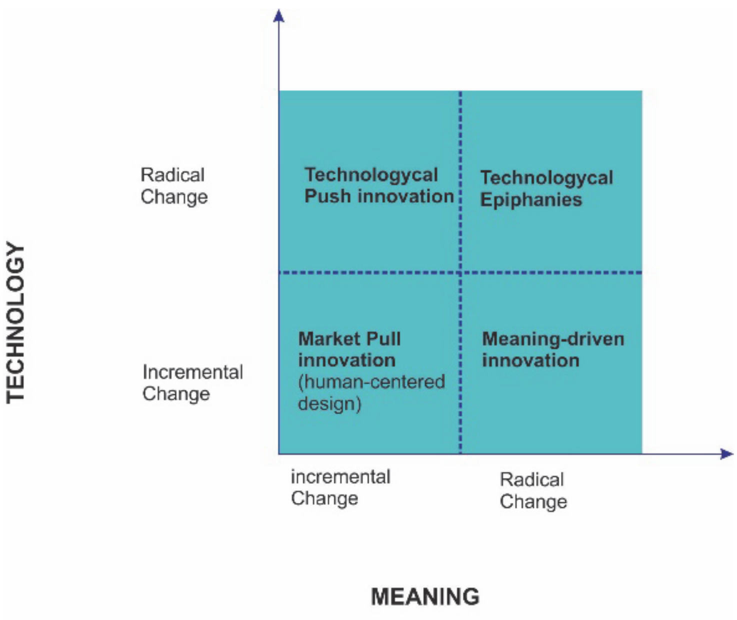

Fig. 1 The two dimensions and four types of innovation. Source: Norman & Verganti (2012, p.12)

We can observe that the human centered design can only create incremental innovation. This is because according with Norman and Verganti (2012) it starts from the analysis of user needs and them develops products to satisfy them. Most of the processes of design works in this way.

The technological push innovation comes from radical changes in technology without any change in the meaning. Norman and Verganti (2012) affirm that because it definitely does not come from users, most of the time is not accept by those.

The technology Epiphanies uses a new technology or the use of existing technology in a totally new context. Its happen “when the design challenges the dominant interpretation of what a product is and create new, unsolicited product the people are not currently seeking” (Norman and Verganti , 2012.)

Mening-Driven innovation “starts from the comprehension of subtle and unspoken dynamics in socio-cultural model and result in a radically new meaning and languages, often implying a change in a social-cultural regime” (Norman and Verganti, 2012).

All these kinds of innovation, in some degree, need to understand the market dynamic, the people aspiration, and some of them need to explore new technology. It is clear that for a successful project is necessary to pay attention on the starting point.

As we can see, radical innovation may be associated with change in either technology or meaning. But how can the design help the organizations to lead to these types of innovations?

Verganti (2010) states that “designers give meaning to products by using a specific design language that is the set of signs, symbols and icons (of which style is just an instance) that deliver the message”.

Based in this definition we can link more precisely design with other theories of innovation. Consider in particular the Figure 2, we may say that innovation may concern a product’s functional utility, its meaning or both.

In particular, innovation of meanings is incremental when a product adopts a design language and delivers a message that is in line with the current evolution of socio-cultural models. Users would probably perceive this product as “fashionable” and maybe stylish as it conforms to existing definitions of beauty, i.e. with a style that leverages on accepted languages. However, innovation of meanings may also be radical, which happens when a product has a language and delivers a message that implies a significant reinterpretation of meanings.

Verganti (2010) mapped three modes of innovation in a two dimension model that relates Functional utility and meaning as demonstrated on figure 2.

The first is Design driven innovation that starts with understanding the subtext and the dynamics not spoken in sociocultural model and results in the radical proposal of new meanings and languages that often imply cultural regime change, however it may not change, so this mode can generate radical or incremental innovation. Note that design driven innovation sometimes is not immediate. It takes time to diffuse and achieve acclaimed success. Users indeed need to understand the radically new language and message, find new connections to their socio-cultural context, explore new symbolic values and patterns of interaction with the product.

The second is Market pull innovation, which starts with the analysis of the needs of users and search for technologies and languages that may meet it. User-centered innovation is allocated in this strategy, despite being more advanced and sophisticated in its technologies, allowing a better understanding of why and how people give meaning to things, its only achieve incremental innovation.

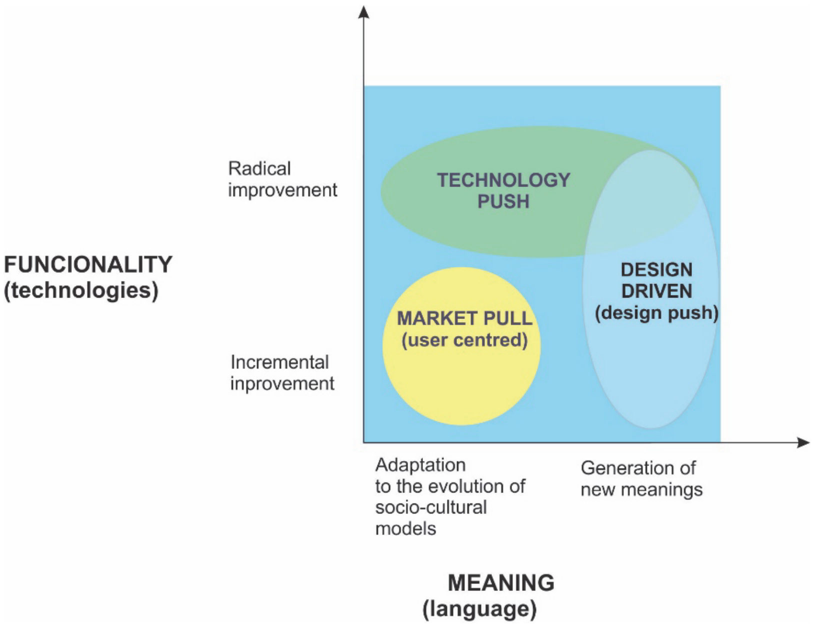

Fig. 2. Innovation strategies. Source: Verganti (2010 p.17)

Finally, the technology driven Innovation. The overlap between the technology driven and design driven, in the upper right corner of the diagram, demonstrates that advances in technological changes are often associated with the radical changes of meaning of the product, i.e. changes in the technological paradigm are often aligned with changing socio-cultural systems.

To cope with the design driven innovation requires a capability to understand, anticipate, propose and influence the emerging of new meanings. The knowledge about the subtle and not expressed-cultural model dynamics are tacit is not codified in books or in sociological scenarios of the future, and this knowledge is distributed. The modeling of socio-cultural model and their impact on the interpretation of the language of the products depends on millions of unpredictable interactions between users, businesses, designers, products, cultural centers, communicational media, schools, artists, among others.

“Design driven innovations are not answers to user needs, but proposals. They explicitly recognize their action as possibly driving change in socio-cultural regimes. Design driven innovation is therefore a pushing innovation activity, a proposal of possible breakthrough meanings and product languages with a high chance of diffusion in future society” (Verganti, 2010 p. 15)

The Design Thinkers value the interaction with this network of actors. They consider these actors as interpreters of the evolution of the future scenario, with which they share their own visions, exchange information on trends and test the robustness of your assumptions.

We must not confuse the user centred innovation with design driven innovation. The first focuses only on an actor, the user, and does not attempt to understand how it assigns meaning to things. The second works with actors and focuses on their relationships to understand how it assigns meaning, to be able to change the meanings.

Verganti called these relationship network of design discourse, “a collective research of meaning and design languages process, i.e. a continuous dialogue on socio-cultural models (foreseen and desired) and its implications on patterns of consumption and product languages, occurring through several explicit and tacit interaction among several actors in the global and local setting“ (Verganti, 2010 p. 22).

This process differs from the user centred approach, as much by nature as by players (Figure 3). The basic characteristics of this approach are:

- A network search process (open innovation).
- Beyond the boundaries of the company, including users, but also several other interpreters.
- Based on the sharing of knowledge.
- Also includes the action of influencing and a social-cultural regime modification.

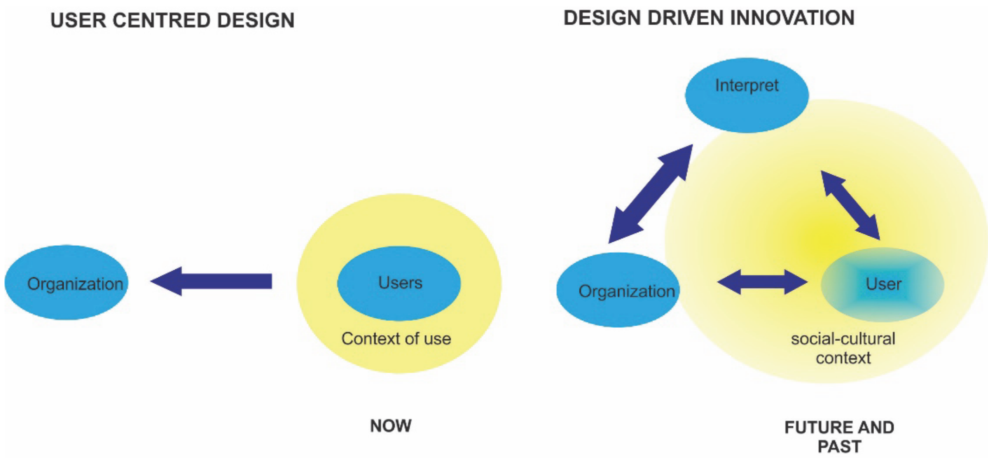

Fig. 3. User centred design and design driven innovation. Source: Verganti (2010 p.22)

The key capability in the user-centered design approach, elicit their needs and be creative in finding solutions. The key capacity in design driven innovation is accessing and sharing knowledge using the design discourse, and more precisely, identify the key performers, to attract them and develop with them a privileged relationship, to share knowledge and recombine and so build a unique proposal.

To the use of the design driven innovation in companies is necessary to access and internalize knowledge of the design discourse, for which requires the design thinker, which became the interpreters of the discourse of design, and all his skills is used to help the organization to have access to that speech (the design).

The design thinker possesses different skills that often are not present in a person. Sometimes these skills help in building links between the different socio-cultural worlds and the industries, and to facilitate the transfer of knowledge of meanings and languages between different contexts. Design driven Innovation call these people as gate keepers. They facilitate the access of the designer to users to bring knowledge about design's languages to the process, and help customers to interpret the design discourse, and to position themselves in this speech.

The key characteristic in the design driven innovation is that designers act as a cross-pollinators of knowledge in languages and technologies.

We can highlight that access to external information should not be restricted only to the gatekeepers, but to the entire organization. So the organization must have the capability to absorb, to understand and assess external knowledge, make sense, and learn, and then adopt new approaches. Open innovation and the skills of design thinker, should be adopted as they may assist the organization to build the absorption capacity.

Based on the foregoing, we may accept that the design process is a process full of knowledge, that to be extracted and shared is necessary the use of the skills of design thinker. We may now understand which skills are those.

3. Design Thinkers skills and the Innovators DNA

The conceptual model shown in this article is intended to assist the process of design driven innovation in organizations by using some skills of design thinkers.

Dyer, Gregersen & Christensen (2011) agree that innovation is triggered by the skill that innovators have to unite ideas (call this cognitive ability of associative thinking), however, innovators think not only different, but also act differently. Some observe the world with an intensity greater than ordinary people. Others create networks with other people creating a collaborative group, while others engage in experimental actions. Innovation and creativity is not just a cognitive ability, but also a matter of behavior.

Creativity is the gear for innovation and have to be practiced. It is a natural human ability, but we lose as we grow up, maybe by shyness or fear of criticism. The authors assume that creativity is a combination of idea plus courage.

They have created a model that demonstrates the innovative DNA to generate innovative ideas, shown in Figure 4, below.

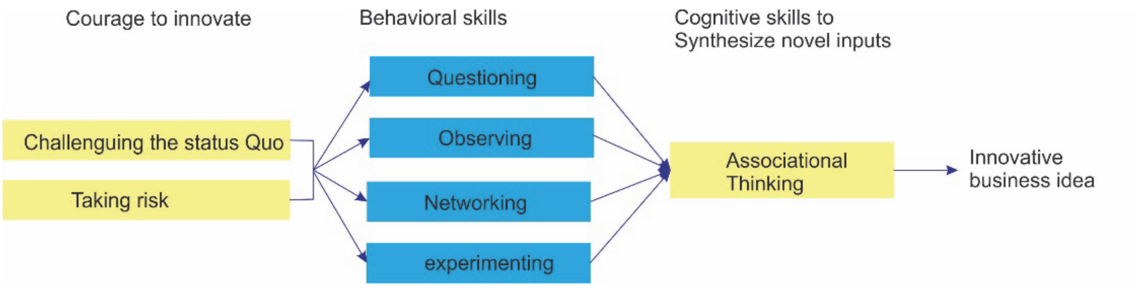

Fig. 4. Innovator’s DNA Model. Source: Dyer, Gregersen e Christensen (2011, p.27)

The courage to innovate, is similar to the Design Thinkers attitude. Martin (2009) says that design thinker possesses a posture that seeks the unknown, and adopts the possibility of surprise, being comfortable wandering inside the complexity, without knowing what's on the other side. This posture of the designer thinker takes the balance between validity (produce results that reach certain goal) and reliability (produce consistent and predictable results), explicitly seeking the validity, without eliminating the reliability. We can say that design Thinkers challeng the status Quo.

Other Design Thinker attitude according with Chas Martin (apud Chohan, 2008) is the long-range vision of design thinker, and this is something that can't be taught, but can be involved in the culture that respect and lets people take risks, make mistakes, and go up to the limits of expectations. The ability of the designer of taking risk helps the organization to adopt innovative postures.

It seems that the behavioral and cognitive skills of innovators are the same of the design thinkers skills. Brown (2009) affirm that the design thinking begins with the skills that designers have learned over time, such as: to align the needs of humans with the technological resources available in the organization; on intuition; the ability to recognize patterns; build ideas which have meaning as much emotional as functional; the ability to question the surroundings and be empathic; and the ability to express themselves differently than by words or symbols. That last one of the most important designer’s skills, because "the act of drawing seems to clear the designer thoughts" (Mozota, 2003), because the design process, it seems, is hard to drive by purely internal mental processes; the designer needs to interact with an external representation.

There's a cognitive limit to the amount of complexity that a person can handle internally; sketch provides a temporary and external storage for the ideas tried and that externalization supports the dialogue that the designer has between the problem and the solution.

The design thinkers uses the design process as much as a critical process, as discovery. He uses drawing as a means of materialization, imagination, or discovery of something that cannot be built on his mind, and also as a means of communication with the other. Cross (2007) states that in these cases, the design process becomes not only a personal but a cognitive process, such as a shared and social process. This process leads to another skill that, according to Brown (2009), is the ability to work in an interdisciplinary way and create networks.

Pinheiro and Alt (2011) claim that the design thinker in order to work in an interdisciplinary way creates islands of visual information that are available throughout the project, allowing the team to navigate without losing the line of reasoning. These islands create spaces of co-creation, which is a form of innovation that happens when people from outside the company as suppliers, employees and customers works with the business or product innovation (Fraser, 2012).

The visual codes developed by the design thinker, when specifying the externalized knowledge, facilitate collaboration on projects. He observes the ordinary and writes his observations and ideas visually.

Fraser (2012) claims that the fastest way to communicate is usually through vision. If drawing a diagram and mapping a system of parts and interrelated forces, for showing a discussion, challenge or solution, it brings clarity and focus at communications and collaborative efforts.

The culture of design thinking encourages the prototype, which is a way of thinking visually. For a design thinker, the prototype is not only a way to validate ideas, but is also a creative process. The only premise is that prototypes need to be testable, but not necessarily physical. Brown (2009) claims that prototypes can be storyboards, scenes, movies, and even a theatrical improvisation.

Competent practitioners of design thinking usually know more than can say. They demonstrate a kind of know-in-practice, it is mostly tacit knowledge. They identify a cognitive process of reflection-in-action as the intelligence that guides the behavior “intuitive”' in practical contexts of thinking and acting, something like “thinking on your feet”'. Reflect-in-action is an experimental framework in which the design thinker finds a way to view the problem with the hands, in the form of prototypes.

The empathy is another very important skill of design thinker, especially in the early stages of the project, when the designer acts in the socio-cultural context as interpreter of the user and their relationships in this context. For Fraser (2012) empathy is to be able to see and feel what others see and feel, leading to a deeper understanding of the opportunity to meet the demands.

Kelley (2005) affirms that the design thinker has another skill, is the ability of cross-pollinate, according with the author they have the childlike ability to see patterns that others can’t, and spot keys differences, however they also have a very adult skill, they think in metaphors, enabling them to see relationship and connections others miss. They act as a matchmakers, creating unusual combinations that often sparks innovative ideas. They are able to see the problems by another angle.

We can see the similarity between the skills and attributes of design thinker with the innovative DNA. The table 5 below demonstrate this relationship.

Design Thinker Skills and Attitude	Behavioral Skills of the innovators	Cognitive skill of the innovators	Courage of innovate
Emphatic Observation	Observing Questioning		
Collaboration	Networking		
Generates Prototypes Visual thinking	experimenting		
Cross-pollinator Creative		Associational Thinking	
work with diferenciation Vision of the future			Challenguing the status Quo
Taking risk			Taking risk

Fig, 5 . Comparison between the skills and attitudes of design thinker with the Innovator's DNA. Source: Demarchi, Fornasier, Ortuño e Marquina (2014, p. 3231)

The design thinking helps in insertion of the design driven innovation using the his full potential of the designer to identify patterns, co-create, and generate re-significations, through visual codes, using its more important skill - the visual thinking.

4. Strategic Integrator Design Management enhanced Model (SiDMe)

The SiDMe model is divided into strategic, strategic/tactical and operational Design, covering the conversion/production of knowledge and integration of knowledge. The model has seven spaces (the eighth is still in phase of study and has not yet been outlined) and they overlap three cycles of divergence and convergence. This article will work with the spaces relative to the knowledge production, consisting of 5 spaces, as shown in figure 6.

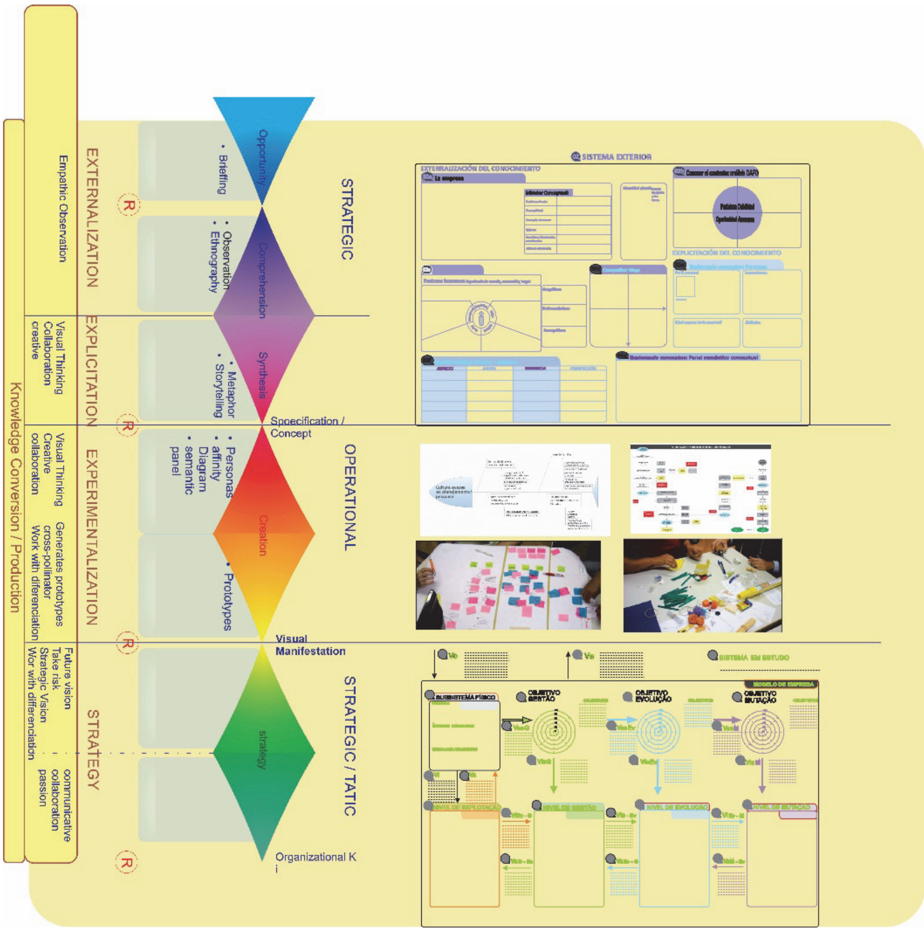

Fig. 6. Strategic Integrator Design Management enhanced Model (SiDMe) with techniques

The model is based on design thinking and through the use of certain techniques emphasizes the skills of design thinker. The demonstration of its uses in this article will be in business design.

The model was applied in various organizations, by the SiDMe Model. and its research group at the University State of Londrina, through a survey of exploratory nature, using the delineation *ex-post-facto*, we could understand the importance of using visual codes for the explicitation of knowledge, assisting the process of sharing and learning knowledge throughout the research group , generating a process of co-creation. In this article will be shown the model application during the laboratory service organizations.

The first cycle of divergence and convergence starts with empathy for others and with significant understanding of the people and what is important to them, so profound and complete. Despite market reports and quantitative surveys provide a good measure of habits, and customer values, most of these relationships are tacit and cultural knowledge, therefore need to be externalized through the empathetic observation.

First happens occurs the divergent, that can be the path to innovation, which first extends the knowledge of the universe to be worked, analyzes the knowledge and information raised, then synthesize usually guided by techniques such as metaphor and/or analogy, then starts the convergent thinking.

The opportunity is triggered by the company, when its feel the need to change and search at the design the opportunity to innovate. Is set a briefing with basic information obtained with the strategic repository, here happens the first knowledge's reduction. The company checks a dissonance in the organization and seeks someone to understand it. In the case of organizations presented here, they sought SiDMe Model. to help them with their problem.

The comprehension space objectively define the scope of the project and its borders, and will identify the profiles of users and other key actors that should be covered, when it will be possible to check which areas of interest that should be explored and provide inputs for the elaboration of the themes that will be investigated, when occur the deep immersion of the designer in the organization. Here the designer uses several techniques to help externalizating and emphasize the skills of empathic observation and intuition of design thinker.

The group went to the field, visited the organization in an attempt to sympathetically understand the organization, spent a few hours with the organizational team understand their wishes, filmed conversations, took photos and worked with members of organizations in the construction of some applied techniques as shown in Figure 1.

Fig. 7. Organizational member demonstrating how the organization works and working with the group in the construction of some visual manifestation

Once impregnated of their concept by means of convergent thinking, the designer starts the synthetic space by the storytelling and visual thinking to extract meaningful patterns from a mass of raw information, fundamentally is a creative act, giving rise to another knowledge's reduction. Once again it is necessary the use of various techniques of knowledge's explicitation applied through visual thinking, creative and intuitive skills.

The group initiates the synthesis and the knowledge's explicitation using visual techniques to share knowledge with the group, and then start the creation space.

The design operational process begins in the space of creation, when the designer uses all their explicit and tacit knowledge aggregated by creative and experimental skills, and converts the concept in objective knowledge. Here begins another cycle of divergence and convergence, which the designer expands creative techniques to then synthesize and reduce, using experimental and collaborative skills from several types of prototypes.

This second cycle is where generated innovative solutions that will contribute to a better experience. This requires that the designer is open to exploring new possibilities, including those that are outside of the existing paradigm.

Here was felt the need to use new visualization techniques for the generation of ideas. It was noticed that the techniques used by the SiDMe Model didn't have a board for this step, and that most of the time was used empirically techniques based on the experience of the researchers, trying to build joint solutions using first the fish bone technique to find the causes for the problems encountered and for creating solutions: the brainstorm; insight cards, affinity diagrams. For a joint construction of the solutions were used prototypes of Lego and other materials, as shown in Figure 2.

Fig. 8. Team working with different techniques in the search for solutions

In the third cycle happens the strategic actions when the designer, by his future vision, creative, posture to take risk and collaboration skills, develops proposals for strategies applications a document entitled SiDMe Model (strategic plan) in a cycle of divergence and convergence and terminates the production of knowledge by the fourth knowledge's reduction as shown in Figure 3.

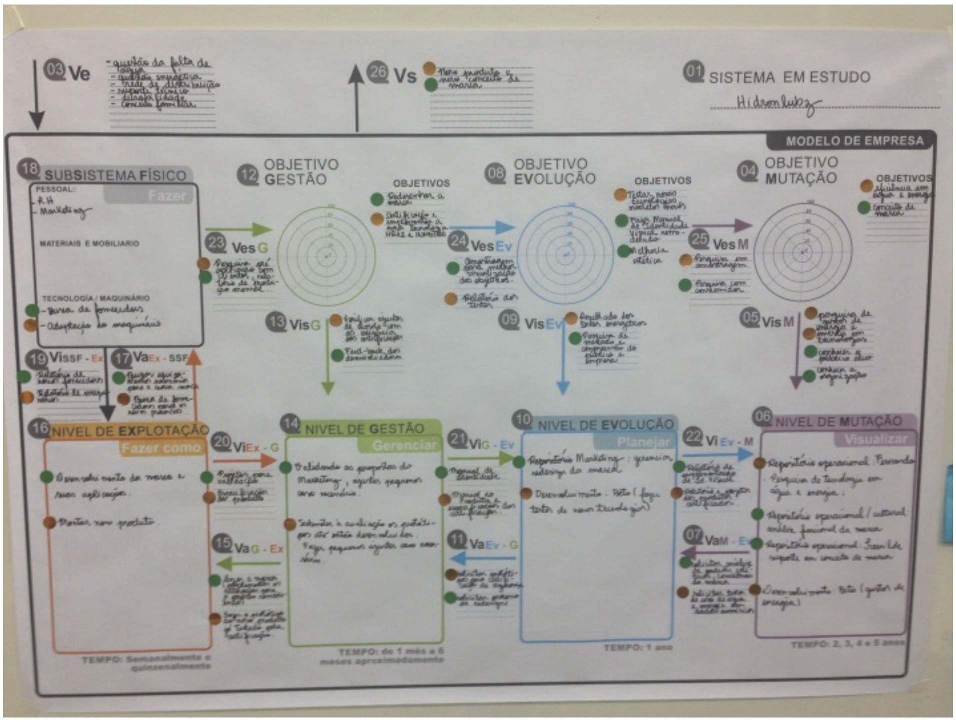

Fig. 9. Completed model within strategic actions

5. Conclusions

After the application of the model it is evident that the SiDMe is a conceptual model that allows the application of Design Thinking through the use of visual techniques impregnated with visual codes.

We can verified that in each space is used techniques of visual preference, and that these were pre select preference techniques and placed on informational board. The LabConde uses a device called IdThink for the spaces of understanding, synthesis and strategic actions, however realized that it will be necessary to develop a device for creating space to assist in explicitation and generation of solutions to the problems of the organizations in a creatively and collaborative way.

Considering the bases of design driven innovation, revolving around the sharing of knowledge obtained from users and their relations, taking into account socio-cultural systems have not yet established, the SiDMe model, aggregate of devices of explicit knowledge based in visual codes, can assist the insertion of this process in the Brazilian organizations. Through visual codes model, which emphasizes the skills of design thinker, helps the process of sharing and learning in the process of co-creation.

A study of Forrest Research cited by Fraser (2012) highlights the attraction of Brazilians by social networks, primarily in conversational and criticizes level. The high degree of interaction with companies that use social networks; and the natural predisposition of co-creating with them, is a sign that Brazilians have pre disposition to co-create. The research also states that 75% of Brazilians online are classified as co-creators volunteers.

Considering technology as knowledge, then, the innovation of knowledge is responsible for cultural exchange: it depends on the culture and generates culture, as a cycle. Culture is a historically transmitted pattern of meanings embodied in symbols, a system of inherited conceptions expressed in symbolic forms by means of which men communicate, perpetuate, and develop their knowledge and their attitudes about life (Geertz, 1989).

So the ID-Think is a fertile land for the implementation of design driven innovation and the skills of design thinkers is a greater tools to assist organizations to adopt it. The design thinker through their skills evidenced by SiDMe model helps the organization to access and internalize knowledge design discourse, assisting in building links between the different socio-cultural worlds and industries, and thus facilitating the transfer of knowledge of meanings and languages between different contexts.

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O Papel Da Experiência No Desenvolvimento De Habilidades De Design Thinker

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Resumo

Este projeto dedica-se á compreensão de como a experiência pode ter uma influência no desenvolvimento das competências do agente de design. Foi baseado em entrevistas e observação conduzida em cinco escritórios de design, localizados em Londrina (Paraná, Brasil), por meio desta pesquisa foi possível identificar quais são as técnicas e métodos mais utilizados pelos profissionais, da área tanto de design gráfico quanto de design de produto e, portanto, verificar como a gestão estratégica do design e design thinking são importantes para o desenvolvimento das competências dos profissionais no processo de inovação das empresas. Tomou como base os estudos de diversos autores, tais como Brown (2009), Cross (2007), Demarchi (2011), Lawson (2006) e Martin (2009), no discurso, entre outras questões, sobre o design thinking e suas implicações. Utilizando a metodologia de etnografia, os dados foram recolhidos, analisados e organizados em tabelas comparativas, relativas ao agente de Design novato e o especialista. Foi comprovado que a experiência pode gerar dois aspectos distintos; uma positiva, que vem como resultado da visão holística e guarante a sensibilidade para o agente lidar com situações de projeto; e a outra desfavorável, uma vez que o especialista é estritamente guiado pela intuição, ele deixa de lado os métodos criativos, dificultando o processo de inovação. Além disso, foi possível verificar que, embora as empresas e os agentes de design trabalhem utilizando métodos e técnicas diferentes, ferramentas visuais como mente mapas, esboços, visuais painéis e maquetes são vistos como recursos essenciais para todos os profissionais.

Palavras-chave: Design Thinking, Gestão Estratégica de Design, Agente de Design , Habilidades do Design Thinker, Especialista.

Abstract

This project is dedicated on understanding how expertise can have an affect on developing the Design Agent skills. It was based on interviews and observation conducted in five design offices located in Londrina (Paraná, Brasil), through this research was possible to *identify which are the techniques and methods most used by professional, from both Graphic and Product Design area, and therefore ascertain how Strategic Design Management and Design Thinking actuate on improving professional's skills on the innovation process of the companies. It took as a basis the studies of several authors, such as Brown (2009), Cross (2007), Demarchi (2011), Lawson (2006) and Martin (2009), which discourse, among other issues, about Design Thinking and its implications. By the use of ethnography methodology, the data was collected, analyzed and organized into comparative charts, relating the novice Design Agents with expert Design Agents. It was proved that experience can hold two distinct aspects; A positive one, that comes as a result from the holistic vision and ensure sensibility to the Design Agent to handle situations; And an unfavorable one, once the expert is strictly guided by intuition, it sets aside creativity hampering the innovation process. Besides it was possible to verify that although the enterprises and the Design Agents work using different techniques and methods, visual tools such as mind maps, sketches, visual panels and mockups are seen as essential resources for all the professionals.*

Keywords: *Design Thinking, Strategic Design Management, Design Agents, Design Thinkers' Skills, Expertise.*

1. Introdução

O design thinking trata de um processo que utiliza os métodos e abordagens do profissional do design a fim de gerar soluções eficientes e criativas para um determinado contexto, sendo também uma ferramenta fundamental para proporcionar inovação às empresas, tornando-as mais competitivas no mercado.

Diversos autores exploraram esse campo e deram suas próprias definições para o termo. Entre eles podemos destacar Brown (2009), Cross (2007), Lawson (2006) e Martin (2009).

Brown (apud MARTIN, 2009, p.62) define o design thinking como [...] uma disciplina que utiliza a sensibilidade e os métodos do designer para atender às necessidades das pessoas com o que é tecnologicamente fatível e qual estratégia viável de negócios pode converter valor para o cliente e oportunidades de mercado.

Para Martin (2009), significa pensar da mesma maneira com que um designer pensa e as organizações que adotam essa disciplina utilizam o processo designado por Pierce (1975), a razão abdutiva, a fim de formar hipóteses explicativas para os problemas de negócios, permitindo aos design thinkers explorar possibilidades futuras sem deixar de lado as alternativas averiguadas no passado.

Os autores Brown (2009), Cross (2007) e Martin (2009) compartilham o mesmo pensamento de que as habilidades de um design thinker são passíveis de serem desenvolvidas por meio da experiência. Além disso, os autores ressaltam quais as ferramentas imprescindíveis aos design thinkers, sendo algumas delas a observação, a imaginação, a habilidade de enxergar e resolver problemas mal definidos, a destreza em utilizar modelos gráficos/não verbais e a adoção de estratégias focadas diretamente na resolução dos problemas.

O design thinking possui caráter experimental. Por meio de briefings e das observações em campo, o designer consegue coletar os dados necessários para decifrar as necessidades e ambições de seu público-alvo. Após um longo período de análise, o designer deve interpretar os dados e sintetizar as ideias a fim de solucionar os problemas da melhor maneira possível.

Brown (2009) destaca que durante o processo, dois tipos de pensamentos são adotados, o divergente e o convergente. Durante o pensamento divergente deve-se criar o maior número de escolhas possíveis para um problema. Isto pode ser feito por meio de técnicas como o brainstorming, cujo "objetivo é abrir um amplo espectro de ideias. Outras abordagens são importantes para fazer escolhas, mas nada melhor que uma boa sessão de brainstorming para criar ideias". Já durante a fase convergente, devem-se eliminar as opções consideradas inapropriadas e decidir o melhor caminho a ser seguido.

De acordo com Martin (2009) o processo de conhecimento pessoal do design thinker é composto por três elementos principais que se influenciam de maneira mútua, a postura, as ferramentas e as experiências. Estes elementos, no entanto, não se manifestam em um processo rígido com fluxo único, podendo ser alterados e elaborados de forma que cada designer seja capaz de desenvolver suas próprias habilidades. O esquema pode ser visto na figura 1 abaixo.

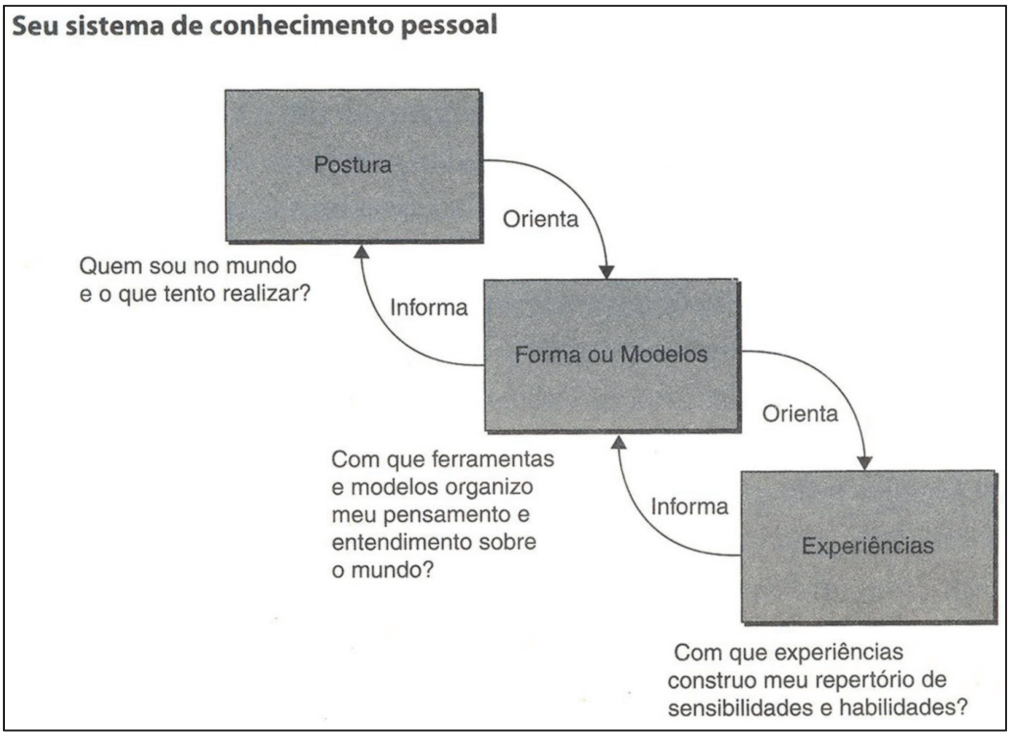

Fig. 1 Sistema de conhecimento pessoal. Fonte: Martin (2009)

Sendo assim, tendo em vista os conceitos relacionados ao design thinking, esse projeto propõe-se a investigar, analisar e comparar as técnicas utilizadas por designers iniciantes e designers experientes, bem como as habilidades utilizadas por estes, a fim de mostrar os resultados e benefícios que esse processo pode oferecer, tanto para o profissional quanto para as empresas.

2. Materiais e Métodos

2.1. Habilidades do design thinker no processo de Design Centrado no Usuário

Os design thinkers possuem determinadas habilidades essenciais que os auxiliam durante o processo de compreensão e síntese de um problema, garantindo a elaboração de um bom projeto.

Cross (2003) evidencia que entre essas habilidades estão a agilidade de pensamento, objetividade na tomada de decisões, facilidade de contextualização, além de curiosidade, imaginação e uma boa argumentação.

Para Lawson (2003), os design thinkers possuem capacidades narrativas assim como um contador de histórias, pois na contextualização de um projeto são hábeis em utilizar referências metafóricas, associações, analogias e mapas mentais. Isso os ajuda a acessar seus repertórios em busca de possíveis soluções que podem ser aplicadas para diversos contextos. Ou seja, por meio de uma solução encontrada, o designer acaba adquirindo conhecimento para solucionar problemas futuros.

Martin (2009, p. 160) destaca as ferramentas-chave dos design thinkers

> [...] observação, imaginação e a configuração. [...] Uma vez que os design thinkers estão à procura de novos 'insights' que lhes permitam avançar o conhecimento, eles devem ser hábeis em ver coisas que outros não veem. Isto requer observar e ouvir cuidadosamente de maneira sensível ao assunto, como um etnógrafo faria.

Brown (2009, apud FORNASIER, 2011, p. 229), assim como Martin, também considera a observação uma habilidade primordial e afirma que

> [...] os design thinkers observam como as pessoas se comportam; como o contexto das experiências os afetam nas relações com os produtos e serviços; como eles levam em conta o pensamento emocional e também sua performance funcional. A partir disso, tentam identificar o que as pessoas não declararam, ou coisas que sejam latentes, ou necessárias e transformam-nas em oportunidades.

Destaca ainda a empatia, o pensamento integrativo e multidisciplinar, o otimismo, a experimentação e a colaboração, sendo todas inerentes ao ser humano.

Em síntese, as habilidades determinantes em um design thinker são, entre outras, as habilidades de encontrar padrões; sintetizar as informações e conhecimentos extraídos; gerar novas ideias a partir de fragmentos, coleta de dados (etnografia), criatividade e imaginação; e gerar empatia.

Tendo em vista tais habilidades, o segundo passo é compreender como estas serão aplicadas para produzir um projeto de sucesso. Há uma série de abordagens utilizadas, no entanto, aqui, serão considerados aspectos relativos ao Processo de Design Centrado no Usuário.

No processo de Design Centrado no Usuário (DCU), o foco principal de um projeto – desde o seu planejamento até a sua concepção - consiste em atender as necessidades e limitações dos usuários. Essa abordagem do design é considerada por muitos autores como a mais adequada, uma vez que a análise do comportamento e o entendimento das necessidades dos clientes levará à elaboração de projetos mais adequados e que atenda melhor a demanda de seus usuários.

Veryzer e Mozota (2005) caracterizam, por meio de um quadro comparativo, as diferenças entre a abordagem tradicional e a abordagem do Design Centrado no Usuário. Na abordagem tradicional a base é a tecnologia e o foco do projeto é no cliente atual e nas estratégias utilizadas. Já no Design Centrado no Usuário a base é o usuário, o estudo do cliente é feito por uma equipe multidisciplinar que focaliza em soluções que podem tanto ser úteis para clientes atuais quanto para clientes futuros, além disso, promove resultados que podem gerar competitividade e inovação.

Assim, pode-se constatar que as habilidades dos design thinkers auxiliam o Processo de Design Centrado no Usuário. O desenvolvimento de produtos inovadores por meio do cruzamento de informações entre profissionais de diferentes áreas (multidisciplinaridade) garante que a empresa consiga entender as necessidades dos diferentes tipos de usuários e, por meio das ferramentas visuais, consiga traduzir, efetivamente, essas necessidades em soluções para o cliente. A visualização e a criação de protótipos são as ferramentas mais valiosas para dar uma perspectiva holística aos projetos. (VERYZER; MOZOTA, 2005)

Esse processo de compreensão, síntese e criação do design thinker pode ser observado de maneira mais detalhada na figura 2 abaixo, retirada do modelo GEIDa (DEMARCHI; FORNASIER; MARTINS, 2013).

Fig. 2 Fragmento do Modelo GEIDa (2013). Fonte: Adaptado de Demarchi; Fornasier; Martins (2013).

O GEIDa é composto por quatro diamantes, que consistem em processos de divergência e convergência do pensamento do design thinker. Os dois primeiros ciclos, mostrados na figura 2, referem-se ao processo de análise, criação de estratégias e elaboração do projeto. Primeiramente, representado como a oportunidade, o agente de design realiza um briefing, onde investiga o propósito de seu cliente. Na compreensão o profissional observa de maneira minuciosa o contexto do projeto, tomando notas e criando painéis visuais que o ajudem a externalizar suas ideias. Durante a síntese, o agente de design, novamente com a ajuda de materiais gráficos, reúne as informações obtidas no processo, para, posteriormente, na etapa da criação, estender suas possibilidades e gerar ideias por meio de técnicas como o brainstorming, e assim conceber diferentes propostas gráficas. Finalmente, o agente de design, converge suas propostas, criando protótipos do produto final.

2.2. Metodologia:

A metodologia utilizada na pesquisa é de caráter etnográfico, com base em referencial teórico de Angrosino (2009). Trata-se de uma pesquisa qualitativa, onde o pesquisador analisará as práticas dos profissionais que utilizam o design thinking, a fim de evidenciar as características dos mesmos de acordo com o período de atuação no mercado.

O observador se posicionará de modo participante, se relacionando com os sujeitos da pesquisa sem interferir na coleta de dados. Terá ainda um cunho exploratório, pois contará com estudos bibliográficos e pesquisa de campo, por meio de observações e entrevistas, relacionando as ideias propostas pelos autores estudados com as experiências relatadas pelos profissionais.

Em relação à delimitação do campo de pesquisa foram selecionadas, primeiramente, 11 empresas de design. Posteriormente esse número foi reduzido para 05, tomando com base as metodologias utilizadas por tais empresas, uma vez que as mesmas empregam princípios específicos ou similares aos do design thinking, fato relevante para a temática do estudo. Foram escolhidas para a realização das entrevistas, respectivamente: Kalau Design, La Casa Comunicação, Eidee, Oapo Design e Visualitá.

Para a escolha foi considerado a diferença no tempo de mercado de cada uma das empresas, como pode ser observado na tabela abaixo.

Tabela 1. Empresas visitadas

Empresa	Nome	Tempo de Mercado	Nº de Agentes de Design Entrevistados
01	Kalau Design	10 anos	01 **(A)**
02	La Casa Comunicação	13 anos	02 **(B e C)**
03	Eidee	5 anos	02 **(D e E)**
04	Oapo Design	10 anos	01 **(F)**
05	Visualitá	24 anos	01 **(G)**

Fonte: O próprio autor.

Analisando a tabela acima é possível verificar que a empresa mais nova é a Eidee, que possui 5 anos de mercado e encontra-se ainda incubada à universidade; Já a Visualitá é a mais antiga, com mais de 20 anos de mercado e uma vasta experiência na área.

Para as entrevistas foi previamente elaborado um roteiro contendo as perguntas-chave direcionadas aos agentes de design, onde foi possível identificar os métodos e técnicas utilizados pelos mesmos. A tabela 2, abaixo, apresenta o protocolo que permeou a observação participante.

Tabela 2. Protocolo

Metodologia	Objetivo da Pesquisa	Perguntas Relevantes do Roteiro
Etnografia Múltipla	● Estabelecer um parâmetro entre o Design Thinking e a dinâmica dos profissionais atuantes como design thinkers de acordo com o período de atuação no mercado. ● Analisar as técnicas e habilidades utilizadas pelos extremos perfis de profissionais, o designer iniciante e o designer experiente, a fim de mostrar os resultados que o processo pode oferecer.	● Utilizam técnicas durante o desenvolvimento de um projeto? Quais? ● São utilizadas técnicas específicas? (ferramentas visuais, conceitos, protótipos, quadros, mapas mentais, etc.) Alguma delas é mais utilizada? ● Você acredita que os métodos ou técnicas utilizados influenciaram de maneira positiva nos resultados do seu trabalho? Como? ● Ao longo de sua experiência profissional você modificou os métodos utilizados no início da carreira? Por quê?

Fonte: O próprio autor.

De todo o questionário quatro perguntas, que estão listadas na tabela 2 acima, se destacaram como essenciais para o objetivo dessa pesquisa. Essas questões consistiram, basicamente, em investigar se os profissionais utilizam técnicas e/ou métodos específicos durante a geração de alternativas e criação de seus projetos, identificá-las e relatar se as mesmas têm produzido resultados válidos. As respostas foram reunidas e analisadas, sendo organizadas em tabelas informativas e comparativas.

3. Resultados e Discussão

Analisando os profissionais entrevistados pôde-se comprovar a efetividade dos estudos de diversos autores que abordam sobre o design thinking, entre eles os estudos de Brown (2009), que afirmam que as habilidades de um design thinker não estão restritas somente aos designers, podendo ser desenvolvidas por qualquer indivíduo por meio da experiência.

A tabela 3 abaixo mostra alguns dados extraídos das coletas de dados, entre eles a diversificação da formação acadêmica dos agentes de design, fato que comprova que a interdisciplinaridade é um fator determinante entre os profissionais que utilizam o design thinking.

Tabela 3. Dados dos agentes de design

Empresa	Agente de Design	Formação Acadêmica	Anos de Experiência
01	A	Administração; Especialização em Gestão Estratégica de Design	20 anos (3 com Gestão Estratégica de Design)
02	B	Design Gráfico; Especialização em Gestão Estratégica de Design	13 anos
	C	Publicidade e Propaganda	11 anos
03	D	Desenho Industrial (Design de Produto); Especialização em Gestão de Design	13 anos
	E	Design Gráfico	5 anos
04	F	Design Gráfico	10 anos
05	G	Arquitetura	29 anos

Fonte: O próprio autor.

A tabela 3 acima mostra ainda o tempo de experiência no mercado de trabalho de cada agente de design entrevistado, tanto nas respectivas empresas visitadas, quanto em outras empresas e/ou como freelancer.

O que se observou foi que os profissionais com menor experiência, como é o caso do agente "E" que possui apenas 5 anos de mercado, ainda utilizam diversas técnicas na elaboração dos projetos. Já os agentes que estão há mais anos no mercado de trabalho, como o agente "G", devido ao nível de expertise, acabam não se submetendo tanto as técnicas, não seguindo de maneira rigorosa as etapas do projeto.

Os agentes "D" e "E" relataram como é constituído o processo de desenvolvimento de projetos da empresa 03 (Eidee), que é em geral definido por quatro etapas: o briefing, a geração de ideias, a pré-visualização e por último a viabilidade de produção. Durante essas fases as principais técnicas utilizadas pelos agentes da empresa são pesquisas desk, mapas mentais, fluxogramas, painéis visuais, análises de similares, estudos volumétricos e criação de protótipos. Todas as etapas são muito bem definidas e o registro do processo é considerado essencial.

Foi possível identificar que, apesar do longo tempo de mercado do agente "D" (13 anos) e de seu grande conhecimento na área, principalmente na questão tecnológica relacionada ao design de produto, sentiu-se a necessidade de algum profissional que utilizasse algumas técnicas e/ou métodos capazes de externalizar as ideias e necessidades da empresa, e para isso, o agente de design "E", se mostrou eficiente, levando inovação à empresa.

Já a agente "G" da empresa 05 (Visualitá), declarou que as etapas dos projetos dependem muito da necessidade do cliente, não seguindo um planejamento tão regrado. As ferramentas visuais como esboços e sketches são sempre utilizadas e consideradas indispensáveis, no entanto, o processo criativo não possui um registro bem definido.

Os profissionais "B" e "C" da empresa 02 (La Casa Comunicação), apresentaram três etapas cruciais utilizadas pela agência: pesquisa, verificação e apresentação visual. No entanto, as etapas também não são bem definidas, podendo ser alteradas conforme a necessidade do cliente.

Segundo a descrição do agente "F", a empresa 04 (Oapo Design), possui etapas e um processo bem semelhantes à empresa 02, pois também não possui um procedimento fixo. O agente descreve que uma das ferramentas visuais mais utilizadas são os mockups, pois ajudam a visualizar o projeto final.

O agente "A", apesar de possuir aproximadamente 20 anos de experiência, teve contato com a Gestão Estratégica de Design e o Design Thinking há apenas 3 anos, então demonstra seguir de maneira mais estruturada as etapas do processo. Também faz grande uso da documentação, assim como o agente "E".

A figura 3, abaixo, apresenta uma simples comparação entre as empresas, demonstrando quais se utilizam mais da intuição e quais são mais amparadas por técnicas.

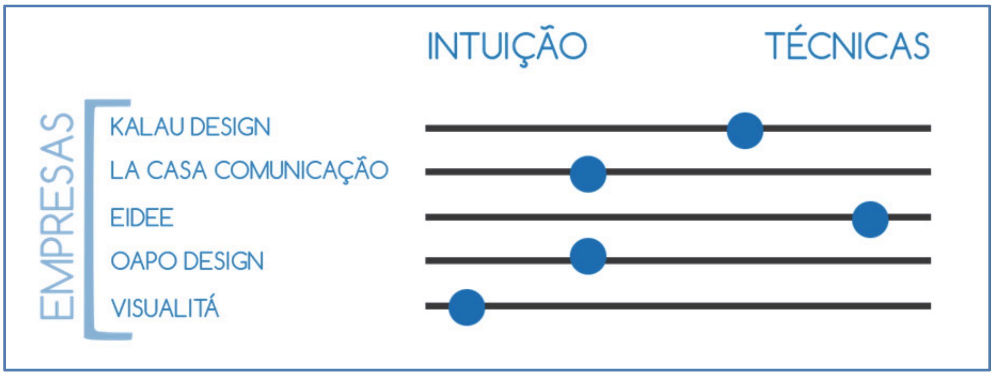

Fig. 3 Diagrama comparativ. Fonte: O próprio autor.

Em geral os profissionais que possuem expertise afirmam que a intuição acaba se tornando muito mais relevante no desenvolvimento dos projetos do que a própria técnica. Reafirmando a ideia de Martin (2009), de que com a experiência o agente de design aprimora sua sensibilidade, os agentes afirmam que à medida que novos problemas vão surgindo, tanto na geração de alternativas, quanto na viabilização, eles recorrem a soluções anteriormente utilizadas em outros projetos.

Constatou-se ainda que, apesar de os agentes trabalharem de formas distintas, alguns seguindo mais rigidamente as etapas do processo, e outros se atentando mais ao "feeling", as ferramentas visuais são consideradas fundamentais e efetivas em todas as empresas visitadas. Em síntese, algumas ferramentas que são mais utilizadas, em geral: mapas mentais, sketches, painéis visuais e, principalmente, mockups.

4. Conclusão

Em síntese, pôde-se concluir por meio dessa pesquisa que, apesar de haver algumas técnicas e métodos considerados imprescindíveis pelos agentes de design entrevistados, como as ferramentas visuais, a experiência continua sendo, ainda, a habilidade mais explorada na hora de gerar alternativas e desenvolver um bom projeto final.

A parte positiva consiste na sensibilidade que a expertise garante aos profissionais, fazendo com que eles sejam capazes de identificar condições semelhantes em problemas passados para solucionar os problemas atuais. No entanto, pode também apresentar aspectos negativos, no que tange à inovação. Ao se prender à intuição, os agentes de design acabam deixando de lado algumas técnicas que poderiam auxiliar na busca de soluções mais criativas.

Portanto, para se tornar um bom design thinker e obter resultados satisfatórios, o profissional deve valorar as experiências adquiridas ao longo de sua carreira, sem deixar de lado o uso conjunto e equilibrado das técnicas e ferramentas oferecidas pelo design thinking.

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Design as a Critical Research

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Abstract

Historically the imaginary and the hegemonic thinking, in the Western globe north, has been marked by the epistemology and capitalists archetypes. Notwithstanding the design seem as a practice and discipline shielded on a simplistic discourse of functional / communicative efficiency, wandering through by multiple aestheticism apparently neutral in relation to the symbolic, but in fact they never are, because what really hapens is that the aesthetic appearance of the generated forms will always be a review of the powers ruling. We start from the understanding that the act of creating an aesthetic artifact, will also be a movement of inscription in a discursive platform (that precedes it), is in itself an narrative act and that fact represent a certain take place in relation to certain symbolic reality. On reflection shown if it sees design as a discipline and / or an instrument of action, whose operational relevance tends to question and simultaneously rehearsing a response, in which more than why interests answer to why.

Apparently the design is a content mediator, but also, it is structure, is body, is idea. We think a design praxis as discipline and enrollment tool of critical thought and social transformation. For guiding research in this text, we propose the following question: Can the Design want for themselves an engagement with the symbolic in order to be an active part in the production of critical thinking in the place where it belongs? Methodologically our argument will be present in two differents moments: 1. a first, exploratory nature where we rescue the draw issues in the practice of design and 2. a second analytical nature concerning the subject issues (graphic and / or utility) design and how it incorporates formal rites, political events and social practices of contemporary everyday life.

We consider the praxis of design as a discipline and critical thinking enrollment tool as agents of social transformation. With this study we seek for contribute phenomenology design by studying the artifacts of configuration as well as the possible messages they convey and what impact they may have on the social network.

Keywords: *Politic, Transformation, Periphery, Project, Democracy*

1. Introduction

Historically the imaginary and the hegemonic thinking, in the Western globe north, has been marked by the epistemology and capitalists archetypes. Notwithstanding the design seem as a practice and discipline shielded on a simplistic discourse of functional / communicative efficiency, wandering through by multiple aestheticism apparently neutral in relation to the symbolic, but in fact they never are, because what really hapens is that the aesthetic appearance of the generated forms will always be a review of the powers ruling. We start from the understanding that the act of creating an aesthetic artifact, will also be a movement of inscription in a discursive platform (that precedes it), is in itself an narrative act and that fact represent a certain take place in relation to certain symbolic reality. On reflection shown if it sees design as a discipline and / or an instrument of action, whose operational relevance tends to question and simultaneously rehearsing a response, in which more than *why* interests answer *to why*.

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We consider the praxis of design as a discipline and critical thinking enrollment tool as agents of social transformation. With this study we seek for contribute phenomenology design by studying the artifacts of configuration as well as the possible messages they convey and what impact they may have on the social network.

2. Of Drawing

We will start with considering two exploratory projects in drawings, which start from a common base, which consists of thinking design as a catalyst for improvise, for error and for the imponderable. With these projects, it was intended to think and reflect drawing as a cartographer for the performative gesture of the quotidian, and the devices of drawing are a prosthetic artefact that is simultaneously a mediator and translator of the conversion of movement (of a body in a space) in design/image production. Drawings characterized by a certain unpredictability, a certain wandering, a certain narrative and meta-narrative chaos. We can legitimately understand these drawings as the narrative sense's linear economy, configuring itself mainly as pure management of randomness, where design is the transgression of the norms that constrain the inhabitability of spaces, constructing/reconstructing this shift, *normalizing* the unpredictable. As we will be able to verify, these are a set of drawings that close among themselves, without a remote control, where it is virtually impossible to predict a beginning, impossible to define an order of action through tem or through contemplating them.

2.1. As a cartographer of the gesture of the body in a quotidian space

The first drawing experience was drafted in 2004, and only years later (2013) was it resumed, inserted within a lecture on drawing (*Drawing in the University Today*). As this early stage, the methodical processes of creation in drawing were composed of a daily log (throughout precisely 18 days) of the movements produced in a household, by the people who cohabited the space, as well as by the objects belonging to it. In a living space as well as in cities, there are passage spaces, where people pass by but don't stop (like hallways), others where one fixates for a longer period of time, and also dead spaces, where nothing happens (like the spaces under furnitures). In order for such log/mapping to occur (of the movements of body and objects), it was required to cover the entire floor of the household with scenery paper, converting the simple living experience of body in a space in an engine of production of registry and consequently of drawing, through drawing devices, or recording prosthetics, the simple experience of a body in space was converted into record production of engine and consequently drawing. In that sense, the person who would enter the *household* space would be given *"the logging machine*". Their sole requirement was to inhabit the *household* space in a natural relationship with the spaces and objects belonging to it. We can state that we are facing the blueprint of a household at the 1x1 scale.

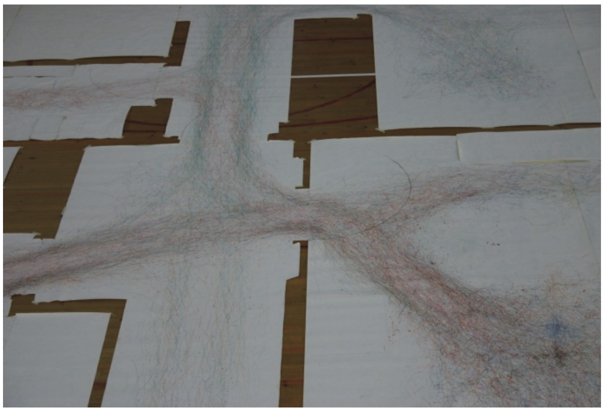

Fig. 1 Marta Calejo, Out of doors, in 2003, Drawing fragment.

Fig. 2 Marta Calejo, Out of doors, in 2003, Drawing total view

Through this record, we can understand which are the most utilized spaces, as well as the established relationship between people and objects. We can state it is a quotidian hyper-narrative. A drawing intended to think of trace, marks, the unexpected and the error as a narrative constructing tacit force. Objects and bodies that intersect, that leave marks and mutually draw each other, in a coexistence that is not peaceful because it is, in certain moments, unpredictable. Unpredictability gains, in this context, a new meaning, translated by the coexistence of space, which are gesture, movement and drawing. We perceive drawing here as a direct and automatic projection of life (whose conceptual proximity was inspired in Pollock). This *modus* of the drawing is marked by an accumulation of lines that, by saturation, prevent a unequivocal reading of events. In this experience, there are, occasionally, little text notes that work as small subtitles, which describe and/or denounce some movements that have existed but are no longer there, and not through the gesture/movement translation that may have left a trace/mark.

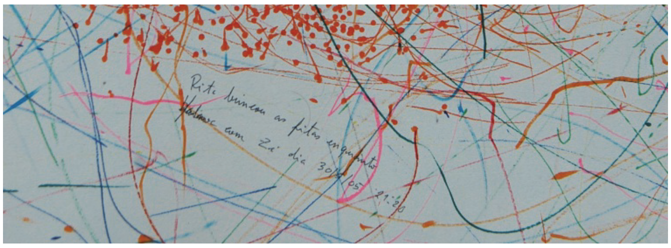

Fig. 3 Drawing detail with legend. Author (2003)

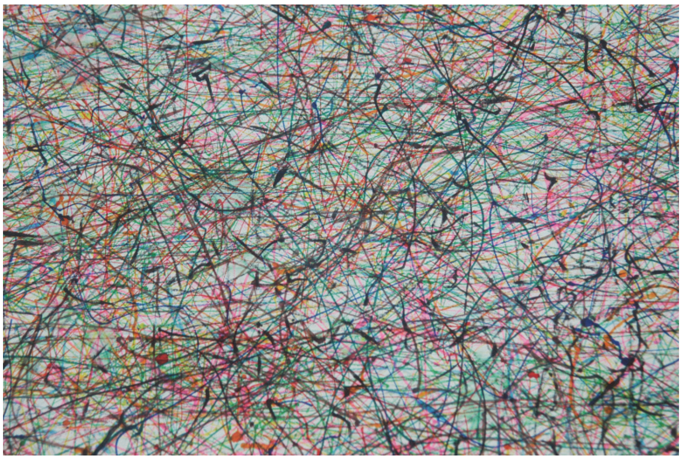

Fig. 4 Drawing mesh detail. Author (2003)

Therefore, spaces are defined as well by the type of registry that they make; i.e., the types of marks that appear *in situs* define spaces and the kind of coexistences and actions that embody the place. When we think of actions, we report to two levels of existence, construction and reconstruction, simultaneously. Those that are calculated (*I'm going this way*, in which there is the consciousness that one is producing a drawing), and the unpredicted ones (*accidentally, one drops a cup of coffee*, adding unpredicted information to the drawing). The accident as a pivotal characteristic of the construction and thought process of drawing. This drawing *modus* transfers to paper the natural processes. The gestures of the body and what they produce in their relation with real space are of a tri-dimensional realm. For example, when a cup falls, it produces a movement in the tri-dimensional space, but when the ending of the fall occurs, a bi-dimensional mark is inevitably printed, that is a trace of what occurred, it is a mirage of a supposed event. We can state it is a certain "thickness" of the image, because it materializes in a gesture making it bi-dimensional, leaving its tri-dimensional nature as an "embedded" reality, a reality "beyond", a reality that it supposed to have occurred, but of which only its results are known, meaning, the marks that compose it. We will go as far as to claim that they are perhaps the consequent result of the sums of accidental *ready made*, and not a choice – they occur in an unpredictable fashion, without given time or space. Echo's of memory, that transfers to the drawing a narrative and meta-narrative map of a quotidian existence in a real space (house) and of space as a container of residues/ marks/ traces (drawing).

2.2. As a cartographer for gesture in the absence of an event

In this second experiment, like in the previous one, we start off from an interpretation of drawing as a cartographer for experiences occurred in a determinate space. But, whereas in the previous drawing the entire floor of a house was covered in paper along a period of 18 days, in this project we contained the action space in a single compartment of the household through a period of 6 hours. In this experience, twenty adults and two children were present (the children were not initially planned for the project). The registers of the children's bodies are differentiated, as it is expected that the manner in which the children manage their coexistence in the space, and of their bodies will be necessarily different. If in the previous project the mesh of traces was colourful, here the option was to create a code of colours that allowed that perceptive differentiation in the graphic log to exist in a clear and indubitable way – to that effect, the following was defined: black markers for adults and red markers for children – like in a map, where paths of differentiated natures have differentiated registers. The results demonstrate that children had not only a different relationship with space, but also a different relationship with the materiality of the drawing, producing a record that not only translated their movements in a graphic image, but also required in certain moments the manipulation of the markers.

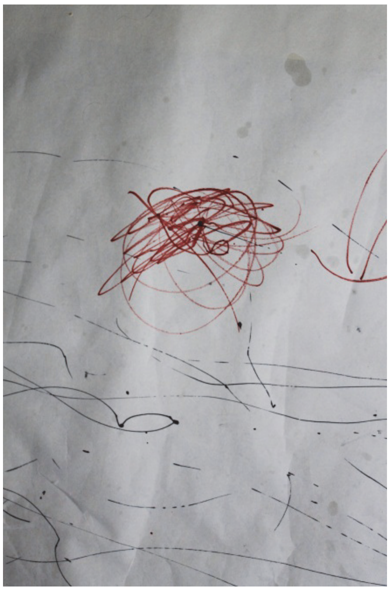

Fig. 5 Traces generated by child. Author (2014)

Peggy Phelan, about performance art, said '*the performance enters the economy of reproduction, it diminishes the promise of its own ontology (...) the ethos of the performance, like in the proposed ontology of subjectivity, is reached by way of disappearance* (Phelan, 1993: 171).' In this process, drawing is also created through disappearance, for of the event *per si*, or what emerges from it, is the record as trace of action. This is, therefore, a drawing that stumbles in the gestures of an action. In the drawing or the drawing *modus* here represented, it is looked upon as something that is documented, collecting in a single space of consignment an account of marks and evidences of a determined event, and in this concrete case, like Jacques Le Geoff taught us, this drawing is simultaneously a document and a monument of the event (Paul Ricoeur 1978: 68). However, this sum of gestures converted in traces is not linear not peaceful, for with any addition of record (trace) a subtraction to the previous information is perceived, through the overlap of a new record. In the same manner as the previous experience, here the drawing also documents the movements of the body in a space, and this was made possible because 'drawing prostheses', similar to the previous ones, were indexed to the bodies of the inhabitants or co-inhabitants of the space, where the paper covered floor served as a support for the drawing.

Fig. 6 Drawing prostheses' in use. Author (2014)

Methodologically, within this creative process, drawing is seen as a document, a testimonial of an event, i.e., as proof/evidence (although a speculative one) that something occurred there, and in that sense, we can state that the generated artefact assumes, tacitly, the shape of a spectrum or a mirage of an action. Lets resume, from the theories of Derrida (1997), the concept of spectre in order to expose a drawing with an appearance that subverts positions between reality and fiction. In this instance we assume spectre as something that is imagined to have happened and, in that sense, drawing is read as a stimulus of an event, i.e., an incentive (although a speculative one) to memory so that something that will soon be absent becomes present. There are similarities the work of Sophie Calle, *Ghosts*, presented in the Dislocation exposition, at the Museum of Modern Art (MOMA), in New York, in 1991, where she exposes what the museum does not have and what the museum cannot offer, using that absence to create her work. Similarly, this is a drawing forged in the absence of an event.

Therefore, in this second experience, the drawing is a fruit of an event, that was intended as consequence of a drawing that sub-exists, suggesting that its energy is generated in the absence of an event. Thus, if in the described project, in point 2.1, short notes were taken along the drawing that recorded the events and the objects that composed the everyday existence in a space (in a taxonomical record of actions), in this second project such references and orientation notes for the reading of the drawing (and of the events occurred in a space) were not made, precisely because the intent was to think of drawing as speculation that generates in the absence of the event, for what we keep from it is a trace, and not the action itself.

From what was described, we can state that we are facing a number of drawings, which their *mimesis* of trace becomes impracticable, it resists, like in *performance art*, to reproducibility (Phelan, 1993: 171-173). This impossibility (of mimicry) is one of the prepositions that we are interested in exploring in the processes of projecting and thinking in design. It is easily verified in some of the objects that we selected for this investigation (fig. 7 and 8) the impracticability of mimicking these objects, outside of their social and political context.


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O Jackpot do Joker continua a crescer
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Fig. 7 Jornal i, First page of the Jornal I, 6-7 October 2012.

Fig. 8 Super Salazar. POPs - Original Portuguese Project. Martins (2013)

Such objects are indexed to specific events and places. For that reason, these are objects that in other places and contexts would result in loss of discursive and symbolic sense. We suggest that apparently such characteristic gives evidence to the artistic heritage of Design.

3. Of Design

In its origin, Design would be the natural heir to the discipline of Drawing. Perhaps, due to its disciplinary proximity, Design, as a creative practice, rescues the above mentioned marks, incorporating itself in a depurated manner (Fig. 9 and 10)[54], in the formal assumption of the object of Design and with that it

[54] The objects we present in this article appear as examples, merely illustrative of what we propose as a desirable conduct for a conception of design which sees it with bigger ethical, social and political implications.

rescues a creation process, that is in its genesis, an heir to drawing practices, and adds diverse levels of significance that we propose to explore.

Fig. 9 Hair disguiser. Ceramics, decorative tiles for toilet. Mir (1994-1999)

Fig. 10 Hair Disguiser Series, Dish. Ceramic. Mir (2003)

Starting from the shape-function equation, there are objects in which their shape emancipates from their function, thus representing a liberation of the object, adding other levels of significance to it. For our investigation, we have elected a set of objects that, although coming from a mass production and of utility purposes, are potentially capable of assuming narratives that go beyond their function. They are limit objects that put to evidence vestige of a narrative or an event that transcends its dimension of utility object. In light of Michell Foucault's heterotopia notion, we consider that we are facing *fragment-objects* capable of incorporating realities that go beyond their bodily boundaries and, this way, present themselves as operative elements that manage to free themselves (through their intrinsic characteristics) from their condition of a mere utility object. These objects are conceptually capable of anticipating formulations and relating conceptual data that stand far beyond the object itself and the technological aspect that composes them, transferring in this manner the natural function that they were destined to initially.

This way, we can state that: the objects we have been enunciating are artefacts capable of positioning conceptually and/or politically before phenomena that occur within the social context of its genesis. In that sense, we can state that such objects, of quotidian usage, emerge in the industrial production panorama, like elements of subversion. Object where one can apprehend a certain preoccupation in the production of critical through their own usability and/or functionalities of the artefact. We consider that these objects work as discursive '*empowerment'*, for they star and give voice to an alternative narrative to the hegemonic narrative. These are objects that communicate beyond their utility, i.e., beyond the canonical 'shape-function' formula. As objects of study, we are interested in the production in Design that understands the artefacts it creates as conceptual positioners by a determined symbolic context, i.e., Design as a shaper of consciousness, as an instrument of analysis and interaction with the *Other.*

We think of Design as a discursive tool while *corpus* of action. We see Design as a possibility of Democracy. In light of what we have been exposing, any of Ana Mir's or Madalena Martins' work are clear illustrations of that, for they largely surpass the shape-function dichotomy, to grant them levels of significance that transcend objects of a functional nature. The same occurs in the *Jornal I* newspaper's first page, as the rules of legibility of the newspaper's page were questioned according to structures of thought and creation processes that propose a critical positioning before specific events. Apparently, we are stand before objects of a quotidian utility, embedded with a subversive nature and questioning, through their own objectual interface, the rites, practices and/or socio-political events of the quotidian life. We believe that such synergy can be a motor for social transformation and production of critical thought in the social tissue in which it inserts. Like, Francisco Laranjo points out, "*To be knowledgeable of the history of formal languages is an invaluable requisite in a practice that must always be contextualized* (…) " (P3, 19/04/2016), in a profession which its ubiquitous work surrounds people's lives constantly and daily.

Jean Baudrillard (1968), in his theoretical legacy, reflected on the relations that objects establish with space, as well as its users, what type of experiences and judgements they make on the users that use them. Coming to the conclusion that multi-usage objects, capable of folding, in the way they relate with space and its users, manage to liberate from their function, but not exactly as an object.

'*While the relationship of the individual in family and society changes, the style of objects and furniture changes as well. (…) In terms of the serial object, in the absence of space restructuring, this 'functional' evolution is simply to resume the Marxist distinction, an emancipation, not a liberation, since it only means the liberation of the object's function and not the object itself'* (Baudrillard, *1968: 23-24)*

In light of this formulation, we can state that the objects brought to analysis, although not fitting in the formal category of *'multi-usage objects'*[55], can be said to be objects that emancipate from their function and that, to a certain extent, free themselves from their object condition, through their formal characteristics as well as through the symbolic understanding we have of them. Clear examples of this are the objects presented in figures 8 and 7. They are objects, engaged with their users, with their time and place. This compromise apparently allows a liberation of the object (as a thing), and J. Baudrillard reclaimed its absence for objects of study.

In the present investigation, Design is approached as a discipline and/or action instrument, and its operative pertinence tends to problematize and simultaneously attempt an answer, in which, more than the *why*, it is important to answer to the *what for*? Apparently, Design is a mediator of contents, but is is also shape, it is structure, body, idea. We perceive Design as an element of transformation. Like J. Butler, regarding the semantic structure that predicts the performative act of the quotidian, that despite not being a direct event, it is first and foremost, the result of the repetition of strongly coded gestures that when appropriated incorrectly, provoke changes in the code of the symbolic and semiotic fabric that supports them. Or, like M. Foucault, whose theorization analysed the way things are shaped will always be a digest of the dominant powers. Or even, like Walter Benjamin when he studied the existence of a collective memory, considered to be the common semantic structure that rules us as elements that belong to the

[55] In his work, J. Baudrillard gives the sofa bed as an example.

same nucleus. We think of Design as a tool with real possibilities of deconstructing the hegemonic narrative.

Just like Derrida, deconstruction or *de-construction* perceived as a double gesture that inverts the order and dislocates structure, i.e., by dislocating that structure we subvert the hegemonic order, provoking a structural alteration in the inside of it, and through that double movement a new order transforms and reinvents in the bosom of the society where the phenomenon occurs. Such subversion and reinvention of the order occurs when, through processes of differentiation, we alter a certain symbolic legacy. This process of *re-presenting*[56], brought to the territory of Design, becomes a powerful instrument of the transformation of the hegemonic narrative. In other words, if we think of Design as a language, when we appropriate the symbols and pervert their semantic code, on a first instance, the consequence will be: the strangeness by the observer who, for the first time, looks at the transformed object. This strangeness is the disquieting pulse of the text (objected here), with its subtexts, that can legitimately be energizing elements of consciousness, a *leitmotiv* for the critical reflection of those (the user) that with it (the object) interact. The message or narrative meaning of the object crosses the sign (artefact of Design) reaching existence and significance outside of it (i.e., in the social fabric). The objects brought to investigation are semiotic elements that have multiple existences, and are everything but *mono linguistic* or a discursive *bricabac*. They represent an incentive to users' critical thought, to a permanent questioning of what happens around them.

This way, we perceive design as simultaneously an exercise of democracy and an instrument of production of critical thought. Assigning designers the double function of creators and critical agents. We debate for a Design with a possibility of creation that results from the possibility of the nature of the drawing manifesting itself in the object of quotidian usage, through creative and reflexive duality. Understanding the practice of Design as an instrument of creation encompassed by technical reproducibility, and being legitimately seen as an element of social transformation.

José Bártolo (2012), in his *Manifest for the Portuguese Design*, attempts to make room for the discussion of the demands of Design as a professional practice. Demanding a larger politicization of creative agents and a positioning on their part in the contents they create. Bártolo refers to Design *'as a form of social production and not as an isolated case of creativity'*[57] and of its agents as social actors with ethical and political responsibilities in the contents they create.

4. Final Considerations

We understand the act of creation is also a movement of inscription in a discursive platform, continuing or not, an already existing narrative and, with this, a positioning before a determinate symbolic reality. In this sense, we interpret Design as a discursive tool, as a *corpus* of action, analysis and interaction with the *Other*. We are interested in the object and the processes of creation, as conceptual positioner, according to a determinate symbolic and discursive structure. We therefore speak of a Design that uses semiotics and its ubiquitous nature (for it is present in city life as much as in people's spaces) as a way of social, ethical and political compromise. Hence Design, as a creation tool, can be an element of social transformation. We believe that the eventually more critical nature of the object, seen as an operative symbolic element

[56] Linguistic game resumed from Derrida's essay, *La Voix et le Phenomene*, i.e., in the sense of a representative element replacing, occupying the place of another *Vorstllung* (*Reprasentation)* [Derrida 1967: 62]
[57] Excerpt taken from point 8 of the manifest *Manifest for the Portuguese Design* (in the editorial of *Artcapital* in October, 2012)

before its context, can be rescued in the territories of drawing to then reach the project of Design, translating this ambivalence in the shape of the object.

For the most part, in what concerns Design's creative activity, there seems to be a propensity for the intent to deviate, regarding the symbolic. Whereas in the contemporary artistic process the symbolic is a symptom of Art, Design wanders through multiple 'aesthetics', tendentiously global and, as such, away from their identifying relationship with a certain time and place.

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Essential competences to fashion design practice for sustainability from the perspective of Design Thinking

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Abstract

The production and consumption of clothing products is characterised by rapid and continuous cycles of purchase, use and disposal of clothes, which leads to several environmental and social impacts. In order to change this reality and promote sustainability, this sector has to undergo deep transformations (Fletcher & Grose, 2011).

In this context, designers play a significant role. In addition to being in the position of decision-making about materials and methods used in the productive process, the questions raised by sustainability demand design skills (Brown, 2010; Gwilt & Rissanen, 2011; Fletcher & Grose, 2011).

However, the role reserved to fashion designers in this context is "more complex than traditional design activities" (Fletcher & Grose, 2011, p. 162). Design practice for sustainability demands different competences from the designer. In view of that, this paper explores the competences in design and fashion design for sustainability, and aims at verifying similarities and differences between them in order to analyse the knowledge inherent to sustainability through design thinking.

The methodology used for the study was deductive, conducted through qualitative exploratory research, outlined by bibliographic research and developed based on several books about design, fashion and sustainability.

The identification of the competences took four aspects into account: types of thinking, types of knowledge (know what to do and why), skills (know-how) and attitudes (be willing to do). Design and fashion design competences for sustainability were compiled separately and then compared for similarities and differences.

As a result, we found that great part of design competences are important for sustainable practices: approximately 58% of attitudes, 36% of thinking, 58% of knowledge and 41% of design skills are common to sustainable fashion design competences.

The comparison shows the importance of attitudes to the work with sustainability – once its addition was significant –, and the need of acquiring specific knowledge of fashion design for sustainability.

Research also shows that, for a professional with design competence, the development of thinking and skills needed for working with fashion design for sustainability is easier.

Keywords: *Knowledge management, clothing sector, design, sustainability.*

1. Introduction

The production and consumption of clothing products is responsible for several environmental and social impacts. These impacts involve from the cultivation and extraction of raw materials to working conditions, cultural identity preservation and clothing maintenance (Salcedo, 2014).

Sustainability poses criticism to the clothing sector, because it is a production and consumption system characterised by rapid and continuous cycles of purchase, use and disposal of clothes. Due to its current structure, the clothing sector has to undergo deep transformations towards sustainability (Fletcher & Grose, 2011).

However, the fashion industry still ignores the transformative nature of the system proposed by sustainability, opting for small settings of operational character (Fletcher & Grose, 2011). But how to transform this reality? According to Brown (2010) and Fletcher and Grose (2011), the issues raised by sustainability require the use of design skills.

Although the design activity is aligned with the needed requirements for a more sustainable production system, the role reserved to the fashion designer in this context is "more complex than traditional design activities"[58], since the transition to a more sustainable scenario implies systemic discontinuities (Fletcher & Grose, 2011, p. 162; Manzini & Vezzoli, 2010).

In order to investigate the core competences needed to fashion designers for the practice of design for sustainability, this paper aims to identify types of thinking, types of knowledge, skills and attitudes that help them in this practice. To identify these aspects, we explore the competences in design and fashion design for sustainability through bibliographic research, verifying similarities and differences between them, in order to analyse the knowledge inherent to sustainability through design thinking.

In Section 2, we present the literature review about the challenges of sustainability, particularly the challenges posed to fashion designers. Next, in Section 3, the concept of competence is defined and we present how the design thinking approach is related to design competences. Section 4 concerns the research method adopted, while Section 5 presents separately the research results regarding the competences in design and fashion design for sustainability. In Section 6, we present the results analysis and discussion. The final considerations are made in Section 7.

[58] “[...] mais complexo que as atividades de design tradicionais […]” (Fletcher & Grose, 2011, p. 162, our translation).

2 Challenges of sustainability

Sustainable development can be defined as:

> systemic conditions under which, at the regional and global level, human activities should not interfere with the natural cycles that underlie all the resilience the planet allows and, at the same time, should not impoverish their natural capital, that will be passed on to future generations (Manzini & Vezzoli, 2010)[59].

However, not only does sustainable development consider the environment, it also requires "integrated and balanced analysis"[60] of different perspectives: economic, environmental, social, cultural and political (Fornasier, 2011; Queiroz, 2014; Vezzoli, 2010). The basic assumption is the need for a radical transformation to create a production and consumption system "profoundly different from what is practiced today"[61] (Vezzoli, 2010).

According to Capra and Luisi (2014), the main problems of our times – whether economic, environmental or social – are interconnected and interdependent. They are systemic problems that show a perception crisis and demand a radical change in thinking and values, as shown in Figure 1.

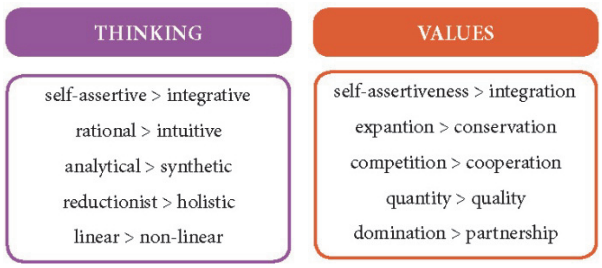

Fig. 1 Change of thinking and values. Source: adapted form Capra & Luisi (2014, p. 38)

Systemic thinking – which proceeds through relationships, patterns and contexts – is at the center of this perception change. This is a contextual thinking that deals with complexity, a concept "associated with systems composed of several parts or agents, highly interconnected"[62] (Bezerra, 2011).

This type of thinking is important to face the challenges of sustainability, since "environmental destruction is a complex system by itself; it is widespread and has deeper causes that are difficult to see and understand"[63] (Braungart & McDonough, 2011).

2.1 Fashion and sustainability: designer's responsibility and challenges

In order to achieve sustainability, all fashion industry must undergo improvements, not only some lyfe cycle phases, such as choice of raw material (Fletcher & Grose, 2011). After all, there are many environmental and social impacts caused by the fashion industry, especially since the advent of fast fashion.

[59] "Condições sistêmicas segundo as quais [...]" (Manzini & Vezzoli, 2010, p. 27, our translation).
[60] "análise integrada e balanceada" (Fornasier, 2011, p. 138, our translation).
[61] "[...] profundamente diferente daquele que se pratica hoje" (Vezzoli, 2010, p. 32, our translation).
[62] "[...] associado a sistemas formados por várias partes ou agentes, extremamente interconectados" (Bezerra, 2011, p. 39, our translation).
[63] "[...] destruição ambiental é um sistema complexo por si só [...]" (Braungart & McDonough, 2011, p. 70, our translation).

Designers can play a significant role in this scenario. They are in a position of making decisions regarding materials and methods used in the production process (Brown, 2010; Gwilt & Rissanen, 2011). Not surprisingly, Benyus (2015) believes that "maybe design is the most powerful lever to move the economy and culture towards a more sustainable society"[64].

In this context, the role of the fashion designer is to seek solutions to the challenges posed by sustainability (Salcedo, 2014). However, for fashion designers to commit to sustainability, they need to know the strategies of design for sustainability: if they do not know what the strategies are, how to apply them and the possibilities they offer, they will not be likely to change their design process to create more sustainable solutions (Gwilt, 2011).

3. Competence: knowledge, skills and attitudes

For a professional to be considered able to perform certain activities, they need competence. This means they need to present the knowledge (head), skills (hands) and attitudes (heart) specific to this task (Durand, 1998, 1999 apud Vieira, 2002).

Knowledge corresponds to *knowledge itself*. It refers to all knowledge accumulated by the person throughout life. There are five types of knowledge, presented in Figure 2 (Fornasier, 2011; Demarchi, 2011).

According to Durand (1997, 199 apud Vieira, 2002), skills relate to *know-how*. It is the ability to perform a task and apply the acquired knowledge – which, in this sense, corresponds to knowing what to do and why. This is a characteristic related to tacit knowledge (Fornasier, 2011).

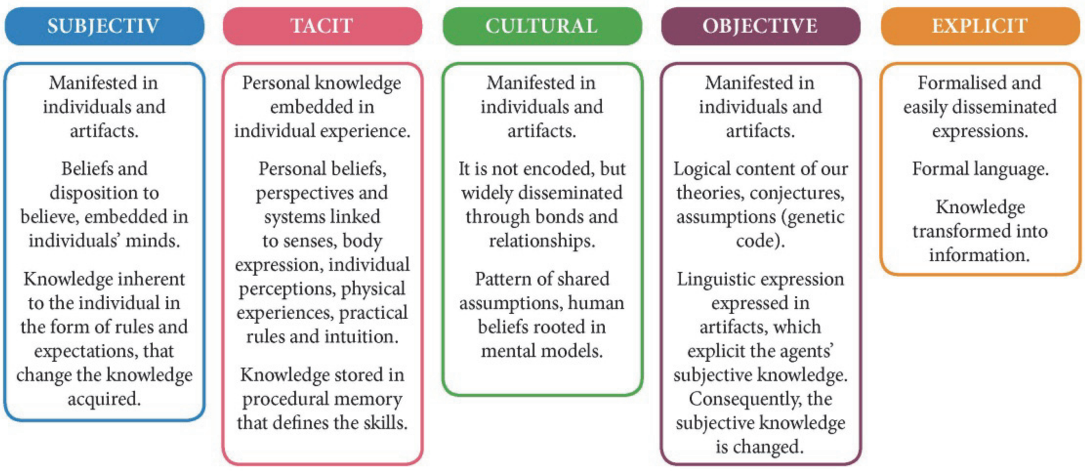

Fig. 2 Types of knowledge. Source: adapted from Fornasier (2011, p. 138)

As pointed out by the literature review conducted by Vieira (2002), attitudes are complex conditions that affect behaviour, producing it or explaining it. It relates to *be willing to do*. According to Fornasier (2011), attitudes correspond to "learnt predispositions, judgment, values, or individual beliefs that determine the course of action or the behaviour", being "embedded in the subjective knowledge"[65].

[64] "[...] talvez o design seja a mais poderosa alavanca para mover a economia e a cultura na direção de uma sociedade de maior sustentabilidade" Benyus (2015, p. 284, our translation).
[65] "[...] predisposições aprendidas, juízo de valores, ou crenças individuais que determinam a maneira de agir ou o comportamento […] embutida no conhecimento subjetivo" (Fornasier, 2011, p. 158, our translation).

3.2. Design thinking: design knowledge, skills and attitudes

Related to design competences is the design thinking approach, which uses design's ability and sensibility to "visualise problems and concepts, develop scenarios and build strategies based on designers' research methods"[66] (Demarchi, Fornasier & Martins, 2010).

Design thinkers use a different type of logic – abductive – through which they seek a balance between deductive and inductive logics to better understand the world (Fornasier, 2011). While the deductive logic (related to "what should be") draws conclusions from general to specific, and the inductive logic (related to "what is efficient") parts from the specific to the general, the abductive thinking is the logic of "what could be" (Martin, 2010).

Other types of thinking are commonly associated with design practice, such as divergent thinking – which multiplies the options for creating choices through the acquisition of knowledge –, and convergent thinking – which decides among existing alternatives (Fornasier, 2011; Demarchi, 2011).

There are two other types of thinking: systemic and integrative. The former – explained earlier in Section 2 – is considered by Cardoso (2013) as the largest and most important design's contribution to meet the challenges of our complex world. Meanwhile, integrative thinking is the very essence of design thinking: it is the ability to see non-linear and multidirectional relations as a source of inspiration, keeping several opposing ideas in tension to reach new solutions (Brown, 2010).

4. Method

In order to identify the competences needed by designers to the practice of fashion design for sustainability, and to verify similarities and differences between the competences in design and fashion design for sustainability, we used the deductive method conducted through qualitative exploratory research, outlined by bibliographic research, which allows us "to identify the current state of knowledge on the subject"[67] (Gil, 2010).

The research was developed based on several books about design, fashion and sustainability. First, we compiled design competences, then, competences in fashion design for sustainability. Both were compared to find similarities and differences.

5. Results

5.1. Competences in Design

To become a design thinker, it is necessary to develop the personal knowledge system (Martin, 2010). This system consists of three elements that are mutually reinforcing: posture (attitude), tools (which indicate knowledge and types of thinking required) and experience (where the skills come from).

According to Martin (2010), attitudes profoundly influence action and guide the choice of what knowledge to accumulate. Accumulated experience is the result of the knowledge and attitudes acquired. The experience forms tacit and objective knowledges and allows improvements on skills and sensitivities, which feed back posture (attitude) and can modify it.

[66] "[...] visualizar problemas e conceitos, desenvolver cenários e construir estratégias baseadas nos métodos de pesquisa dos designers" (Demarchi, Fornasier & Martins, 2010 p. 5, our translation).
[67] "[...] a identificação do estágio atual do conhecimento referente ao tema" (Gil, 2010, p. 30, our translation).

The thinking, knowledge, skills and attitudes typical of design thinkers are highlighted in Figure 3. We elaborated it based on the following authors: Brown (2010), Martin (2010), Demarchi (2011), Fornasier (2011), Mozota (2011) Bezerra (2011), Cardoso (2013) and Margolin (2014).

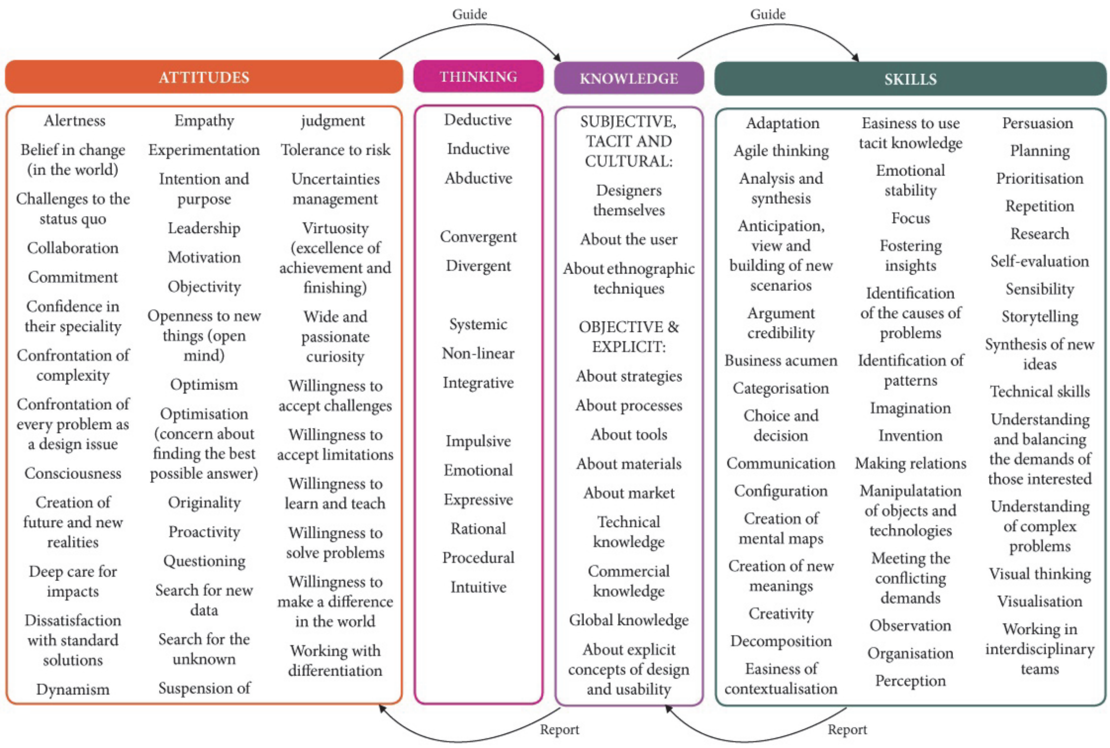

Fig.3 Competences in design. Source: based on Brown (2010), Martin (2010), Demarchi (2011), Fornasier (2011), Mozota (2011) Bezerra (2011), Cardoso (2013) and Margolin (2014).

5.2. Competences in Fashion Design for Sustainability

We compiled the essential competencies for the practice of fashion design for sustainability in works that approach sustainability, design for sustainability and sustainable fashion: Benyus (2015), Braungart and McDonough (2013), Brown (2010), Capra and Luisi (2014), Cardoso (2013), Fletcher and Grose (2011), Gwilt (2014), Queiroz (2014), Salcedo (2014) and Vezzoli (2010). The result of this literature review is presented in Figure 4.

The theoretical review reinforces the need to develop new competences. Sustainability implies, from the fashion designer's part, "a new attitude when making design decisions"[68] (Salcedo, 2014). It also requires a radical change of perception and thinking patterns (Capra & Luisi, 2014; Fletcher & Grose, 2011).

[68] "[...] uma nova atitude na hora de tomar decisçoes de design" (Salcedo, 2014, p. 89, our translation).

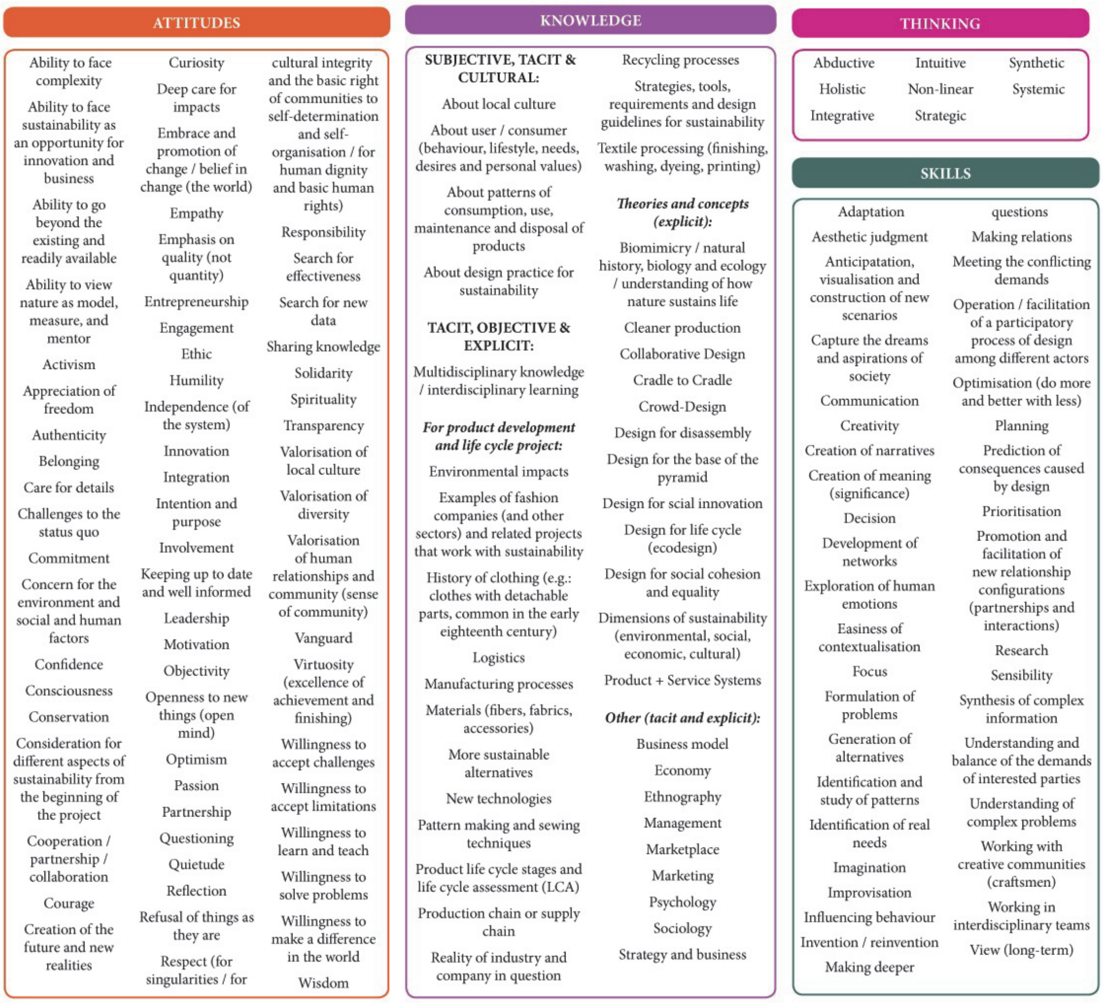

Fig. 4 Competences in fashion design for sustainability. Source: based on Benyus (2015), Braungart and McDonough (2013), Brown (2010), Capra and Luisi (2014), Cardoso (2013), Fletcher and Grose (2011), Gwilt (2014), Queiroz (2014), Salcedo (2014) and Vezzoli (2010)

6. Discussion

In Figure 5, we present the competences identified in common between design and fashion design for sustainability. Statistical analysis reveals that great part of the competences in design are important to the practice of sustainability: approximately 58% of attitudes, 36% of types of thinking, 58% of knowledge and 41% of design skills are common to competences in fashion design for sustainability.

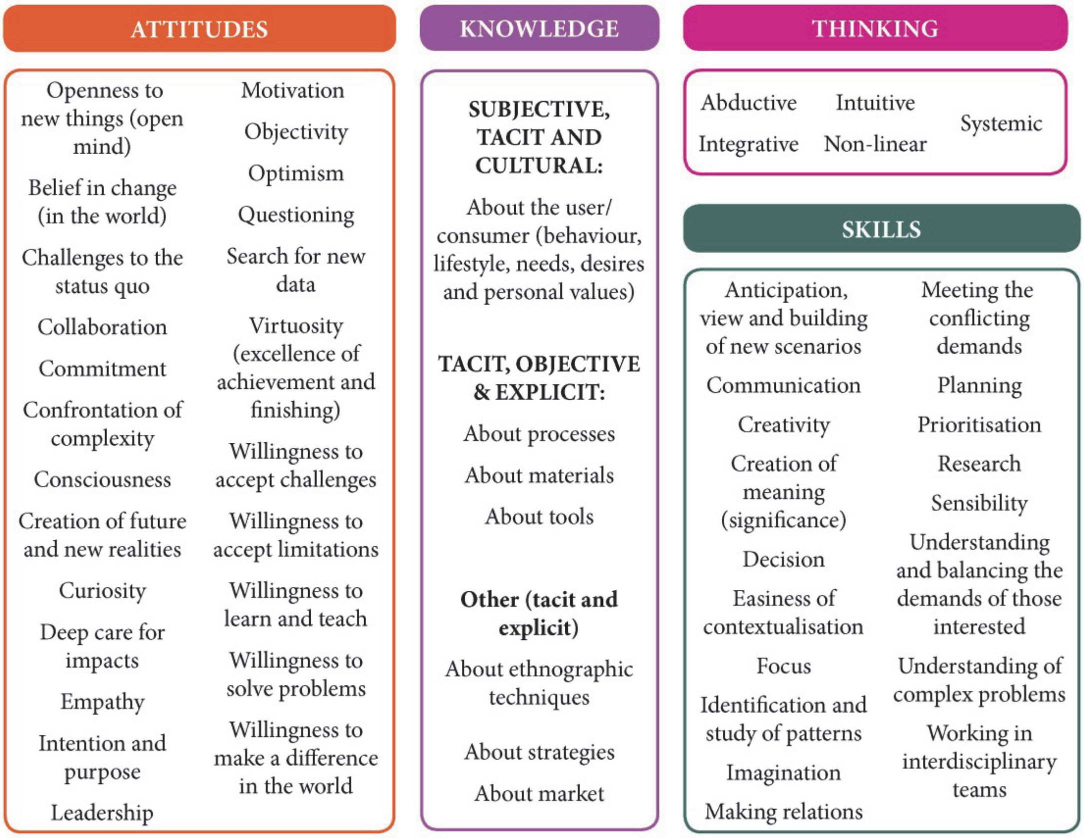

Fig. 5 Convergence between competecens in design and fashion design for sustainability

We notice that, if on the one hand, most of the design attitudes are necessary for the practice of fashion design for sustainability, on the other hand, fashion design for sustainability requires a much wider range of attitudes, which influence the actions and decisions of the designer, boosting them to work with sustainability. Regarding design thinking, not all types of thinking relate directly to sustainability, but some of them are essential, such as systemic, intuitive, integrative and non-linear. However, other types of thinking are added to competences in fashion design for sustainability: synthetic, holistic and strategic.

While design knowledge identified in Figure 3 can be considered more generic, the knowledge necessary to the practice of fashion design for sustainability – shown in Figure 4 – is more specific, encompassing various design for sustainability theories and concepts. In common, there is the need to know deeply the product user or consumer, as well as knowledge regarding processes and materials – which include knowledge of impacts and more sustainable alternatives. Also, in common, there is the knowledge of tools, adding design tools for sustainability into design thinking tools.

Regarding skills needed for the practice of fashion design for sustainability, many are similar to design skills, as few are added to these. Among the common skills, we hihglight those related to systemic thinking: understanding complex problems, easiness of contextualisation, creating relationships, identifying and studying patterns.

The comparison between competences in design and fashion design for sustainability reveals the importance of attitudes to work with sustainability, since the addition of attitudes was significant. As mentioned in Section 3, attitude is related to *be willing to do*, it influences the action and the acquisition of knowledge. Therefore, we can say that working with sustainability in fashion demands more attitudes from designer, involving stronger predispositions, values and beliefs.

Equally significant is the increase of knowledge, justified by the indication of specific knowledge regarding fashion design for sustainability, while design one presented in Figure 3 was generic. We notice there is lot of knowledge to be acquired for the practice of fashion design for sustainability, that will influence design decisions, since it relates to knowing what to do and why.

On the other hand, the research shows fewer skills are needed to fashion design for sustainability, compared to design ones. We consider important to note that nearly half of skills for sustainability are also design skills. Considering that they are the result of acquired attitudes and knowledge, we can say that, once the designer is willing to work with sustainability and seeks the needed knowledge, they will be able to easily develop the skills needed through design for sustainability practice.

7. Final considerations

Sustainability poses a challenge to the fashion industry because of the structure this system has, as we mentioned in the Introduction. In order to deal with that, Brown (2010) and Fletcher and Grose (2011) believe design skills can contribute to the issues raised by sustainability.

Because of this, this article aimed to identify the essential competences for the practice of fashion design for sustainability and compare them to the competences in design, verifying similarities and differences between them.

In Section 2, we saw that sustainable development requires radical changes in behaviour and in the way we understand how the world works. Designers can play an important role in this change, since they make decisions related to materials and methods used in the production process and can influence the development of more sustainable lifestyles.

For fashion designers to be able to develop more sustainable products, they must be competent for this activity. As discussed in Section 3, this means that they need to provide specific knowledge, skills and attitudes to this task, meaning that fashion designers need to add new competences to the design competences.

Identifying the design competences through literature review was the first stage of the research presented in this paper. For this, our starting point was the desing thinking approach, which is related to design competence, since it uses the design sensitivity and skills. As design thinking also involves designers' way of thinking, we also considered types of thinking as part of design competences.

After the second stage, in which we identified competences in fashion design for sustainability, the results were compared, which allowed us to analyse the knowledge inherent to sustainability through design thinking.

The results confirm the convergence of the issues raised by sustainability and design competences. They also show that sustainability requires new competences from fashion designers.

The research highlights the importance of attitudes to work with sustainable fashion and the need for knowledge acquisition related user/consumer, materials and production processes, as well as design tools and concepts for sustainability.

It also shows that, for a professional with expertise in design, it is easier to develop thinking and skills necessary to work with fashion design for sustainability, since few elements are added to these factors, as compared to attitudes and knowledge.

Our study would thus enhance the importance of design thinking and knowledge and competences management to allow fashion designers to able to transform the fashion system towards sustainability.

Given the limitations of the research presented in this article, since it was based solely on theoretical sources, we consider it necessary to advance the study and examine the relevance of the competences identified in theoretical basis in the practice of fashion design for sustainability. We believe that the practice of fashion design for sustainability investigation can present new competences, as well as new convergences between the competences in design and fashion design for sustainability.

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TANGIBLE ASPECTS

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Designing the mesoscopic approach of an autonomous linear dynamical system by a quantum formulation

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Abstract

This paper is an attempt to translate the quantum formulation from physics to general systems modelled by dynamical systems. Their quantum formulation provides a mesoscopic approach due to the stochastic nature of quantum theory. A quantum formulation needs a previous Hamiltonian. A first order Hamiltonian was provided in past works by following Dirac's generalized dynamics. The corresponding quantum approach, given by a first order Schrodinger equation, was provided from the Hamiltonian found, by applying the corresponding quantization rules. The split of the wave function in its amplitude and phase provides the probability conservation law for the square amplitude and the Hamilton-Jacobi equation for the phase. However, this last equation lacks the stochastic term, in opposition to the stochastic term appearing for the current Schrodinger equation corresponding to the physics laws. Thus, the approach presented in past works is unsuitable to obtain a mesoscopic approach for dynamical systems. The hypothesis here presented considers the existence of a second order Hamiltonian from the base that the physics laws can be defined with a similar structure. The existence of a Hamiltonian like this is proved to be always possible for the case of an autonomous linear dynamical system. In the beginning the Schrodinger equation is written for this case, as well as its time-independent version. This case does present a mesoscopic approach, which is developed and its stochastic term is stressed. The general solution of the Schrodinger equation is found and two application cases are presented. In the conclusions section some ways are sketched about how to generalize the formalism to nonlinear dynamical systems.

Keywords: *linear autonomous dynamical system, Hamiltonian, Hamilton-Jacobi equation, Schrodinger equation, mesoscopic approach.*

1. Introduction

The objective of this paper is to present a quantum formulation for dynamical systems and to deduce from it a mesoscopic approach for this kind of systems. Note that the definition of dynamical sytem here considered is a coupled set of first order differential equations with the time as independent variable. In addition, “mesoscopic” means “deterministic” plus “stochatic”.

Take into account that this kind of systems relate dynamically variables of different nature, in opposition to the dynamical systems studied in physics whose nature is spatial-related. The first systems are also referred here as general systems and the second systems are also referred as natural systems. In addition, from a pure mathematical point of view, the natural systems are coupled sets of second order differential equations with the time as independent variable, in opposition to the general systems here considered with a first order differential structure.

Besides, the Hamiltonian of a natural system permits, trough the quantization rules of the Copenhagen formalism (Galindo & Pascual, 1990), getting the corresponding Schrodinger equation. In addition, from the polar form of the wave function is eassy to deduce that: (a) the probability is conserved for the square amplitude of the wave function; (b) the phase holds the Hamilton-Jacobi equations except a stochastic term. The stochastic term can be introduced into the Hamiltonian and, from it, to the previous dynamical equations. These new equations present the old deterministic term plus a stochastic term that depends on the amplitude of the wave function, i.e, the mesoscopic approach to a natural system.

The same program of research described for natural systems in physics is here broutgt for general systems as an attempt to state an isomorphism between physics and general systems theory. Depenning in the formalism, the approach here presented starts from a deterministic general system without a stochastic term. In order to reach a quantum formulation a Hamiltonian is needed on which applies the quantization rules of the Copenhagen formalism. The first Hamiltonian provided is first order in momenta (*first order Hamiltonian* from now onwards), provided by Pontryagin (1985), although other similar first order Hamiltonians can be provided following Hava’s method (1973) or Dirac’s generalized dynamics (1964). In the beginning the quantization rules are applied, arising a first order Schrodinger equation (Micó, 2014a; Micó, 2014b). However, the polar split of the first order Schrodinger equation does not present a stochastic term for the Hamilton-Jacobi equation, and a mesoscopic approach is not possible with this approach (Micó, 2014b).

The option followed in this paper is trying to obtain a second order Hamiltonian in momenta (*second order Hamiltonian* from now onwards) that provides a second order Schrodinger equation. Only if some conditions hold the functions that define the general system is possible to obtain a second order Hamiltonian. In fact, the application cases given by the one-dimensional systems and by the autonomous linear systems hold always those conditions. This last case is what provides the title of the paper. In addition, it can be seen that this second order Schrodinger equation does provide the stochastic term in the corresponding Hamilton-Jacobi equation.

Moreover, the present approach is compared with the approach presented by Haken (2004) through the Fokker-Planck equation, for which the starting point is a stochastic differential system, i.e., the Ito equations. These equations present the stochastic terms in advance, and from them, the Fokker-Planck equation is derived, which would be equivalent to a real (non complex) second order Schrodinger equation.

The presentation of the paper contents are the following. Section 2 is devoted to the revision of the first order Hamiltonian and its corresponding first order Schrodinger equation. Section 3 provides the structure of a second order Hamiltonian and the conditions for its existence. The second order Schrodinger equation and its probabilistic interpretation is provided in Section 4. The mesoscopic approach derived and its comparison with Haken’s approach is presented in Section 5. Section 6 is devoted to the application cases: the one-dimensional systems and the autonomous linear systems. The paper discussion and the paper conclusions are presented in Section 7.

2. First order Hamiltonian and first order Schrodinger equation

Let $q_k(t)$, k=1, 2, …, n, be the state variables of a general system, being n the *system dimensions*, with $\boldsymbol{q} = (q_1, q_2, \dots, q_n)$:

$$\dot{q}_k(t) = f_k(t, \boldsymbol{q}) \quad (1)$$

From now onwards every subscript will vary from 1 to n. Pontryagin's approach (Pontryagin, 1985) provides the eassiest first order Hamiltonian in momenta to (1):

$$H(t, \boldsymbol{q}, \boldsymbol{p}) = V(t, \boldsymbol{q}) + \sum_j f_j(t, \boldsymbol{q}) \cdot p_j \quad (2)$$

where $\boldsymbol{p} = (p_1, p_2, \dots, p_n)$ are the canonical momenta and $V(t, \boldsymbol{q})$ is a known function to be optimized. In Dirac's generalized dynamics (Dirac, 1964) $V(t, \boldsymbol{q})$ is deduced from the formalism as well as in Hava's approach (Havas, 1973). See (Micó, 2014a) and (Micó, 2014b) for the details of both approaches. In the subsequent development of the theory, this term is considered zero, because no function has to be optimized. Thus, the corresponding canonical equations, with $V(t, \boldsymbol{q}) = 0$, are:

$$\dot{q}_k = \frac{\partial H(t,\boldsymbol{q},\boldsymbol{p})}{\partial p_k} = f_k(t, \boldsymbol{q}) \quad (3)$$

$$\dot{p}_k = -\frac{\partial H(t,\boldsymbol{q},\boldsymbol{p})}{\partial q_k} = -\sum_j \frac{\partial f_j(t,\boldsymbol{q})}{\partial q_k} p_j \quad (4)$$

Then (3) holds (1). The Hamilton-Jacobi equation is a partial differential equation for the action $S(t, \boldsymbol{q})$, corresponding to the Hamiltonian (2), which can be written by using the vector notation, $\boldsymbol{f}(t, \boldsymbol{q}) = \big(f_1(t, \boldsymbol{q}), \dots, f_n(t, \boldsymbol{q})\big)$, $\boldsymbol{\nabla} = \left(\frac{\partial}{\partial q_1}, \dots, \frac{\partial}{\partial q_n}\right)$:

$$\frac{\partial S(t,\boldsymbol{q})}{\partial t} + \boldsymbol{f}(t, \boldsymbol{q}) \boldsymbol{\nabla} S(t, \boldsymbol{q}) = 0 \quad (5)$$

To find the Schrodinger equation corresponding to the Hamiltonian (2), the quantization rules provided for the Copenhagen formalism of the quantum theory must be followed (Galindo & Pascual, 1990). The formalism points out that the Hamiltonian becomes an operator, $\widehat{H}(t, \widehat{\boldsymbol{q}}, \widehat{\boldsymbol{p}})$, such that it operates on the wave function $\Psi(t, \boldsymbol{q})$ as:

$$\widehat{H}(t, \widehat{\boldsymbol{q}}, \widehat{\boldsymbol{p}})\, \Psi(t, \boldsymbol{q}) = \frac{1}{2}\big(f_i(t, \widehat{\boldsymbol{q}}) \hat{p}_i + \hat{p}_i f_i(t, \widehat{\boldsymbol{q}})\big)\, \Psi(t, \boldsymbol{q}) \quad (6)$$

such that:

$$f_i(t, \hat{\boldsymbol{q}})\ \Psi(t, \boldsymbol{q}) = f_i(t, \boldsymbol{q})\ \Psi(t, \boldsymbol{q})\ (7)$$

$$\hat{p}_i\ \Psi(t, \boldsymbol{q}) = -i\sigma \frac{\partial \Psi(t, \boldsymbol{q})}{\partial q_i}\ (8)$$

being σ the system Planck constant, which in the present approach is considered hypotetically particular of each system and not coinciding with the Planck constant of physics. Another hypothesis about the system Planck constant is that the particular value represents a limitation of the mathematical knowledge of the system. However, this hypothesis has not been yet demonstrated.

From (7) and (8) in (6), using again the vector notation, and after some computations:

$$\hat{H}(t, \hat{\boldsymbol{q}}, \hat{\boldsymbol{p}})\ \Psi(t, \boldsymbol{q}) = -i\sigma \boldsymbol{f}(t, \boldsymbol{q}) \boldsymbol{\nabla} \Psi(t, \boldsymbol{q}) - i\frac{\sigma}{2}\left(\boldsymbol{\nabla f}(t, \boldsymbol{q})\right)\Psi(t, \boldsymbol{q})\ (9)$$

Therefore, following the quantization rules (Galindo & Pascual, 1990) the Schrödinger equation is written as:

$$i\sigma \frac{\partial \Psi(t, \boldsymbol{q})}{\partial t} = \hat{H}(t, \hat{\boldsymbol{q}}, \hat{\boldsymbol{p}})\ \Psi(t, \boldsymbol{q})\ (10)$$

The substitution of (9) in (10) provides:

$$i\sigma \frac{\partial \Psi(t, \boldsymbol{q})}{\partial t} = -i\sigma \boldsymbol{f}(t, \boldsymbol{q}) \boldsymbol{\nabla} \Psi(t, \boldsymbol{q}) - i\frac{\sigma}{2}\left(\boldsymbol{\nabla f}(t, \boldsymbol{q})\right)\Psi(t, \boldsymbol{q})\ (11)$$

Equation (11) is the first order Schrödinger equation corresponding to the general system (1). Its probabilistic interpretation can be done through the split of the wave function in polar coordinates:

$$\Psi(t, \boldsymbol{q}) = \mathrm{A}(t, \boldsymbol{q})\ e^{i\frac{\mathrm{B}(t, \boldsymbol{q})}{\sigma}}\ (12)$$

where $\mathrm{A}(t, \boldsymbol{q})$ is the amplitude and $\mathrm{B}(t, \boldsymbol{q})$ is the phase. The substitution of (12) in (11) provides, respectively for real and the imaginary parts of the equation (after cancelling the term $e^{i\frac{\mathrm{B}(t, \boldsymbol{q})}{\sigma}}$):

$$-\mathrm{A}(t, \boldsymbol{q}) \frac{\partial \mathrm{B}(t, \boldsymbol{q})}{\partial t} = \mathrm{A}(t, \boldsymbol{q}) \boldsymbol{f}(t, \boldsymbol{q}) \boldsymbol{\nabla} \mathrm{B}(t, \boldsymbol{q})\ (13)$$

$$-\sigma \frac{\partial \mathrm{A}(t,\boldsymbol{q})}{\partial t} = -\sigma \boldsymbol{f}(t,\boldsymbol{q})\boldsymbol{\nabla}\mathrm{A}(t,\boldsymbol{q}) - \frac{\sigma}{2}\mathrm{A}(t,\boldsymbol{q})\big(\boldsymbol{\nabla f}(t,\boldsymbol{q})\big) \ (14)$$

Dividing (13) by $\mathrm{A}(t,\boldsymbol{q})$ and dividing (14) by σ and subsequently multiplying it by $2\mathrm{A}(t,\boldsymbol{q})$:

$$\frac{\partial \mathrm{B}(t,\boldsymbol{q})}{\partial t} + \boldsymbol{f}(t,\boldsymbol{q})\boldsymbol{\nabla}\mathrm{B}(t,\boldsymbol{q}) = 0 \ (15)$$

$$\frac{\partial \mathrm{A}^2(t,\boldsymbol{q})}{\partial t} + \boldsymbol{\nabla}\big(\boldsymbol{f}(t,\boldsymbol{q})\mathrm{A}^2(t,\boldsymbol{q})\big) = 0 \ (16)$$

Equation (15) provides the same Hamilton-Jacobi equation (5) for $\mathrm{B}(t,\boldsymbol{q})$, and Equation (16) provides the probability conservation of $\mathrm{A}^2(t,\boldsymbol{q})$, being $\boldsymbol{f}(t,\boldsymbol{q})$ the corresponding probability current density. Note that, contrary to the natural systems, a stochastic term in (15) that could difference it of (5) does not arise in this context. The Schrödinger equation (11) seems to be a deterministic approach to the general systems rather than a stochastic one. Therefore, it can not be a good mesoscopic approach to (1).

3. Second order Hamiltonian

In order to find a second order Hamiltonian, Equation (1) must become a second order system of differential equations. It is possible by taking the time derivative at the two sides of (1):

$$\ddot{q}_k(t) = \dot{f}_k(t,\boldsymbol{q}) = \frac{\partial f_k(t,\boldsymbol{q})}{\partial t} + \sum_l \frac{\partial f_k(t,\boldsymbol{q})}{\partial q_l}\dot{q}_l = \frac{\partial f_k(t,\boldsymbol{q})}{\partial t} + \sum_l \frac{\partial f_k(t,\boldsymbol{q})}{\partial q_l} f_l(t,\boldsymbol{q}) \ (17)$$

And the new Hamiltonian posed is:

$$H(t,\boldsymbol{q},\boldsymbol{p}) = \frac{1}{2}\sum_{jl} u_{jl}p_j p_l + \sum_j f_j(t,\boldsymbol{q})\cdot p_j \ (18)$$

where u_{jl} is a constant simetric matrix, i.e., a matrix with every element contant such that $u_{jl} = u_{lj}$. The problem now is searching the elements of u_{jl} in (18) such that the canonical equations hold (17). Thus, applying those equations on (18):

$$\dot{q}_k = \frac{\partial H(t,\boldsymbol{q},\boldsymbol{p})}{\partial p_k} = f_k(t,\boldsymbol{q}) + \sum_l u_{kl}p_l \ (19)$$

$$\dot{p}_k = -\frac{\partial H(t,\boldsymbol{q},\boldsymbol{p})}{\partial q_k} = -\sum_j \frac{\partial f_j(t,\boldsymbol{q})}{\partial q_k} p_j \ (20)$$

The corresponding Hamilton-Jacobi equation of the Hamiltonian (18) for the action $S(t,\boldsymbol{q})$, is:

$$\frac{\partial S(t,\boldsymbol{q})}{\partial t}+\frac{1}{2}\sum_{jl}u_{jl}\frac{\partial S(t,\boldsymbol{q})}{\partial q_j}\frac{\partial S(t,\boldsymbol{q})}{\partial q_l}+\boldsymbol{f}(t,\boldsymbol{q})\boldsymbol{\nabla}S(t,\boldsymbol{q})=0 \quad (21)$$

Note that if the general system is autonomous, i.e., no function of (1) depends on the time, the same happens with the functions of (17), which becomes:

$$\ddot{q}_k(t)=\dot{f}_k(\boldsymbol{q})=\sum_l\frac{\partial f_k(\boldsymbol{q})}{\partial q_l}f_l(\boldsymbol{q}) \quad (22)$$

Moreover, in the autonomous case, the Hamiltonian does not depend explicitly on the time and it becomes a constant of the dynamics, wich coincides with the system energy *E*, i.e.:

$$E=\frac{1}{2}\sum_{jl}u_{jl}p_jp_l+\sum_j f_j(\boldsymbol{q})\cdot p_j \quad (23)$$

To obtain the values of the matrix u_{jl} in (18), Equations (19) and (20) must be compared with (17). To do this, the time derivative is taked at the two sides of (19):

$$\ddot{q}_k(t)=\frac{\partial f_k(t,\boldsymbol{q})}{\partial t}+\sum_l\frac{\partial f_k(t,\boldsymbol{q})}{\partial q_l}\dot{q}_l+\sum_l u_{kl}\dot{p}_l \quad (24)$$

Substituting respectively $\dot{q}_l$ and $\dot{p}_l$ from (19) and (20) in (24) and regrouping after some calculations:

$$\ddot{q}_k(t)=\frac{\partial f_k(t,\boldsymbol{q})}{\partial t}+\sum_l\frac{\partial f_k(t,\boldsymbol{q})}{\partial q_l}f_l(t,\boldsymbol{q})+\sum_j p_j\left(\sum_l u_{jl}\frac{\partial f_k(t,\boldsymbol{q})}{\partial q_l}-\sum_l u_{kl}\frac{\partial f_j(t,\boldsymbol{q})}{\partial q_l}\right) \quad (25)$$

Thus, in order that (25) and (17) coincide:

$$\sum_l u_{jl}\frac{\partial f_k(t,\boldsymbol{q})}{\partial q_l}-\sum_l u_{kl}\frac{\partial f_j(t,\boldsymbol{q})}{\partial q_l}=0\ ;\ \forall k,j=1,2,\dots,n \quad (26)$$

Note that being constant the elements of the matrix u_{jl}, the Hamiltonian (18) is only valid for those cases that the matrix u_{jl} holds (26). Take into account in (26) that the cases $k=j$ hold identically, thus the cases $k<j$ are the unique ones to consider because the cases $k>j$ provide the same particular equations than $k<j$. This outcome is easy to check by exchanging the subscripts $k\leftrightarrow j$ in (26). Such as it is shown in Section 6, Equation (26), and therefore the Hamiltonian (18), is always valid for the one-dimensional (n=1) case, and for the $n\geq1$ case of autonomous linear dynamical systems.

4. Second order Schrodinger equation and its probabilistic interpretation

By assuming that (26) holds the Hamiltonian (18), the Schrodinger equation can be deduced by applying the corresponding quantization rules to (18) (Galindo & Pascual, 1990). Note that the rule (8) provides for the second order in momenta of (18):

$$\frac{1}{2}\sum_{jl} u_{jl}\hat{p}_j\hat{p}_l\,\Psi(t,\boldsymbol{q}) = -\frac{\sigma^2}{2}\sum_{jl} u_{jl}\frac{\partial^2\Psi(t,\boldsymbol{q})}{\partial q_j \partial q_l} \quad (27)$$

Considering (27) together (6)-(10), the second order Schrodinger equation deduced is:

$$i\sigma\frac{\partial\Psi(t,\boldsymbol{q})}{\partial t} = -\frac{\sigma^2}{2}\sum_{jl} u_{jl}\frac{\partial^2\Psi(t,\boldsymbol{q})}{\partial q_j \partial q_l} - i\sigma\boldsymbol{f}(t,\boldsymbol{q})\boldsymbol{\nabla}\Psi(t,\boldsymbol{q}) - i\frac{\sigma}{2}\left(\boldsymbol{\nabla f}(t,\boldsymbol{q})\right)\Psi(t,\boldsymbol{q}) \quad (28)$$

For the case of autonomous systems the functions $\boldsymbol{f}(t,\boldsymbol{q}) = \boldsymbol{f}(\boldsymbol{q})$, and the change:

$$\Psi(t,\boldsymbol{q}) = e^{-i\frac{E}{\sigma}t}\psi(\boldsymbol{q}) \quad (29)$$

can be done in (28), being E the system energy (22):

$$\frac{\sigma^2}{2}\sum_{jl} u_{jl}\frac{\partial^2\psi(\boldsymbol{q})}{\partial q_j \partial q_l} + i\sigma\boldsymbol{f}(\boldsymbol{q})\boldsymbol{\nabla}\psi(\boldsymbol{q}) + \left(i\frac{\sigma}{2}\boldsymbol{\nabla f}(\boldsymbol{q}) + E\right)\psi(\boldsymbol{q}) = 0 \quad (30)$$

Equation (30) is the time-independent second order Schrodinger equation, always valid for autonomous dynamical systems that hold (26). Note that conversely to the natural systems this equation is complex, not real.

The probabilistic interpretation of (28) can be done again through the split of the wave function in the polar coordinates (12). Its substitution in (28) provides, respectively for the real and the imaginary parts of the equation (after cancelling the term $e^{i\frac{\mathrm{B}(t,\boldsymbol{q})}{\sigma}}$):

$$-\mathrm{A}(t,\boldsymbol{q})\frac{\partial\mathrm{B}(t,\boldsymbol{q})}{\partial t} = \frac{\mathrm{A}(t,\boldsymbol{q})}{2}\sum_{jl} u_{jl}\frac{\partial B(t,\boldsymbol{q})}{\partial q_j}\frac{\partial B(t,\boldsymbol{q})}{\partial q_l} + \mathrm{A}(t,\boldsymbol{q})\boldsymbol{f}(t,\boldsymbol{q})\boldsymbol{\nabla}\mathrm{B}(t,\boldsymbol{q}) - \frac{\sigma^2}{2}\sum_{jl} u_{jl}\frac{\partial^2\mathrm{A}(t,\boldsymbol{q})}{\partial q_j \partial q_l} \quad (31)$$

$$-\sigma\frac{\partial\mathrm{A}(t,\boldsymbol{q})}{\partial t} =$$
$$-\sigma\boldsymbol{f}(t,\boldsymbol{q})\boldsymbol{\nabla}\mathrm{A}(t,\boldsymbol{q}) - \frac{\sigma}{2}\mathrm{A}(t,\boldsymbol{q})\left(\boldsymbol{\nabla f}(t,\boldsymbol{q})\right) - \sigma\sum_{jl} u_{jl}\frac{\partial A(t,\boldsymbol{q})}{\partial q_j}\frac{\partial B(t,\boldsymbol{q})}{\partial q_l} - -\mathrm{A}(t,\boldsymbol{q})\frac{\sigma}{2}\sum_{jl} u_{jl}\frac{\partial^2\mathrm{B}(t,\boldsymbol{q})}{\partial q_j \partial q_l} \quad (32)$$

Dividing (31) by $\mathrm{A}(t,\boldsymbol{q})$ and dividing (32) by σ and subsequently multiplying it by $2\mathrm{A}(t,\boldsymbol{q})$:

$$\frac{\partial \mathrm{B}(t,\boldsymbol{q})}{\partial t}+\frac{1}{2}\sum_{jl}u_{jl}\frac{\partial B(t,\boldsymbol{q})}{\partial q_j}\frac{\partial B(t,\boldsymbol{q})}{\partial q_l}+\boldsymbol{f}(t,\boldsymbol{q})\boldsymbol{\nabla}B(t,\boldsymbol{q})-\frac{\sigma^2}{2\mathrm{A}(t,\boldsymbol{q})}\sum_{jl}u_{jl}\frac{\partial^2\mathrm{A}(t,\boldsymbol{q})}{\partial q_j\partial q_l}=0 \quad (33)$$

$$\frac{\partial \mathrm{A}^2(t,\boldsymbol{q})}{\partial t}+\boldsymbol{\nabla}\left[\left(\boldsymbol{f}(t,\boldsymbol{q})+\boldsymbol{F}(t,\boldsymbol{q})\right)\mathrm{A}^2(t,\boldsymbol{q})\right]=0 \quad (34)$$

Equation (34) represents the law of probability conservation with current density $\boldsymbol{J}(t,\boldsymbol{q})$:

$$\boldsymbol{J}(t,\boldsymbol{q})=\boldsymbol{f}(t,\boldsymbol{q})+\boldsymbol{F}(t,\boldsymbol{q}) \quad (35)$$

with components:

$$J_j(t,\boldsymbol{q})=f_j(t,\boldsymbol{q})+F_j(t,\boldsymbol{q})=f_j(t,\boldsymbol{q})+\sum_l u_{jl}\frac{\partial B(t,\boldsymbol{q})}{\partial q_l} \quad (36)$$

Besides, (33) is the Hamilton-Jacobi equation (21) plus a correction term $V(t,\boldsymbol{q})$:

$$V(t,\boldsymbol{q})=-\frac{\sigma^2}{2\mathrm{A}(t,\boldsymbol{q})}\sum_{jl}u_{jl}\frac{\partial^2\mathrm{A}(t,\boldsymbol{q})}{\partial q_j\partial q_l} \quad (37)$$

5. The mesoscopic approach to dynamical systems

The term (37) provides the stochastic part of the second order quantum formulation that the first order quantum formulation does not provide. In fact, if this term is considered in the Hamiltonian, it becomes:

$$H_s(t,\boldsymbol{q},\boldsymbol{p})=\frac{1}{2}\sum_{jl}u_{jl}p_jp_l+\sum_j f_j(t,\boldsymbol{q})\cdot p_j+V(t,\boldsymbol{q})=H(t,\boldsymbol{q},\boldsymbol{p})+V(t,\boldsymbol{q}) \quad (38)$$

which has as canonical equations:

$$\dot{q}_k=\frac{\partial H_s(t,\boldsymbol{q},\boldsymbol{p})}{\partial p_k}=f_k(t,\boldsymbol{q})+\sum_l u_{kl}p_l \quad (39)$$

$$\dot{p}_k=-\frac{\partial H_s(t,\boldsymbol{q},\boldsymbol{p})}{\partial q_k}=-\sum_j\frac{\partial f_j(t,\boldsymbol{q})}{\partial q_k}p_j-\frac{\partial V(t,\boldsymbol{q})}{\partial q_k} \quad (40)$$

Developing now the same operations (24) and (25) on (39) and (40), and considering that (26) holds:

$$\ddot{q}_k(t)=\frac{\partial f_k(t,\boldsymbol{q})}{\partial t}+\sum_l\frac{\partial f_k(t,\boldsymbol{q})}{\partial q_l}f_l(t,\boldsymbol{q})-\sum_l u_{kl}\frac{\partial V(t,\boldsymbol{q})}{\partial q_l} \quad (41)$$

Equation (41) represents the mesoscopic approach to the dynamical system (17). Obviously it is considered like this because $V(t,\boldsymbol{q})$ depends on $\mathrm{A}(t,\boldsymbol{q})$, i.e., on the square root of the probability density.

If the time integral is taken at both sides of (41):

$$\dot{q}_k(t) = f_k(t,\boldsymbol{q}) - \sum_l u_{kl} \int_{t_0}^{t} \frac{\partial V(t,\boldsymbol{q})}{\partial q_l}\, dt \quad (42)$$

Equation (42) is the mesoscopic approach saught for the general systems (1) under the assumption of (26). This mesoscopic formulation is the opposite one to the followed for the stochastic differential equations known as Ito equations and the Fokker-Planck equation (Haken, 2004). In that approach, the Ito equations present the stochastic terms in advance, i.e.:

$$\dot{q}_k(t) = f_k(t,\boldsymbol{q}) + \sum_l u_{kl}\, w_l(t) \quad (43)$$

where u_{kl} are constant known elements and $w_l(t)$ are the stochastic terms, which have a mathematical white noise structure, i.e.:

$$\langle dw_l(t)\rangle = 0 \;;\; \langle dw_l(t), dw_m(t)\rangle = \delta_{lm} dt \quad (44)$$

In (44) "< >" represents the time average. From the Ito equations (43) and from (44) the Fokker-Planck equation can be deduced (Haken, 2004):

$$\frac{\partial \rho(t,\boldsymbol{q})}{\partial t} + \boldsymbol{\nabla}\big[\big(\boldsymbol{f}(t,\boldsymbol{q}) + \boldsymbol{F}(t,\boldsymbol{q})\big)\rho(t,\boldsymbol{q})\big] = 0 \quad (45)$$

where $\rho(t,\boldsymbol{q})$ is the probability density. Equation (45) represents also the law of probability conservation with current density $\boldsymbol{J}(t,\boldsymbol{q})$:

$$\boldsymbol{J}(t,\boldsymbol{q}) = \boldsymbol{f}(t,\boldsymbol{q}) + \boldsymbol{F}(t,\boldsymbol{q}) \quad (46)$$

with components:

$$J_j(t,\boldsymbol{q}) = f_j(t,\boldsymbol{q}) + F_j(t,\boldsymbol{q}) = f_j(t,\boldsymbol{q}) - \frac{Q}{2}\sum_l \sum_m u_{jm}\, u_{ml} \frac{\partial ln\big(\rho(t,\boldsymbol{q})\big)}{\partial q_l} \quad (47)$$

Equation (47) has a more general structure if $u_{kl} = u_{kl}(t, \boldsymbol{q})$. However, (47) is enougth to compare it with (34). In addition, Q is the so-called diffusion parameter. Observe that if the equivalence $\rho(t, \boldsymbol{q}) \rightarrow \mathrm{A}^2(t, \boldsymbol{q})$ is assumed, the difference between (34) and (47) is present in the vector $\boldsymbol{F}(t, \boldsymbol{q})$, which in the Fokker-Planck equation depends on $\rho(t, \boldsymbol{q}) \rightarrow \mathrm{A}^2(t, \boldsymbol{q})$, but not on the generalized action $B(t, \boldsymbol{q})$.

The connection between both formulations could be hypothetically appreciated if the term $B(t, \boldsymbol{q})$ could be put in function of $A(t, \boldsymbol{q})$ by (33) and substituted in (34). Even if this substitution was able to be done as an approximated calculation, the connection could be stated. Also the relationship between the system Planck constant σ and the diffusion parameter Q could be investigated. By the moment, these hypotheses have not been solved yet.

6. Application cases

To obtain the second order Schrodinger equation (28) for the application cases, the method consist in getting, if possible, the values u_{jl} that hold (26). If the system is autonomous, the equation considered is the time-independent second order Schrodinger equation (30).

Two cases are here considered that hold (26): the one-dimensional case, trying to solve the autonomous case and its particular linear case, and the linear autonomous case for an arbitrary dimension.

6.1. The one-dimensional case

Note that if n=1, (26) holds trivially. If for this case the subscripts are avoided by being unnecessary. The Hamiltonian (18) can be written as:

$$H(t, q, p) = \frac{1}{2} u\, p^2 + f(t, q)\, p \quad (48)$$

The value of the parameter u in (48) is non-determined in advance. The corresponding second order Schrodinger equation is:

$$i\sigma \frac{\partial \Psi(t,q)}{\partial t} = -\frac{\sigma^2}{2} u \frac{\partial^2 \Psi(t,q)}{\partial q^2} - i\sigma f(t, q) \frac{\partial \Psi(t,q)}{\partial q} - i \frac{\sigma}{2} \frac{\partial f(t,q)}{\partial q} \Psi(t, q) \quad (49)$$

If the system is autonomous, the system energy is:

$$E = \frac{1}{2} u\, p^2 + f(q)\, p \quad (50)$$

and the time-independent second order Schrodinger equation:

$$\frac{\sigma^2}{2} u\, \psi''(q) + i\sigma f(q)\, \psi'(q) + \left(i \frac{\sigma}{2} f'(q) + E\right) \psi(q) = 0 \quad (51)$$

The change:

$$\psi(q) = e^{-\frac{i}{u\sigma}\int f(q)\,dq}\Omega(q) \ (52)$$

provides, after some calculations, the differential equation:

$$\Omega''(q) + \left(\frac{f^2(q)}{u^2\sigma^2} + \frac{2E}{u\sigma^2}\right)\Omega(q) = 0 \ (53)$$

Note that although (53) seems a real differential equation, their solutions can be complex. For autonomous nonlinear systems, for instance the logistic function case $f(q) = aq\left(1 - \frac{q}{b}\right)$, the search ot its solutions represents by itself an open investigation field. For instance, for a complete handbook of differential equations such as (Polyanin & Zaitsev, 2002), no solutions are found for this case. Note as well that the exact solution is necessary to find the possible eigenvalues as energy levels and the corresponding eigenfunctions.

However, if the function is linear, then $f(q) = \alpha_0 + \alpha q$. However, the linear functions are not interesting in the applications except if they are a first order approximation to the nonlinear ones about a steady state $q = Q$, for which $f(Q) = 0$.

The first order approximation of a nonlinear function with a steady state $q = Q$ about this state is $f(q) \cong f(Q) + f'(Q)(q - Q) = -f'(Q)Q + f'(Q)q$. The change $x = -f'(Q)Q + f'(Q)q$ and $\overline{\Omega}(x) = \Omega\left(q = \frac{x + f'(Q)Q}{f'(Q)}\right)$ can be done in (53) and it becomes:

$$\overline{\Omega}''(x) + (\beta_1^2 x^2 + \beta_0)\overline{\Omega}(x) = 0 \ ; \beta_1 = \frac{1}{uf'(Q)\sigma} \ ; \beta_0 = \frac{2E}{u(f'(Q)\sigma)^2} \ (54)$$

The solutions of (54) are a linear combination of the Parabolic-Cylinder functions (see Equation 2.1.2-1.1 of Polyanin & Zaitsev, 2002). However, by the functions *DSolve* and *Expand* of MATHEMATICA-10.2 the solution can be put in function of the Hermite functions $H(\nu, \mathrm{y})$, wich become (complex or real) polynomials if the parameter ν is an integer. The final outcome, after multipliying by the complex exponential of (52) and definining $\bar{\psi}(x) = \psi\left(q = \frac{x + f'(Q)Q}{f'(Q)}\right)$, is:

$$\bar{\psi}(x) = e^{-i\beta_1 \frac{x^2}{2}}\overline{\Omega}(x) =$$

$$= k_1\, e^{-i\beta_1 x^2} 2^{\frac{-i\beta 0 + \beta 1}{4\beta 1}} H\left(-\frac{1}{2} + \frac{i\beta 0}{2\beta 1}, \frac{-1 + ix\sqrt{\beta 1}}{\sqrt{2}}\right) + k_2\, 2^{\frac{-i\beta 0 + \beta 1}{4\beta 1}} H(-\frac{1}{2} + \frac{i\beta 0}{2\beta 1}, \frac{-1 + ix\sqrt{\beta 1}}{\sqrt{2}}) \ (55)$$

$$\psi(q) = \bar{\psi}\big(f(Q) + f'(Q)(q - Q)\big) \ ; \beta_1 = \frac{1}{uf'(Q)\sigma} \ ; \beta_0 = \frac{2E}{u(f'(Q)\sigma)^2} \ (56)$$

Equations (55) and (56) represent the general solution of the time-independent wave function, being k_1 and k_2 in (55) arbitrary complex constants. Note that the parameter $\nu = -\frac{1}{2} + \frac{i\beta 0}{2\beta 1}$ is not an integer in both Hermite functions, thus neither the condition of the system energy quantization nor the convergence of the wave function in $q \to \pm\infty$ is provided. Therefore, if concrete values of k_1 and k_2 in (55) permit the quantization of the system energy and the convergence of the wave function in $q \to \pm\infty$ is still under investigation. However, a hypothesis hold is that this research could be developed on the square wave function $\Psi^2(t,q) = \psi^2(q)$ rather than on the function $\psi(q)$.

6.2. The autonomous linear multidimensional case

An autonomous linear multidimensional system is a particular case of (1), which takes the following formula:

$$\dot{q}_k(t) = a_0 + \sum_j a_{kj} q_j \text{ (57)}$$

Note in (57) that a_{kj} is not a simetric matrix and it is a generalization to $n \geq 1$ dimensions of the linear case studied in Section 6.1. In fact, similarly to that case, the interesting case is the study of the linear approximation to a nonlinear case about a steady state $\boldsymbol{q} = \boldsymbol{Q}$, for which $\boldsymbol{f}(\boldsymbol{Q}) = \boldsymbol{0}$. If in (1) a first order approximation about $\boldsymbol{q} = \boldsymbol{Q}$ is done:

$$f_k(\boldsymbol{q}) \cong f_k(\boldsymbol{Q}) + \sum_j \left.\frac{\partial f_k(\boldsymbol{q})}{\partial q_j}\right|_{\boldsymbol{q}=\boldsymbol{Q}} (q_j - Q_j) = -\sum_j \left.\frac{\partial f_k(\boldsymbol{q})}{\partial q_j}\right|_{\boldsymbol{q}=\boldsymbol{Q}} Q_j + \sum_j \left.\frac{\partial f_k(\boldsymbol{q})}{\partial q_j}\right|_{\boldsymbol{q}=\boldsymbol{Q}} q_j \text{ (58)}$$

And comparing (57) and (58):

$$a_0 = -\sum_j \left.\frac{\partial f_k(\boldsymbol{q})}{\partial q_j}\right|_{\boldsymbol{q}=\boldsymbol{Q}} Q_j \,;\, a_{kj} = \left.\frac{\partial f_k(\boldsymbol{q})}{\partial q_j}\right|_{\boldsymbol{q}=\boldsymbol{Q}} \text{ (59)}$$

Note moreover that for an autonomous linear multidimensional system (57) and (58), from (59) can be deduced that:

$$\frac{\partial f_k(t,\boldsymbol{q})}{\partial q_j} = a_{kj} = \left.\frac{\partial f_k(\boldsymbol{q})}{\partial q_j}\right|_{\boldsymbol{q}=\boldsymbol{Q}} \text{ (60)}$$

Thus the conditions (26) become for this case:

$$\sum_l u_{jl} a_{kl} - \sum_l u_{kl} a_{jl} = 0 \,;\, \forall k, j = 1,2, \ldots, n \text{ (61)}$$

In (61) a_{kl} are known constants by (60), thus (61) will hold generally.

The concrete application case chosen is the Van der Pol oscillator, with x as oscillating variable and ε as parameter:

$$\ddot{x}(t) - \varepsilon(1 - x^2)\dot{x}(t) + x(t) = 0 \quad (62)$$

By doing the changes $q_1 = \dot{x}$ and $q_2 = x$, (62) becomes the two-dimensional dynamical system:

$$\left.\begin{array}{c} \dot{q}_1(t) = -q_2(t) + \varepsilon\big(1 - q_2^2(t)\big)q_1(t) \\ \dot{q}_2(t) = q_1(t) \end{array}\right\} \quad (63)$$

The only steady state of (63) is $\boldsymbol{Q} = (Q_1, Q_2) = (0,0)$. The linearization about $\boldsymbol{Q}$ is:

$$\left.\begin{array}{c} \dot{q}_1(t) = f_1(q_1, q_2) = \varepsilon q_1(t) - q_2(t) \\ \dot{q}_2(t) = f_2(q_1, q_2) = q_1(t) \end{array}\right\} \quad (64)$$

Thus, from (60) and (64), the elements a_{kl} of (60) are: $a_{11} = \varepsilon$, $a_{12} = -1$, $a_{21} = 1$ and $a_{22} = 0$. And (61) provides for k=1 and j=2 the equation:

$$u_{12}a_{11} + u_{22}a_{12} = u_{11}a_{21} + u_{12}a_{22} \quad (65)$$

Note in (65) that the case j=1 and k=2 provides the same equation, and that the cases j=k hold identically. In addition, considering that $u_{21} = u_{12}$, the outcome equation is:

$$u_{11} - \varepsilon u_{12} + u_{22} = 0 \quad (66)$$

A solution of (66) is $u_{12} = u_{22} = 1$ and $u_{11} = \varepsilon - 1$. Then, the time-independent second order differential equation can be written as:

$$\sigma^2\left(\frac{(\varepsilon-1)}{2}\frac{\partial^2\psi(\boldsymbol{q})}{\partial q_1^2} + \frac{\partial^2\psi(\boldsymbol{q})}{\partial q_1 \partial q_2} + \frac{1}{2}\frac{\partial^2\psi(\boldsymbol{q})}{\partial q_2^2}\right) + i\sigma\left((\varepsilon q_1 - q_2)\frac{\partial\psi(\boldsymbol{q})}{\partial q_1} + q_1\frac{\partial\psi(\boldsymbol{q})}{\partial q_2}\right) +$$
$$+\left(i\frac{\sigma\varepsilon}{2} + E\right)\psi(\boldsymbol{q}) = 0 \quad (67)$$

Actuallly, even for a linear two-dimensional case, the corresponding time-independent second order differential equation (67) is complex to be solved. In this case, as well as in similar cases, the search of the solution is an open research by the moment.

7. Discussion and conclusions

This paper is an attempt to state an isomorphism between natural laws in physics and general systems. It is done by translating the quantum theory from the first field to the second one. It must be valued taking into account the works (Micó, 2014a) and (Micó, 2014b) together the present paper. The three papers together go beyond the derivation of a Schrodinger equation for general systems. It is like this because they try as well to state an analytical formalism for general systems, i.e., a Lagrangian-Hamiltonian approach plus a study of the Hamilton-Jacobi equation, and what are the roles that these approaches play to interpret the quantum theory provided.

Note that the formalism provided is still an open research. First of all it is correct under some assumptions and, besides, it just arrives until some unsolved points. The following paragraphs try to discuss these assumptions and points.

The first assumption is the second order structure of the Hamiltonian to reproduce the equations of the general systems in Section 3. Although there could be other options, it is taken from the physics in order to obtain a mesoscopic approach that a first order Hamiltonian of Section 2 does not provide.

Note that the second order Hamiltonian (18) also assumes that the functions u_{jl} must be constant. In addition, this Hamiltonian is correct if Equations (26) hold. All the subsequent derivations of the formalism also depend on the fact that (26) must be held. Fortunately, the one-dimensional and the linear autonomous cases hold Equations (26), such as it is proved in Section 6. If for some other cases Equations (26) holds, such as nonlinear multidimensional cases with dimension greater than one, it should be checked for the particular cases under study. For instance, the author has checked that the nonlinear case of dimension two given by the predator-prey system does not hold (26). Due to, neither the second order Hamiltonian (18) nor the second order Schrodinger equation (28) can be applied for this case.

The way about how to generalize the second order Hamiltonian (18) to be correct for any dynamical system (1) redefined as the second order form (17) is being investigated by the author. One way sketched is considering that the constants u_{jl} become functions $u_{jl}(t, \boldsymbol{q})$. In fact, the author has checked that similar but more complex structures can be derived for the Hamilton-Jacobi equation (33) and for the probability conservation law (34) although the functions $u_{jl}(t, \boldsymbol{q})$ become unknown. In addition, they also present a similarity to the Fokker Planck equation (45) when the constant stochastic values u_{kl} of (43) become functions $u_{kl}(t, \boldsymbol{q})$ (Haken, 2004). However, by the moment no definitive conclusions about the mathematical structure of these functions haven been obtained.

Other ways to overcome the first order approaches of Section 2 could be considered in a future researches. A way is the consideration of a canonical transformation on (2) that provides a second order Hamiltonian. An alternative way is considering the addition of a term in (2) that contains the momenta elevated to a fractional exponent between one and two, in such a way that the fractional calculus should be used to develop the quantization rules.

Other problem to be commented is that provided in (Micó, 2014b) about the meaning of the system Planck constant in the case of general systems. In that work was said that *the system Planck constant is particular of each system under description. The point of view defended is that it represents the mathematical limits of the system knowledge. However, the most probable is that some experiments must* *be designed to find the particular values of these constants*. The hypothesis about the nature of this constant continues being the same. The existence of a *diffusion parameter* in the context of the Fokker-Planck equation (45)-(47) own of each system strengthens this argument. Another question is if both constants are related in some way. Finding the actual relationship between both formalisms, the quantum approach here presented and the corresponding to the Fokker-Planck equation should be also a future strength of research.

Finally, the open questions of the theory presented must be investigated. First of all, the solution (55)-(56) is not acceptable for a one-dimensional linear autonomous system, unless a suitable combination of the two independent functions provides the eigenvalues for the system energy and the corresponding eigenfunctions. Another open question is if this problem happens only with linear systems and for nonlinear systems the eigenvalues and eigenfunctions arise. However, note that getting solutions of a nonlinear problem such as (51)-(53) is a great problem by itself. The same conclusion can be deduced when the system has a dimension greater than one, although the system is linear, such as it happens in (67): getting the solution of that partial differential equation is by itself a problem of great complexity.

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Industrial design for aircraft: models and usability for comfort in the cabin

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Abstract

This contribution introduces an innovative model of assessment and validity of the formal-dimensional-functional structure for passenger seats in economy class in the Aerospace industry. In fact in this field, the design, ergonomics and engineering determine unpublished cooperation scenarios where roles are inverted, merge and recur repeatedly, in order to establish progress in the different planning and subject areas, having a synergistic and proactive perspective.

The research activities have been developed within the framework of the research project "IMM_Interiors with Multifunctional Materials_DAC_Distretto Aerospaziale Campania" (Campania Aerospace District), in which experts from different branches of knowledge such as designers, innovative materials engineers, mechanical engineers, biologists and technical physicists from the Second University of Naples were involved. The use of new methodological dimensions resulted in the identification of common activity protocols, which were used as foundations in the planning stage, interdisciplinary and shared. The aim was to obtain a passenger seat configuration suitable to meet the demands and needs of the greatest number of individuals, according to their specifications and through the integration of innovative technologies and materials.

The impact of different cultural factors, the mixture of roles and subjects, the layering of competences and heterogeneous and contradictory operational references have contributed towards a shared narrative where knowledge and experience have established the key principles in the course of evaluation and validity (methodological-designing inclusive).

This route has allowed the acquisition of interdisciplinary skills and expertise qualified to obtain tangible results from the identification of methodological and design issues useful to optimize, innovate and strengthen the design process.

The goal was to make the acquisition of user needs systematic, through investigation and evaluation methods aimed at translating them into a structured format noted on the design process according to the principles of good design. In particular studies and research of prior art patents and thorough investigation literature regarding the state of the art of existing seat configurations and structures were carried out. Feasibility, comfort and reliability of the existing solutions in order to analyse and evaluate each component of ergonomics, human factors (physical ergonomics), user centred design and new human factors (pleasantness of use), where characteristics and specific meanings of quality, understood as a user-seat interaction quality are preferred.

Keywords: Design, Aircraft-comfort, Ergonomics, Usability, Experiences

1. Introduction

This paper proposes an innovative model of evaluation and functional/formal arrangement validation of passenger seats in the aerospace industry, where design, ergonomics and engineering set new and unprecedented collaboration scenarios where the roles are reversed, merged, and are constantly being renewed in order to gain advancement in various fields, in a synergistic and proactive way.

The research activities have been developed within the Department of Civil Engineering, Design, Construction and Environment under a research project of IMM (Interiors con Materiali Multifunzionali) and DAC (Distretto Aerospaziale Campania) who have seen committed researchers and designers, experts in innovative materials, mechanical engineers, biologists and technical physicist.

The work is part of a research context, where the design of new structural solutions of seats to ensure ergonomics and passenger comfort by limiting the weight gain, are discussed. Based on these indications, in part imposed by the new amendments to the applicable regulations, in part by the need to ensure the necessary appeal demanded by increasingly demanding customers, which are accustomed to a high level of comfort, the research project has set itself to study solutions to meet the changing needs of aviation, without any significant impact on aircraft performance by virtue of mandatory increases in weight that could be incurred from a slavish application of solutions and materials used on large transport liner.

In particular, the aim was to systematize the acquisition of user needs, through investigation and assessment methods designed to identify needs and translate them into a structured format and verifiable within the design process according to the principles of good design. In particular the quality of interaction between the user and the seat, through the assessment of the compatibility between the product specifications, the features and the user's ability, and performance in the system in which it operates, from the functional to the perceptive-cognitive, up to the emotional aspects.

2. Usability as a model of experience and pragmatic approach

Numerous studies from the design research have shown that the functional and hedonistic characteristics of a product are two independent factors affecting the definition of the satisfaction of the consumer.

The use, possession, interaction with a product can generate different types of cognitive perceptions and emotional responses. Some products, beyond the functional correspondence, represent the conditions which define the meanings of the contexts where people live, instruments by which people construct their identity. Analyzing the subjective experience that users live through the products, or who will experience using the same, the designer interprets the experience of people as a source of inspiration and generation of solutions.

Among the most innovative approaches in cognitive psychology, for the study of the relationship between people and artifacts, the distributed cognition approach represents a new paradigm for analyzing the work, playful, and everyday activities that humans conduct through mutual relations and through the relation with the artifacts that populate the contexts in which interactions occur.

The distributed cognition paradigm asserts that the ability of human beings to carry out any activity, from the everyday ones to the more complex, depends on the distribution of all the necessary knowledge among the people, the artifacts used and the contexts where the activities take place and the interactions between these components (Rizzo 2009).

The design of usable artifacts implies considering the needs of people can quickly learn the ways of interaction, allowing them a quick execution of tasks, maintain a low error rate and help maximize user satisfaction.

The research on design and other related areas refers to the insights of these schemes. The objects, therefore, should pass on their experience, their value, should communicate information, to reflect certain uses, and are signs of a particular social status and a certain cultural level, *chairs, beyond supporting the body, also bring out the personality, the body language, and the social position* (Bürdek, 1992).

The designer then, through a product, designs not just real things, but also something immaterial, so it is absolutely necessary that the object speaks for itself. The Barthes message was that what people own is able to convey a range of meanings that are equivalent to a language, and for an object conveying the proper meaning is undoubtedly part of its function.

Jean Baudrillard, Umberto Eco and Luis Prieto developed the discourse on the functionality of the objects. Umberto Eco takes Barthes to articulate the concept of function, thanks to the use of category connotation/denotation, through which he tries to account for the primary and secondary functions of objects. Prieto reassesses the concept of function in a more rigorous way thanks to the introduction of the category working/utilities, adapting to the objects that of signifier/signified (Ponzio, Calefato, Petrilli, 2006).

Braudrillard, instead, takes and carries to the extreme the idea of a spectacularized function and in it he sees the main characteristic of the goods in a capitalist system, through which a dissolution of the object itself is operated.

To design products with a good level of usability, guidelines, and different standards have been developed. The various authors who have studied to clarify the concept of usability have found themselves in trouble to trace its borders. Currently, the author who seems to find favor of the HCI (Human Computer Interaction) community is Shackel, who states that the usability of an artifact is its ability, in terms of human cognitive characteristics, to be used easily and effectively by a specific category of users to carry out activities within defined environmental contexts.

Shackel was among the first to develop the usability model. This model dates back to 1991 and at the conceptual level starts from the acceptance that declines in utility, usability, likeability, and costs.

Jakob Nielsen, instead, defines usability as the extent of the user's quality of experience in interaction with something, be it a website or a traditional software application or any other tool with which the user can operate. According to Nielsen, a product is usable when it is easy to learn, allows for utilization efficiency, is easy to remember, allows few, low gravity interaction errors and is pleasant to use.

Conceptually, the usability of a product measures the cognitive distance between the design model (product model and its operating mode owned by the designer and incorporated in the artifact) and the user model (working model of the product / service which the users construct by themselves and which regulates the interaction with it). Although usability is one of the dimensions that define the overall quality of an interactive product, it is measured by its interface, which should expose immediately its peculiarities, limits and modes of operation, highlighting the relationship between actions that the user can perform on the same interface, and the results that can be achieved. Its analysis should provide guidelines for the design and redesign, in fact, the usability center is the knowledge that each alternative design should be evaluated by potential users, in order to have sufficient margin to correct wrong design choices, caused by not taking into account the physical and cognitive characteristics of end users.

The user needs have assumed, therefore, a particular quality characteristic that has been revealed in the recent past and that today requires the design process should be given a renewed attention to the functional rules and a marked sensitivity to the needs of users ; each individual is different, more or less able about physical and cognitive condition in relation also to the personal experiences and stages of development. […] The result of a design which is conscious of the needs is the construction of more and more "well-performing" setting, suitable to be "experienced" by the people who have "different profiles", which move interacting between themselves and with the environment itself (Garofolo, Conti, 2012).

For example, the blind receive information needed for the construction of a real world primarily through the tactile and auditory perception, as well as through kinesthetic experiences. The auditory sense is a very important aspect of the orientation of the blind, as it allows them to move safely in a structured space, and gives them the power to sense the presence of obstacles.

Beside the auditory sense, the blind person makes use of the sense of touch, which plays an important role in the development and acquisition of concepts. The sense of touch is used not only statically but also in a dynamic and exploratory way (active touch). […] Tactile perceptions are received through any part of the body, but primarily through the hands that are the privileged organs of touch. Hands, through careful and accurate palpation, identify the different details of the object to "understand" and permit, therefore, the blind person to get a mental picture of the object and acquire the spatial position (Bilotta, 2002).

In the planning stage, the study of emotions and perceptions are important because they affect the actions of people, their expectations, their plans with respect to products that they meet and deal with. Referring to the emotional aspects, Donald Norman draws up a classification of three different levels of the human brain: the visceral level [emits quick judgments about what is good or bad, safe or dangerous, by sending the proper signal to the muscles and alerting the rest of the brain], the behavioral level [site where the large majority of human behavior resides] and reflective level [covers the control function and general reflection]. Such levels reported in design differ from one another and, in particular visceral level is pre-awareness, pre-thought, where what counts is the first impression, the initial impact of a product, the appearance, the tact, the sensations it produces; the behavioral level concerns the utilization, the experience the user has about a product: function, performance, and usability; finally the reflective level where lies the conscience and the higher degrees of feelings, emotions and reasoning.

La distinzione fra il pensiero esperienziale e quello riflessivo merita di essere presa in considerazione, e questo almeno in parte perché molta della nostra tecnologia sembra costringerci verso un estremo o l'altro. Con gli artefatti adatti potremmo potenziare ciascuna modalità cognitive (Norman, 1995).

[The distinction between the experiential and the reflective thinking deserves to be taken into account, at least in part because much of our technology seems to force us to one extreme or the other. With the proper artifacts, we could strengthen each cognitive modality].

The experiential cognition includes mental states, in which we perceive and react to stimuli from the environment efficiently and without appreciable efforts. This condition manifests itself mainly through the unconscious stages of human behavior, drawing directly from the experience and knowledge already stored in the user's mind. In fact *l'elaborazione esperienziale comporta una certa attività intellettuale, ma è simile ad un riflesso in quanto l'informazione rilevante deve già esistere nella nostra memoria e l'esperienza non fa altro che riattivarla* (Norman, 1995).

[the experiential processing involves a certain intellectual activity, but it is similar to a reflection, in that the relevant information must already exist in our memory and what experience does, is just reactivating it].

2.1 Methodological and behavioral dimensions – human center

The present work has been structured on new methodological dimensions that identify common protocols of activity on which to base the design process, interdisciplinary and shared, aimed at setting up new passenger seats in the cabin can be adapted to different user needs and with the integration of new technologies and materials.

The structure of the research aims to discover a "creative" methodological approach, based on the need to address the difficult challenges that contemporary society imposes at an increasingly rapid pace, entrusting to the discipline of industrial design the enhancement of the cultural capital or, more avowedly, to facilitate the transition from the material to the immaterial cultural capital through the instruments of knowledge, skills, and creativity. The methodologies applied to the industrial design discipline and the evolution of the same discipline methods, underpin the cultural and scientific background knowledge as a starting point for the construction of thought as a response to the needs; they are also based on the skills that, starting from knowledge, surpass it, complementing and making it operational; the whole thing coming through the instrument of creativity for the achievement of the proper and necessary balance between intuition and reason, design and science.

Such research starts from the methodological basis, which places man at the center of the design process, in which the designer's role becomes more complex, since, beyond knowing the techniques, he/she must also provide a formal value to the product, and must be a careful observer of the reality around him/her to interpret the experience of people, including through the support of cognitive sciences. People interact with the artifacts, as Donald Norman points out, through the synergy of three different mental images, the first is the image in the designer's mind, "the designer model", then there is the image the user has of the device and its functioning "user model" and the third is the system image. In an ideal world the two models should be identical and, accordingly, the user should understand and use the object in an appropriate manner; unfortunately, this does not always happen, designers do not communicate with end users, they just provide the product specifications.

This complexity of knowledge has meant that, especially in cognitive science, a strong interest has been developed in the anchoring process of new information on old, on a combination of knowledge from different areas, the integration of knowledge resources often fragmented between different actors [and] of re-use of the acquired knowledge (Anselmi, 2009).

Therefore, Norman, as an experimental psychologist, focuses on the ways in which people interact with the artifacts. In describing the interaction with objects, he uses a human action model [Fig. 1] consisting of seven stages, where there are two possible problem areas that need attention in the design, the execution "hemisphere" defines the transition from the emergence of an intention to formulate a sequence of actions necessary to implement them, while the "hemisphere" of the assessment defines the effort needed to interpret the system status and to determine its compliance with the intentions. It is on this theoretical foundation that has been developed the "UCD_Ucer Center Design" methodological approach [Fig. 2], which is the ability to detect, through structured and verifiable methods, experiences and user requirements and turn them into design and evaluation tools.

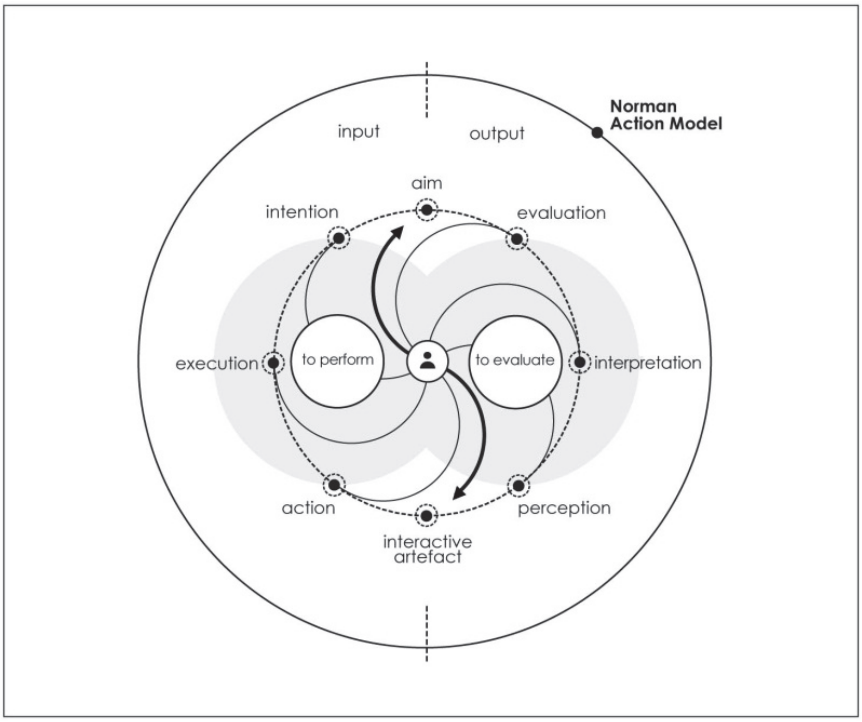

Fig. 24 Action Model of Norman (1991), freely interpreted by Capece S. (2009)

Inverting a J. Rubin's well-known definition, we can say that the UCD is not just a philosophy of intervention that puts users at the center of design and manufacture of products, but also, and primarily, the techniques, processes, methods and procedures necessary to verify and design the usability of products and systems (Rizzo, 2009).

In literature, there are a different set of principles behind this design method. In 1985, Gould and Lewis identify four basic principles on which to develop a project aimed at the acquisition and evaluation of user needs. The first principle focuses on users and their tasks; the second principle concerns activities through iterative cycles of planning, evaluation and redesign, where the planning stage is followed by the assessment of the system, together with the users, before getting to the final implementation, and verify that it has fulfilled the established requirements, while the fourth and final principle regards the presence, within the work team, of multidisciplinary skills.

The UCD is configured, in fact, as a cyclical pattern based on continuous monitoring of the assumptions and design solutions, and the ability to capture and translate, in terms of project implementation, targeted information which is used at each stage of the production process and product development. The methodological path of User Center Design in the 90s and specifically in 1999 was expanded to include project activities sanctioned by the standard ISO 13407 in human-centered design processes.

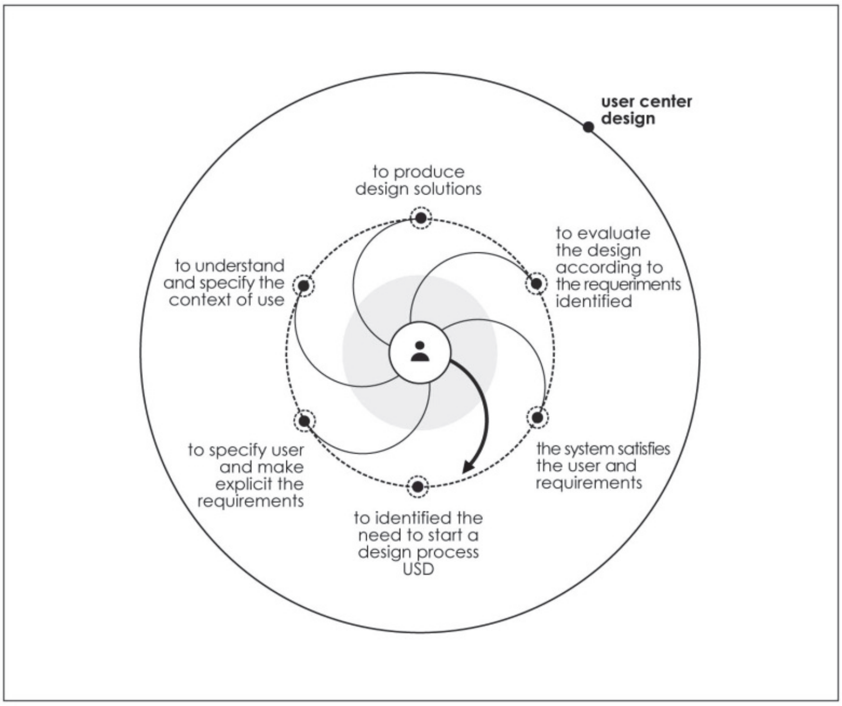

Fig. 25 Model of user centre design: user indirect participation, Rizzo F. (1999), freely interpreted by Capece S. (2009)

The activities that define this process consist of the identification of a need; understanding and specification of requirements and user characteristics, production of design solutions, design evaluation with respect to the identified requirements and the satisfaction that user gets by the system.

Since the '90s, the User Center Design has undergone an evolution going from the design of computer-based interactive products to the design of products and services and also, by changing the original purpose, from design method for usability to design method of user experience. The user experience [Fig. 3], broadly defined and addressed in the design discipline, sets as a basic element in the design path, the study, and research on the same user experience by placing the latter at the heart of the process. We can therefore state that *while the traditional UCD has dealt to identify problems that users showed during the interaction with the products and how to resolve them, the experience-based design has produced some new themes for reflection and application of design such as designing for the user experience, find inspiration by the user, the empathic design, and hedonism. From a design point of view, the study of emotions is relevant to the design itself as these are a not negligible aspect of the experience, they influence people's actions, their expectations, their future plans with respect to products they meet and relate to* (Rizzo, 2009).

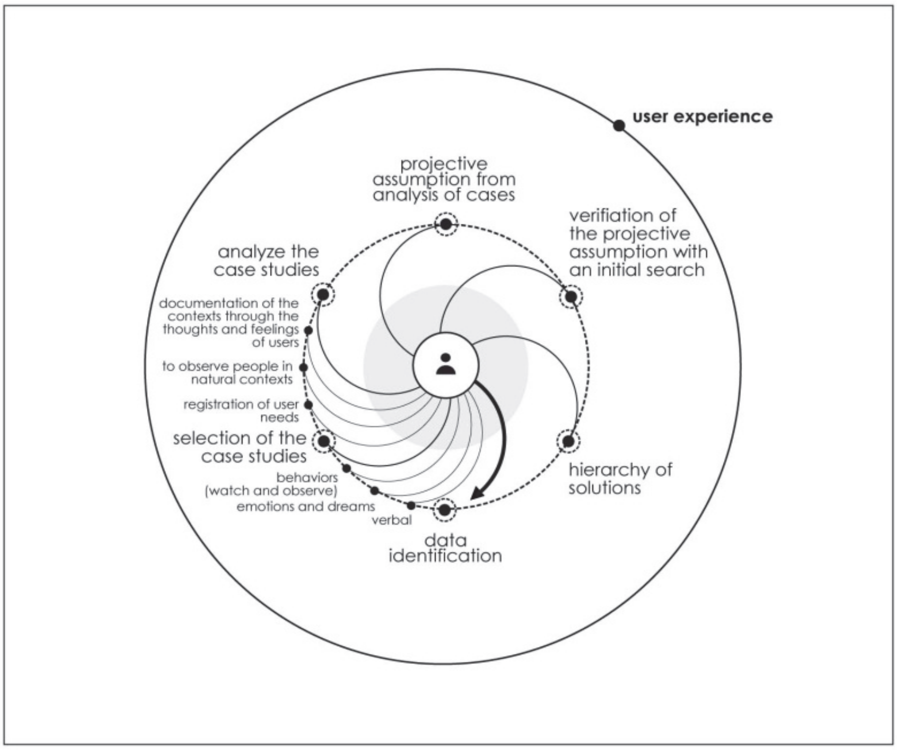

Fig. 26 User experience: indirect experiential participation, Rizzo F. (1999-2003), freely interpreted by Capece S. (2009)

The experience methods, unlike the traditional methods found in User-Centered Design, build the project on the basis of user's dream, their imagination and reworking of all that they have done, seen and known previously. In this regard, Jane Fulton Suri, chief creative of Iseo, argues that «*through observations designers can learn, through empathy they may be inspired to imagine new and better solutions for people* (Rizzo, 2009).

Moreover, to better understand the user experience, Jane Fulton Suri distinguishes three modes of action, the first one is to observe what people really do, both in their natural contexts and through prototypes which people may be exposed to, the second is to ask people to participate, either by registering their needs and documentation of contexts, or through the record of their thoughts and feelings; and finally the third mode deals with evidence and verification of the things directly, to get a personal perspective on an experience that is being designed and that is typically experienced by users.

The framework for action should not be seen as a scenario outlined to accommodate a sequence of actions and interactions, but becomes especially a context of meanings and possible social and cultural shared interactions. In this way, the environment, in which one or more actors are located, loses the connotation of a stable information provider and becomes a multi-componential scenario in which the actions take place and the information dynamically follow each other.

The context, as states Giuseppe Mantovani (1995), cannot be defined as something predetermined, but you need to consider the scenario of action as a space that is, at the same time, both physical and conceptual. Within it, the actors perceive the overall situation in which they are to act using conceptual models peculiar of their culture. Will be through the same action, also, that cultural models will be reviewed and amended making use of the information that the dynamic context offers.

3. The evolution of comfort models in the aircraft interiors

Comfort represents a subjective synthesis of the elaboration of the quality of the interaction between user, product and environment, and it is attributable to a complex set of tangible and intangible factors, such as physiological, physical and psychological.

Several definitions for the concept of comfort can be found in literature, *Pineau's (1982) definition of comfort included everything that contributes to human wellbeing and convenience of the material aspects of life, while Slater (1985) described comfort as the physiological, psychological, and physical harmony between human beings and their environment that ultimately deliver a pleasant state. Tiger (1992) highlighted a connection between pleasure and comfort by suggesting that the human brain, which monitors the comfort of the body, rejects pain and seeks pleasure* (Ahmadpour, 2014).

Furthermore, Dumur, Bernard, and Boy suggested four points of view towards comfort, psychological comfort is a state of quiet enjoyment and being free from worry and disappointment with regards to basic human needs (e.g. food, security, etc.), entailing aesthetics comfort (satisfying one's taste for forms, sound, smell, etc.), socialization comfort (incorporating the need for social relationships as well as privacy) and conformity (the sense of belonging to a group); physical comfort is the state of being free from issues pertaining to physical, physiological, and biomechanical states; sociological comfort is related to one's ethnic and social class, and, technological point of view in comfort refers to those material inputs from the environment that provide pleasurable sensations (Dumur, Bernard, Boy, 2004).

These concepts are the foundation of the interpretative models of the experience of comfort. It is particularly relevant the model [Fig. 4] proposed by De Looze et al. in which the result of the interaction process is defined as three macro levels: "human level", "seat level" and "environment level". Each of these levels exerts a specific influence in the definition of comfort and in the characterization of the respective/different variables. The human level represents the anthropometric variability of the user, while, the seat level is based on the characteristics and structural variables such as the inclination of the backrest, the width of the seat and the hardness of the pillow. Furthermore, the environment level influences on the comfort evaluation considering the activities performed by the user and the characteristics of the reference context (De Looze, Kuijt-Evers, Van Dieën, 2003).

The methods of De Looze et al. (2003) and Moes (2005) provide the basis of the theoretical framework [Fig. 4] proposed by Vink and Hallbeck (2012) in which the perception of comfort and discomfort is defined through the interaction between "product", "person" and "usage / task". *Perception process is dependent on the person, the object in work-space (seat), the purpose and why this object is used* (Vink, 2014).

In fact, the interaction effects are produced by the responses of the human body through postures, muscle movements and senses. These responses, according to the expectations, are perceived subjectively and interpreted as "comfortable", "you feel nothing" (no discomfort) and "feelings of discomfort".

Inside the aircraft, the users-passenger interact with the environment through the activation of their senses, starting by the visual impact continuing with the processing of external inputs of different nature (smell, sound and touch). These inputs are evaluated according to subjective factors such as user-passenger expectations, previous experiences and frame of mind, which influence the perception of the comfort during seating use experience.

Through the analysis of the user experience in the aircraft environment, Admahpour et al. (2013) describe a model [Fig. 5] regarding the comfort experience, in which is reported the relationship between the users-passenger and the perception as result of the seat-human interaction inside the aircraft. The authors define the process of interaction as the result of a complex system in which there are multiple factors, such as “environmental factors” related to the physical and social aspects and the context of use, “human characteristics”, which include physical, anthropometric and psychological elements, and “expectations”, based on the expectations of users- passengers before and during the flight experience.

The model also includes, “time and activity”, represented by the influence of the activities carried out in the reference environment on the comfort evaluation, the "perceptions of cabin", as a general idea of the quality of the cabin, the “physical impacts”, relating to the postures and the movement of users-passengers, the “appraisal”, based on a subjective evaluation of cognitive processes (result of the seat-human-environment interaction), and expressed as positive or negative emotions.

Therefore, the frame of mind, also plays a significant role in how passengers live the flying experience. But it is only after the complex process of interaction that the perception (subjective) of comfort or discomfort is determined, which may induce the adaptation of the user-passenger in the reference enviroment, changing his position and/or the activity carried out.

Continuing with the analysis of the user experience, Admahpour (2014) focuses the method on the perception of the user [Fig. 4], filtered through psychological (“peace of mind”) and physical factors (“physical wellbeing”), including “proxemics”, understood as the control of the personal and social space, “pleasure”, “satisfaction”, associated with the efficiency, effectiveness and usability, and the “association”, regarding the interaction between the environment and personal feelings. Finally, the above processes determine the level of comfort or discomfort within a period of time and relating to the social context of the flight, that could influence the behavior or future choices of the user-passengers (Admahpour, 2014).

According to the previously described methodological aspects, the factors of comfort such as “human characteristics”, “expectations”, “physical impacts”, “appraisal”, “proxemics”, “pleasure”, “satisfaction” and “association”, have been integrated in the ergonomic principles and the good design values. These have been included for the configuration of a new and inclusive methodological-design model, and for the evaluation and validation of the arrangement between the shape design, dimensions and functionality of the passenger seats.

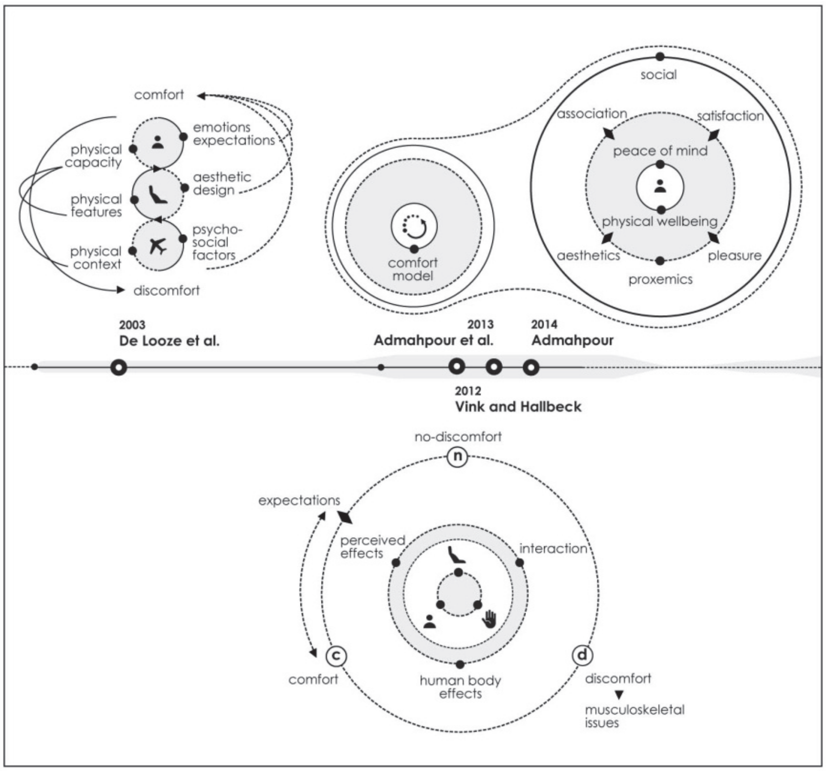

Fig. 27 Timeline of the evolution of the theoretical models of comfort in the aircraft interior based on the proposals of De Looze, Kuijt-Evers, Van Dieën, (2003); Vink and Hallbeck, (2012); Ahmadpour, Robert, and Pownall, (2013), this framework is illustrated to Figure 5; Ahmadpour (2014); the illustration of timeline is freely interpreted by the authors of the contribution.

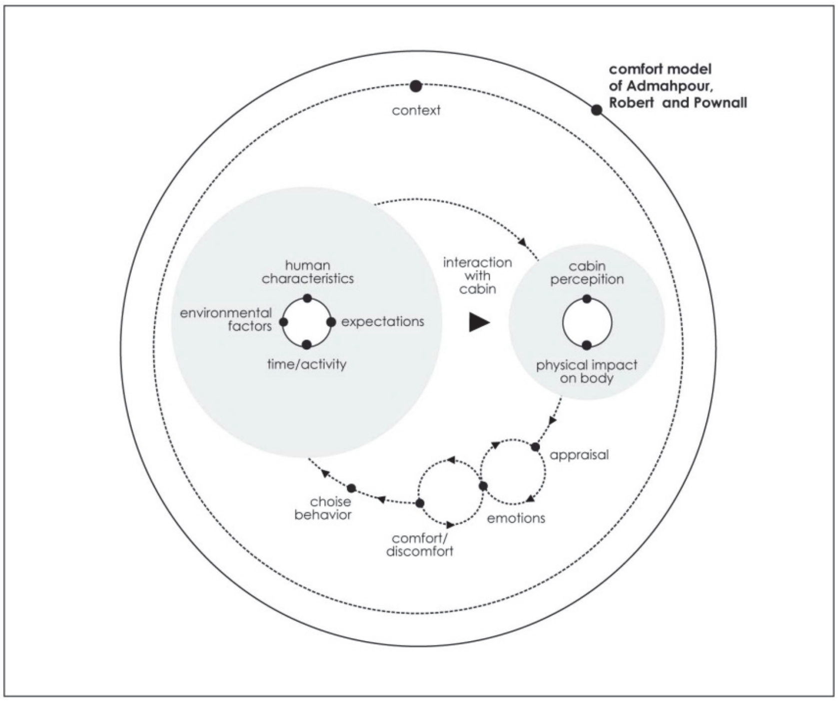

Fig. 28 A model of passenger comfort experience based on the proposals of Ahmadpour, Robert, and Pownall (2013), freely interpreted by the authors of the contribution.

4. Usability and comfort methods evaluation

The process of identification and analysis of the needs, which will be used for the ergonomic intervention, precedes the verification of usability and comfort conducted through the passenger seat evaluation by specialists and the involvement of a sample of users able to represent, for features, aptitudes and skills of use, those who use and will use the product.

The usability and safety testing methods are based on the collection of information concerning the manner in which the man-product interaction is performed within a given context of use, and make possible to identify and analyze the behavior of users, their needs and, finally, the type and frequency of errors that users can take when performing the required tasks (Tosi, 2005).

According to Wilson J. R., the test methods can be divided into methods of direct observation and methods of indirect observation. The direct observation methods are based on techniques of observation and evaluation of user behavior when interacting with the product. They are also defined objectives methods, as they are able to provide precisely the objective information, and consist of the collection of data relating to the behavior and performance of users during the execution of specific activities (Wilson, Corlett, 1995).

The indirect observation methods allow, instead, to collect information relating to the interpretation that users give to what they are doing. These are also called subjective methods and concern the realization of reports on the behavior, attitudes and opinions of users. Their subjectivity refers to the fact that the information produced is filtered by the observer's assessment.

Subjective measurements are considered an essential tool for evaluation, given that they collect information and problems resulting from the user's interactive experience. The theme of subjective evaluation has been widely debated in the literature, deeply analyzing multiple aspects that intervene on the very nature of evaluation.

The subjective evaluation is used to identify relations that cannot be analyzed without user assistance as, motivation, satisfaction, preferences, performance, usability and comfort. Psychometric tools, in this way, seek to create a multidimensional analysis of usability, measuring a complex set of variables. In fact, as pointed out by Kirakowski, the usability evaluation is a combination of subjective judgment, such as satisfaction, and objective data, such as performance. On the other hand, although there is interesting analysis on the multidimensional usability (Chin, Diehl and Norman, 1988; Glendon, Stanton and Harrison, 1994; Jordan, 1994) this issue has not yet been addressed through a systematic study that can provide the elements on which eventually some metrics can be built.

4.1 Subjective measurements through psychometric tools

The classification of usability methods in the literature is distinguished in an analytical approach based on structured tests processed by an expert and an empirical approach, based on the direct involvement of users.

The analytical assessments (also called heuristics analysis or expert evidence) are conducted by specialists who, on the basis of their specific skills, analyze the product trying to anticipate problems that typical users of the system can meet in different stages of use of the product.

Empirical assessments or user tests, instead provide for the direct involvement of a sample of users in the evaluation process. The tests with users rely on the realization of experiments and do not presuppose an absolute rigor of the procedures, but allow you to bring out a greater number of problems and to identify even unexpected aspects of a product usability.

The need to detect and monitor the perception of usability that users develop in connection with the use of the system has led to the development of different types of questionnaires that differ in theoretical constructs. The most used in the literature are listed below:

The Questionnaire for User Interaction Satisfaction (QUIS), developed in 1988, based on the assumption that the user's use satisfaction, considered as subjective satisfaction, is a relevant indicator of usability of the system (Chin et al. 1988; Wallace, Norman e Plaisant, 1988; Shneiderman, 1987). This tool, now in version 7.0 of development, is composed of eleven sections built in a hierarchical way (Harper, Slaughter and Norman, 1997): a personal data questionnaire, six scales measuring general impression on the system, four measures related to interface-specific factors, and finally an optional section that evaluates the online help and support manuals. The assessment is expressed on a 9-point scale.

The Software Usability Measurement Inventory (SUMI), developed by the Human Factors Research Group of the University of Cork (Ireland) in 1990, consists of 50 items, divided into five subscales, Efficiency, Affect, Helpfulness, Control and Learnability. The usability measurement scales have been developed taking into account the usability ISO 9241-11 definition of usability features that identifies it as the effectiveness, efficiency and satisfaction of a particular user, engaged in a particular task and use context. The assessment is expressed on a 3-point scale (agree, undecided and disagree). In literature there are conflicting opinions on the validity of the SUMI, by some is considered one of the best validation instruments (Baber, 2002), while others point out the lack of a comparative validation that provides a proof of the real ability of analysis.

The Computer System Usability Questionnaire (CSUQ) is an evolution of The Post-Study System Usability Questionnaire (PSSUQ) developed to measure user satisfaction in interaction with a system in laboratory environments through contextualized questions in the survey (Lewis,1992). The CSUQ differs from its predecessor because it is not contextualized, so it can be used out of the laboratory and is built to create stable factors of investigation. The concept on which it is based is that usability is related to standardized measures of satisfaction and the purpose of this tool is to provide them. The CSUQ consists of 19 questions on a seven-point scale with a range from "strongly disagree" to "strongly agree".

The System Usability Scale (SUS) was developed in 1986 by Digital Equipment Corporation and was implemented in 1996 as the global usability of a system in a context (Brooke, 1996). This tool evaluates the satisfaction meant as subjective response in the interaction with a system. The SUS does not use multidimensional metrics but attempts to capture the usability as the user's aptitude for a specific interface in a given context of use, referring to the ISO 9241-11 definition. The SUD consists of ten questions measured on a five-point scale, with a range from "strongly disagree" to "strongly agree".

The Usability Evaluation (Us.E.), developed in 1999 at the Cognitive Ergonomics Laboratory of the Department of Psychology, University of Rome "La Sapienza", starts from the assumption that usability is a multidimensional construct (Di Nocera et al., 1999; Di Nocera, Ferlazzo e Renzi, 2003). Initially built, in version 1.0, on four dimensions obtained through factor analysis has come, in the current version 1.1, to a composition in three dimensions: handling, satisfaction, and attractiveness. The Us.E. 1.1 consists of 24 questions with a five-point scale with a range from "Absolutely False" to "Absolutely True".

The Purdue Usability Testing Questionnaire (PUTQ) is a test consisting of 100 questions on the interface of the structured system of eight factors relating to the human-machine interaction. These factors are compatibility, consistency, flexibility, learnability, minimum actions, minimum memory load, perceptual limitation, help to operator.

The Experience Sampling Method (ESM) is a procedure developed to study the behavior and subjective experience in real life. In fact, this procedure is based on the real-time detection of self descriptions that the subjects themselves provide about the external situation and their state of consciousness during the occurrence of events. The testing period is usually one week long, with an average of 6/8 signals per day distributed according to a randomized scheme throughout the day.

5. Protocol for the evaluation of comfort – perceived usability of passenger seats

Starting from the study and analysis of the existing configurations in literature and the current patents of existing passenger seats and from the assessments of structural, feasibility, comfort and reliability analysis of the current passenger seats, new validation and evaluation tools of usability and comfort of passenger seats have been defined, in order to analyze and evaluate the various components of ergonomics of the seat through the observation of the interaction user-environment-product. The activities [Fig. 6] focused on the study of the requirements of the identification and the estimation of the parameters of comfort, as well as on the conception of design criteria suitable to obtain favorable conditions for end users, in order to configure a new ergonomic design of the seat and a proper level of comfort for the passenger even on medium-long distances, trying to avoid the so-called "economy class syndrome" that leads to serious consequences for the health of the occupant.

The aim will be to analyze and evaluate each component of the ergonomics of the passenger seat through the user-environment-product interaction according to a sequence that, starting from the physical-dimensional interaction condition and by the correspondence of the product to the anthropometric characteristics and to the capacity of users movement, involving aspects of perceptual and cognitive sphere, the emotional sphere, and finally to the social.

As a knowledge or set of knowledge, ergonomics is a wealth of knowledge and analytical tools that can become a tool for innovation and stimulating factor of the creative process to which the ergonomics provide the ability to imagine and analyze in a structured form the multiplicity of situations and conditions that define and determine the interaction between user and product (Tosi, 2005).

In detail, the quality of interaction between the user and the seat, the assessment of compatibility between the characteristics of the product, the specifications, and the user's physical abilities, the activities that this place and achieved performance, have been taken into account.

The first phase of evaluation focused on the identification of the dimensional parameters of interest and of the relative anthropometric parameters. These parameters will be reported both to the static and dynamic dimensions. Similarly to the definition of anthropometric indices, there is the need to identify the categories of users targeted by the project and their physical and dimensional characteristics, the specifications of the planned and / or likely actions, and the constraints imposed by all the context variables.

In parallel, the emotional components oriented to the study and design of the subjective aspects of the interaction user/passenger seat will be evaluated. Among these, the emotions psychology, the areas of social and anthropology studies, while developing evaluation and intervention methodologies which are distant both from disciplinary origin and as intervention languages and tools, include and assess the subjective dimension of interaction, to date remained at the margins of the ergonomics interest.

User feedback in this case will be represented by system usability, i.e. the effectiveness, efficiency and satisfaction that specific users can experience using the product within the reference airplane cabin, by the comprehensibility of the information available and the language in which they are presented, by the ease by which you can carry out the control procedures and/or dialogue, by the opportunity to receive appropriate feedback at the end of each procedure.

Taking into consideration the tactile properties of the materials used, as well as sensory effects produced by the formal solution proposal, the color and the surface treatment of the passenger seat, the relationship will be established between the proposed seat and the sensory quality actually perceived by the user.

In referring to the subjective requirements of usability, factors related to the direct experience of the use of the product and the ease by which you can carry out the operation will be taken into account, through a perceptual and emotional dimension and the ability to meet the most strictly subjective needs, related to user satisfaction.

To further ensure that the seat provides comfortable performance in the design phase and evaluation, we must take into account the variability of parameters such as, the "seat pitch", the "backrest and seat pocket" and the "human body space" (Vink 2011).

This paper has chosen to treat analysis and the passenger seat assessment in respect of each component of the ergonomics, human factors (physical ergonomics); user-centered design and new human factors (user pleasantness), which highlights aspects and specific meanings of quality, intended as user-seat quality of interaction.

The planned tests will be based on both direct and indirect observation methods that will be organized according to the following sequence:

- the test of Physical Ergonomics – Human Factors (Quality = compatibility) to assess the physical characteristics of the session, the physical, physiological and psycho-perceptual abilities of the tester, the characteristics of the activities to be performed and the physical – social context in which activities will be carried out;

- the User-Centered Design test (quality = compliance to the use) to evaluate the ability of the product (seat) to respond to the needs posed by its use within a given context;

- the New Human factors test - Comfort of use (quality = value - User pleasure) to evaluate the comfort of use attributed to the relationship with the seat, that is the judgment that users express, consciously or not, in terms of annoyance, appreciation, strangeness or familiarity with the product.

In particular in the first test – Physical Ergonomics – Human Factors – will be defined and evaluated the dimensional and functional requirements characterized by compatibility between the characteristics of the passenger seat and the context in which this fits; the specifications and capabilities of users as well as the constraints and the variables of the reference environment. Therefore, the compatibility between the users' body size (static and dynamic), the reachability zones and the spaces of movement necessary to perform the given task, will be specified. Similarly, the size of the physical environment taken as a reference (dimensional requirements); the compatibility between the characteristics and physical abilities of the user, the physical activities required and the physical size constraints posed by the seat and / or the cabin, will be analyzed.

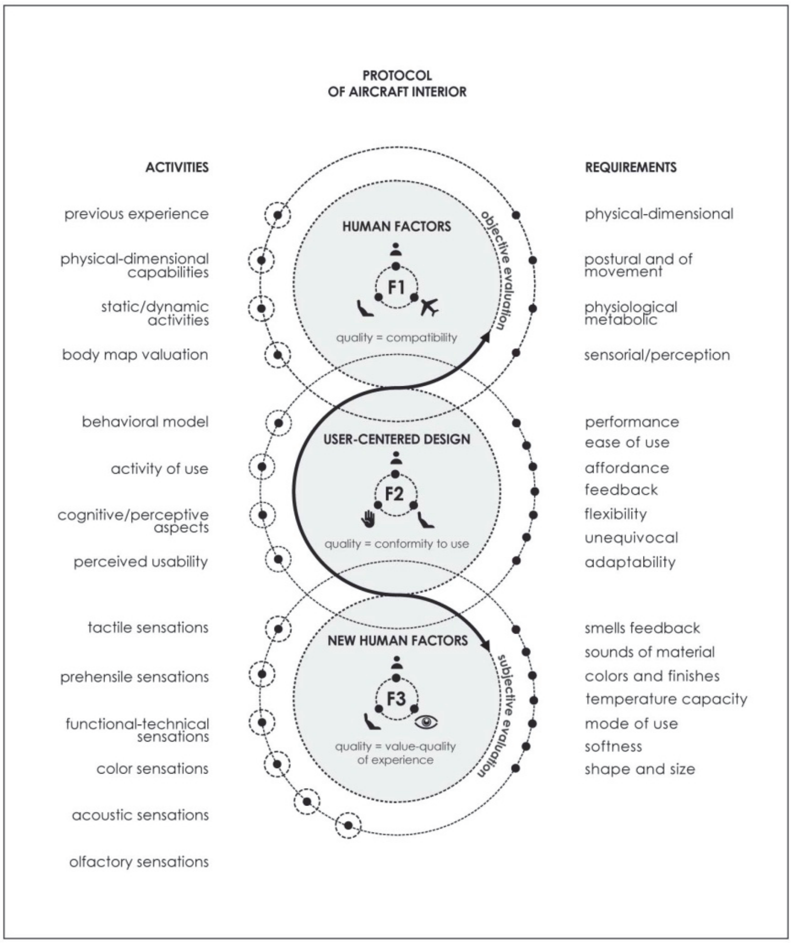

Fig. 29 *"Ergonomia per il progetto" Tosi F. (2005), freely interpreted by the authors of the contribution.*

The definition and comparison of dimensional and functional requirements will be based on knowledge of the anthropometric characteristics and physical capabilities of the human body and will require the identification of the group of user to which the project targets and, in parallel, the analysis of physical activities to be performed.

In the second test – User-Centered Design – the interaction subjective dimension, contextualizing the results of analysis and supporting the user's active involvement, will be evaluated and defined. The user will have to simulate the use of the seat as it happens in real life since the behavior pattern associated with the reference activity will be detected. The performance, ease of use, affordance, feedback, flexibility, correspondence to a predefined conceptual model, unequivocalness and adaptability will be analyzed, in order to record the types of error and difficulties encountered.

The relationship between the user and the product is a dynamic process with many facets, which concerns perceptual and cognitive aspects of the use of the product, how it is absorbed the information that comes from the product, how it is interpreted and which user actions they are a result of.

In the third test - New Human factors - pleasantness of use - the characteristics and reactions of the subject that can be measured using the techniques developed by cognitive psychology will be assessed and defined. The goal will have to assess the aspects of sensory pleasantness of the passenger seat, covering tactile sensations (shape and size of the object); prehensile sensations (the quality, the softness, the grip capability of the surface); functional sensations (use modality and activation); thermal sensations (the conductivity and the heat capacity); chromatic sensations (colors, surface finishes and the chromaticity of the object); acoustic sensations (loudness of the material, of action, of the detectors, and acoustic feedback) and finally the taste and olfactory sensations.

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Estudo da adaptação antropométrica de mobiliário residencial em madeira maciça produzido na cidade de Manaus

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Resumo

Este artigo apresenta um breve estudo sobre a adaptação antropométrica de mobiliário de madeira maciça, produzido e comercializado na cidade de Manaus. Neste, buscou-se verificar se as medidas aplicadas à produção de mesas e cadeiras (sem ajustes) estão em conformidade com as normas e padrões técnicos vigentes. Para tanto, realizou-se: levantamento bibliográfico, abordando a situação do setor moveleiro no Amazonas, ergonomia e antropometria, buscando aprofundar os conhecimentos acerca da temática estudada, conhecendo-se as principais limitações e potenciais para investimento na melhoria da qualidade do mobiliário de madeira maciça sem ajustes. Organizou-se os dados pesquisados para a geração de duas tabelas, com base nas dimensões dos seguimentos corpóreos humanos de usuários extremos (mulher percentil 5% e homem percentil 95%), apresentando recomendações de diversos autores de ergonomia, , viabilizando seu uso como parâmetro para o dimensionamento de mesas e cadeiras. Além de pesquisa de campo, para anotação das medidas e comparação posterior com as dimensões das tabelas propostas; e cálculos de estatística descritiva, e inferencial, com o propósito de facilitar a apreciação acerca da validade dos dados coletados por meio da aplicação do teste de t de Student. Como resultado, observou-se que o mobiliário em questão não é produzido com base em recomendações ergonômicas e/ou quaisquer tipo de estudo relacionado, uma vez que as medidas analisadas encontravam-se em conformidade com as referencias adequadas e outras eram simplesmente ignoradas. Tornando os produtos inadequados, face ao desconforto gerado, quando utilizados por longos períodos, principalmente se comparados com móveis industrializados, tendo em vista que estes apresentam as mesmas condições de dimensionamento com menor preço de mercado.

Keywords: *Design, ergonomia, antropometria, mobiliário, madeira maciça.*

Abstract

This article presents a brief study about the anthropometric adaptation of solid wood furniture, manufactured and commercialized in the city of Manaus. It searches to verify if the measures used to the production of tables and chairs (without adjustments) are in conformity with the current standard norms and patterns. Therefore, it were made: bibliographic collection, where topics referred to the situation of the furniture sector in Amazonas were approached, ergonomics and anthropometric and human body measures, in an effort to deepen the findings about the studied theme, by means of the knowledge of the main limitations and potentials to the investment in the improvement of the quality of the solid wood furniture without adjustments. In this section, there were an organization of the researched data to the creation of two tables, based on the dimensions of human body segments of extreme users (woman percentile 5% and man percentile 95%), presented by Felisberto and Paschoarelli (2000), following as well the recommendations of various authors of ergonomics, between them: Quaresma (2011), Kroemer and Grandjan (2005), Dul and Weerdemester (2004) and Moraes and Pequini (2000), enabling its usage as a parameter to the sizing of tables and chairs; field research, where there was the collection of data through search form for annotation of the measures obtained in loco on the carpentry shops, to be afterwards compared to the dimensions of the suggested tables; calculations of descriptive statistic (total amplitude, standard deviation and coefficient of variation), since they allow to appreciate the total number of values found in a class and map the differentiation among those obtained and recommended, and inferential, with the intension of facilitate the appreciation on the validity of the collected data by means of the implementation of the t Test of Student. With the obtained result, it was observed that the furniture in question is not produced based on ergonomic recommendations and/or any type of related study, as the measures analyzed were not found in conformity with the recommendations of the tables generated and the others were merely ignored. This fact ends up turning the products less attractive, in face of the discomfort created, when utilized by long periods of time, especially if compared to industrialized furniture, taking into consideration that those ones present the same condition of sizing with less Market price.

Keywords: *Design, ergonomics, anthropometry, furniture, solid wood.*

1. Introdução

As movelarias de Manaus possuem potencial para ganhar maior projeção no mercado local, pois os produtos de madeira maciça são mais resistentes e preferidos para decorar espaços com beleza e estilo. Entretanto, a Superintendência da Zona Franca de Manaus - SUFRAMA (2003) revelou em um estudo, que marcenarias locais possuem *layout* inadequado à produção, com equipamentos obsoletos e ausência de pessoal qualificado, o que compromete significativamente a qualidade dos móveis em madeira maciça produzidos localmente.

Sabendo-se que o mercado atual prima pela eficiência produtiva e preço baixo do produto, tem-se buscado alternativas de design diferenciado e estratégias comerciais como formas de atender as necessidades dos consumidores. Para Souza *et al.* (2010) é cada vez maior a procura por produtos de melhor qualidade, que propiciem segurança e conforto durante o uso, sinalizando a importância da ergonomia na indústria moveleira como um fator de grande competitividade. Assim, o mobiliário residencial também deve ser projetado de modo a proporcionar conforto durante os mais diversos tipos de atividades, pois é fundamental que as pessoas adotem posturas corretas, evitando-se dores lombares e musculares (ombros, pescoço, nádegas, pernas e braços).

Nesse contexto, projetar móveis observando dimensões que respeitem os limites e esforços físicos do ser humano garante além do conforto, saúde e bem-estar. E tratando-se de mobiliário de madeira maciça e sem ajustes, os que merecem maior atenção em relação ao dimensionamento são mesas e cadeiras, objetos deste estudo, pois o dimensionamento incorreto desse mobiliário implica em prejuízos pela postura incorreta que se possa adotar, o que segundo Kroemer e Grandjean (2005), pode provocar anormalidades permanentes à coluna.

Souza et al. (2010) afimam, que ainda não existem normas técnicas direcionadas para mobiliário de uso residencial no Brasil, dificultando a elaboração de projetos de qualidade, facilitando a concorrência injusta com móveis de má qualidade disponíveis no mercado. Embora, tenha-se conhecimento de estudos realizados por Felisberto e Paschoarelli (2000) que apresentam valores tabelados dos segmentos corpóreos para a população brasileira. Estes, se usados corretamente, contribuem para a melhora na qualidade dos produtos produzidos e comercializados, proporcionando melhores condições de conforto e segurança à população.

Assim, esta pesquisa buscou verificar se os produtos de madeira maciça produzidos e comercializados na cidade de Manaus selecionados para este estudo, encontram suas medidas em conformidade com àquelas propostas pelos diversos autores de ergonomia conhecidos na atualidade, os quais foram organizados em duas tabelas geradas também como resultado deste estudo.

2. Referencial teórico

2.1. O setor moveleiro no Amazonas

Em conformidade com dados fornecidos pelo SEBRAE (Serviço Brasileiro de Apoio as Micro e Pequenas Empresas) em 2010, foram identificadas 456 movelarias nos municípios do Amazonas, e segundo informações da diretoria do mesmo orgão, deste total apenas 147 movelarias encontram-se atuantes na cidade de Manaus.

Sabe-se que o setor moveleiro apresenta uma série de problemas, e encontra em um estágio atrasado, visto que 80% dos estabelecimentos apresentam *layout* inadequado, entre outras dificuldades. Além disso, 84% dos empreendimentos trabalham em sistema de produção "sob encomenda" e somente 16% produzem em série (SUFRAMA, 2003), entre outros problemas frequentes destacam-se:

- Indefinição da situação fundiária;
- Perdas no transporte, principalmente quando realizado por via fluvial;
- Veículos inadequados para o transporte de madeira;

- Ausência das técnicas de exploração e manejo adequados às espécies florestais, pré-requisito fundamental para obtenção da certificação ambiental e, consequentemente, garantia de venda no mercado internacional;
- Falta de visão empresarial nos aspectos administrativos, produtivos e mercadológicos por parte dos empresários atuantes no ramo;
- Ineficiência ou ausência de processo de secagem e/ou preservação da madeira;
- Baixo rendimento e deficiência quanto à qualidade do produto (por equipamentos obsoletos, falta de manutenção preventiva e mão-de-obra qualificada);
- Inobservância ou desconhecimento da legislação ambiental.

Além dos aspectos supracitados, deve-se salientar a ausência de preocupações relacionadas ao uso de normas e outras referências técnicas para determinação das dimensões dos mobiliários, principalmente no que diz respeito à utilização adequada das medidas antropométricas do público consumidor.

2.2. Ergonomia aplicada à mobiliário sem ajustes

A antropometria é o conjunto de medidas do corpo humano necessárias ao processo projetual de espaços, mobiliários e equipamentos, incluindo-se variáveis pertinentes à faixa etária, sexo, raça e, inclusive, grupos ocupacionais, conforme afirma Bittencourt (2011). Tais referências de variação nas dimensões humanas consideram-se de extrema importância, considerando as diferenças representativas a partir dos extremos de qualquer população.

Contudo, tratando-se de projetos de mobiliários, deve-se levar em conta a natureza da atividade a ser realizada, uma vez que as posturas naturais do corpo – posturas do tronco, braço e pernas que não envolvam trabalho estático – e movimentos naturais são condições necessárias para um trabalho eficiente, sendo imprescindível a adaptação do local de trabalho às medidas do corpo e à mobilidade do operador (KROEMER E GRANDJEAN, 2005).

Estas, também aplicam-se na construção de mobiliário residencial, pois os mesmos, assim como a mobília de postos de trabalho, devem ser projetados de modo a proporcionar conforto e segurança ao usuário durante sua utilização, diminuindo o aparecimento de lesões.

2.2.1. Variáveis humanas aplicadas ao projeto de mobiliário

Para o projeto de cadeiras, Panero e Zelnik (2003), consideram como uma das principais dificuldades em seu projeto o fato de que a atividade de sentar é dinâmica, ou seja, os indivíduos encontram-se em constante movimento pela adoção de diversas posturas, tratando-se da alternância entre contração e extensão muscular por meio de tensão e relaxamento dos músculos, conforme citam Kroemer e Grandjean (2005).

Fialho *et al.* (2007) afirmam, que existem poucas publicações a respeito de dados antropométricos dinâmicos e funcionais da população brasileira, dificultando a realização de projetos adaptados à população.

Contudo, um estudo intitulado *"Modelos humanos em escala para dimensionamento ergonômico preliminar de postos de trabalho"* proposto por Felisberto e Paschoarelli (2000) aponta medidas para o correto dimensionamento de mobiliário em geral, que podem ser utilizados para adequação do mobiliário residencial, pois apresenta um parâmetro antropométrico (medidas dos segmentos corpóreos humanos), tratado estatisticamente, obtido por meio de dados de diversas fontes de antropometria (tabelas de diversos autores e entidades competentes). Logo, a utilização deste estudo tende a contribuir para adequação do mobiliário residencial.

2.2.2. Variações nas dimensões do corpo, faixas de projeto e percentis

Para Kroemer e Grandjean (2005) a grande variabilidade nas medidas corpóreas entre indivíduos é um fator agravante na qualidade do mobiliário produzido na atualidade, considerando que não se deve projetar buscando atender a "pessoa média", e sim as pessoas mais altas (acomodar as pernas sob a mesa) ou as pessoas mais baixas (alcançar dada altura).

Atendendo, portanto aos usuários maiores e menores no projeto de postos de trabalho e de móveis, pois, geralmente, não é possível projetar o espaço de trabalho para atender as pessoas de dimensões extremas (muito grandes e muito pequenas), sendo necessário que se satisfaça às necessidades da maioria da população.

O uso de tabelas antropométricas pode ser entendido como referencial, sem, contudo, ser recomendado como prática indiferenciada, conforme afirma Bittencourt (2011), uma vez que existem variações dimensionais, tanto para homens quanto mulheres.

Assim, para que se possa projetar produtos para uma determinada população, torna-se necessário conhecer o conceito de *percentil (p)* que é definido como "unidade estatística (1 de 100) de uma distribuição normal da população" (BOUERI, 1991). Para Quaresma (2011) os percentis mais frequentemente utilizados são o 5%, que apresentam as menores dimensões de uma população, e o 95% que representa maiores dimensões de uma população. Estes dois, em uma distribuição populacional normal, correspondem às medidas extremas de 90% de uma população.

Deste modo, caso decida-se projetar para o percentil 90% central de uma população, deve-se excluir o 5% menor (mulheres com dimensões muito menores) e o 5% maior (homens dimensões muito maiores), uma vez que esses valores percentuais representam apenas 10% (5% mulheres e 5% homens) de toda a população (KROEMER e GRANDJEAN, 2005).

Embora não existam normas específicas para dimensionamento de mobiliário residencial, conforme afirmam Souza et al. (2010), os dados utilizados para postos de trabalho lhe são úteis. Assim, optou-se por utilizar a tabela de segmentos corpóreos humanos proposta por Felisberto e Paschoarelli (2000).

A Figura 1, a seguir, identifica as medidas antropométricas tabeladas que serão utilizadas ao longo deste estudo para análise do correto dimensionamento do mobiliário.

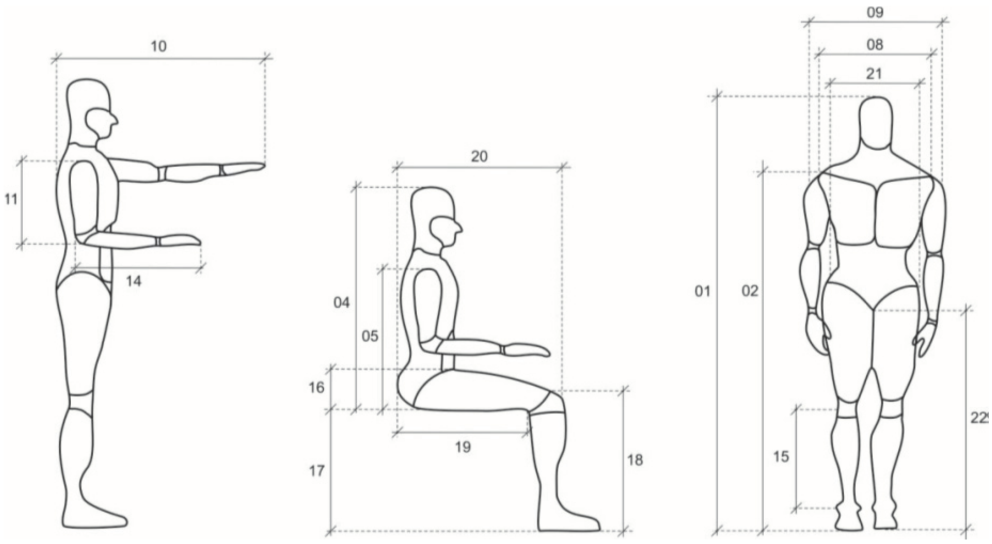

Fig. 30 Representação bidimensional das 29 variáveis antropométricas. Fonte: Felisberto e Paschoarelli (2000).

3. Metodologia

Para este trabalho, utilizou-se a pesquisa de campo, orientada por Marconi e Lakatos (2011), realizando as três etapas recomendadas: bibliográfica, coleta de dados e registro de dados coletados. Para a observação de campo, realizado no setor moveleiro do Amazonas, teve-se como universo de pesquisa 19 estabelecimentos, aplicando-se o método quantitativo-descritivo de verificação de hipótese, delineando e analisando as características dos fenômenos comprovados por controle estatístico. O estudo foi estruturado com base na ergonomia, direcionada aos aspectos antropométricos e medidas do corpo humano, tendo como referência os estudos orientados por Felisberto e Paschoarelli (2000) e complementados por Dul e Weedemester (2004), Quaresma (2011) e Moraes e Pequini (2000). Dos quais, foram geradas duas tabelas para experimento de aplicação das medidas para o desenvolvimento de mesas (34) e cadeiras (22) de madeira maciça. A partir dos dados gerados, pôs-se em prática uma análise comparativa com a realidade das medidas encontradas no mercado para esses produtos, a qual teve como suporte a estatística descritiva e inferencial. As observações registradas na referida fase, possibilitou verificar nos produtos analisados a existencia de variáveis compatíveis e não compatíveis ao seu processo de fabricação.

4. Desenvolvimento

A hipótese verificada partiu da premissa de que os marceneiros locais não utilizavam medidas antropométricas consideradas adequadas para o dimensionamento de mobiliário para a população local, não fazendo uso de nenhum padrão dimensional normatizado ou baseado em dados antropométricos. Para sua averiguação, elaborou-se um formulário de coleta de dados, possibilitando o registro das várias dimensões encontradas durante visita aos estabelecimentos apontados pelo SEBRAE/AM (CERVO, DA SILVA e BERVIAN, 2007).

A seleção da amostra de estabelecimentos a serem visitados para coleta de dados deu-se de acordo com a equação 1 a seguir:

$$n_0 = \frac{(z_{\alpha/2})^2 . p\,(1-p)}{(e)^2} \qquad (1)$$

Aplicando-se a equação de amostragem proporcional (Equação 1), com erro tolerável igual a 8% (0,08) e intervalo de confiança de 95% (z = 1,96), levando-se em conta a proporção de 10% (p=0,10) das movelarias, obteve-se a amostra inicial de 54 movelarias.

$$\mathrm{n} = \frac{\mathrm{n_0}}{1+\frac{\mathrm{n_0}}{\mathrm{N}}} \qquad (2)$$

Encontrado o valor da amostra inicial (n_0), tornou-se possível calcular o valor estimado da amostra (n), Equação 2, obtendo-se uma amostra total de 40 estabelecimentos.

A técnica de amostragem utilizada foi estratificada propocional, permitindo que se obtivesse um número de movelarias a serem visistadas em cada zona da cidade, partindo-se de uma população total contida nos estratos. Os dados referentes ao cálculo das amostras (n), proporção (p) e universo (N) de pesquisa encontram-se na Tabela 1.

Para sua aplicação, definiu-se como população, os estabelecimentos que comercializam mobiliário de madeira na cidade de Manaus, que conforme dados fornecidos pela diretoria do SEBRAE/AM (2010), era de aproximadamente 147 movelarias distribuídas pelas seis zonas da cidade. Do total da amostra estimada obtida, ressalta-se que foram incluídas apenas movelarias que trabalhavam com comercialização de mesas e cadeiras de madeira, excluindo-se as que não trabalhavam com a matéria-prima e mobiliário selecionado, bem como as que não aceitaram participar da pesquisa.

Tabela 1 - Divisão de movelarias por Zona, dados de 2010.

Zona	Universo (N)	Proporção (p)	Amostra (n)
Leste	30	30/147 = 0,20	8
Sul	12	12/147 = 0,08	3
Norte	40	40/147 = 0,27	11
Oeste	20	20/147 = 0,14	5
Centro-Sul	20	20/147 = 0,14	6
Centro-Oeste	25	25/147= 0,17	7
Total	147	1,00	40

4.1. Procedimentos para coleta de dados

A coleta foi realizada por meio de entrevistas, realizadas entre fevereiro a agosto de 2013, aplcando-se formulários, e identificando-se as medidas utilizadas na confecção do mobiliário em estudo. Os dados foram obtidas por meio de visitação as movelarias indicadas pelo SEBRAE/AM e, posteriormente, foram compilados em planilha eletrônica para comparação com as recomendados pelas tabelas geradas neste estudo. O formulário para a coleta de dados foi dividido em três blocos de perguntas que, por sua vez, foram estruturados a partir de temas de interesse da pesquisa, quais sejam: Dados da empresa, buscando-se obter informações para fins de identificação e caracterização da empresa; Informações sobre os produtos, identificando os produtos, seus tipos, quantidade, qualidade e forma de produção; Medição dos produtos, identificando como ocorre e quais são as utilizadas para seu dimensionamento.

Esses blocos foram subdivididos em oito temas, quais sejam: Identificação da empresa, Caracterização da empresa, Identificação dos produtos, Quantidade dos produtos, Qualidade dos produtos, Produção, Padrão de dimensionamento e Mensuramento dos produtos. Os temas geraram 'vinte e uma' perguntas, entre abertas e fechadas, utilizando-se linguagem informal, conforme orientam Marconi e Lakatos (2011), e considerando o público ao qual o formulário foi aplicado, em sua maioria, com baixo grau de instrução (marceneiros e ajudantes). As questões geradas foram codificadas e organizadas dentro de classes a fim de facilitar sua posterior inserção em tabelas.

4.2. Procedimentos para análise e interpretação de dados

4.2.1. Recomendações antropométricas para dimensionamento de mobiliário proposto para a população local

Por não possuir faixas de ajustes (madeira maciça), o mobiliário foco da pesquisa contemplou as medidas recomendadas por Felisberto e Paschoarelli (2000), que possui referencia dos seguimentos corpóreos para a população brasileira, sendo a que mais se aproxima da população local, devendo-se considerar os percentis 5% (mulher) e 95% (homem) como principal referência dimensional, uma vez que são os mais frequentemente utilizados, como já mencionado.

Portanto, a seleção das medidas recomendadas foi realizada conforme segue:

As utilizadas como referência para o dimensionamento de cadeiras (Tabela 2) foram baseadas nas da tabela proposta por Felisberto e Paschoarelli, e se baseiam nas referencias dos seguimentos corpóreos humanos, exceto as medidas "Vão entre assento e encosto" que foram extraída de Dul e Weerdmeester (2004), "Inclinação do encosto" de Kroemer e Grandjean (2005) e "Ângulo da borda do assento" de Cakir et alii. (1978), pois tratam de medidas para dimensionamento de cadeiras.

Tabela 2 - Medidas para dimensionamento de cadeiras residenciais baseada em dados de seguimentos corpóreos humanos.

	Medidas recomendadas para cadeiras residenciais (cm)	
A	Altura total da cadeira	99 -
B	Almofada lombar (vão assento-encosto)	10 - 20
C	Inclinação do encosto (em relação ao assento)	105° - 110°
D	Altura do assento	36
E	Largura do assento	41
F	Profundidade do assento	42
G	Ângulo da borda do assento	4° - 6°

Fonte: Adaptada de Felisberto e Paschoarelli (2000), Dul e Weerdmeester (2004), Kroemer e Grandjan (2005), Cakir et alii. (1978).

As utilizadas como referência para o dimensionamento de mesas (Tabela 3) foram extraídas de Dul e Weerdmeester (2004), por se tratarem de medidas para mesas, exceto a altura da mesa que foi extraída da tabela proposta por Felisberto e Paschoarelli (2000). Esta, pode ser obtida por meio da altura piso-joelho (do chão a parte superior do assento) mais a distância do assento até a parte debaixo do cotovelo flexionado (do assento até a parte superior da coxa) (QUARESMA, 2011) do homem percentil 95%, por se tratar do usuário maior.

Tabela 3 - Medidas para dimensionamento de mesas de jantar residenciais baseada em dados de seguimentos corpóreos humanos.

	Medidas recomendadas para mesas residenciais (cm)	
A	Altura (h)	72
B	Largura (l)	120
C	Comprimento (c)	91,4 -

Fonte: Adaptado de Dul e Weerdmeester (2004), Felisberto e Pascoarelli (2000), Quaresma (2011).

Por tartar-se de mobiliários de madeira maciça e sem possibilidade de ajustes, a única medida que poderá apresentar variação, será a de "Comprimento", uma vez que poderá ser maior de acordo com a quantidade de pessoas que deverá ser comportada à mesa. Para tanto, deve ser considerada, aquela da Limitação Lateral do Passo (Zona de Topo) que se trata da elipse corporal, vinculado à largura dos ombros (61 cm), baseada em uma separação interpessoal ampliada para um diâmetro de 91,4 cm por pessoa (HOROWITZ *apud* BITTENCOURT, 2011). O valor em questão proporciona maior conforto aos usuários, visto que permite sua livre movimentação.

Portanto, a dimensão 'c' (comprimento), 91,4 cm é considerada apenas para comportar uma pessoa confortavelmente, ou duas pessoas, uma de cada lado da mesa. Para comportar quatro pessoas, deve-se levar em conta que entre um indivíduo e outro (lado a lado) deve haver o espaço mínimo de 15,2 cm (91,4cm – 61 cm = 30,4/2 = 15,2 cm). O mesmo serve para acomodação de seis ou mais pessoas.

4.3. Procedimentos estatísticos

Para a realização desta etapa, utilizou-se duas áreas distintas da estatística: a Descritiva e a Inferencial. Da primeira foram utilizadas as duas categorias, quais sejam:

4.3.1. Medidas de posição

Utilizando-se os cálculos da média, mediana, moda, máximo e mínimo, pois permitem encontrar o valor médio das dimensões da peça (altura, largura, entre outros) para a produção de móveis. O objetivo destes cálculos foi verificar os valores que se repetem com maior frequência para que possam ser posteriormente comparados aos valores recomendados por autores de ergonomia.

4.3.2. *Medidas de dispersão ou de variabilidade*

Aplicando-se cálculos de amplitude total (Equação 3), desvio-padrão (Equação 4) e coeficiente de variação (Equação 5), visto que permitem apreciar o número total de valores encontrados em uma classe e, ainda, mapear a diferenciação entre os valores obtidos.

$$\mathrm{A} = \mathrm{Xmáx} - \mathrm{Xmín} \quad (3)$$

$$\mathrm{S} = \frac{\sqrt{\sum_{i=1}^{n}(xi-\bar{x})^2}}{n-1} \quad (4)$$

$$\mathrm{CV} = \frac{\mathrm{S}}{\bar{\mathrm{X}}}.100 \quad (5)$$

Como as tabelas geradas para este estudo (Tabelas 2 e 3 acima) apontam medidas de único valor, havendo também casos onde aponta intervalos, a validação dos dados procedeu por meio da comparação de médias pela aplicação do teste de *t de Student* ao nível de 5% de probabilidade. Como o desvio padrão da população (σ) era desconhecido, este foi estimado por meio do desvio padrão amostral *S* e distribuição *t* com *n-1* de graus de liberdade, conforme afirma Costa, Cardoso Neto e Nascimento (2006).

$$\mathrm{t} = \frac{\bar{\mathrm{X}} - \mu}{\frac{\mathrm{S}}{\sqrt{\mathrm{n}}}} \quad (6)$$

4.4. Interpretação de dados

A interpretação dos dados deu-se pela utilização de dois softwares em conjunto: Excel e SPSS. O primeiro utilizado para categorizar, organizar e visualizar os valores mensurados obtidos pela aplicação dos *formulários de coleta de dados*. O segundo para realização dos cálculos estatísticos pré-estabelecidos e a geração dos gráficos analíticos.

Para a validação das medidas propostas nas tabelas geradas, quanto ao dimensionamento de mesas e cadeiras em madeira maciça sem ajustes para a população local, realizou-se simulações de uso dos produtos, auxiliadas pelo utilização de dois softwares distintos: *Blender*, para a modelagem do mobiliário com as medidas propostas nas tabelas; e *MakeHuman*, destinada a modelagem dos bonecos antropométricos para testes, conforme medidas dos seguimentos corpóreos humanos proposta por Felisberto e Paschoarelli (2000).

5. Resultados e discussão

5.1. Universo de pesquisa

Os dados fornecidos pelo SEBRAE/AM (2010) apontavam um quantitativo de 147 marcenarias distribuídas pelas diversas zonas da cidade de Manaus. Durante as visitas constatou-se que, embora tivessem sido visitados 100% dos endereços indicados pelo SEBRAE/AM, apenas 41% dos estabelecimentos foram localizados, dos quais somente 36% encontravam-se em pleno funcionamento. Os 59% restantes não foram localizados ou não eram de conhecimento dos moradores locais.

Os estabelecimentos encontrados estavam distribuídos da seguinte maneira 10% desses estabelecimentos trabalhavam com madeira maciça, 7% apenas com MDF e/ou Compensado, 5% eram madeireiras ou serralherias, 7% produziam apenas portas e janelas, 3% eram metalúrgicas, 2% trabalhavam apenas com revenda, outros 2% trabalhavam com outros produtos de madeira e outros 5%, embora tenham sido localizados, encontravam-se desativados.

Outros 2% que também trabalhavam com móveis de madeira maciça foram encontrados por indicação dos moradores das regiões visitadas, logo, não constando na listagem.

Portanto, foi verificado *in loco* que a maioria das marcenarias não mais existia, uma vez que mudaram de endereço ou de negócio. Portanto, dos estabelecimentos apontados pelo SEBRAE/AM, apenas 15 trabalhavam com produção de mobiliário em madeira maciça. Outros 4 estabelecimentos foram obtidos por meio de indicação dos moradores locais, logo, o quantitativo total de movelarias utilizadas para este estudo foi de 19 estabelecimentos.

5.2. Análise e interpretação de dados

Durante a verificação *in loco* dos 19 estabelecimentos, que trabalhavam com madeira maciça, em funcionamento, aplicou-se os formulários como forma de mapear as medidas utilizadas para a produção de mesas e cadeiras, sem ajuste, de madeira maciça, chegando-se as seguintes interpretações:

5.2.1. Cadeiras

Foram levantados 22 exemplares de cadeiras, bem como as dimensões de cada exemplar, estas foram comparadas com aquelas recomendadas na Tabela 2, possibilitando a aplicação dos procedimentos estatísticos já descritos. Os valores de médias e desvios padrões foram obtidos através da aplicação dos procedimentos de estatística descritiva apresentador no item Material e Métodos, possibilitando assim a aplicação do teste de *t de Student* (Equação 6) para cada medida separadamente, conforme a seguir:

Utilizando-se da tabela de Distribuição de *t de Student* com 21 graus de liberdade (n-1 = 22-1) e Intervalo de Confiança de 95% (α = 0,05 / 2 = 0,025), obtém-se o valor tabelado de t (2,4138). Em seguida, foram calculados os valores de t para as medidas Altura Total da Cadeira (A) (t = 7,44), Altura do Assento (D) (t = 13,20), Largura do Assento (E) (t = 2,37) e Profundidade do Assento (F) (t = 0,00), uma vez que são as únicas que são consideradas importantes pelos marceneiros locais para a produção de cadeiras.

Dimensão A – Altura total da cadeira

Comparando-se o valor de t calculado (t = 7,44) maior do que o de t tabelado (t = 2,4138) percebe-se que existe uma diferença significativa entre as dimensões coletadas e a dimensão recomendada pela Tabela 2, concluindo-se, portanto que as medidas utilizadas pelos marceneiros para a altura da cadeira encontram-se muito acima da recomendada, o que poderia implicar em acidentes (bater a cabeça no encosto da cadeira, quando inclinada para trás).

Dimensão D – Altura do assento

Comparando-se o valor do t calculado (t = 13,20) com o do t tabelado (t = 2,4138), conclui-se que as medidas de altura de assentos encontradas também apresentam diferença significativa quando comparados com a dimensão recomendada pela Tabela 2, podendo acarretar em dores musculares (compressão da poplítea, parte de trás da coxa) quando utilizadas por longos períodos de tempo.

Dimensão E – Largura do assento

Comparando-se o valor do t calculado (t = 2,37) com o do t tabelado (t = 2,4138), conclui-se que as medidas de largura de assentos encontradas não apresentam diferença significativa quando comparados com a dimensão recomendada pela Tabela 2, uma vez que essa dimensão se trata da largura do quadril da maior mulher. Contudo, deverão ser observados os espaços entre uma cadeira e outra, para o caso de mesas de quatro a seis lugares, respeitando-se a Zona de Topo de cada indivíduo, ou seja, entre uma cadeira e outra deverá ser respeitado o espaço de 15,2 cm no mínimo, conforme visto anteriormente.

Dimensão F – Profundidade do assento

Comparando-se o valor do t calculado (t = 0,00) com o do t tabelado (t = 2,4138), conclui-se que as medidas de comprimento / profundidade de assentos encontrados não apresentam diferenças significativas em relação a recomendada pela Tabela 2. Contudo, deve-se levar em conta que de uma amostra de 22 cadeiras analisadas, 46% (10 exemplares) encontravam-se com o valor acima do estabelecido o que é considerado prejudicial, uma vez poderia causar dores musculares pelo estrangulamento da parte de trás do joelho (poplítea) o que forçaria os usuários menores a se sentarem mais próximos da ponta da cadeira, adotando posturas incorretas pela inutilização do encosto da cadeira.

Dimensões B e C – Vão assento encosto e inclinação do encosto

Neste caso, apenas dois fabricantes apresentaram medidas consideradas padrão para o dimensionamento de seus produtos (B = 7 cm e C = 90º), sendo consideradas irrelevantes ou desnecessárias para os demais.

5.2.2. Mesas

Foram levantados 34 exemplares de mesas sem ajustes em madeira maciça, das quais: 12 mesas de dois lugares, 17 mesas de quatro lugares e 5 a mesas de seis lugares. Foram levantadas também suas dimensões para comparações com as recomendadas na Tabela 3, possibilitando a aplicação dos procedimentos estatísticos descritos anteriormente. Os valores de média e desvio padrão, para cada uma das classes de mesas distintas, foi obtido separadamente, por meio da aplicação dos procedimentos e estatística descritiva descritos anteriormente, possibilitando a aplicação do teste *t de Student* (Equação 6), conforme a seguir:

Utilizando-se da tabela de Distribuição de *t de Student* com 11, 16 e 4 graus de liberdade (n-1) e Intervalo de Confiança de 95% ($\alpha = 0{,}05 / 2 = 0{,}025$), obtém-se os valores tabelados de t ($t = 2{,}5931$; $t = 2{,}4729$ e $t = 3{,}4954$) para os exemplares de dois, quatro e seis lugares, respectivamente. Em seguida, foram calculados os valores de t para as medidas Altura da Mesa (A), Largura da Mesa (B), Comprimento da Mesa (C).

Dimensão A – Altura da mesa

Nos casos de exemplares de mesas de dois ($t = 10{,}20$) e quatro lugares ($t = 16{,}87$), foram encontradas diferenças significativas de dimensões, quando comparadas com a dimensão apontada na Tabela 3. Nos exemplares para seis lugares ($t = -3{,}86$) analisados, embora apresentem a medida de 80 cm (todos), segundo o teste de *t de Student*, não existem diferenças significativas. Contudo, essa dimensão quando aplicada incorretamente pode ocasionar desconforto muscular no antebraço e dores nos ombros (quando muito alta) e inclinação da coluna para frente (quando muito baixa).

Dimensão B – Largura da mesa

Para todos os casos analisados, foram encontradas variações dimensionais significativas. Por se tratar da dimensão mínima para a acomodação das pernas abaixo da mesa, essa medida é de grande importância e, levando-se em conta a configuração de duas pessoas sentadas uma de frente para a outra, a dimensão apontada na Tabela 3 deve ser respeitada, o que não ocorre.

Dimensão C – Comprimento da mesa

Para os casos de exemplares de dois ($t = 12{,}62$) e quatro ($t = -0{,}27$) lugares foram encontradas diferenças dimensionais significativas, enquanto que nos casos de exemplares de seis lugares ($t = -2{,}06$) percebeu-se que não foram encontradas variações dimensionais significativas. Contudo, para os casos de mesas de dois lugares deve-se levar em conta a medida mínima de 91,4 cm, nas de quatro lugares 182,8 cm e nas de seis 274,2 cm, ou seja, é inadmissível a utilização de medidas abaixo das dimensões indicadas, uma vez que as dimensões apontadas representam a Zona de Topo, ou seja, o espaço mínimo necessário para a acomodação de usuários, lado-a-lado, sem que um invada o espaço pessoal do outro.

Tendo em vista os dados analisados e as Tabelas 2 e 3 geradas, fez-se a simulação de uso das medidas propostas para dimensionamento do mobiliário proposto.

5.3. Simulação de uso

Para fins de validação desta pesquisa, além da aplicação do teste de *t de Student*, viu-se a necessidade de simular a aplicação das medidas recomendadas nas Tabelas 2 e 3 para a população local, ou seja, mulher percentil 5% (menor mulher) e homem percentil 95% (maior homem), tendo em vista que não se está projetando para um único usuário e sim para uma população inteira. Os bonecos antropométricos utilizados para as análises foram dimensionados de acordo com a tabela proposta por Fellisberto e Paschoarelli (2000) que apresenta as medidas dos seguimentos corpóreos humanos. A seguir são apresentadas as simulações de uso da cadeira com as medidas dos segmentos corpóreos humanos, sugeridas na Tabela 2, resultante deste estudo, por cada um dos percentis (5%, 50% e 95%) tanto de homens (Figura 2), quanto de mulheres (Figura 3).

Observando-se as Figuras 2 e 3 nota-se que a cadeira apresentada atende desde a menor mulher (percentil 5%) ao maior homem (percentil 95%), uma vez que todos os usuários puderam firmar os pés no chão sem que houvesse a necessidade de sentar-se mais à frente da cadeira. Percebe-se também que, com isso, não houve o esmagamento da fossa popliteal (parte de trás do joelho), nem tampouco compressão da parte de baixo da coxa.

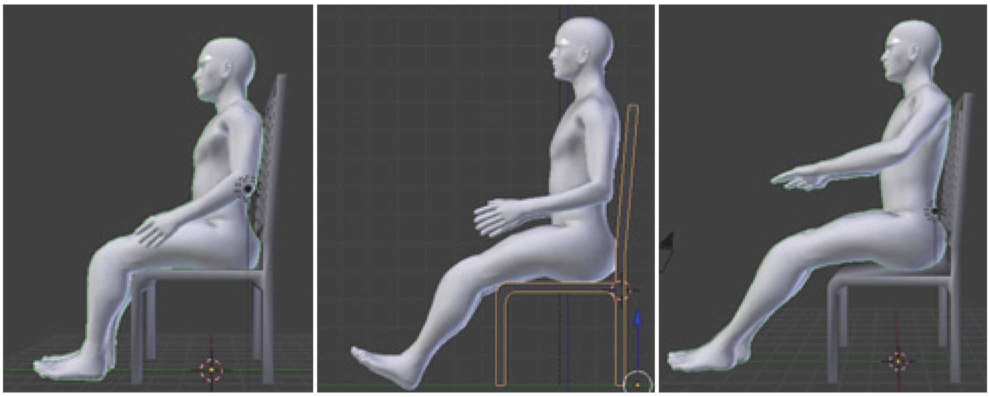

Fig. 31 - Homem percentil 5% (menor), homem percentil 50% (médio), homem percentil 95% (maior), respectivamente.

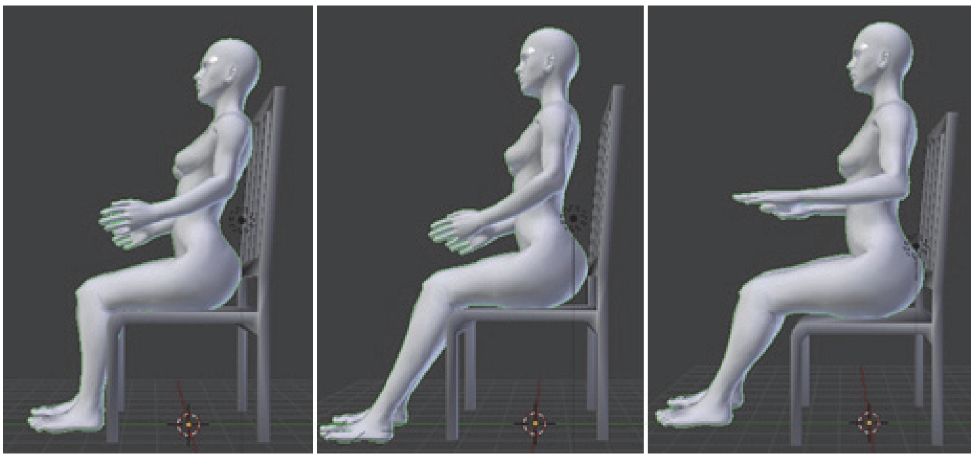

Fig. 32 Mulher percentil 5% (menor), mulher percentil 50% (médio), mulher percentil 95% (maior), respectivamente.

O mesmo tipo de simulação foi feito para as mesas (dois, quatro e seis lugares), entretanto, como todas possuem as mesmas dimensões de largura (120 cm) e altura (72 cm), utilizou-se para simular a acomodação das pernas sob e dos braços apenas um exemplo, neste caso o da mesa de dois lugares (Figura 3).

Observando-se a Figura 3 nota-se que as mesas apresentadas atendem desde a menor mulher (percentil 5%) ao maior homem (percentil 95%), uma vez que ambos conseguem acomodar suas pernas, sem que haja contato, conseguindo apoiar seus braços sobre o tampo da mesa sem que para isso haja a necessidade de elevar os ombros ou curvar-se para frente, adotando posturas incorretas, tensionando os músculos dos ombros e pescoço. Salienta-se que as medidas aplicadas na mesa utilizada na simulação também servem para acomodação do percentil 50% (homens e mulheres).

Ainda sobre o caso das mesas, houve a necessidade de simular também a acomodação dos usuários lado-a-lado, para validação dos comprimentos. Para tanto, simulou-se a Zona de Topo, buscando ilustrar que as mesas apresentadas possuem espaço suficiente para a acomodação de cada indivíduo, respeitando seu espaço pessoal (Figura 4).

A Figura 4 apresenta a vista de topo da simulação de uso por homens do percentil 95%, uma vez que apresentam maior largura de ombro, o que poderia dificultar sua movimentação quando acomodados próximos a outros usuários do mesmo porte. Nessa imagem, nota-se que, independentemente do tipo de mesa simulada (dois, quatro ou seis lugares), todos os usuários encontram-se perfeitamente acomodados, sem contato com os demais.

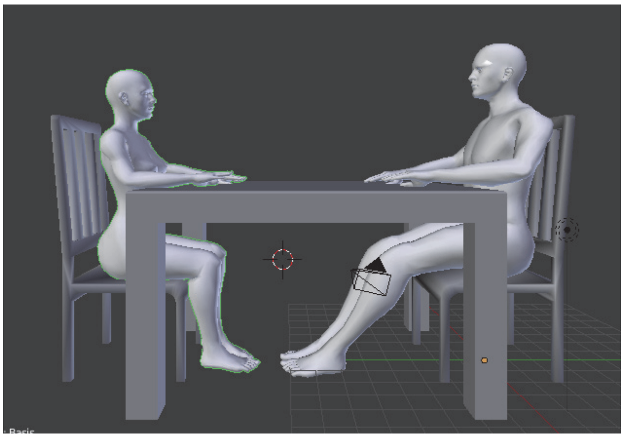

Fig. 33 À esquerda, mulher percentil 5% (menor) e à direita, homem percentil 95% (maior).

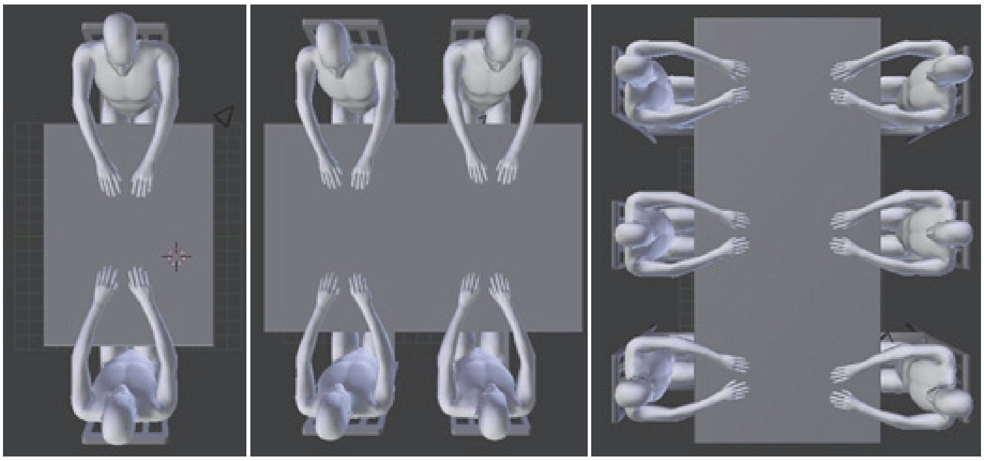

Fig 34 Acomodação dos usuários maiores (homem percentil 95%) nas mesas de dois, quatro e seis lugares, respectivamente.

5. Considerações finais

Dado o exposto, percebeu-se a necessidade de disseminação das tabelas geradas neste estudo como auxilio ao correto dimensionamento de mesas e cadeiras residenciais de madeira maciça sem ajustes, produzidas e comercializadas na cidade de Manaus.

As marcenarias locais produzem e comercializam estes mobiliários de madeira maciça sem ajustes com medidas que podem ser consideradas inapropriadas, por não apresentarem padrão dimensional, sem base em normas, não somente pela falta de conhecimento técnico dos marceneiros, mas também pela ausência das mesmas, voltadas para o dimensionamento de mobiliário residencial.

Contudo, tem-se o conhecimento de uma tabela que possui medidas antropométricas dos seguimentos corpóreos humanos da população brasileira, permitindo sua adaptação para dimensionamento do mobiliário em questão, auxiliando na geração de duas novas tabelas com medidas recomendadas para dimensionar o mobiliário para a população Amazonense, tendo em vista que este estudo trata de mesas e cadeiras sem ajuste de medidas.

As tabelas geradas permitiram constatar que tanto as mesas, quanto as cadeiras residenciais de madeira maciça sem ajustes comercializadas na cidade de Manaus não são produzidas com base em recomendações ergonômicas e/ou qualquer tipo de estudo relacionado. Este argumento sustenta-se pelo seguinte: a) Cadeiras: as medidas A, D, E e F (altura total da cadeira, altura, largura e profundidade do assento, respectivamente) não se encontravam em conformidade com o recomendado por este estudo, ou outra publicação científica e as medidas B, C e G (vão assento-encosto, inclinação do encosto e ângulo da borda do assento) são ignoradas pelos marceneiros locais, embora sejam tão importantes quanto às demais; b) Mesas: as dimensões A (altura da mesa) e B (largura da mesa), consideradas críticas, necessárias para o apoio dos braços sobre a mesa, bem como para a acomodação das pernas sob a mesa, sem que haja prejuízos de saúde aos usuários, também não se encontravam em conformidade. Para ambos os tipos de mobiliário, foram encontradas medidas muito acima do indicado nas tabelas de medidas recomendadas, em alguns casos.

Portanto, entende-se que os marceneiros locais não utilizam padrão dimensional que possa ser considerado adequado ao desenvolvimento de mesas e cadeiras residenciais em madeira maciça, o que termina por tornar os seus produtos menos ergonômicos, face ao desconforto gerado pelos mesmos quando utilizados por longos períodos, podendo ser considerados superfaturados quando comparados com móveis industrializados, nas mesmas condições de dimensionamento, com menor preço de mercado.

Deste modo, percebe-se a necessidade da criação de mecanismos para divulgação dessas tabelas como maneira não somente de orientar, mas também de conscientizar os fabricantes acerca da importância do correto dimensionamento desses produtos por meio de apontamentos sobre o que é ergonomia e antropometria, bem como os benefícios gerados pela aplicação dessas medidas e de que forma, não só os produtores como os usuários podem ser beneficiados com isso.

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Harnessing User's Knowledge In The Construction Of Rating Flows: The Design Of A Collaborative System Applied To Academic Repositories

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Abstract

Artifacts developed over several ages, such as libraries, encyclopedias, and databases, show the cultural evolution of information systems. Compiling, organizing and visualizing information is a task that has been carried out by mankind for thousands of years. The added difficulty in effectively communicating information in various sectors and services of our society reveals that an efficient communication of information is of the utmost importance in the current network society. The glut of information is directly related to the fact that the information we are exposed to is not subject to a filtering and organization process. This reveals an urgency to develop strategies that not only prioritize the organization and searching, but also increase the efficiency of the communication process, in order to promote an efficient framework to the user's cognitive and perceptual field. Therefore, the task of designing complex information systems in an accessible manner currently represents an important goal and an imperative task to the Design/er.

The publication and the querying of papers, journals, books, is an integral part of the research process. However, the querying and information visualization process in a scientific academic repository often proves to be a complicated and inefficient task, as the wide range of results hardly fits in the user's specific subject. However, if we equate that the knowledgeable objects are accessed by a significant number of users with a specific interest in a topic and that, in the course of their research, each user handles a significant amount of results, it is, then, possible to consider the existence of an hierarchical and relational structure of evidences that emerges from the relationship established between the users, their specific interests and knowledge concerning a topic and the querying performed. Therefore, it is fundamental to consider the users' experience and the leading role that it plays concerning the information filtering process.

This paper aims to present key insights on the information glut problematic related to/associated with a massive amount of knowledge objects stored, and proposes a new approach/system applied to the academic scientific repositories. A collaboration system is designed, in order to filter and visualize the rating flows based in users' experience, instead of the usual citation "object" centered approach. The focus of this work is to describe one part of the system: the experimental implementation of an interactive hierarchical structure.

Keywords: *collaboration, design, information, hierarchical structures, visualization.*

1. Introduction

Aspects such as the structuring and presentation of information, framework and content filtering are an urgent and ongoing challenge nowadays (Thackara, 2006), fact that is evident throughout the cultural evolution of information systems (Wright, 2008). However, due to Humanity's tremendous effort to collect and store information in earlier times (idem, 2008), the need to design and develop strategies to filter and reduce the information volume becomes evident (Card et al., 1999), (Wurman, 2001), (Thackara, 2006), (Wright, 2008), (Gleick, 2011) in the current digital information society (Castells, 2010). In fact, the current digital repositories of knowledge (DRK) only constitute an apparent solution to the problematic, as they allow the reduction of the distance and limits of the access to information and make a wide typology of knowledge objects available online (KO) (e.g. books, scientific journals, papers, thesis). Despite the referred advantages, the current problems addressed to DRK are directly related to filtering processes and the visualization of the retrieved information (Thackara, 2006). Although the KO is just one click away, the search for information on DKR proves to be a complex, inefficient and arduous task. This procedure is exacerbated by a slow query process of long lists of results (Marks et al., 2005, p. 57-59), which implies an individual analysis process of each KO (in the specific context of papers, books, thesis). In this sense, it becomes clear not only an intrinsic problem related to the wide range of results obtained that translates into a visualization difficulty due to the disturbing amount of data available in the users' cognitive and perceptual field, but also a problematic directly related with the filtering of the KO. Usually, the search engines of the DKR merely allow a search/filtering process based on topics like keywords, author, ISBN, subject, year of publication, title, among other similar examples. However, there are two other problems that are related to the lack of information concerning the characteristics of knowledgeable objects and users, because in both cases the available metadata is very limited, and, in the case of the users, they are virtually nonexistent.

In this sense, the current knowledge retrieval systems are insufficient, due to the exponential amount of published scientific knowledge made available online. In fact, according to Börner (2010, p. 12), the current DKR do not allow a clear understanding of the various academic entities and their numerous and complex interdependencies. Therefore, the design and development of new visual languages and new communicative paradigms, whose purpose is the representation of knowledge structures at different scales, is an important and urgent issue in the complex field of academic research (Börner, 2010, p. 12). In this sense, this article aims to describe part of a system that intends to allow visualization of a wide range of KO, based on the rating flows, through a specific and interactive visual structure in order to provide relevant and efficient results for the user. A brief explanation of the rating process, which is based on a simplified evaluation factor/metric, is presented in point 2.1.

The problem with information flood reveals another issue concerning the exponential growth of stored KO, which is directly related to the user's inability to consult each KO individually, given the wide range of results obtained. This fact shows that the cooperation factor is a key component in the filtering process, through the rating of the KO by the academic community. Understanding and visualizing the collaborative structure of evidences reflecting the multiple perspectives and individual experiences of each user proves to be the key equation in allowing a more efficient insight of the KO with greater relevance, based in the wisdom of the academic community in a particular field of research.

2. Digital Knowledge Repositories And The Problematic Of The Information Glut: Brief Analysis Of The Context

Taking into account the evolution of biological and cultural information systems (Wright, 2008), the current digital libraries are the main source for Humanity knowledge (Börner et al., idem, 2002). In this sense, it is fundamental to develop and redesign new interfaces focused on management, access, visualization and understanding of the various information types stored in the DKR. In fact, the DKR are key artifacts in the access to a wide typology of KO. The current research and development in the field of interfaces and Information Visualization (InfoVis) concerning DKR is directly related to the problematic of the information flood (Card et al., 1999), (Wurman, 2001), (Wright, 2008), (Castells, 2010), (Gleick, 2011), fact that is originated by increased storage and processing capacity, interconnection between different systems and development of new interfaces that facilitate both access and publication of contents.

According to Börner et al. (2002), the fast pace of scientific discoveries and technical development, and the appearing of new fields and themes in increasingly shorter periods, significantly contributed to a consequent increase of scientific publications. However, in spite of the published data being scientifically valid, the problematic of scientific information stored and available online also contributes to the current problem of the information abundance in academic contexts (Thackara, 2006, p. 163). That implies that this is a problem concerning scientific knowledge networks. In the field of DKR it is directly related to cataloguing, categorizing, structuring and allowing visualization of an exponential amount of produced and published scientific content and it clearly shows that users are experiencing difficulties to perceive and process such large volumes of available KO. Such fact stresses the need to conceptualize and develop new artifacts concerning the retrieval, visualization and communication of all stored data types, such as data resulting from users' interaction with DKR and KO. The current DKR interfaces are featured by advanced data analysis techniques, in order to display results, normally in the form of extensive lists of KO (Marks et al., 2005, p. 57), and organized according to a metric (e.g Association for Computing Machinery Digital Repositories) (Kim et al., 2011, p. 123). However, this is not an adequate solution, due to the growing volume of stored KO (Dushay, 2004). In this sense, InfoVis constitutes a viable response to difficulties concerning search and navigation tasks, as it allows a greater cognitive and perceptual efficiency (Marks et al., 2005, p. 57-69), (Kim et al., 2011, p. 123-136). This efficiency is ensured by the fact that InfoVis has the capacity to transform abstract data on visual attributes (e.g. shapes, colours, scales), therefore reducing the cognitive and perceptual effort required to process large volumes of information.

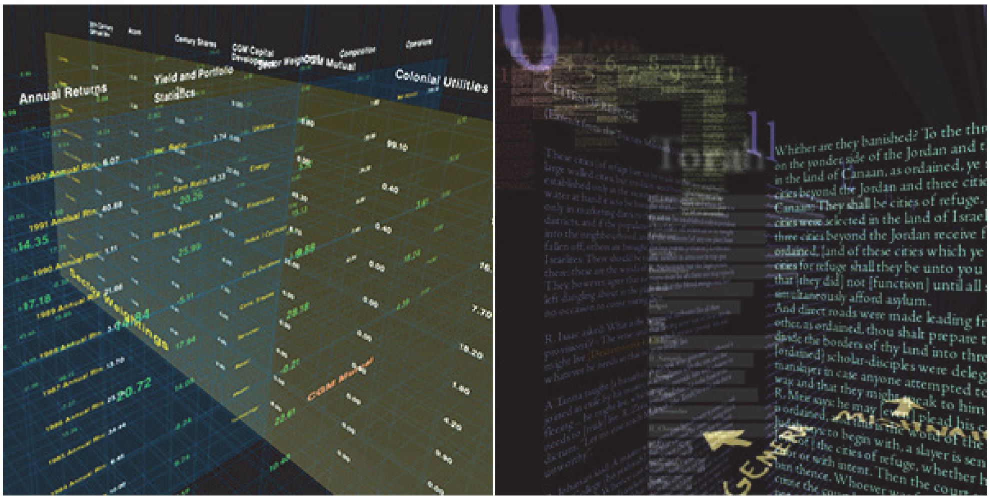

Fig.1 Information Landscapes. Visible Language Workshop. MIT Media Lab. Cooper (1994).

In fact, the main purpose of InfoVis lies fundamentally in structuring complex information spaces (Cooper, 1994) [Fig.1], proving to be an asset to the interaction of users with DKR (Börner et al., 2002). This means not only a reduction on the degree of cognitive processing effort, by taking into account difficulties concerning the slow process of consultation and reading, but also translates into a more efficient perceptual process based on visual attributes, that allows efficient decoding and presentation of patterns and evidences imbued in the data, some of them unnoticeable until then (idem, 2002). In fact, the InfoVis makes use of the advantages and capacity of the human perceptive and cognitive system (Card et al., 1999), in order to assist the user with his mental organization and structuring of data while accessing and decoding complex information spaces (Shiri, 2008, p. 764-765). In this sense, it is stated by Börner et al. (2002) that the integration of InfoVis in interfaces such as digital libraries and repositories is fundamental, particularly in terms of search time; understanding and decoding a complex and broad set of data; visualization of relationships and evidences; simultaneous visualization of data and multiple perspectives; access to efficient sources of communication; quick access to contents and new forms of analysis.

According to Börner et al. (2002), the interfaces aimed to the DKR are defined by four implementation scenarios: identifying the composition of a particular result; providing an overview of the entire collection and facilitating of retrieval tasks; visualizing the interaction between user and data in relation to the documents available, in order to evaluate and upgrade the interaction properties; improving the sharing methodology of both information and collaboration (idem, 2002).

The current DKR are, in fact, the principal knowledge repositories, (Fox et al., 2002 p. 506-507), and the design of user-friendly interfaces for management, access and efficient understanding of the complex volume of stored data is nowadays both an imperative challenge and an essential task of the Designer (Wurman, 2001). To sum up, and according to Börner et al. (2001, p. 12-15), it is fundamental to study and develop interactive visualizations concerning the field of DKR, taking into account the following key points: intuitive interfaces; fast and efficient access to an increasing volume of KO; new ways to analyze the KO; addition of new data to existing information (e.g. metadata) and easier sharing of information.

2.1 Knowledge Networks: Brief Analysis Of The Context

Currently we live in a globally connected network society (Castells, 2001), (Wright, 2008), in which "billions of people produce trillions of connections" (Hansen et al., 2010, p. 3). Such fact is extensively expanded by the exponential development of Information and Communication Technologies, the appearance of the digital social networks (Web 2.0) being an example of it. According to Wright (2008, p. 9), if we consider only one focused perspective on the current cultural information systems, this proves to be shallow. In fact, the hierarchical and network systems and the tension between these two coexistent structures (idem, 2008) form the structural and organizational model that permeates in all layers of our biosphere, as well as in our infosphere (idem, 2008), (Castells, 2010), (Gleick, 2011). An example is the natural biological organization that follows an hierarchical logic (Simon, 1996, p. 172), (Wright, 2008). At the infosphere level, the World Wide Web is an hierarchical structure, as it obeys a physical system (hardware) organized hierarchically, and it simultaneously is a relational structure composed of an exponential number of hyperlinks (Yam, 1997), (Wright, 2008), (Gleick, 2011). In this sense, we can consider that hierarchies and networks are the basic structures of information, and that understanding them is fundamental to comprehend the biological and cultural evolution of information systems (Yam, 1997), (Wright, 2008).

In fact, the DKR is actually featured by hierarchical structures. One example of this is the organization per alphabetical order of the KO. Another example is a book or paper index. However, scientific papers or books are defined by a relational structure of hyperlinks (bibliographic references), namely a complex structure of citations between several KO. In fact, scientific publications are based on a set of references based in previous work, which holds a substantial impact on the actual research object, usually located at the final section of each paper or book, specifically the reference section. According to Börner et al. (2014, p. 170), the visualization of information networks is a branch of InfoVis, intending to perform the analysis of both natural/biological and digital/cultural networks, specifically, social networks, information science, bibliometrics, scientometrics, econometrics, infometrics, webometrics, communication theory, sociology of science and many other disciplines. In this context, the connections are featured for example by collaborations between authors, quotes from papers and patents (ibid*.,* 2003, p. 4), (idem, 2014, p. 170). In the case of scientific knowledge networks, the main objective is to identify the authors, papers or knowledge domains with the largest number of connections, (e.g. citation and collaboration); network properties (e.g. size and density); structures (e.g. clusters) (idem, 2014, p. 170). It should be noted that the analysis around knowledge networks/domains is defined by three scales, specifically micro, meso and macro. In this sense, it is important to highlight that the presented experiemental implementation is in the meso level. According to Börner et al. (2014, p. 3-7), the meso level is featured by values between 101 and 10,000 records, such as the number of researchers of a single university and/or a particular subject that is investigated.

It should be noted that this subfield of InfoVis is intrinsically linked to the metric of the impact factor of a journal or paper, meaning that the importance of a scientific publication is directly related to the number of citations: the greater is the number of citations, the bigger is the impact/relevance of the publication. It is therefore important to highlight Garfield and his fundamental contribution to the study of communication/scientific dissemination (field of bibliometrics, scientometrics). In fact, Garfield (1963, p. 5) revealed concerns with the aesthetics of scientific communication, taking into account its chaotic state in the 1963 period (Garfield, 1964, p. 88). According to Wright (2008, p. 203), the article published by Vannevar Bush, *As We May Think* (1945) (1996, p. 35-46), inspired Garfield to explore and develop new forms of access to scientific journals (Wright, 2008, p. 203). Therefore Garfield develops a methodology called citation ranking, that is a tool to assess the impact factor of academic publications based on the number of citations (Garfield, 2003, p. 363-339), (Wright, 2008, p. 203). The Science Citation Index then allowed measuring of the impact factor of the KO determined by the cumulative value of citations. In fact, the bibliographic citation is a common practice in various types of academic publications and an important measure of credibility and popularity for research projects, journals, papers, researchers and institutions (idem, Garfield, p. 363-339), allowing equating the existence of a vast relational structure and/or similarities between subjects (Lima, 2011, p. 102).

Taking into account the vast scenario of academic publications, it is possible to infer the existence of a vast hierarchical and relational structure in which it is, for example, possible to gain insight about the proximity between distinct areas (Lima, 2011, p. 102) and /or citation patterns between different areas: which papers are most cited in a given area; which area has the highest number of citations; and if an author of a paper is cited by other authors. In fact, a large part of quantitative studies about science is based in the analysis of hierarchical and relational structures that are based on the reference or citation of publications or coauthoring, namely cooperation structures between researchers (Staudt, 2011, p. 1). This means that two researchers are interconnected when they are co-authors in one or more KO (Newman, 2001b). According to Newman (2001b), quantitative analyzes of relational structures are defined by the number of papers written, the number of authors of a paper, the number of contributors, the existence and the extent of a researchers network and the degree of network clusters.

According to Meirelles (2013, p. 49), individuals are actors (vertexes or nodes) and links (edges) between individuals are ties. This designation might refer to trust and cooperation ties between two or more individuals, or from an ordinary member between groups, among other examples (idem, 2001), (Hansen, 2010, p. 34-35).

In short, in the academic collaborative social networking actors are researchers, and the bonds that emerge from their collaborative relationships represent the co-authoring linkages between one or more papers. According to Börner (2015, p. 60-61), network analysis and techniques that enable the visualization of relational structures allow to answer the question "with whom?". However, it should be noted that the hypothesis here presented highlights one fundamental question: “Which?”. It stresses the need to promote an approach around the retrieval problematic and the obtained results, through the visualization of the hierarchical structures (the main object of study of this article) and the relational structures that emerge from each user’s interaction with researched objects.

3. Material and Methods

The equated hypothesis is a new paradigm that determines a change on the approach focus, usually centered in the citation of KO or authors. That means that this article presents an experimental implementation of one part of the system, specifically the design and computation of a contention hierarchical structure using the programming language Processing, intended to assure the visualization of KO with greater relevance within a particular branch of knowledge. As mentioned before, it emerged from the relationship of a problem concerning the retrieval and filtering of KO and the visualization of the structure of evidences that results from the relationship established between the users’ queries and the enrichment process (rating) of the KO. Therefore, instead of the usual “object” centred approach, it establishes an approach based on user’s experience.

The main goal of this point is to present and describe one part of the system, that is the experimental implementation of an interactive hierarchical structure. It should be noted that in the absence of data concerning the rating of KO, it was decided to simulate hypothetical contexts of interaction by using a set of structured data between users, KO, ratings, knowledge domains and knowledge subdomains. In this context, a set of fictitious data (meso level) was generated in order to simulate the interaction of users while performing their consultation and rating of the stored KO in the DKR. The use of fictitious data concerning the metadata of the KO (e.g. ISBN, Title, Year) should also be highlighted. MySQL was used to implement the database system, as it is an open-source relational database management system. A more detailed description of the modeling of relations in the database is out of the scope of this article.

The decision to maintain the evaluation system centered in and closed to the academic community is related to the advantage of being able to identify the type of user (Student, Professor, Researcher). As the system can only evaluate the KO one time, and taking into account that in open systems such as Amazon or Ebay the user remains anonymous and normally uses a pseudonym making it impossible to know what type of user it is (Rheingold, 2002), in the particular case of the formulated hypothesis the access to the institutional repository and rating of the KO is conducted in accordance to each user's access credentials.

3.1 Simplified Weighting Factor: Brief Explanation

Regarding the KO rating process, the evaluation was made based in a range of integers from one to five, which is directly related to the user's knowledge subdomain and with the KO subdomain. Therefore, at the relational level, the sub-levels of the knowledge branch of the users and of the KO were considered. This means that in the hierarchy of relations, particularly between the users and the KO, a linkage between the user's knowledge subdomain and the KO subdomain is considered. Thus, in knowledge domain, Design is taken into account on various subdomains, such as, for example, Communication Design and/or Information Design. Considering the weighting factor, it should be noted that a greater weight is assigned to users whose subdomains are directly related to the subdomain of the consulted article. Therefore, the rating of a user who belongs to the subdomain of the consulted KO has more weight than a user who does not belong to the general domain or subdomain of the KO.

Despite being outside of the scope of this article, a more rigorous approach will be considered in the rating of the KO consulted. In this context, a distinct weighting factor between users belonging to different knowledge subdomains of the same domain must be considered. This means that, if the KO consulted belongs to the subdomain Multimedia, the weight of an evaluation of a user belonging to the subdomain Communication Design should be inferior to the weight of an evaluation from a user belonging to the subdomain Multimedia. It should also be noted that both users belong to the same field of knowledge, namely Design. It would also be important to consider each different type of user, making it essential to assign different weighting factors to Students, Professors and Researchers. The modeling of relations between users of the same subdomain, although described, remains an open question that will be the subject of future studies and work.

Concerning the simplified weighting factor, the rating of an user that belongs to the knowledge subdomain of the KO consulted has a greater weight than the rating of a user who does not belong to the KO subdomain. It should be highlighted that the evaluation weight of users who belong to the same subdomain of a knowledge domain of the KO is equal. However, it presents a higher weight in comparison to a user that does not belong to the knowledge domain or subdomain of the consulted KO, as a value of one (+1) is assigned to the evaluation performed. This implies that the simplified weighting factor is associated with a correlation of the subdomain of the user and the subdomain of the KO consulted.

Thus, the weight of an evaluation would function in two directions, to improve or decrease the rating impact. A study on a parameter that balances the final evaluation is outside the scope of this article. The example included on the previous paragraph reveals the kind of complexity that could be implemented at the level of relations between the knowledge subdomains of each knowledge domain and the knowledge subdomains and the typology of users. It should be noted that the ratings assigned by users of the knowledge subdomain of the KO have greater resistance to change when compared to the ratings assigned by users that do not belong to the KO subdomain. However, if the number of evaluations performed by users who do not belong to the KO subdomain increases, the value can tend to the evaluation allocated by these users due to the increased number of evaluations.

The approach stated in this section considers a relationship based on the KO subdomain and in the user's knowledge subdomain. It should, however, be noted that in the present approach a different weighting factor was not implemented, neither in terms of subdomains nor in terms of user's type. This means that only the user knowledge subdomain was considered, despite belonging to a knowledge domain. It should also be highlighted that, in case of equated hypothesis, the views of the structures will be available only if there is a participation of the user.

3.2 Contention Hierarchical Structure: Experimental Implementation with Ordered And Squarified Treemap

The main objective of the experimental implementation is the visualization of the KO with greater relevance within a particular subdomain of knowledge. It should be noted that this experimental implementation is based on the treemap algorithm developed by Fry (2007, p. 182-219) in the programming Processing language, specifically the Ordered Treemap (SHNEIDERMAN et al., 2001), (BEDERSON et al. 2002) and the *Squarified Treemap* (*Bruls et al.*, 2000, p. 33-42) algorithms. In this sense, the main objective of this point consists in the experimental implementation of both structures. In both cases the size of the squares varies according to the relevance of the KO in a particular knowledge domain. As previously mentioned, the proportion of the areas is based on an evaluation factor, as described in section 2.1 (Simplified Weighting Factor). The two knowledge domains are defined by two colours (grey and blue): a range of grey and blue shades define the various subdomains of the two principal knowledge domains.

Regarding the treemap context, this is a visualization technique that is originally based on the algorithm developed by *Johnson et al.,* (1991) and *Shneiderman* (1992). It consists on a rectangular hierarchical structure of containment, aimed to the visualization of a large hierarchical structure of quantitative data (Card et al., 1999), (CHEN, 2006, p. 190-194). The Treemap technique is fundamentally characterized by a rectangular layout, divided into a sequence of rectangles, in which the area of each rectangle corresponds specifically to a given attribute of the data (BEDERSON et al., 2002). It is also characterized by an efficient use of the layout space when compared to horizontal or vertical relation hierarchical structures, which are very extensive structures. Thinking of disadvantages of the Treemap algorithm it is important to highlight that the rectangular shapes do not allow an efficient comparison between areas of identical proportions when randomly positioned in space, and that in the case of rectangles with very small proportions it is not possible to perfom an efficient selection of the areas (BRULS et al., 2000).

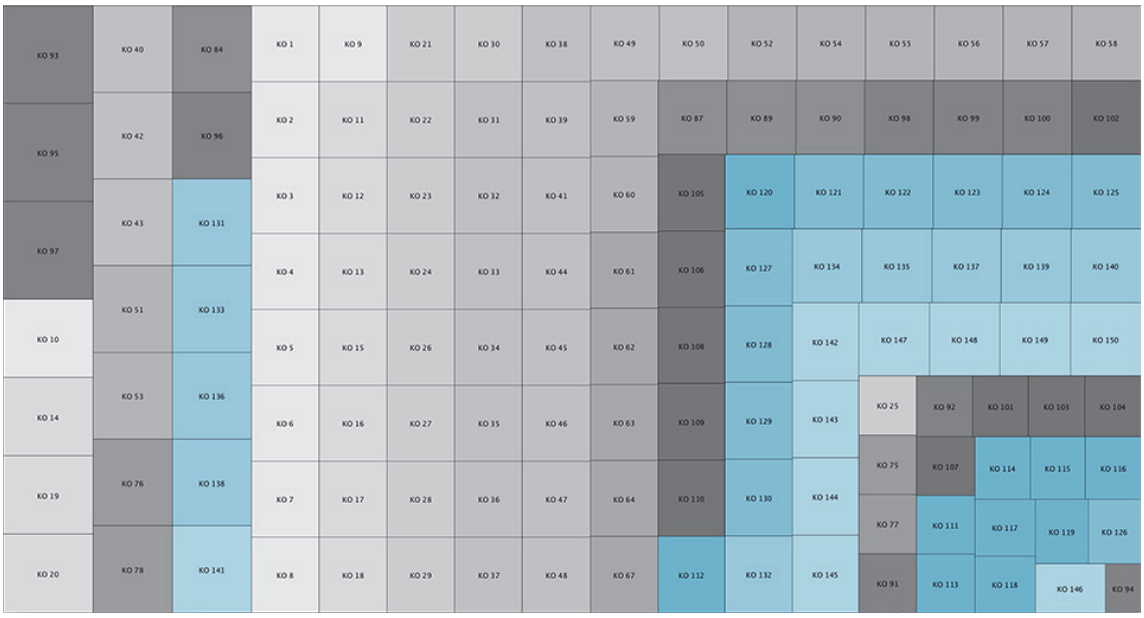

Fig. 2. Experimental implementation of the Squarified Treemap Algorithm. Bruls et al. (2000)

According to Bruls et al. (2000), the Squarified Treemap algorithm [Fig. 2.1] allows the transformation of rectangles with similar proportions into square shape proportions. That said, the main advantages of this algorithm are the efficient use of available layout space; the easier distinction and selection between square shapes when in comparison to rectangular shapes, as, even if the shape proportions are similar, it is easier to establish comparisons; and the improved presentation accuracy. As it is pointed out by Bruls et al. (2000), the main disadvantage of this technique lies in the ordering of subjacent data (sibling data), because it is not possible to establish comparisons between the subjacent data, as they are not organized according to a relation of proximity, such as by area or by colour. This means that it is not possible to establish comparisons with KO with most relevance in a specific knowledge subdomain.

Schneiderman et al. (2001) and *Bederson et al.* (2002), taking into account the several algorithms developed (*Strip/Clusters Treemaps, Squarified Treemaps,*) (MEIRELLES, 2013, p. 32), emphasize several disadvantages, despite the improvements in areas such as visualizations modes and integration of smaller proportions in a single layout. In fact, they prove to be unstable when the data is changed (Updates) and disadvantageous in comparison to the ordering and agglomeration of adjacent data, originating layouts that do not allow the establishing of comparisons, as well as efficient visualization of patterns.

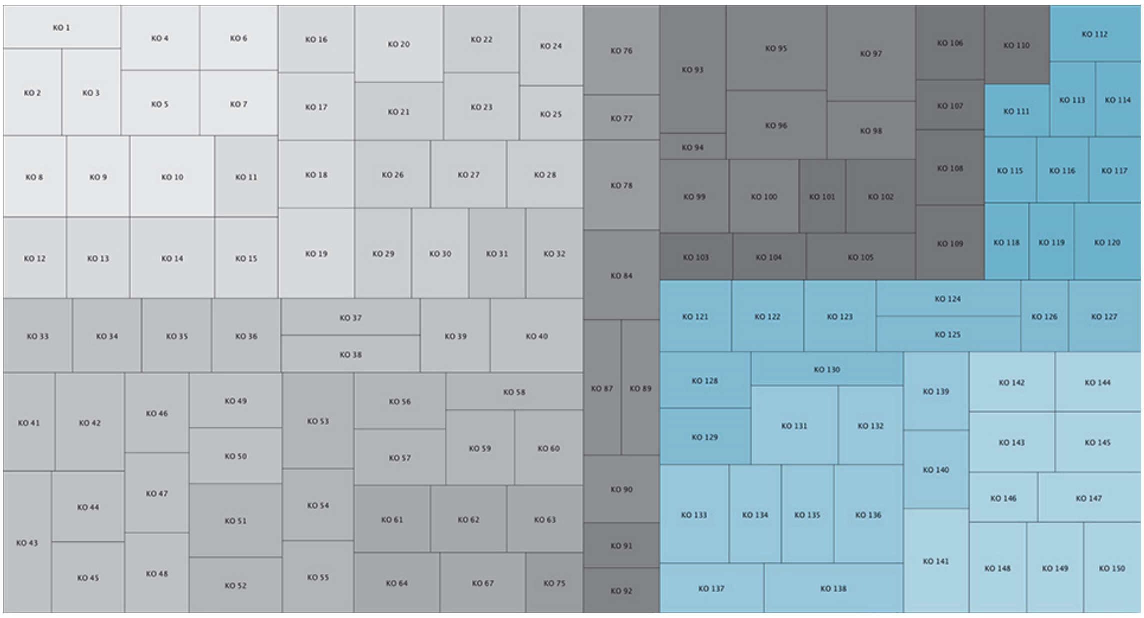

Fig. 2.1 Experimental implementation of the Ordered Treemap Algorithm. Bruls et al. (2000).

In the *Ordered Treemap* algorithm [Fig. 2.1] (Shneiderman et al., 2001), (Bederson et al. 2002) previously ordered data preserves the proximity/adjacency in the layout. In this sense, we highlight the algorithm adaptability, taking into account the problem of dynamic data representation, allowing the previously ordered data to maintain a position of proximity on the layout, as well as a balanced proportion ratio of the rectangles.

To sum up, the Ordered Treemap algorithm is distinguished by the following characteristics: in the dynamic updates the changing of the forms occurs relatively smoothly; it preserves the subjacent data order in the layout; and it generates rectangles with reduced proportion ratio.

4. Discussion And Future Work

In terms of results, and although being preliminary, it can be deducted that treemaps constitute the most efficient search solution, by translating synthetically a large structure of evidences. In this sense, the two hierarchical containment structures tested (Squarified and Ordered Treemap) allowed to provide a birds-eye perspective of the KO with greater weight within a knowledge domain. This means that the greater the rating of the KO is, the bigger is the area it occupies. In fact, each area represents a KO, and each area's size varies according to the weight of the global evaluation assigned. Taking into account the advantages and disadvantages of the studied algorithms, one must conclude that it is fundamental to establish a fusion between this two types of Treemaps, an issue that it will be studied and implemented in future work.

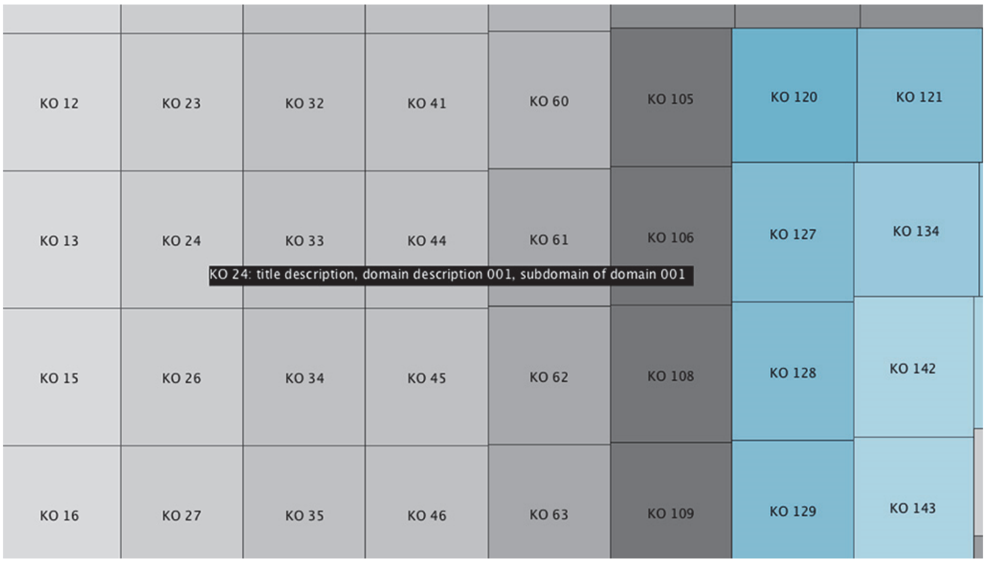

Fig. 3 Experimental implementation of the interactive tooltip (Ordered Treemap Algorithm)

Given the limited space of the areas to show relevant information about the characteristics of the KO (metadata), an interactive tooltip was implemented [Fig. 3] in order to provide specific details on the KO, specifically metadata such as ISBN, Title, Year, Author/s, title, type of KO and subdomain and the average of the ratings assigned by the community. In this sense, the tooltip is shown when a specific area of a particular KO is clicked. Tufte (2009, pp. 178-182) points out that the integration of tables, graphs and words (legends) is fundamental, because even though they belong to different systems, they have a single purpose: the presentation of information. It is nevertheless necessary to pursue improvements in areas such as presentation and communication of metadata, a theme that will be addressed in future work.

To summarize, the advantage of using this structure lies in the fact that it gives, at first glance, a panoramic view of the most relevant KO within a particular area of knowledge. It is important to emphasize that the collaborative filtering mechanism conceptualized and implemented plays a key role in allowing users to perform a more sustained and directed research on their specific theme, based on the relevance of the KO that is determined by the "wisdom of crowds."

Intending to optimize the preliminary results of this study, it is fundamental to maintain open lines for future work, the implementation of the interactive zooming techniques being one of the key components.

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O Design Sistêmico como método de inovação aplicado a fornos tradicionais de cerâmica vermelha no Amazonas – Brasil

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Resumo

Este trabalho analisa alguns sistemas tradicionais de cocção cerâmica, propondo uma nova configuração sistêmica. Mediante a avaliação da produção de blocos cerâmicos, tomamos como foco de pesquisa o processo de queima em fornos tradicionais, levando em consideraçao questões econômicas e sociais do Amazonia brasileira. Esta pesquisa tem como propósito, desenvolver um novo sistema, considerado eco-eficiente e sustentável, unindo o que é tecnicamente viável na área de tecnologias limpas, com o que é culturalmente desejável em relação aos produtos sem prejudicar os usuários de seus sistemas, bem como as relações sociais de produção que estão envolvidas durante o processo. Com base em dados levantados a partir de visitas técnicas realizadas as empresas de cerâmica da região do Iranduba e entrevistas a expertises do setor a nível nacional, observou-se outros aspectos que prejudicam a qualidade do processo de cocção cerâmica. Geralmente se utilizam fornos com queima ineficiente da lenha ou outros insumos energéticos, resultando em uma série de inconvenientes que comprometem o desempenho produtivo e econômico, causando danos ambientais, sobretudo quando se trata das pequenas e médias empresas. Em se tratando de uma análise sobre o estudo de caso, a interpretação dos dados coletados se caracteriza por um esquema não rígido, considerando que os elementos envolvidos compõem blocos conceituais que visam gerar os requisitos e parâmetros considerados essenciais a projetação de um novo sistema de queima cerâmica. Buscando materializar as necessidades e objetivos do projeto, se lançou mão do modelo de Design concorrente, abordando os aspectos formais, ergonômicos e funcionais do sistema, incorporando a estes o contexto social, econômico, tecnológico e ambiental.

Keywords: Design, estudo sistêmico, fornos olaria.

Abstract

This work analyses some traditional brick kilns cooking systems, and proposes a new systemic configuration. Upon evaluation of the production of ceramic blocks, we took the burning process in traditional ovens as the research focus, taking into account economic and social issues of the Brazilian Amazon. This research aims to develop a new system, that can be consireded both eco-efficient and sustainable. By putting together what is technically feasible in the area of clean technologies, what is culturally desirable for products without harming the users of their systems, we respect the social relations of production involved in the process. Based on data collected from technical visits in the ceramic companies of the Iranduba region, as well as the results of interviews with the expertise of the national industry, we detected other aspects affecting the quality of the ceramic firing process. In general, the stoves use inefficient burning of wood and other energy inputs, yielding a number of drawbacks that compromise the productive and economic performance, causing environmental damage, particularly when it occurs in small and medium enterprises. In this case study, the interpretation of the collected data is characterized by a non-rigid scheme, considering that the involved elements make conceptual blocks aimed at generating the requirements and parameters considered essential to design a new ceramic firing system. To realize the needs and objectives of the project, we made use of the concurrent model design, by addressing the formal, ergonomic and functional system aspects, and incorporating the social, economic, technological and environmental contexts.

Keywords: Design, systemic study, bricks kilns.

1. Introdução

Segundo dados da NEAPL/AM, 2009, a maioria das empresas de cerâmica vermelha do Amazonas, se configuram como micro e pequenas empresas à margem dos avanços da modernização tecnológica e/ou administrativa. Em sua maioria, as empresas estão organizadas com estrutura familiar, onde tanto os proprietários quanto os empregados exercem funções diversificadas.

Os aglomerados produtivos que juntos poderão evoluir para a formação de um único Arranjo Produtivo Local – APL, são compostos pelos Polos cerâmicos do Ariaú, Cacau-Pirêra e Iranduba, onde se encontram instaladas 27 empresas cerâmicas, das quais mais da metade está instalada no Polo de Cacau-Pirêra, na margem direita do rio Negro, frontal à sede municipal de Manaus (SEPLAN, 2009).

O setor da cerâmica vermelha emprega como combustíveis, principalmente a lenha nativa (50%) e resíduos de madeira (40%): cavaco, serragem, briquetes e outros resíduos. Dados do setor apontam uma tendência no aumento do uso de lenha de reflorestamento visando à sustentabilidade energética do empreendimento e levando a um excedente de biomassa para comercialização de madeira, contudo essa é uma tendência que não se aplica ainda ao âmbito de estudo desta pesquisa, havendo ainda necessidade de intervenções por parte do setor público, no que tange ao desenvolvimento de programas de reflorestamento no Amazonas voltado para esse segmento da indústria ou demais segmentos (SEPLAN - AM, 2009).

O bloco cerâmico também é conhecido como tijolo de oito furos, sendo este o produto cerâmico mais consumido em Manaus, onde 90% destes blocos provêm da região de Manacapuru e Iranduba. Esta produção abastece quase totalmente a capital, cuja distribuição da produção se divide do seguinte modo: 25% são de olarias de grande porte com capacidade de produção que pode chegar a 50.000 tijolos por dia; 25% são de olarias de médio porte com capacidade média de 30.000 tijolos diários; e os 25% restantes são de olarias de pequeno porte que não passam de 10.000 tijolos por dia. Porém, esse material é um dos que ocasiona um elevado índice de perda na construção civil, chegando a um valor médio de 13% (FURG, 2005).

Em relação ao custo médio da indústria cerâmica da região, o consumo da lenha e derivados se destaca dos demais, indicando baixa eficiência dos fornos e alto custo desse insumo. Também se observa os custos com energia elétrica, contudo os custos administrativos e referentes a comercialização são baixos. Essa relação ocorre em razão da pequena estrutura administrativa e ausência de estrutura comercial na maioria das empresas (NEAPL/AM, 2009).

Dentre as principais questões que afetam o Setor Cerâmico, principalmente o Segmento de Cerâmica Vermelha, destaca-se a baixa qualidade dos produtos, observada em uma parcela significativa da produção, em função das grandes variações dimensionais e baixa resistência mecânica observada. Este fato gera grandes perdas durante o processo produtivo. (SILVA 2007). Dentre outros fatores que influenciam essa baixa qualidade dos blocos cerâmicos, há a natureza do material utilizado, sendo a fase da queima o processo mais crítico conforme observado durante as visitas técnicas realizadas às empresas da região.

Este artigo apresenta um recorte da pesquisa, destacando uma avaliação, por parte de especialistas do setor da indústria de ceramica vermelha, sobre os processos tradicionais da produção de cerâmica vermelha, especificamente sobre os sistemas de queima ainda utilizados pelas pequenas e médias olarias a nível de Brasil. , considerando como ambiente de estudo o Pólo oleiro de Iranduba e Manacapuru, cidades próximas a Manaus, capital do Estado do Amazonas – Brasil.

Esta pesquisa se delimita aos aspectos tecnológicos sobre o processo de produção de blocos cerâmicos em fornos tradicionais que fazem uso de insumos madereiros e que apresentam as respostas a partir de um estudo sistêmico, com base no Modelo de Design Concorrente (Hernandis 2003). O estudo realizado propõe uma adaptação tecnológica entre os sistemas de queima, que funcionam a partir do modo de queima com a chama em sentido desecendente e o sistema de queima conhecido como downdraft, de acordo com os trabalhos de Khan et al (1989) apud Borges (1994), citado por Mota et al (2015), os quais demonstraram que a combustão por processo downdraft propicia a queima da lenha praticamente completa, diferenciando-se entre os processos de queima tradicionais. Esta ocorre por meio de modificações morfológicas e geométricas na câmara de combustão, tornando a combustão adiabática e invertendo o fluxo de ar.

2. Abordagem Metodológica

Em razão da concepção de um novo sistema de queima para cerâmica estrutural, considerando os aspectos relativos ao método de pesquisa utilizado, lançou-se mão de uma abordagem metodológica híbrida, incorporando a esta elementos descritivos de base teórica, observacional e de cunho qualitativo por meio de pesquisa junto a expertises e empresários do setor da cerâmica vermelha a nível nacional e local.

Esta pesquisa analisa dois sistemas tradicionais de cocção cerâmica, propondo uma geometrização sistêmica analítica com base no método sugerido por Hernandis (2003), cujo propósito se fundamenta sob as práticas orientadas para analisar e desenvolver com mais especificidade os aspectos funcionais, formais, ergonômicos, culturais, sociais e tecnológicos do produto. Os resultados preliminares desta aplicação gerou um novo modelo respeitando os parâmetros conceituais do sistema em estudo.

O modelo de design concorrente, baseado na teoria geral de sistemas, proposto por Hernandis (2003) para a criação de produtos inovadores, representado pela figura 01, centra-se na definição de todos componentes intervenientes no processo de design, para definir o produto. Com base em toda a informação recopilada, definem-se os aspectos formais, funcionais e ergonômicas do produto como subsistemas principais na formulação de atributos e na emissão de variáveis que circulam dentro de um sistema vivo para a formulação de uma solução (Paixão-Barradas, Pacheco, & Hernandis, 2012) apud (Mota et al 2015) e (Rivera et al 2015). O uso de um modelo sistémico especifico, como este, justifica-se pela possibilidade que este oferece em poder examinar as variáveis necessárias para o design do produto, considerando a dinamicidade e constante atualização que os produtos devem possuir para manter-se no mercado ou cativar outros mercados. Uma forte característica deste modelo é sua plasticidade através da retroalimentação das informações e consequentemente do feedback de todas as partes que compõem o modelo, nas quais as próprias variáveis se tornam nas responsáveis por analisar, comprovar e manter todo o sistema ativo e controlado (Pacheco, Hernandis, & Paixão-Barradas, 2012). Tomando como referência as definições de Briede e Hernandis (2011), as análises dos subsistemas e relações comuns entre os dois tipos de fornos estudados, demonstram como a partir da definição abstrata, inicial do projeto, elementos comuns podem ser definidos para uma representação maior de produtos, independentemente de suas características de forma. (BRIEDE e HERNANDIS, 2011).

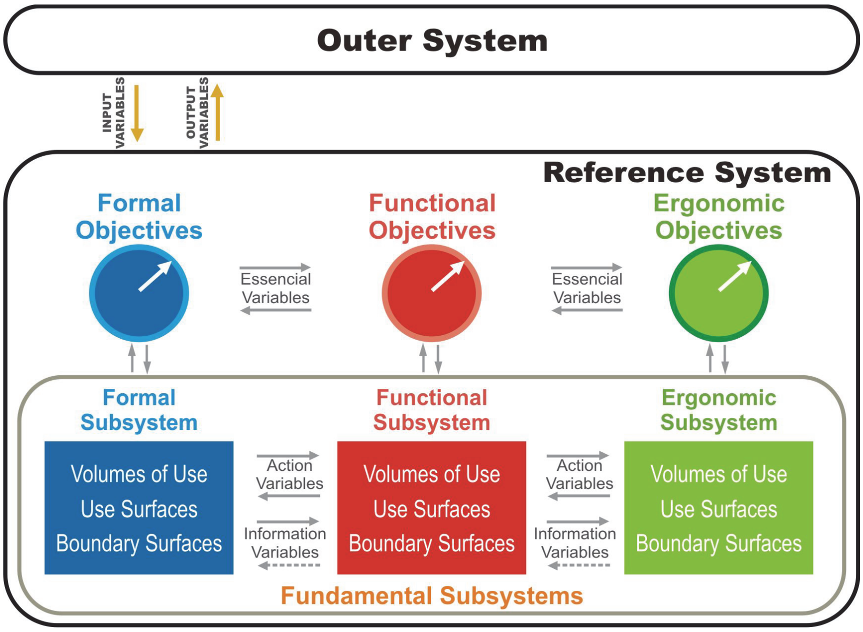

Fig. 1 Modelo de Design Concurrente. Fonte: Adaptado de Hernandis (2003) e Rivera et al (2015).

Esta fase da pesquisa, corresponde aos aspectos práticos, especificamente as fases de coleta e compilação de dados em busca de informações junto a especialistas, bem como no desenvolvimento de uma aplicação, seguindo os conceitos estabelecidos pelo modelo de design concorrente. Desta forma se evidencia descritivamente as variáveis essenciais e informacionais do sistema em estudo, para propor um novo conceito que atenda os objetivos da pesquisa.

Ficou estabelecido, por meio do percurso metodológico atribuído a esta pesquisa, que as variáveis que alimentam e movimentam este sistema teria como fonte os resultados das pesquisas teóricas, por meio de consulta bibliográfica, pesqusia de campo e entrevistas a expertises do setor da indústria e da pesquisa, assim como empresários do pólo oleiro estudado. Os objetivos que direcionam a pesquisa prática no que se refere a entrevista a especialistas, busca analizar por meio de uma estrutura de questionários virtuais, basicamente três objetivos principais, estando presentes em todos os contetxtos, quais sejam: a) avaliar o que existe; b) levantar as necesidades para resolução do problema e; c) validar as quetões conceituais desenvolvidas para o sistema em estudo.

Antes de elaborar o instrumento da entrevista, buscou-se entender os fundamentos psico-sociais que envolve o processo de entrevistas. O desenvolvimento do instrumento de pesquisa a especialistas obedece a uma estrutura lógica, conforme sugerido por Dillman (1978, p. 12), que afirma: … "o processo de mandar um questionário a respondentes em potencial, conseguir que completem e devolvam o questionário de maneira honesta pode ser visto como caso especial de 'troca social' ". Complementando a abordagem, o mesmo autor também coloca que há três fatores que devem ser considerados a fim de maximizar a qualidade das repostas (Dillman, 1978, p. 18), como por exemplo: reduzir o custo de resposta por parte do respondente, recompensar o respondente e establecer confianaça.

O questionário elaborado considera o objetivo da entrevista em termos dos conceitos a serem pesquisados e da população-alvo. Utilizando-se como ponto de partida as considerações de Schuman & Kalton (1985), resumidas na Figura 02. Diante do esquema que esclarece a relação existente entre os elementos que constituem uma entrevista, apresenta-se na seqüencia seus objetivos, os conceitos derivados destes, bem como a identificação da população e da amostra. Também se apresentam os elementos técnicos da entrevista, como: a) Os itens da entrevista, representados pelas questões / perguntas do instrumento, constantes anexados ao relatório final desta pesquisa; b) O modo de administrar, representado pelo meio de difusão da entrevista (questionário online); c) Método de edição e codificação dos dados; d) Método de processamento dos dados e; e) Análise dos dados por meio de representação gráfica.

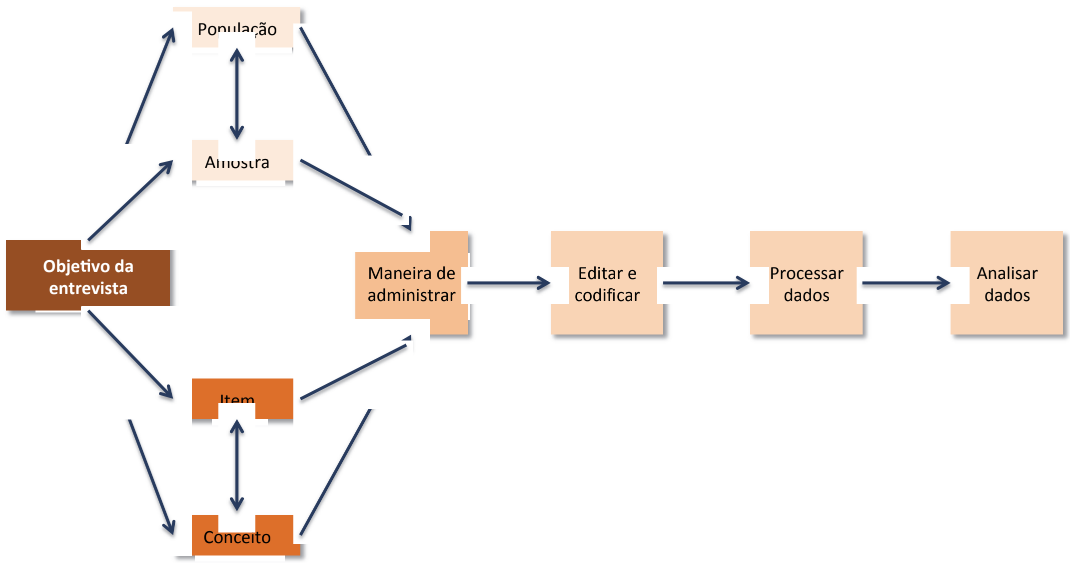

Figura 02: Arquitetura conceitual de uma entrevista. Fonte: Schuman & Kalton (1985)

O objetivo principal desta entrevista foi coletar dados que consolidassem as informações sobre a temática desenvolvida na pesquisa. Os itens da entrevista envolvem os aspectos relacionados ao processo produtivo com ênfase na queima em fornos tradicionais. Desta forma foram analisados os aspectos tecnológicos, ergonômicos, ambientais e culturais, compondo parte do contexto investigativo para o desenvolvimento de um modelo de forno mais eco eficiente, que responda sobretudo as necessidades de desenvolvimento sustentável para este setor.

O universo estudado, seleção e tamanho da amostra investiga um grupo de especialistas e empresários locais, que pelo critério de tipicidade faz parte do contexto investigado. Foram selecionados 18 expertises das áreas de tecnologia cerâmica, ciências ambientais, ergonomia industrial, materiais industriais, engenharia civil e engenharia de produção, assim como 8 empresários de pequeno e médio porte do Polo Oleiro de Iranduba. O tipo de amostra dentro do espaço amostral definido se caracteriza como não-pro balística, ou seja, selecionada pelos critérios de acessibilidade e tipicidade.

O processo de análise e interpretação dos dados desta pesquisa varia em função dos diferentes aspectos que estruturam a mesma, e seguem os passos orientados por Carvalho e Vergara, 2002, p. 84.

3. Discussão dos resultados da entrevista a expertises e empresários do setor da cerâmica industrial.

O método de pesquisa qualitativa utilizada se caracterizou como: a) Estudo de Caso: Este método de pesquisa qualitativa é um estudo profundo de um indivíduo ou fenômeno específico no seu contexto de vida; b) A Coleta de dados: Entrevistas – Questionários escritos e estudos indutivos sobre aspectos, percepções e pensamentos observados a partir dos estudos em pesquisa exploratória e; c) Organização da entrevista. em 4 (quatro) blocos conceituais, abordando os aspectos relacionados a pesquisa, cujos gráficos encontram-se anexado ao relatório de pesquisa geral e que por uma questão didática não se insere aqui neste artigo.

As primeiras questões apresentadas aos especialistas, conforme mostra o gráfico 01, detectou o nível de aceitação dos sistemas tradicionais de cocção cerâmica, que ainda fazem uso de combustíveis lenhosos. Os resultados da entrevista apontam que estes sistemas ainda são indispensáveis para o abastecimento da cadeia produtiva, considerando que grande parte dos produtores de tijolos e telhas, dentro do âmbito nacional, ainda fazem uso destes sistemas por questões de viabilidade técnica e sobretudo econômica.

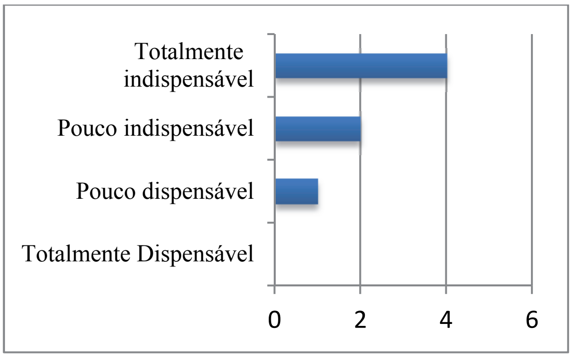

Gráfico 01: o nível de aceitação dos sistemas tradicionais de cocção cerâmica

Conforme apresenta o gráfico 02, os expertises corroboram com os dados apontados pela literatura consultada (VASCONCELOS et al 2012), estes fornos ainda predominam o segmento da indústria cerâmica nacional. Desta forma pode se dizer que o desenvolvimento de um sistema de queima ecoeficiente irá contribuir de forma significativa para o setor a nível nacional. Isso fortalece a ideia desenvolvida por esta pesquisa, que é tornar mais eco eficiente o sistema tradicional da queima cerâmica.

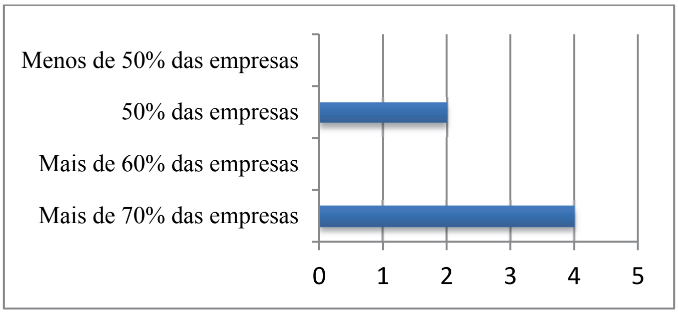

Gráfico 02: Predominancia dos fornos de queima tradicional no cenário nacional.

Considerando a hegemonia da área de conhecimentos dos expertos entrevistados, são agrupados por blocos os aspectos tecnológicos, ergonômicos, ambientais e sócio/culturais. O bloco de entrevista referente aos aspectos sócio culturais foram dirigidos diretamente aos empresários da zona estudada (polo oleiro de Iranduba). Os aspectos investigados junto aos expertises e empresearios do setor forneceram os dados necessários para consolidar as ideias pré-estabelecidas por meio de levantamento bibliográfico e observacional em campo, além disso, estes dados alimentaram o modelo de design concorrente, utilizado como método de desenvolvimento do novo sistema e foram explorados em quatro blocos distintos por meio da entrevista. Estes blocos perfazem todo os contexto investigado e extrapolado pelo MDC, sendo estes:

1) O aspecto tecnológico buscou identificar características gerais da produção com foco na queima envolvendo o sistema exterior, de acordo com o M.D.C (Hernadis 2003), considerando a tipologia dos fornos tradicionais mais utilizados por pequenas e medias empresas. Os expertises do setor da indústria foram questionados quanto as características das necessidades de inovação em função da acessibilidade tecnológica e sobre os critérios de produtividade, ganhos econômicos e qualitativos da produção, além das características estruturais e operacionais mais comuns e mais representativas, entre os modelos de fornos "abóboda" e "paulistinha", que de acordo com Vasconcelos et al (2012), estes modelos de fornos fazem parte do contexto produtivo de quase todas as empresas do polo oleiro do Estado do Amazonas.

2) O aspecto ergonômico: Qualquer ambiente de trabalho deve buscar adequações ergonômicas que reduzam as exigências biomecânicas e cognitivas dos operadores do sistema, permitindo que o mesmo se sinta confortável para executar suas tarefas. Os atributos macro ergonômicos da produção, foram identificados por meio de algumas características, com foco na queima, envolvendo os aspectos do ambiente de trabalho e sua influência sobre o operador do sistema de queima. Além disso, foram detectados alguns aspectos que relacionam a tipologia dos fornos tradicionais utilizados, como disfunções e riscos acidentais sofridos pelo executor da tarefa destes sistemas.

Considerando o contexto macro ergonômico, os entrevistados avaliaram por grau de importância as seguintes questões: a) o grau de importância da exposição ao calor proveniente do processo de queima sofrido pelo operador do sistema; b) o grau de importância dos riscos acidentais, aos quais está exposto o operador do sistema; c) o grau de importância da pouca iluminação durante a execução da tarefa do forneiro; d) o grau de importância do ruído para com o desempenho do operador do forno; e) o grau de importância dos agentes químicos, resultantes das características ambientais locais, as quais estão expostos os operadores do sistema de queima e; f) o grau de importância da umidade resultante das características ambientais locais, as quais estão expostos os operadores do sistema de queima;

3) Aspecto Ambiental: Este bloco aborda os aspectos tecnológicos da produção dos fornos que fazem uso de combustíveis madeireiros, considerando os parâmetros ideais de otimização da produção em termos de ganhos produtivos e ambientais, avaliando por grau de importância as seguintes questões: a) a queima eficiente que promova redução de insumos madeireiros, da lenha ou outro material combustível; b) a redução de perdas produtivas em função da melhoria do processo de queima; c) a redução de resíduos e poluentes; d) a melhoria do produto final, a partir da melhoria do processo.

Os resultados apontam que a maioria dos entrevistados atribuíram valores de significativa importância para todos os itens, que representam alguns parâmetros ideias de otimização da produção, considerando os ganhos produtivos e ambientais. Esta pesquisa avaliou alguns aspectos ambientais da produção, que envolvem a utilização de insumos madeireiros, bem como o desperdício dos mesmos. Esta avaliação teve foco na queima cerâmica, envolvendo os aspectos ambientais do sistema exterior, abordado pelo MDC (Modelo de Design Concurente), por Hernandis 2003;

4) Aspecto Sócio/Cultural: Os aspectos sócio/culturais que influenciam a falta de modernização das pequenas e médias empresas, a partir do foco da pesquisa, que estuda um dos elos mais críticos desta cadeia produtiva (sistema de queima), este bloco de questões, avaliou dentre os especialistas e empresários do setor, alguns aspectos que influenciam a falta de modernização das pequenas e médias empresas.

Considerando que a maioria das empresas de cerâmica vermelha do Estado do Amazonas se configuram como micro e pequenas empresas à margem dos avanços da modernização tecnológica e ou administrativa, foi verificado dentre os entrevistados algumas razões pelas quais este fato ainda se justifica, sendo julgado por grau de influência elementos que contribuem e/ou explicam este status tecnológico.

Os resultados apontam que a maioria dos entrevistados concordam que a falta de acesso a tecnologias economicamente viáveis influencia muito essa realidade e que o atraso tecnológico é um reflexo das características do setor. Além disso, ao se verificar o resultado, é observado que os entrevistados possuem opiniões divergentes, no que diz respeito a falta de compromisso com as normas vigentes, por parte dos empresários e/ou não cobrança devida por parte dos setores públicos responsáveis, caracterizando responsabilidades mútuas, considerando que os agentes, tanto empresários, como poder público possuem uma cota igualitária neste contexto. A última questão deste bloco avalia se a falta de conhecimento, por parte dos empresários, em relação a outras e novas tecnologias também influenciaria para com a continuidade do atraso tecnológico nas pequenas e médias olarias do Estado do Amazonas. Os resultados confirmam a existência de uma influencia significativa neste sentido, permitindo ressaltar que o direcionamento deste estudo para a realidade observada poderá suprir esta demanda de informação e acesso a novas tecnologias, tornando-se justificável o desenvolvimento de um novo sistema que proponha uma alternativa satisfatória.

A partir dos resultados obtidos com a pesquisa realizada por meio de consulta bibliográfica, pesquisa observacional, entrevista a expertises do setor industrial cerâmico e empresários do polo oleiro de Iranduba – Manaus, AM, ficam estabelecidos alguns requisitos de projeto, considerados variáveis de ordem qualitativa e quantitativa que orientam e delimitam o desenvolvimento do novo sistema. Estes requisitos permitem gerar, por meio de parâmetros técnicos, alternativas solucionadoras para o problema pesquisado.

Com base nos aspectos investigados, que refletem os objetivos propostos pelo MDC (Modelo de Design Concorrente, Hernandis 2003), foram organizados em grupos de requisitos, correspondentes as características do problema de pesquisa. Estes grupos de requisitos são apresentados e ordenados pela tabela 01.

Tabela 01: Parametrização do Projeto

Requisitos Tecnológicos de projeto	**Parâmetros tecnológicos de projeto**
1) Utilizar sistema de queima invertida; 2) Os fatores técnicos operacionais devem ser considerados essenciais no que diz respeito a influência destes sobre a qualidade final dos blocos cerâmicos, otimizando os elementos de apoio que compõem os subsistemas; 3) Manter padrão de queima da carga; 4) Gerar calor gradativo com respeito a curva de queima; 5) Modificar a geometria do queimador; 6) A curva de queima deve ser monitorada; 7) O modo do empilhamento da carga na câmara de cocção deve ser planejado, considerando melhor aproveitamento da temperatura; 8) A regulagem e alinhamento dos queimadores devem ser consideradas essenciais; 9) A disposição espacial dos queimadores deve ser considerada em função da distribuição homogênea dos gases quentes durante o processo de queima; 10) Deve haver uma relação funcional e sub sistêmica entre o formato da câmara e os queimadores; 11) Deve ser contemplado o isolamento das paredes dos fornos.	• Utilizar processo de queima adiabática; • Otimizar os aspectos técnicos em função do processo de queima adiabática; • A curva de queima deve ser monitorada com a utilização de medidores digitais; • O modo do empilhamento da carga na câmara de cocção deve ser realizado, considerando melhor aproveitamento da temperatura, fazendo uso do método de empilhamento em xadrez (checkerwork) ou em camadas longas (benches), conforme sugerido por Fonseca (1997) apud F. H. Norton (1973), de maneira que permita a circulação dos gases, para se obter uma máxima regularidade da temperatura e do calor. Uma colocação em demasiadamente aberta ou separada permite que os gases passem com certa facilidade, o que não é aconselhável; • A regulagem e alinhamento dos queimadores devem ser consideradas essenciais, respeitando o método de alimentação das fornalhas, conforme a técnica de queima adiabática e o controle da curva de queima; • A disposição espacial dos queimadores deve ser considerada em função da distribuição homogênea dos gases quentes durante o processo de queima; Deve haver uma relação funcional e sub sistêmica entre o formato da câmara e os queimadores; Deve ser contemplado o isolamento das paredes dos fornos; • Deve haver uma otimização espacial e geométrica entre os subsistemas que operam conjuntamente com os queimadores e câmara de cocção.
Requisitos Ergonômicos de projeto	**Parâmetros ergonômicos de projeto**
1) Melhorar aspectos macro ergonômicos (conforto ambiental); 2) Melhorar a manipulação da carga antes e depois da queima; 3) Adaptar e ou melhorar os elementos de acionamento dos sistemas; 4) Reduzir a exposição do trabalhador aos agentes nocivos do processo de queima.	• O novo sistema de queima deve oferecer as condições devidas para que o operador do forno não se exponha ao calor emanado dos queimadores de combustível, não entre em contato com poluentes, como fumaça, agentes químicos e não se exponha a riscos acidentais durante o processo de abastecimento das fornalhas; • Deve haver a inserção de um sistema de coleta de cinzas proveniente da queima para facilitar a manutenção e limpeza; • A adaptação do processo de queima adiabática promove a queima da chama em

	sentido invertido, evitando que o operador do sistema entre em contato com as chamas; • O sistema de tiragem (chaminé) promove tanto o direcionamento do fluxo dos gases quentes para a área interna da câmara, quanto o direcionamento da fumaça ocasionada pela queima;
Requisitos Ambientais de projeto	**Parâmetros Ambientais de projeto**
1) Reduzir fumaça e poluentes provenientes da queima; 2) Redução de perdas produtivas; 3) Redução de insumos madereiros como fonte energética de queima.	• Deve haver uma redução da queima dos insumos a partir da otimização da queima dos mesmos por meio de sistema adiabático; • Deve haver uma adaptação entre o processo de queima tradicional e queima adiabática, proporcionando eficiência da queima dos insumos, que consecutivamente reduzirá perdas produtivas.
Requisitos Sócio / Culturais de projeto	**Parâmetros Sócio / Culturais de projeto**
1) Manter a geometria predominante dos fornos paulistinha e abóboda; 2) Manter os materiais constitutivos comumente utilizados na construção de fornos tradicionais; 3) Quebrar paradigmas do retardo tecnológico das pequenas e médias olarias; 4) Motivar e viabilizar o acesso a tecnologias economicamente viáveis; 5) Motivar o compromisso com o meio ambiente.	• Deve haver uma interlocução estrutural que relacione os parâmetros constitutivos, formais e funcionais, considerando simplicidade da forma, utilização de materiais de fácil aquisição no mercado local e utilização de técnicas construtivas já conhecidas na construção dos fornos tradicionais; • Os custos de implantação do novo sistema deve se adequar a realidade das PIMES; • O novo sistema deve ser versátil do ponto de vista da adaptabilidade combustível; • A formatação do novo sistema de queima deve atender aos requisitos funcionais e operacionais, representando uma adequação do item viabilidade técnica e viabilidade econômica.

Todos estes requisitos e parâmetros encontram-se distribuídos e interrelacionados no modelo sistêmico aplicado ao desenvolvimento do novo sistema de queima. A aplicação deste método para esta pesquisa se restringiu as análises estrutural, funcional e morfológica, por meio do qual se reconheceu e compreendeu os tipos e números de componentes dos subsistemas envolvidos, bem como princípios de montagem, tipologia de união e estruturas de suporte. A análise funcional permitiu se avaliar as funções técnicas e físicas de cada subsistema, incluindo aspectos ergonômicos (macro análise) do ponto de vista da ergonomia ambiental. Com base em tais análises, as informações daí advindas compuseram a estrutura subsistêmica absorvida pelo modelo de design concorrente (Hernandis 2003).

3.1. Aplicação do Modelo de Design Concorrente ao Estudo de Caso – Resultados preliminaries.

Este artigo apresenta a aplicação deste modelo de forma resumida, considerando que a representação completa e aplicada do MDC tornar-se-ia ilegível neste documento, em função de sua estrutura gráfica, portanto, foram resumidas as definições do sistema exterior, objetivos e os subsistemas formal, ergonômico e funcional, bem como suas relações com os aspectos sócio culturais, ambientais e tecnológicos, apresentando desta forma os conceitos técnicos do novo sistema de queima para cerâmica estrutural tradicional.

No geral a estrutura do modelo sugerido por Hernandis (2003), tem como objetivo analisar os vários fatores externos ao problema estudado, considerando as interfaces entre o que se está estudando e estes fatores.

A figura 03 apresenta a aplicação deste Modelo de Design Concorrente, como método sistêmico aplicado ao estudo em questão. O Sistema Exterior, prevê especificamente as variáveis de entrada (VE) que determinam o funcionamento do sistema estudado, compondo os objetivos Formais, Funcionais e Ergonômicos do produto. Estes objetivos representam a conversão da problemática detectada por meio da análise do problema, em metas a serem alcançadas. Estas metas possuem VE - Variáveis Essenciais que se relacionam entre si e que formam os subsistemas Formais, Funcionais e Ergonômicos, respectivamente. Entre cada um destes subsistemas, interatuam as diferentes variáveis de ação e de informação que estabelecem o vinculo e a interação, indispensáveis ao funcionamento do modelo. A partir dos subsistemas se estabelecem os volumes de uso, as superfícies de uso e os limites de contorno do produto, elementos delimitadores dos parâmetros que devem possuir o produto conceitual, retroalimentando o modelo e fornecendo assim os meios para se alcançar as metas do projeto.

Os subsistemas funcional, ergonômico e formal foram estudados e desenvolvidos de acordo com as variáveis essenciais e informacionais, advindas de todos os critérios, requisitos e parâmetros definidos como indispensáveis. Considerando que o produto desenvolvido se trata de um sistema aberto e definido como um conjunto de elementos que se relacionam entre si e com o ambiente, havendo, portanto, contextos diferenciados e ao mesmo tempo integrados, sujeitos a sofrer interferencias positivas e negativas, dependendo do modo como este se interfaceia. Neste sentido a estrutura do sistema macro foi dividida em áreas de estudo, sendo elas: a) Área de queima (fornalha, grelha e cinzeiro); b) Área de queima e difusão dos gases (crivos, base subterrânea e chaminé) e; c) Área de empilhamento e queima de carga (câmara, portas e teto). Sobre todas estas áreas e relacionado a cada susbsistema (funcional, ergonômico e formal) todas as áreas foram representadas e desenvolvidas respeitando o volume de uso, superfície de contorno e superfície de uso.

De posse das observações e compilação dos dados acerca do ambiente e influencias que se relacionam com este sistema, foram obtidos, por meio de critérios relativos aos aspectos concernentes ao forno de queima cerâmica, os objetivos formais, funcionais e ergonômicos do novo sistema de queima. A partir da definição de tais objetivos como resultante das variáveis de entrada, foi desenvolvido uma modelagem préliminar de acordo com critérios funcionais, volumétricos e de usabilidade de produto.

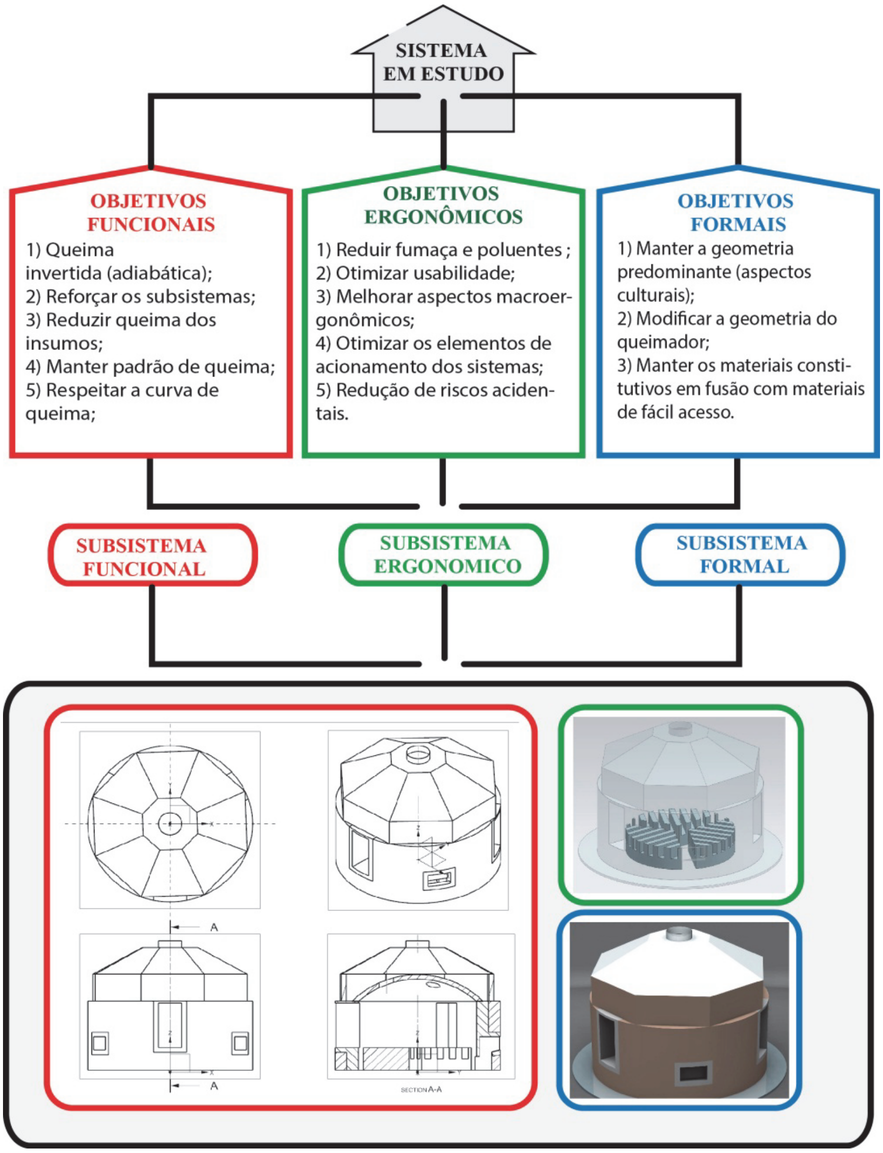

Figura 03: Representação resumida da aplicação do Modelo de Design Concorrente aplicado a fornos tradicionais de cerâmica vermelha no Amazonas - Brasil

4. Conclusão

O objetivo desta pesquisa tem como cerne a queima da cerâmica vermelha, cuja motivação se justifica a partir do forte apelo de cunho sustentável que possui, considerando que os resultados pretendidos irão contribuir de maneira considerável para a minimização da queima irregular de lenha, poluição do ar, bem como tornar mais eficiente o processo produtivo e melhorando a qualidade final do produto (tijolo).

A análise sobre a produção de cerâmica vermelha se justifica em função de sua grande projeção de uso em meio as empresas de pequeno e médio porte na região estudada, considerando que todas as empresas utilizam esses modelos de fornos, sejam eles de uso exclusivo ou não. As informações aqui apresentadas se respaldaram tanto em observações realizadas em chão de fábrica, como em entrevistas a expertises do setor e junto aos empresários

Também é importante colocar, que este processo, considerado tradicional, em função de suas características ainda rudimentares, é o segmento produtivo que abastece o setor da indústria civil local, em forte crescimento no Estado do Amazonas, contudo, em função das adversidades e limitações existentes no contexto produtivo da cerâmica estrutural tradicional e especificamente amazônico, torna-se cada vez mais necessário e justificável a implementação de mecanismos que possam auxiliar o desenvolvimento de produtos eco eficientes para a indústria, sobre os quais possam atuar os elementos indispensáveis à redução dos impactos ambientais negativos, assim como o uso racional dos recursos naturais.

A utilização do método de Design concorrente para este trabalho, sugerido por Hernandis (2003), possibilitou tanto uma análise pormenorizada do problema em questão, quanto a realização de uma modelagem teórica e prática que se materializará em forma de sistema inovador de queima para cerâmica estrutural, fazendo-se cumprir todos os requisitos inerentes a esta pesquisa.

Os benefícios originados a partir da contribuição do Design Sistêmico para o desenvolvimento de um novo sistema de queima se concretizará por meio dos testes simulados em protótipo, os quais serão divulgados com a continuidade desta pesquisa, contudo os resultados preliminares adiantam a eficácia do método de modelagem sistêmica, garantindo uma estrutura concreta de desenvolvimento projetual.

5. Agradecimentos

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Development of the Happiness Index in a country

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Abstract

In this paper, a Happiness Index is built through the Human Dignity Respect Index which is explained by Author (2014). The index is created using three main values: development, freedom and equality. But the equality is explained by solidarity, justice and peace. Then, the Happiness Index is developed with this five concepts. The aim of this paper is to obtain the minimum quantitative variables to explain these values as well as to obtain a generic formula, which allows measuring the happiness of a country/region. The term "generic" is introduced because this formula could be extrapolated to any country. The variables to obtain the Development Index are health (Life Expectancy at birth), income (Gross National Income per capita), education (Mean year of schooling and Expected years of schooling) and education quality (Primary school teachers trained to teach, Performance of 15-year-old students in reading, mathematics and science, Pupil–teacher ratio, primary school and Public expenditure on education). The Freedom Index is calculated through Net migration rate, International inbound tourists, Exports and imports and Research and development expenditure. In the case of Solidarity Index, the variables are At-risk-of-poverty rate, Share of total population living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames of floor and Material Deprivation rate. Prison population and Homicide rate are the variables which are used to obtain the Peace Index. Finally, the Justice Index is calculated with Police Officers, Professional Judges, Prison population and Crimes and violence. In this work the index is calculated for a selection of countries of European Union (Austria, Croatia, Cyprus, Czech, France, Iceland, Latvia, Lithuan, Portugal, Slovenia, Spain, Sweden and United Kingdom). This selection is produced because the data information is not available for all countries. The data information is obtained from EUROSTAT and the Human Development Report (UNDP, 2014). Finally, the Happiness Index has been compared with Overall Life Satisfaction Index from UNDP (2014).

Keywords: *Happiness Index, UNDP, Overall Life Satisfaction Index.*

1. Introduction

The interest to measure the happiness is increasing in last years. Authorities, academic and professionals are committed to improve nonmonetary welfare of people.

In this paper, a Happiness Index is built with quantitative variables that are defined in the United Nations Development Report (UNDP) and EUROSTAT.

The literature review shows differents authors who try to measure the happiness of people through satisfaction enquiries. George Gallup created the GNW (Gross National Well-Being), in which the state of person is measured from 1 to 10. The scale of life satisfaction of Diener (1985), in which happiness is measured by 5 questions that are answered on a scale from 1 to 7. The scale of subjective happiness created by Lyubomirsky (1999), where four questions measurethe happiness on a scale from 1 to 7.

Moreover, there are other organizations that try to measure the happiness of a country, as The Happy Planet Index (*HPI*) is a measure which captures the degree to which long and happy lives are achieved per unit of environmental impact. It is calculated through, life expectancy at birth, Experiencec well-being ladder of life (Gallup) and ecological footprint. Or the Overall Life Satisfaction Index that is created by created by Adrian G. White and is used in the UNDP Reports. In this calculation, subjective well being questions are involved about health, wealth, and access to basic education.

The Index presented in in this work is calculated through the terms that Caselles A. proposes in his research “Trying to evaluate the human dignity in a social group” which was presented in 9th Congress of the European Union of Systems (UES-EUS). Valencia (Spain), 2014. There, an exhaustive analysis of the literature has been done to conclude that the supreme value is Human Dignity and a Human Dignity Respect Index has been proposed.

In this work, the Happiness Index has been built from the Human Dignity Respect Index. Immediate subordinated values to human dignity are *development*, *freedom* and *equality*. Subordinates to equality are *solidarity*, *justice* and *peace*. In Figure 1 the causal diagram shows the relation between them.

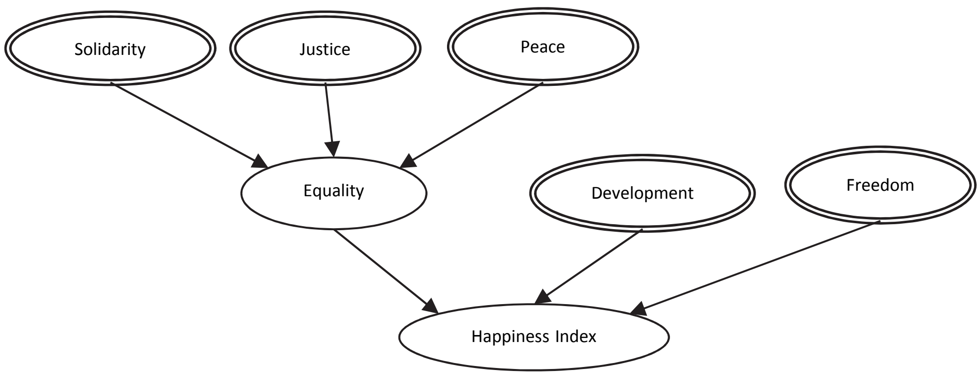

Fig 1. Causal diagram of the degree of respect to Human Dignity (which is considered equivalent to the Happiness Index).

The aim of this paper is to obtain the minimum quantitative variables to explain these values as well as to obtain a generic formula, which allows measuring the happiness of a country/region. The term “generic” is introduced because this formula could be extrapolated to any country, nevertheless in this work the index is calculated for a selection of countries of European Union (13 countries) in 2013, because the data information is not available for all countries in the UNDP (2014) and Eurostat.

The rest of the paper is organized as follows. Section 2 presents, explains and builts the Happiness Index through the five subindices: Solidarity, Justice, Peace, Freedom and Development. Section 3 shows the value of these subindex in the different countries. The Happiness Index and the relation with the Overall Life Satisfaction Index are developed in Section 4. Finally, some conclusions and suggestions for future research appear in Section 5.

2. Happiness Index Formula

The methodology to obtain the Happiness Index is the methodology used in UNDP Reports.

Minimum and maximum values (values limits) are determined to transform the real variables into variables with values between 0 and 1. With this method, all variables can be used in the same formula because they have the same dimension.

The minimum and maximum values are obtained by two different ways. On the one hand, the variables which are obtained from UNDP Reports, in this case the maximum and minimum value are selected from a temporal serie (1996-2014) for all countries are considered in these Reports- On the other hand, the variables obtained from EUROSTAT, the maximum and minimum are chosen from a temporal serie (2000-2014) for the countries studied in this paper.

2.1 Development

The definition of Development from Caselles (2014) is "*Options of survival and self-fulfillment. It includes: life/health, social progress (education, culture, etc.) and standard of life (economic resources, comforts, etc.).*".

It is related with the Human Development Index (*HDI*). Nevertheless, the *HDI* is not used in this paper because the Happiness Index is built per gender. The Gender Development Index (*GDI*) is also calculated in the (UNDP). The new *GDI* measures gender gaps in human development achievements by accounting for disparities between women and men in three basic dimensions of human development: health, knowledge and living standards using the same component indicators and the same methodology than in the *HDI*.

Note that the *GDI* reveals the level of delay experienced by women respect to males and how much women advance in every dimension of human development to bridge the delay. This index provides some insight into real gender differences in human development achievements, and is useful to design regulatory tools to reduce the differences. But, the *GDI* is not the variables used to study the development, other variables have been used to obtain the development, and it is explained in the following paragraphs.

The quantitative variables used for this measurement are related with the *GDI* and are explained in detail in the UNDP.

LEBI "Life expectancy at birth: Number of years a new born infant could expect to live if prevailing patterns of age-specific mortality rates at the time of birth stay the same throughout the infant's life.

$$lebi = \frac{1}{\dfrac{prpf}{\left(\dfrac{lebf - 22.50}{87.50 - 22.50}\right)} + \dfrac{prpm}{\left(\dfrac{lebm - 17.50}{82.50 - 17.50}\right)}} \quad (1);$$

$$prpf = \frac{popf}{popt} \quad (2); \qquad prpm = \frac{popm}{popt} \quad (3).$$

Where *LEBF* and *LEBM* are the Female and Male Life Expectancy at Birth respectively. *PRPF* and *PRPM* are the Females and Males proportion. *POPF* Female population, *POPM* Male population and *POPT* Total population.

MYSC Mean year of schooling: Average number of years of education received by people ages 25 and older, converted from education attainment levels using official durations of each level.

EYSC Expected years of schooling: Number of years of schooling that a child of school entrance age can expect to receive if prevailing patterns of age-specific enrolment rates persist throughout the child's life.

EDIF and *EDIM* are the Education Index by gender, which is calculated by education variables, *MYSC* and *EYSC*.

$$edif = \frac{\dfrac{mysf - 0}{15 - 0} - \dfrac{eysf - 0}{18 - 0}}{2} \quad (4);$$

$$e\dim = \frac{\dfrac{mysm - 0}{15 - 0} - \dfrac{eysm - 0}{18 - 0}}{2} \quad (5);$$

Where *MYSF* and *MYSM* are the Female and Male mean year of schooling respectively and *EYSF* and *EYSM* are the Female and expected years of schooling respectively.

With Education Index by gender, is calculated the Education Index. *EDIN*,

$$edin = \frac{1}{\dfrac{prpf}{edif} + \dfrac{prpm}{e\dim}} \quad (6);$$

GNIP Gross National Income per capita (PPP \$): Aggregate income of an economy generated by its production and its ownership of factors of production, less the incomes paid for the use of factors of production owned by the rest of the world, converted to international dollar."

$$gnip = \frac{1}{\dfrac{prpf}{\left(\dfrac{Log(gnif) - Log(100)}{Log(75000) - Log(100)}\right)} + \dfrac{prpm}{\left(\dfrac{Log(gnim) - Log(100)}{Log(75000) - Log(100)}\right)}} \quad (7);$$

Where *GNIF* and *GNIM* are the Female and Male Gross National Income per capita respectively

Note that Health is measured with Life Expectancy at Birth. This variable can embrace the level of Health in a country.

In the case of Education the Education Quality should be included. This concept is shown in the Table 10. Education Achievments (UNDP, 2015), and the following four variables have been chosen to obtain the Education Quality, *EDLI*.

$$edly = \sqrt[4]{\frac{pstt - 0}{100 - 0} \cdot prms \cdot (1 - \frac{rpts - 7}{25 - 7}) \cdot \frac{pexe - 2}{10 - 2}} \quad (8);$$

Where,

PSTT Primary school teachers trained to teach: Percentage of primary school teachers that have received the minimum organized teacher training (pre-service or in-service) required for teaching at the primary level.

PRMS Performance of 15-year-old students in reading (*PERE*), mathematics (*PEMA*) and science (*PESC*): Score obtained in testing of skills and knowledge of 15-year-old students in these subjects essential for participation in society.

$$prms = \frac{\left(\dfrac{pere - 100}{1000 - 100}\right) + \left(\dfrac{pema - 100}{1000 - 100}\right) + \left(\dfrac{pesc - 100}{1000 - 100}\right)}{3} \quad (9);$$

RPTS Pupil–teacher ratio, primary school: Average number of pupils per teacher in primary education in a given school year.

PEXE Public expenditure on education: Current and capital spending on education, expressed as a percentage of GDP.”.

Finally, the Development Index, *DEIN*, is calculated with (10),

$$dein = \sqrt[4]{lebi \cdot edin \cdot gnip \cdot edli} \quad (10).$$

2.2 Freedom

The definition of Freedom that is given by Caselles (2014): “*non-restrictions to self-fulfillment. This would be the total freedom that, obviously, in a group must be limited by the dignity of the other members of the group.*” The equation 11 presents the quantitive variables which have been selected to obtain the Freedom Index, *FRIN,*

$$frin = \sqrt[6]{\frac{rami-(-1000)}{1000-(-1000)} \cdot \frac{inst-0}{100-0} \cdot \frac{iito-0}{100000-0} \cdot \frac{mpsu-0}{100-0} \cdot \frac{exim-0}{100-0} \cdot \frac{rede-0}{5-0}} \quad (11).$$

Where,

RAMI Net migration rate: Ratio of the difference between the number of in-migrants and out-migrants from a country to the average population, expressed per 1,000 people.

INST Stock of immigrants: Ratio of the stock of immigrants into a country, expressed as a percentage of the country's population. The definition of immigrant varies across countries but generally includes the stock of foreign born people, the stock of foreign people (according to citizenship) or a combination of the two.

IITO International inbound tourists: Arrivals of nonresident visitors (overnight visitors, tourists, same-day visitors and excursionists) at national borders.

MPSU Mobile phone subscriptions/Internet Users: Number of subscriptions for the mobile phone service expressed per 100 people.

EXIM Exports and imports: The sum of exports and imports of goods and services, expressed as a percentage of gross domestic product (GDP). It is a basic indicator of openness to foreign trade and economic integration and indicates the dependence of domestic producers on foreign demand (exports) and of domestic consumers and producers on foreign supply (imports), relative to the country's economic size (GDP).

REDE. Research and development expenditure. Current and capital expenditures (both public and private) on creative work undertaken systematically to increase knowledge and the use of knowledge for new applications, expressed as a percentage of GDP. It covers basic research, applied research and experimental development.

2.3 Peace

Also following Caselles (2014), peace can be defined as *"absence of violence, coercion and fear"*.

The corresponding quantitative variables, which are extracted from the UNDP (2015), are the following:

PRPO "Prison population: Number of adult and juvenile prisoners —including pre-trial detainees, unless otherwise noted —expressed per 100,000 people.

RAHO Homicide rate: Number of unlawful deaths purposefully inflicted on a person by another person, expressed per 100,000 people."

The Peace Index, *PEIN*, is

$$pein = \sqrt{\left(1-\frac{prpo-0}{100000-0}\right) \cdot \left(1-\frac{raho-0}{100000-0}\right)} \quad (12).$$

2.4 Solidarity

The definition of Solidarity that is given by Caselles (2014): "*it is considered synonymous of brotherhood, that is to say, mutual aid*" can include the following variables:

The information to create the Solidarity Index, *SOIN*, is obtained in EUROSTAT,

$$soin = \sqrt[3]{\left(1-\frac{ripr-0}{100-0}\right)\cdot\left(1-\frac{pldw-0}{100-0}\right)\cdot\left(1-\frac{madr-0}{100-0}\right)} \quad (13).$$

RIPR. At-risk-of-poverty rate. The share of persons with an equivalised disposable income below the risk-of-poverty threshold, which is set at 60 % of the national median equivalised disposable income (after social transfers).

PLDW. Share of total population living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames of floor. The indicator is defined as the percentage of the total population living in a dwelling with either a leaking roof, or damp walls/floors/foundation, or rot in window frames or floor.

MADR. Material Deprivation rate. The indicator is defined as the percentage of population with an enforced lack of at least three out of nine material deprivation items in the 'economic strain and durables' dimension.

2.5 Justice

Following Caselles (2014) justice can be considered as the set of, "*mechanisms of prevention, protection and compensation for individuals or groups face to possible damages or benefits*".

In this case, descriptors are not in the UNDP reports. For this reason, the information is obtained from statistical databases. In the EUROSTAT, the following information is obtained,

POOF. Police Officers. Policias por habitante.

PRJU. Professional Judges. Jueces por habitante.

PRIP. Prison population. Gente en prisión por habitante.

CRPO. Crimes and violence. %

With these information the Justice Index, JUIN, is calculated with (14),

$$juin = \sqrt[4]{\left(1-\frac{\frac{poof}{popt}-0}{1-0}\right)\cdot\left(1-\frac{\frac{prju}{popt}-0}{1-0}\right)\cdot\left(1-\frac{\frac{prip}{popt}-0}{1-0}\right)\cdot\left(1-\frac{crpo-0}{100-0}\right)} \quad (14).$$

3. The Index in the Countries

In this section the value of each subindex is shown. The subindices is necessary to obtain the Happiness Index.

Note that attempted to perform the calculation for all countries of the European Union, but it could not be possible because of the absence of data from some of them, which is why in some tables are seen more countries than others.

Table 1 shows the Development Index, Iceland and Sweeden are the most develop countries in the EU and Bulgaria is the least develop country.

Table 1. Development Index by Country

Country	Development Index	Country	Development Index
Austria	0.789	Ireland	0.803
Belgium	0.808	Italy	0.774
Bulgaria	0.671	Latvia	0.741
Croatia	0.717	Lithuania	0.758
Cyprus	0.775	Poland	0.764
Czech	0.720	Portugal	0.757
Estonia	0.770	Romania	0.677
Finland	0.803	Slovakia	0.721
France	0.769	Slovenia	0.767
Germany	0.807	Spain	0.775
Greece	0.750	Sweden	0.829
Hungary	0.742	U.K.	0.777
Iceland	0.837		

In regard to Freedom Index (Table 2) the most and least free countries in the EU are Denmark and Estonio respectively.

Table 2. Freedom Index by Country

Country	Freedom Index	Country	Freedom Index
Austria	0.455	Latvia	0.288
Belgium	0.417	Lithuania	0.352
Croatia	0.205	Luxembourg	0.402
Cyprus	0.373	Montenegro	0.216
Czech	0.359	Netherland	0.422
Denmark	0.532	Portugal	0.180
Estonia	0.163	Serbia	0.312
Finland	0.363	Slovenia	0.243
France	0.321	Spain	0.364
Germany	0.380	Sweden	0.412
Iceland	0.326	Switzerlan	0.319
Ireland	0.366	U.K.	0.192
Italy	0.263		

The Justice and Peace Index (Table 3 and 4) are high in all countries, remark that Croatia and Iceland have the same justice index. 0.990, and the Peace Indeces are different in the third decimal.

Table 3. Justice Index by Country

Country	Justice Index	Country	Justice Index
Austria	0.961	Malta	0.961
Bulgaria	0.926	Montenegro	0.977
Croatia	0.990	Netherland	0.938
Cyprus	0.943	Norway	0.980
Czech	0.953	Poland	0.978
Denmark	0.965	Portugal	0.965
Estonia	0.959	Romania	0.952
France	0.945	Serbia	0.936
Greece	0.943	Slovakia	0.969
Hungary	0.956	Slovenia	0.971
Iceland	0.990	Spain	0.950
Latvia	0.963	Sweden	0.966
Lithuania	0.985	U.K.	0.944

Table 4. Peace Index by Country

Country	Peace Index	Country	Peace Index
Austria	0.99945	Lithuania	0.99891
Belgium	0.99939	Luxembourg	0.99970
Bulgaria	0.99734	Montenegro	0.99830
Croatia	0.99846	Netherland	0.99639
Cyprus	0.99879	Norway	0.99934
Czech	0.99944	Poland	0.99980
Denmark	0.99956	Portugal	0.99906
Finland	0.99967	Romania	0.99958
France	0.99951	Serbia	0.99852
Germany	0.99904	Slovakia	0.99927
Hungary	0.99862	Slovenia	0.99947
Iceland	0.99925	Spain	0.99923
Ireland	0.99966	Sweden	0.99976
Italy	0.99926	Switzerlan	0.99959
Latvia	0.99924	U.K.	0.99936

Finally, the Solidarity Index (Table 5) shows the most solidarity country, Norway, and the least, Bulgaria.

Table 5. Solidarity Index by Country

Country	Solidarity Index	Country	Solidarity Index
Austria	0.877	Latvia	0.703
Belgium	0.850	Lithuania	0.757
Bulgaria	0.661	Luxembourg	0.876
Croatia	0.771	Malta	0.843
Cyprus	0.720	Netherland	0.886
Czech	0.884	Norway	0.924
Denmark	0.875	Poland	0.821
Estonia	0.815	Portugal	0.744
Finland	0.915	Romania	0.710
France	0.872	Serbia	0.691
Germany	0.864	Slovakia	0.852
Greece	0.746	Slovenia	0.803
Hungary	0.698	Spain	0.820
Iceland	0.886	Sweden	0.910
Ireland	0.823	Switzerlan	0.900
Italy	0.780	U.K.	0.836

4. Hapiness Index vs Overall Life Satisfaction Index

In this section the Happiness Index is calculated as

$$hain = \sqrt[5]{dein \cdot frin \cdot juin \cdot pein \cdot soin} \quad (15)$$

Table 6 shows the Hapiness Index for each country (Formula) and the Overall Life Satisfaction Index (Satisfaction Index) which is calculated throw a quiz in UNDP. In Figure 2 the same is represented and the r^2 is 0.5027.

Table 6. Index by Country

COUNTRY	Formula	Satisfaction Index
Austria	0.74168166	0.74
Croatia	0.57865172	0.6
Cyprus	0.6654394	0.62
Czech	0.68312945	0.63
France	0.6711497	0.66

Iceland	0.69938758	0.76
Latvia	0.61657566	0.51
Lithuan	0.66763397	0.58
Portuga	0.55896431	0.5
Sloveni	0.61762304	0.61
Spain	0.68453398	0.63
Sweden	0.74034153	0.76
United Kingdom	0.58577153	0.69

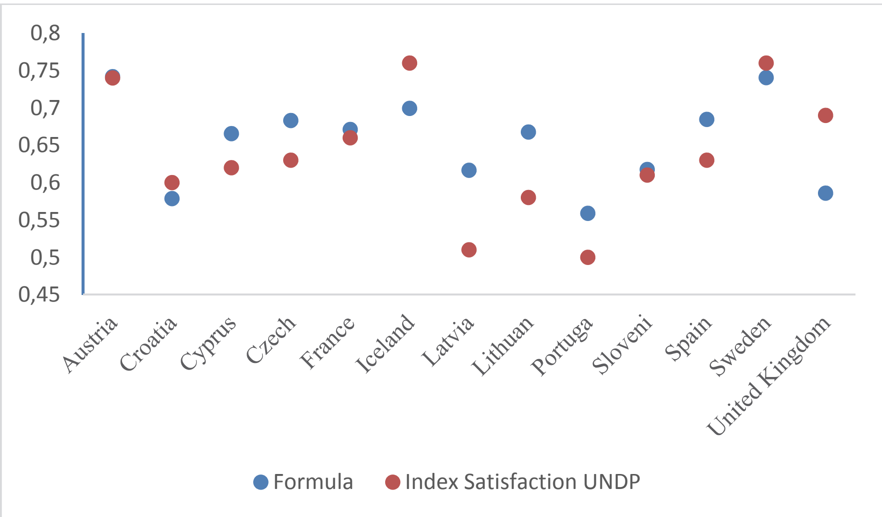

Fig 2. Happiness Index (Blue Point) and Overal Life Satisfaction Index (Red Point). R^2=0.502745

5. Conclusions

This paper has presented the formula to calculate the Happiness Index. The qualitative variables involved are obtained from Caselles (2014) and they are the development, freedom, justice, peace and solidarity. These variables have been calculated through cuantitative variables which are defined by the UN's Human Development Report (UNDP, 2014) and also through the Eurostat.

The formula of the Hapiness Indexis is generic, i.e., it is applicable to any country in the world. That is why here the index is calculated for 13 countries of the European Union. The countries have not selected randomness, all counties studied in the UNDP (2014) have been studied in this paper but some of them have not enough data to calculate the formula completely.

This index is compared with the Overall Life Satisfaction Index presented by the UN in its reports, and notes that the value is are similar in the countries studied.

In the future work, we will try to get enough data to get calculate this index for a greater number of countries in the world, not only countries of the European Union.

In addition, this index will be included in a socio-demographic dynamic model (Sanz et al., 2016) to observe the relation between demographic rates and the same.

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Scrap denim-PP composites as a material for new product design

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Abstract

The growing interest of manufacturing companies to use its scraps as raw material to design and develop alternate products has led them to new ways of processing them. The present project arises from a jeans manufacturing company's interest on making an effort to reuse its daily denim scrap to manufacture a different kind of product without diversifying its capabilities. Some studies on denim-binder mixtures have been previously performed, amongst which binders such as corn starch and vinyl adhesives were used. In the present work some preliminary findings are shown using denim in its woven form combined with polypropylene, a common waste worldwide. The goal of this project is based on the assessment of some of the mechanical properties from the obtained mixtures in order to determine their attributes and possible fields of application in the process of designing new products. For that purpose, the materials' testing was structured in four stages regarding the variables linked to the diversification of the mixes. In the first stage a sandwich-like material was prepared, consisting of two denim skins and a polypropylene core. In the second stage a multilayered "film-stacking" material was developed. In the third stage, a combination was developed consisting of polypropylene mixed with 5% weight of shredded denim. Based on these preliminary findings and the inherent attributes of denim, the fourth stage is a first attempt to use the obtained materials to design new products. In this process an introductory material-product mapping was used in order to provide early insights and define scenarios and user profiles. The results of the whole process yield a first approach to configure future experiments using combinations of denim scrap and other thermoplastic polymers in order to use them in new product development.

Keywords: *Polymer-denim composites, upcycling, product development, user profiles.*

1. Introduction

There is a growing interest among some manufacturing companies to develop new composite materials based on upcycling its own industrial scrap to use it for product development. Composite materials are basically defined as a mixture of two or more constituent materials that possess different physical or chemical properties. To make such a combination, there must be at least 5% of one of these constituent elements, producing a material with considerably different properties from those of the individual components (Mathews, 2003). There are two phases in such materials: a continuous phase, known as the matrix (polymer, ceramic or metal), and a dispersed one known as the reinforcement (fibers and particles), which can have different configurations.

Polymer based composites are generally classified depending on the type of reinforcement employed in the mix: from particles of mineral origin such as talcum powder and clays, to fibers, either natural or synthetic.

In the case of polymer matrix-textile fiber mixtures, experimentation has been performed with linen using several polymer matrices such as polylactic acid (PLA), polyhydroxybutyrate (PHB), Polybutylene succinate (PBS), and polybutyrate (PBAT). It was found that the specific tensile strength and modulus of these composites were similar to those of glass fiber reinforced polyester (Bodros, et. al.: 2006) and are higher than composites such as PP-linen (Oksman, et. al.: 2003). Regarding PLA-denim composites, mechanical and thermal properties also improve compared to similar composites made with other fibers (Lee, *et al*: 2010). With respect to polypropylene-denim mixtures, Haque, et al (2014) reported that the more fibers are used, tensile strength decreases but in contrast, there is an increase in flexural strength.

Among industrial applications of polymer-cotton composites (denim being the most widely used) due to its properties, several car manufacturers use them in upholstered panels to improve acoustics in the interiors of certain vehicles (Ahmad, Choi & Park, 2014). Notwithstanding previous works, the present study is a first approach to evaluate such mixtures without the use of coupling or compatibility agent treatments, aiming to minimize or reduce reprocessing operations within the company.

On the other hand it is important to mention that research from Instituto Nacional de Ecología y Cambio Climático (INECC), has found that plastics constitute 11% of the total composition of waste in Mexico (Frías, Lema & Gavilán, 2007). Solid waste of thermoplastic materials can be reused as raw material to produce new products, with the caveat that these materials can degrade during thermal reprocessing, partially diminishing some of its properties compared to its virgin counterpart. Regarding polypropylene (PP), the chosen material, it is a semi-crystalline polymer (presenting both crystalline and amorphous phases) and among its most useful properties, it has a wide processing window (allowing it to be transformed using a variety of processes) presenting greater stiffness and higher melt temperature than polyethylene. This material is considered a *commodity* in the world market given the fact that its demand constitutes 25% of the world plastics production (IHS, 2015) and due its wide range of molecular architectures and grades it is used to manufacture multiple kinds of products. In Mexico, this is the highest demanded resin, reaching an estimated quota in 2012 of about 1'102,000 tons per year (Conde, 2012).

The goal of the present work is to understand the effects of denim content in a thermoplastic polymer matrix. To attain this goal, three different combinations have been studied under tensile and flexural modes. It is possible to produce composite materials with industrial scrap that have similar properties of those to the unfilled polymer matrix. This is a first approach to the subject and therefore there are several variables to be considered in order to increase the mechanical performance of the new material described in this document. Such variables include fiber orientation (for woven textile) or the effect of temperature on the fiber during processing, just to name a few.

On the other hand, mechanical properties aside, another important aspect of this project is that unlike other fibrous materials, denim's ubiquity in the global market and acceptance among consumers from different social backgrounds and ethnical contexts, has made it an important part of modern culture for its embedded meaning (Miller & Woodward, 2007). During the design process such aesthetic and symbolic qualities were key factors to develop alternative products with the denim-PP composites.

2. Method description

2.1. Materials for stages 1, 2 and 3

For these two stages, samples were prepared using denim in its woven form. The polymer used is a PP random copolymer supplied by REPSOL (Spain) with a MFI of 21 (230 °C; 2,16 kg, ISO 1133) and a density of 0.905 g/cm^3 (ISO 1183). The denim blend used has a composition of 76 % cotton warp, and 22 % polyester with 2% polyurethane weft.

For the third stage, and based on preliminary results from the previous stages, denim trim scrap was cut in small pieces and shredded using an industrial blending machine. Later the shredded denim fibers were sun dried and mixed with recycled PP scrap. This preparation used 5% wt of shredded denim fiber.

2.1.1. Sample Preparation

A compression molding IQAP-LAP model PL 15 hydraulic hot press machine was used for the sample fabrication. Two types of composite structures were prepared: a sandwich composite consisting of two denim skins and a PP core, and a multilayer laminate consisting of 4 layers of denim and 5 layers of PP in film stacking configuration. In order to obtain regular samples, the material was compression molded using a steel frame with a squared cavity of 150 mm by side and a thickness of 2.5 mm.

For the sandwich structure the core was molded with the following processing conditions: plate temperature set at 220 °C, a pressure of 4 MPa and a cooling time of 5 minutes. Afterwards the denim skins were thermally compressed to the core using the hot plates of the press during 2 minutes.

The multilayered composite was molded using an initial pressure of 1 MPa for 3 minutes to start melting the first layers of plastic and denim and pressure was progressively increased with each layer to reach 5 MPa. Temperature remained constant at 220 ºC during all the forming stages.

2.1.2. Experimental procedure

Prismatic specimens for flexural and tensile testing (see figure 1) were obtained from the plaques using a precision circular saw. All tests were performed with a Galdabini Sun 2500 universal testing machine using a 5kN load cell. Three point bending flexural tests were performed in accordance to the ISO 178 standard with a crosshead speed of 1 mm/s. Tensile tests were performed in accordance to the ISO 527 standard.

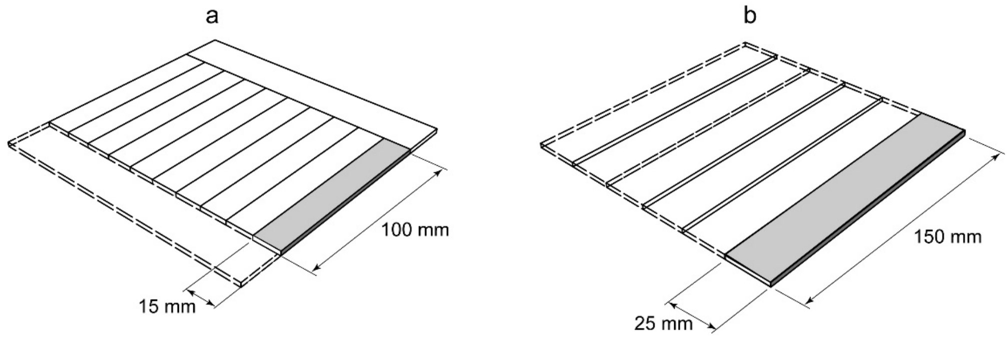

Fig. 1. Specimen sectioning for: a) flexural testing; b) tensile testing.

3. Results and discussion

Results of both, the tensile and three point bending flexural tests are presented in table 1. It can be observed that all the elastic modulus values from the new composites fall below the virgin plastic materials' and that their maximum strengths do so in a larger scale. In the specific case of the sandwich material, these values –elastic module and maximum strength- are not much different from those of the virgin polymer matrix.

The film stacking multilayered material presents even lower values to those observed on the sandwich configuration. This means that as the content of fabric increases in this composite, the mechanical properties will decline. This is attributable to the fact that the stiffness of the fabric is lower than that of the polymer matrix's, therefore instead of reinforcing the composite material it weakens the new product.

Table 1. Denim-PP composites' mechanical properties compared to virgin PP.

	Tension			**Bending**		
Specimen	**E (MPa)**	**$\square_M$ (MPa)**	**$\square_B$ (%)**	**E_b (MPa)**	**$\square\square_M$ (MPa)**	**$\square_{fB}$ (%)**
PP (virgin)	1322 ± 78	42 ± 2	>100	737 ± 72	39,3 ± 0,3	n/b
Denim	283 ± 4	26 ± 1	30 ± 3	-	-	-
Sandwich	1064 ± 65	22 ± 3	12 ± 3	643 ± 208	19,7 ± 7,8	n/b
Film stacking	-	-	-	305 ± 70	18,5 ± 2,5	n/b
PP + denim shreds	-	-	-	551 ± 80	12.6 ± 1,0	n/b

The mechanical properties in tensile and flexural mode of these composites can be observed in figures 2 and 3. It is quite noticeable that the performance of these materials is below the performance of virgin PP. In other experiments (Foulk, et al, 2006) it has been observed that the mechanical performance of the composite can increase by using coupling agents and compatibilizers.

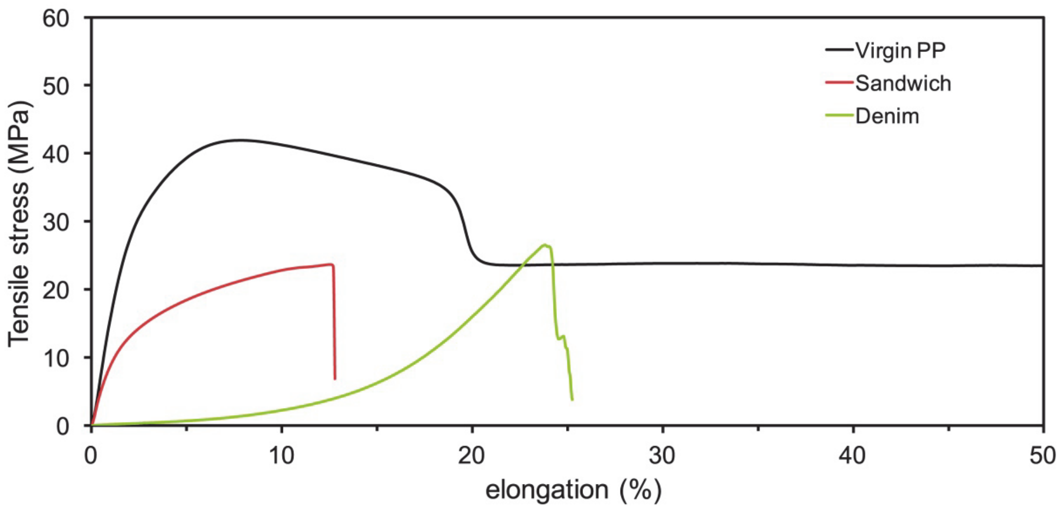

Fig. 2. Tensile behavior of denim-PP composites with respect to the unfilled material.

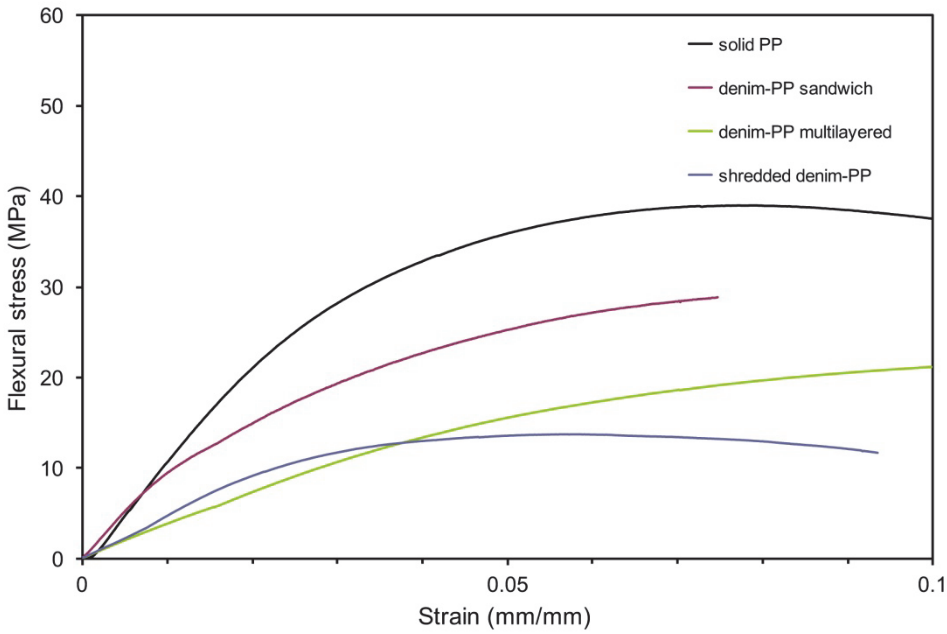

Figure 3. Comparative study of denim-PP composites' flexural behavior against virgin PP.

Considering the results from table 1, the sandwich structure in tensile mode has a Young's Modulus similar to the virgin material. This is due because at low strain rates, the fabric does not work mechanically until 10 % of elongation, whilst the denim-PP composite breaks just above this value. The maximum strength value falls down to half the one from the virgin material. Mechanically, denim fibers do not work but occupy a significant volume of the composite, therefore, denim acts more as internal and superficial defects and consequently weakens the new material. This can be seen more clearly in the ultimate strength and strain values, but not in the modulus.

Regarding flexural tests, (see figure 3) it is noticeable that they present a similar trend to the one observed in tensile mode tests. Unlike the latter, flexural tests, stop at 5% elongation, and at this point of the test the load will not break the specimen. Conversely, the material tested in tensile mode (see figure 4) displays little or no plastic deformation at the fracture zone, this means that the fabric inhibits the plastic deformation of the matrix which, by itself is capable of doing so if subjected to heavy loads. It can be observed that strain values drop significantly with the inclusion of denim fabric.

The fabric alone was tested under tensile mode and it can be observed that it tears at very long crosshead displacements (see figure 2). It is clear that this material presents very low stiffness compared to the composites but it starts tearing at higher strengths than those of the new composites.

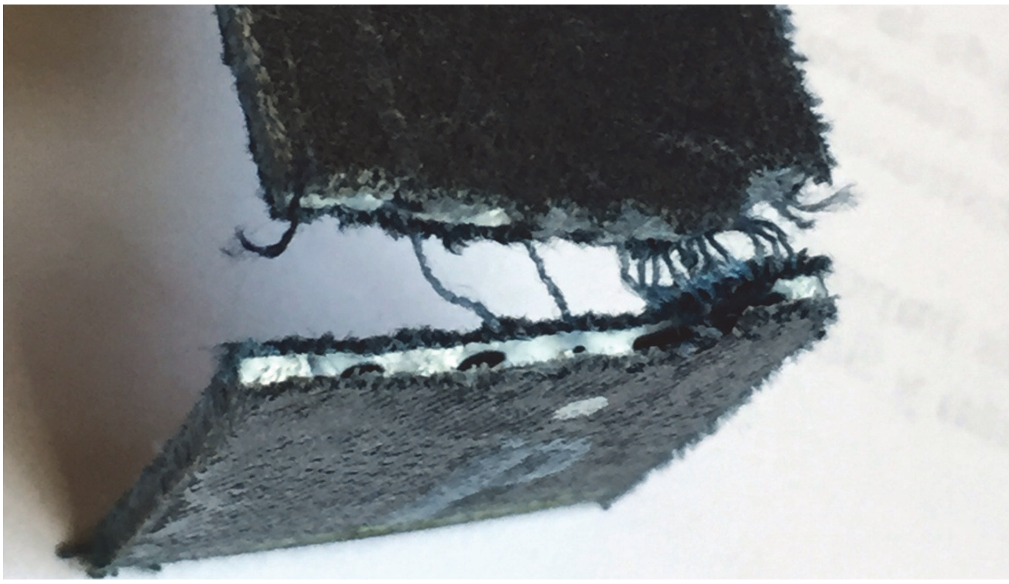

Fig. 4. Close up at the fracture zone of denim-PP tensile specimen.

Flexural tests of the shredded denim-pp mix show a similar behavior to the one observed in the sandwich and multilayered preparations. Despite displaying a lower stiffness compared to the virgin material, the values are higher than those observed in the multilayered composite. There is also a change in behavior in the elastic zone of the curve, where the slope becomes slightly steeper at low strain rates (see figure 3). This can be attributed to the presence of knots within the mix, affecting the interphase between the fibers and the polymer matrix. These samples presented low stiffness and moderate plastic deformation accompanied by delamination, hinting a possible use in applications under impact mode.

4. Stage 4: Design research and material application

Once the mechanical tests were performed, the resulting properties were given to the design teams in order to understand the material's application possibilities. Due to the fact that these composites presented similar or lower stiffness values and limited strengths compared to virgin PP, a property comparative was developed. Another important aspect that was kept in mind about the composites was its low apparent density (0.75 g/cm^3 for the shredded denim-PP composite, and 0.88 g/cm^3 for the layered materials) a quality suitable for products that could potentially benefit through weight reduction. At this point, in order to build scenarios, the teams reviewed what had been done with denim outside the garment industry. The results of this first material-product mapping were graphically presented in material-product map shown in figure 5.

Fig. 5. Material-product mapping.

The teams identified several uses with different forms of this material: shredded fibers, partially shredded, trimmed figures, in combination with a variety of binders, such as eco-resins, and thermoplastics. In few cases, to say the least ones, some products were developed making new yarns from denim shreds to produce new fabrics.

Another key element observed during this stage was that denim fibers were visible in most of the composites developed with them, adding a distinctive trait to the final product. From this analysis, several areas of opportunity were drawn: home decoration, architectural and construction applications, car parts, fashion accessories and apparel, personalized accessories and safety gear. As research continued, the design teams observed that many of these products were offered to a particular type of user: an environmentally conscious well educated kind, yet eager to acquire new/fashionable items. Considering denim's symbolic qualities and the idea that this industrial trim/scrap can be used to make new materials and contribute to protect/preserve the environment, designers explored the possibility of developing tailor-made products.

Fig. 6. Urban cyclist psychometric profile.

For this purpose, two user profiles were studied: a) young professionals using technologies in their daily life; b) urban cyclists. In both cases, these users openly express their points of view and have an easy-going lifestyle. In the present work the attention will be given to the second group. In figure 6 the user profile is graphically explored.

Urban cyclists are a new kind of social movement. It is mostly about young people, aged between 15-25, the eldest are attending college or studying a major, and most of them are tech savvy. For this group, riding in the city is a personal statement and as they keep up with it, they are subjected to different kinds of threats, such as heavy traffic, occasional harsh weather conditions and continuous dog chases, just to name a few. The design team surveyed a sample of 100 urban cyclists from the city of Guadalajara, in order to understand their specific needs. Due to its lower stiffness, at first the team thought of designing a tool pouch based on the multilayered material, but the survey showed that most of the users would rather have someone with mechanical skills repair their bicycles. Instead, the object that was mostly sought after were cargo bags. Another question of the survey confirmed the assumption regarding the willingness to acquire products made with recycled materials: 90% had a positive response. In the following step, the team analyzed several products that were manufactured using different kinds of industrial waste, and compared their properties. A radar comparison graph is shown in figure 7.

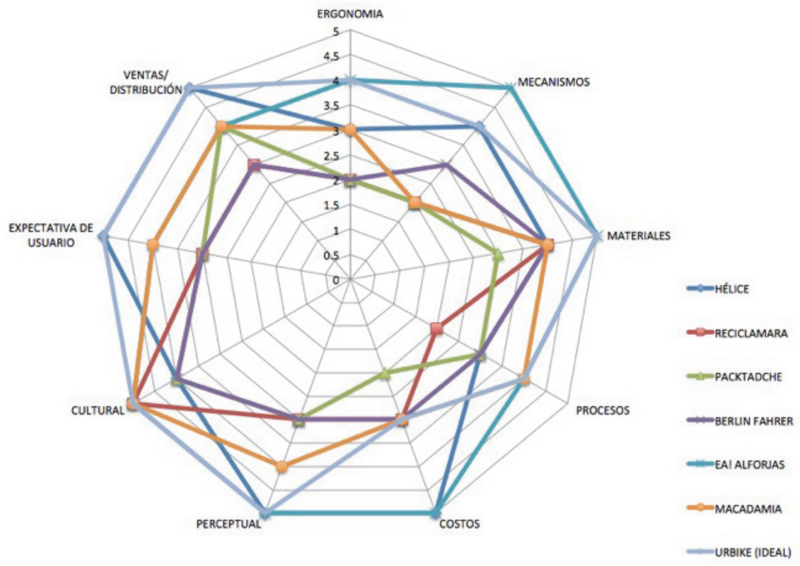

Fig. 7. Radar comparative graph.

Six products are displayed in this graph but four were rather significant by the materials employed for their fabrication: recycled tire tubes, cardboard, recovered leather, and recovered canvas. Some materials with lower densities than the denim-PP composite presented certain inconveniences: cardboard had a limited durability; tire tube products were not so appealing despite its inherent flexibility; recovered leather was relatively heavy; and canvas is not completely puncture resistant. Designers chose to use the sandwich structure instead of the multilayered, taking advantage of its higher stiffness and low density. Figure 8 shows several sketches of the product.

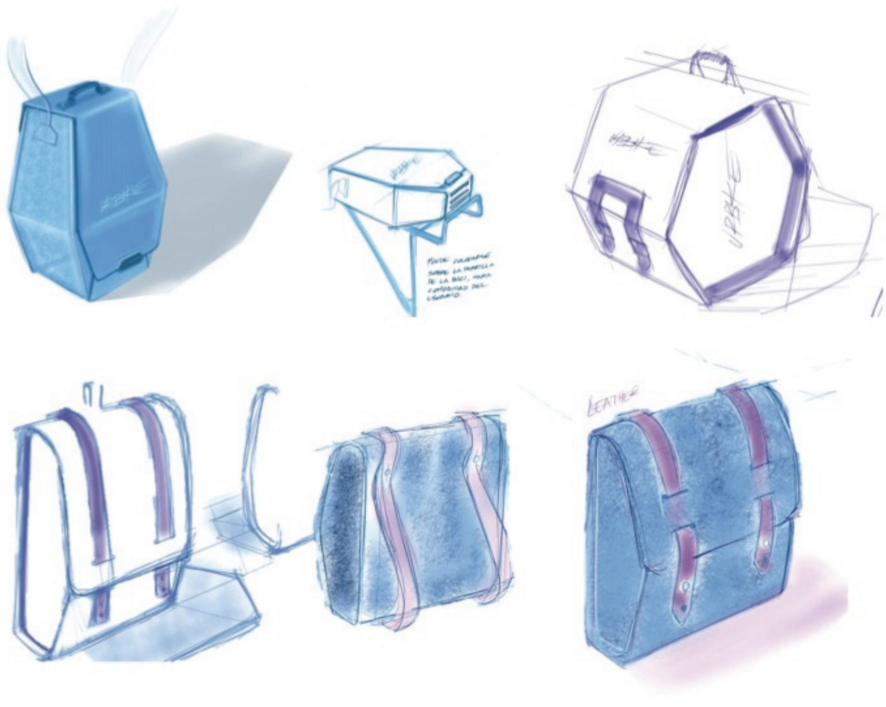

Fig. 8. cargo bag sketches.

5. Conclusions

In the present study some mechanical properties of denim scrap-PP composites were evaluated. It was observed that none of the mixtures had a higher mechanical performance than the virgin polymer matrix. Despite the results, the stiffness of some mixtures was not drastically affected by the denim fibers. Designers were able to compare the preliminary findings with data from other materials and managed to understand the possibilities of the new material to be used in the fabrication of a product. During this process, information visualization became an important strategy to understand the new materials as well as the users and their needs. It is important to note that more research is needed to fully understand the properties of the composites and assess its application for product development.

6. Acknowledgements

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A eficiência da materialidade. O recurso a ferramentas digitais de simulação e fabricação aditiva na procura de uma maior eficácia dos dispositivos

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Resumo

A praxis do Design de produtos, condicionada pelas crises sociais e ambientais que o mundo atravessa, deve passar pela procura de uma cada vez maior eficiência dos objetos na sua dimensão ambiental. Embora esta questão esteja a jusante de questões eventualmente mais relevantes na minimização deste problema, e que têm a ver com a legitimação da própria existência dos dispositivos, a otimização do recurso a matérias-primas no fabrico de objetos é de fulcral importância. A possibilidade de otimizar os produtos pela redução da incorporação de matéria-prima no seu fabrico e adequar o material a uma determinada utilização é central no seu processo de desenvolvimento. Por outro lado, as novas possibilidades trazidas pela fabricação aditiva no sentido de reduzir a quantidade de materiais e processos industriais associados à produção de componentes técnicos complexos permitem perspetivar uma melhoria significativa do impacto ambiental tradicionalmente associado à sua obtenção.

O presente artigo procura examinar como as tecnologias digitais de análise, otimização e fabricação aditiva poderão constituir uma resposta viável para uma produção mais eficiente do ponto de vista da incorporação de recursos não-renováveis e da minimização do impacto ambiental associado às tecnologias de produção tradicionais.

Será efetuada uma pesquisa bibliográfica relativa à questão da sustentabilidade e tecnologias de fabricação aditiva, assim como às suas relações com o design.

Serão seguidamente identificados exemplos que testemunhem o estado atual da aplicabilidade destas tecnologias na produção direta de objetos, a partir dos quais se procurarão tirar conclusões que permitam entender em que medida as tecnologias aditivas poderão ter um impacto positivo na sustentabilidade ambiental, e como poderá o design posicionar-se perante esta nova realidade.

Palavras chave: *design, sustentabilidade, fabricação aditiva.*

Abstract

The praxis of product design, conditioned by social and environmental crises that the world is facing, must go through the search for increasing efficiency of objects in its environmental dimension. Although this issue is downstream from possibly more relevant issues to minimize this problem, and that have to do with the legitimacy of the existence of the devices themselves, optimizing the use of raw materials in the manufacture of objects is of crucial importance. The ability to optimize products by reducing the incorporation of raw materials in their manufacture and adapting the material for a particular purpose, is central to the development process. Moreover, new possibilities brought by the additive manufacturing to reduce the amount of materials and industrial processes associated with the production of complex technical components, allows to foresee a significant improvement in environmental performance traditionally associated with its obtainment.

This paper seeks to examine how digital Technologies of optimization, analysis and additive manufacturing, may constitute a viable response to a more efficient production from the point of view of the incorporation of non-renewable resources and minimize the environmental impact associated with traditional production technologies.

A bibliographic research on the issue of sustainability and additive manufacturing technologies, as well as its relations with design will be made.

Examples will then be identified, which witness the current state of the application of these technologies in the direct production of objects, from which the drawing of conclusions will be sought, allowing us to understand to what extent the additive technologies can have a positive impact on environmental sustainability, and how can the design positions itself to this new reality.

Keywords: design, sustainability, additive manufacturing

1. Introdução

A problemática ambiental subjacente da atividade humana tem, na atualidade, uma urgência que cresce a cada dia que passa. Passamos a coexistir no quotidiano com os dramáticos impactos da atividade desregulada do mundo ocidental, com consequentes catástrofes ambientais e uma enorme pressão sobre os ecossistemas, a qualidade do ar e da água. A situação atinge proporções dramáticas em países com elevados níveis de produção industrial, como a China, mas também em países pobres como o Gana, apenas para dar dois exemplos que ilustram a capacidade devastadora da atividade humana, independentemente da prosperidade ou situação geográfica dos países. Sendo desde há muito conhecida a realidade de Agbogbloshien no Gana, para onde, segundo o site *WorstPolluted.org*, são anualmente exportadas 215.000 toneladas de lixo eletrónico (que se prevê poder chegar ao dobro em 2020, no caso de se manter a linearidade do crescimento económico), o alarme soou veementemente no final de 2015 com o elevado nível de poluição do ar atingida em Pequim, para onde uma empresa canadiana passou a exportar ar embalado no início de 2016. Segundo o site do jornal The Telegraph, *"Cada embalagem de 7,7l é vendida por um montante aproximado de €13, o que representa um custo 50 vezes maior que uma garrafa de água mineral na China."* O ar passou assim de um bem vital gratuito a um produto transacionável, não por capricho ou excentricidade, mas por necessidade vital. Adensa-se, portanto, com o passar do tempo, a nuvem que paira sobre a humanidade, apesar das preocupações ambientais fazerem parte do debate mundial desde os anos sessenta, fortemente impulsionado pelo livro "Silent Spring" de Rachel Carson, que Al Gore qualifica como o "*registo de nascimento do movimento ecológico*".

Nos anos setenta, o design começa a considerar a questão ambiental como tema central da sua atividade. Tomás Maldonado, já em 1970 reconhecia que, "*o ambiente humano, um dos muitos subsistemas que compõem o vasto sistema ecológico da natureza é o único subsistema que possui a capacidade virtual e real de provocar perturbações substanciais – isto é – irreversíveis, no equilíbrio dos outros subsistemas"* (Maldonado, 1970). No ano seguinte, Victor Papanek publica o livro "*Design for the real world*", obra que se foi tornando referencial, e que já nessa altura alertava para a necessidade de repensar a prática do design, alegando que "*Nunca afirmaremos suficientemente que, nos problemas de poluição, o designer está mais implicado que a maioria das pessoas*" (Papanek. 1971).

45 anos passaram desde a publicação do livro de Papanek, e apesar de todos os esforços, estratégias, metodologias, campanhas e diferentes abordagens ao design, os resultados são diminutos, e não foram compensando a degradação galopante do ambiente.

A mudança necessária deveria passar por mudanças a vários níveis, a maior parte dos quais sociais e políticos, mas também ao nível da forma como são projetados, fabricados e utilizados os objetos e diferentes dispositivos.

A forma de projetar e produzir está em plena mudança. As tecnologias digitais de modelação evoluíram num curto espaço de tempo, começando pela capacidade de modelar e visualizar objetos em ambiente virtual, seguindo-se a capacidade de imprimir esses modelos a três dimensões. A tecnologia progrediu e atingiu a capacidade real de produzir objetos e componentes mecânicos fiáveis e precisos, de forma direta e em diferentes tipos de materiais. Esta possibilidade coloca o design perante uma forma completamente nova de se relacionar com o fabrico e a difusão dos objetos e obriga-o a entender como se adaptar às novas possibilidades tecnológicas, e sobretudo, entender em que dimensão estas poderão contribuir para minimizar os impactos associados à produção.

2. A eficiência da materialidade

Embora se parta do princípio que a questão da sustentabilidade ambiental não se limita às questões relacionadas com a matéria e a sua transformação em objetos, esta é uma dimensão determinante na resolução do problema. A eficiência da materialidade, entendida enquanto qualidade do que é material, é um aspeto incontornável. Este é o foco central da maioria das áreas que se debruçam sobre a sustentabilidade dos objetos na sua dimensão material, nomeadamente o eco design, o *cradle-to-cradle* ou a economia circular. A redução da quantidade de matéria processada para satisfazer as necessidades das sociedades contemporâneas deverá decrescer substancialmente, de forma a poder encarar-se a possibilidade de um futuro para o planeta.

"*Starting from here, while bearing in mind the growing population, as calculated, and the growing demand of the emerging and developing countries, as justified, the third parameter surfaces –*

technological eco-efficiency – with a rather impressive result: the sustainable requirements are realistic, but only if eco-efficiency is increased 10-fold. In other words: we can consider as sustainable only those production–consumption systems that employ 90% less material input per unit of service than is actually accounted for in contemporary industrial society." (Vezzoli & Manzini, 2008)

Manzini conclui que tal implicará um processo de desmaterialização do que a sociedade procura para melhorar a sua qualidade de vida. Esta consistiria numa redução drástica da quantidade de produtos e serviços necessários para uma qualidade de vida socialmente aceitável, acompanhada de um decréscimo colateral dos fluxos de material e energia utilizada, referindo ainda que tal pode ser conseguido através da redução da procura de produtos e serviços incrementando a inteligência do sistema, e diminuindo os seus fluxos de material e energia.

O panorama atual dos produtos de grande consumo continua a basear-se numa forte incorporação de energia e matérias-primas. A forma dos objetos está dependente de constrangimentos tecnológicos que muitas vezes condicionam a sua eficiência, na medida em que constantemente necessitamos de balancear o que se quer fazer com o que a tecnologia permite fazer.

3. Tecnologias digitais no design de produtos

3.1 Considerações gerais

Há 26 anos, Alan Pipes (Pipes, 1990), escreveu nas primeiras linhas do seu livro que o CAD (*Computer Aided Design*) poderia alterar a função do designer antevendo a importância que as tecnologias digitais 3D teriam no seu trabalho, e ainda antes de ser patenteada a primeira impressora 3D afirmou que "*... the need for prototypes may not be eliminated, but fewer of them will be required and the ones that have to be made will be nearer to the real thing.*" Anos mais tarde, Chang (Chang et al, 1998) definiu novos princípios orientadores visando a produção rápida do produto com a integração objetiva de metodologias digitais no paradigma de produção DFM (*Design for Manufacturing)*. Também Hague (Hague et al, 2003), referindo-se aos novos processos aditivos de fabricação, propõe o uso destas tecnologias como uma filosofia aplicada de projeto, desde as etapas iniciais do desenvolvimento do produto com o objetivo de projetar artefactos de forma mais flexível e económica e considera que "*... This new design freedom will place much more responsibility on the designer to think about exact requirements of a part*".

No livro "*Digital Design and Manufacturing*", Schodek (Schodek et al. 2005) efetua uma análise detalhada das tecnologias digitais aplicadas ao design industrial e destaca a prototipagem rápida e a "*free-form fabrication*" como ferramentas ideais para o que apelida de "*soft tooling*", e moldes utilizando metais em pó para produzir objetos de extrema complexidade. Na sequência desta evolução, Ian Gibson (Gibson, 2010) amplia o alcance do DFM para o conceito de emergente DFAM (*Design for Additive Manufacturing*). Considerando a possibilidade dos designers ignorarem os constrangimentos inerentes a processos tradicionais de produção afirma: "*... maximize product performance through the synthesis of shapes, sizes, hierarchical structures, and material compositions, subject to the capabilities of AM technologies*."

Wholers (Wholers, 2011) assume a fabricação aditiva como um processo emergente de produção e acredita que num futuro próximo se tornará a tecnologia de maior utilidade no desenvolvimento e fabrico de produtos:

"Additive manufacturing (AM) is going places that many of us never anticipated. Frankly, I believe we've only seen the tip of the iceberg. The more I explore the future potential of AM and 3D printing

technology, the more excited I become. I truly believe that AM will develop to become the most useful technology for the development and production of products than any other".

No livro "*Fabricated: The new world of 3D printing*" Lipson (Lipson et al, 2013) afirma que a impressão 3D já não é uma nova tecnologia dado que há décadas que existem equipamentos a produzir objetos e, segundo o autor *"... in the past few years, 3D printing technology has been driven rapidly forward by advances in computer power, new design software, new materials, and the rocket fuel of inovation, the Internet*."

3.2 Fabricação/Produção Aditiva (additive manufacturing)

Apesar da expressão Impressão 3D (3D Printing) ser utilizada vulgarmente para definir este tipo de tecnologias o comité ASTM (Intenational Committee F42 on Additive Manufacturing Technologies) define a fabricação aditiva como:

"...additive manufacturing as the process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methods. Synonyms include additive fabrication, additive processes, additive techniques, additive layer manufacturing, and freeform fabrication."

O termo Impressão 3D, mais específico, é definido pelo comité ASTM 42 como a fabricação de objetos através da deposição de material utilizando um cabeçote de impressão, um bocal ou outra tecnologia de impressão. É normalmente associado a sistemas de baixo custo e equipamentos com capacidades de fabricação aditiva limitada.

A FA é utilizada para construir modelos físicos, protótipos, madres, componentes de ferramentas e produzir diretamente peças em plástico, metal, cerâmica, vidro e materiais compósitos.

3.3 Processos

Todos os processos da FA apresentam semelhanças. O conceito base é o mesmo. Partindo de um modelo CAD 3D, a fabricação consiste na junção de materiais em sucessivas camadas. Hopkinson (Hopkinson, 2006) identificou mais de vinte sistemas de prototipagem rápida mas reconhece que parte deles não terão capacidade para fabricar diretamente objetos funcionais. Num estádio anterior da tecnologia, os processos de FA eram divididos em três categorias que dependiam do estado inicial da matéria-prima utilizada. Chua (Chua, 2005) e Volpato (Volpato, 2007), separavam os processos em três grupos: os baseados em líquido, os baseados em sólido e os que utilizavam material pulverizado.

Em janeiro de 2012, o comité ASTM F42 aprovou uma lista, definindo designações e especificações para cada processo, que denominou "*Standard Terminology for Additive Manufacturing Technologies*":

Extrusão de materiais (*material extrusion*) - processo aditivo onde o material é seletivamente distribuído através de um bocal ou orifício;

Ejeção de materiais (*material jetting*) - processo aditivo onde gotículas do material de construção são seletivamente depositadas;

Ejeção de ligante (*binder jetting*) - processo aditivo onde o líquido ligante é seletivamente depositado para agregar materiais pulverizados;

Laminação em folha (*sheet lamination*) - processo aditivo onde folhas de material são cortadas e ligadas por camada para formar o objeto;

Foto polimerização em cuba (*vat photo polymerization*) - processo aditivo onde um líquido depositado numa cuba é seletivamente curado através de luz;

Fusão em cama de pó (*powder bed fusion*) - processo aditivo onde energia térmica funde seletivamente regiões determinadas na cama de pó;

Deposição por energia direcionada (*directed energy deposition*) - processo aditivo onde um foco de energia térmica é utilizado para fundir materiais que vão derretendo à medida que são depositados.

3.4 Vantagens da produção aditiva

O facto destas tecnologias, de uma forma geral produzirem objetos por sobreposição de secções planas, faz com que se possam obter formas altamente complexas sem a necessidade de se possuir particular conhecimento ou destreza técnica. O tempo associado à obtenção desta forma é assim drasticamente reduzido, ao mesmo tempo que são possíveis formas outrora impensáveis de serem produzidas com as tecnologias de fabrico convencionais.

A forma complexa ganha viabilidade, uma vez que a sua produção passa a ter um valor de produção semelhante ao da forma simples e, como refere Diegel (Diegel et al, 2010) "... *With additive manufacturing, complexity and geometry no longer affect manufacturability."*

A possibilidade tecnológica de reduzir os constrangimentos formais a que estão sujeitos os produtos permite caminhar no sentido de dispositivos mais eficientes tecnicamente, e mais duráveis emocionalmente quer pela satisfação técnica que proporcionam quer pela possibilidade de os aproximar mais das reais necessidades e espectativas dos utilizadores.

Apesar dos materiais utilizados nos processos que permitem peças mais perfeitas, dado a sua especificidade e complexidade na produção, apresentarem na generalidade custos elevados, o facto de se utilizar apenas a quantidade necessária para produzir o objeto evita desperdício e, como Alice Rawsthorn menciona "*...which is not only beneficial environmentally, but financial too, because it reduces the risk of manufacturers wasting money on superfluous raw material.*" (Rawsthorn, 2013)

4. Relação do design com a produção aditiva numa perspetiva de sustentabilidade

Nas palavras de Nathan Stegall (Stegall. 2006), "*The field of design... has become a major focal point for sustainability, which is not surprising since poorly designed industrial systems, products, and buildings can greatly contribute to environmental and social degradation*."

Entende-se que neste domínio, nomeadamente em termos da qualidade dos dispositivos e do seu impacto na natureza, as tecnologias de produção aditiva vieram ampliar a possibilidade do design poder produzir objetos mais eficientes, mais duráveis, mais próximos dos utilizadores, e simultaneamente menos nocivos na sua relação com o ambiente. Como Alice Rawsthom conclui "... *3D printing also offers an important opportunity to make progress on the sustainable front.*" (Rawsthorn, 2013)

Inicialmente, as tecnologias de impressão 3D utilizavam-se unicamente para a produção de modelos de estudo, integrados no processo de desenvolvimento do projeto. Ainda na atualidade, e embora as tecnologias aditivas sejam já utilizadas em várias áreas, nomeadamente na medicina e na indústria aeroespacial, este tipo de tecnologia está muito associada à ideia de modelo e não de produto, na medida em que as tecnologias mais democratizadas (*makers*) ainda não atingiram um nível de rigor superficial ou uma resistência física adequada à maior parte das utilizações. Por outro lado, os produtos que já se fabricam com recurso a estas tecnologias apresentam custos elevados que não permitem a sua maior difusão, e são essencialmente utilizados em situações específicas em que se mostraram competitivos face às tecnologias até agora utilizadas. Com o seu desenvolvimento, as tecnologias aditivas deixarão de ser entendidas como ferramentas de prototipagem para passarem a ser entendidas como ferramentas de produção.

A própria relação do designer com o utilizador poderá mudar, e esta nova forma de relacionamento permitirá uma maior adaptação dos produtos aos utilizadores, mas também a possibilidade de recolher dados sobre o desempenho do objeto de uma forma muito mais direta, na medida em que se reduzem os filtros ou intermediários da informação.

O relatório de 2012 da CSC (*Computer Sciences Corporation*) (CSC, 2012) aponta já uma substancial diferença nessa relação[69] que passará por um encurtamento da cadeia, nomeadamente no que se refere à montagem, distribuição, armazenamento e venda. O design poderá nesta medida obter um maior proveito económico, garantindo em simultâneo ao utilizador um menor custo de aquisição e uma maior qualidade e adaptação às suas necessidades específicas.

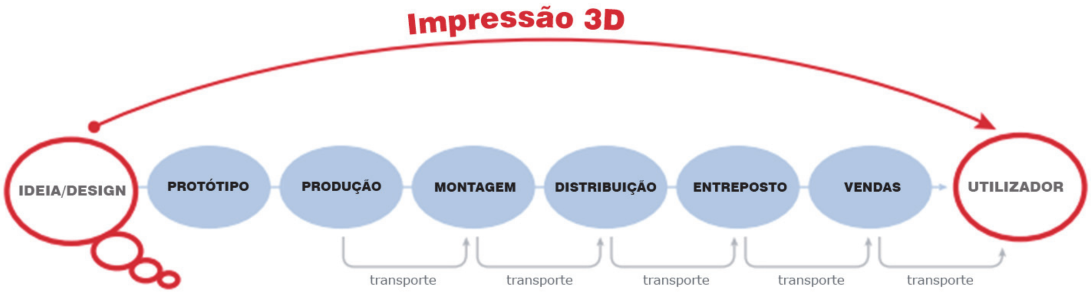

Fig. 1 A oportunidade de longo prazo para particulares (Fonte: Adaptado de (CSC, 2012))

Os produtos dispensarão também o enorme custo económico e ambiental associado ao seu transporte entre as diferentes fases do seu ciclo, e a toda a logística associada.

A adaptação do design e da produção aditiva, numa perspetiva de sustentabilidade ambiental, poderá ser analisada através da sua possibilidade de correspondência a uma estrutura de economia circular, cuja intenção é eliminar o lixo ou a poluição, através de uma relação com os objetos que passa pelo seu uso, cuidado, reparação, reutilização e reciclagem.

4.1 Adaptação ao utilizador

Nas economias desenvolvidas, a customização era a norma para ricos e pobres, isto até à revolução industrial, quando a mecanização permitiu produzir grandes quantidades de objetos estandardizados de forma mais eficiente e económica do que a produção convencional (Rawsthorn, 2013).

A produção baseada numa tecnologia que se desliga da necessidade de estandardização, na medida em que a obtenção de formas deixa de estar dependente de moldes ou ferramentas específicas, permitirá estabelecer uma ligação, outrora muito improvável, entre o utilizador e o designer, facilitando fortemente a precisão com que o objeto se adapta à sua utilização específica.

[69] Embora o relatório se refira aqui ao "design" como "desenho", na perspetiva de um utilizador poder imprimir diretamente os objetos que desenha na impressora que possui em casa, o diagrama fornece uma imagem clara daquela que pode ser entendida como a realidade da relação entre o designer e o utilizador, assim como as vantagens ambientais daí decorrentes.

Quer seja através de dispositivos médicos, como aparelhos ou próteses, quer seja através das opções que muitas empresas já disponibilizam (opções estas geralmente limitadas a um leque de escolhas definido), a possibilidade de personalização dos produtos tem vindo a aumentar, o que permite prever que o nível de adaptação terá tendência a acompanhar esta evolução.

Poderemos antever ironicamente um regresso a uma relação entre o utilizador e os produtos semelhante à que prevalecia na pré-industrialização, em que muitos objetos comuns, desde roupa a mobiliário, eram fabricados por medida.

A adaptação ao utilizador é também potenciada pelo facto do protótipo, em rigor, passar a ter o mesmo custo que qualquer um dos seus múltiplos, e o primeiro protótipo validado, mesmo para uma série elevada, pode imediatamente ser vendido e utilizado. Salvo em negociações por escala, as peças de uma pequena série custam exatamente o mesmo que as de uma grande.

Um utilizador, com o mínimo conhecimento informático, passará a relacionar-se muito facilmente com o produtor em plataformas na internet. Provavelmente, tal como se desenvolveu globalmente o serviço de cópia, impressão e digitalização de documentos, também esta tecnologia estará disponível em todas as cidades, e a fabricação de objetos passará a ser local, perto do utilizador.

Como afirma Stegall "*...another implication for the form of a product is decentralization: products that make people dependant on large, centralized, distant organizations (current power companies and large power generation plants are prime examples) encourage people to be ignorant of how they work and their environmental impact*." (Stegall, 2006)

4.2. Aumento da vida útil dos produtos

Uma das dimensões mais interessantes oferecidas pela produção aditiva é a sua capacidade de contribuir para uma maior duração dos produtos. Esta é determinante na perspetiva da sustentabilidade, na medida em que reduz significativamente a necessidade de substituição dos dispositivos por razões de falência técnica ou por razões emocionais.

Em termos de relação emocional, a possibilidade dos produtos serem mais personalizados estabelece relações mais duráveis com os utilizadores. Diegel (Diegel et al. 2010) refere-se a esta questão ao afirmar que "*... Designers can stimulate desirability, increase pleasure and deepen attachment by designing products that not only function better, are more aesthetically pleasing than comparable products, but are also tailored to better suit the individual needs of the user.*"

O aspeto mais interessante consiste no fato das tecnologias de fabricação aditiva poderem contribuir para aumentar a vida útil dos produtos já existentes. Frequentemente somos confrontados com pequenas avarias, que implicam a substituição de uma peça. Não menos frequente é essa peça já não existir no mercado, ou implicar um custo de tal maneira elevado que torna mais económica a substituição do objeto todo por um novo. Em muitos casos, seria possível prolongar consideravelmente o tempo de vida do objeto, se fosse possível reproduzi-la de maneira económica. Este problema pode ser perfeitamente ultrapassado recorrendo à realização da peça através de produção aditiva.

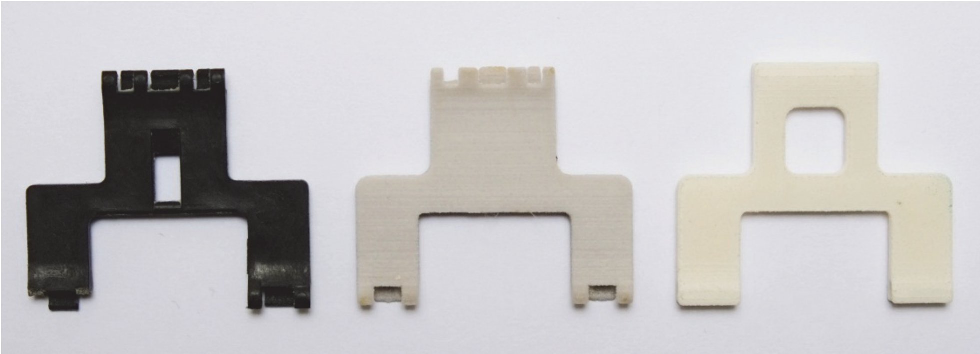

Fig. 2 Peça recuperada de uma impressora3 D - ZPRINTER

A figura 2 mostra uma peça danificada de uma impressora 3D ZPRINTER, originalmente fabricada por injeção de polímero, e duas fases da sua reprodução, a primeira, na mesma máquina e a segunda, otimizada e mais resistente onde foi usada a tecnologia SLS (*Selective Laser Sintering*). No primeiro caso, procedeu-se à replicação mimética da peça, nomeadamente no que diz respeito aos encaixes onde passa um eixo de rotação. No segundo caso, foi possível corrigir facilmente o problema de fragilidade desses encaixes, completando a superfície cilíndrica. Neste caso, obtemos um produto final com uma maior fiabilidade, na medida em que foi produzido por uma tecnologia que não limita a forma. No caso da peça original, a forma estava condicionada pela tecnologia de produção, que obriga à supressão de partes simétricas do corpo cilíndrico para permitir a abertura do molde. Acerca desta intervenção, pode referir-se que comparativamente, a peça representou um custo de reparação 100 vezes inferior ao que custaria a reparação com componentes originais.

Este exemplo permite apontar as diversas vantagens do processo:

1 – Rapidez na substituição da peça;

2 – Prolongamento do tempo de utilização da máquina;

3 – Redução dos constrangimentos produtivos que deram origem à peça, possibilitando assim otimizar o seu funcionamento.

Fig. 3 Future Baroque (Fonte: Something & Son)

A dimensão de prolongamento da vida útil das coisas é também explorada na instalação "*Future Baroque*" (Fig. 3) que o grupo "*Something & Son*" realizou para o museu Tate Modern, em Londres.

O projeto *future baroque* insere-se numa investigação que procura práticas que permitam incrementar a sustentabilidade ambiental das cidades, respeitando e enriquecendo em simultâneo edifícios antigos que pela desadequação à legislação atual teriam de ser profundamente alterados ou demolidos.

A instalação começa por ser uma fachada ornamentada, cujas formas são obtidas por técnicas tradicionais de moldagem, que são gradualmente substituídas por réplicas impressas. Esta técnica permite que no processo de substituição se coloquem elementos semelhantes, mas muito mais ornamentados do que os anteriormente existentes.

4.3 Produtos mais leves e eficientes

Nas técnicas convencionais de produção é frequente configurar os produtos de modo a que, além de suportarem as condições de uso, a sua forma seja adequada a determinada tecnologia de fabricação. Podem ser indicados exemplos como no caso da injeção de plásticos em que a forma do produto deverá permitir a fluência da matéria durante o preenchimento do molde ou situações em que a peça deverá obedecer a determinada geometria para evitar maquinações complexas e ser simples de montar. Os processos de produção aditiva associados à flexibilidade formal permitida pelas ferramentas de modelação e simulação possibilitam a eliminação de moldes e outros acessórios da produção convencional originando peças com as mesmas especificações funcionais e utilizando menos material.

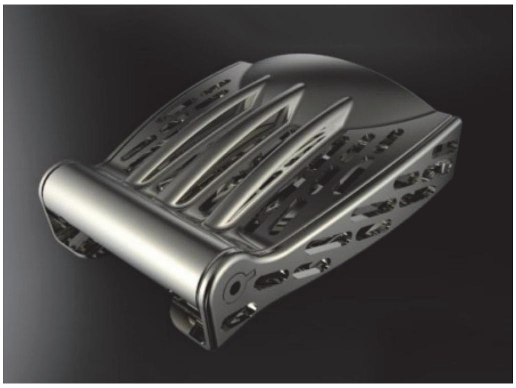

Fig. 4 Otimização da fivela do cinto de segurança (Fonte: Crucible Industrial Design)

A figura 4 apresenta uma fivela do cinto de segurança de um avião otimizada e produzida em titânio com a tecnologia DMLS (*Direct Metal Laser Sintering*). Este produto fez parte de um projeto[70] de pesquisa sobre o uso de processos aditivos de produção para reduzir as emissões de carbono. O projeto, inicialmente, segundo os promotores, parecia impossível dado que o DMLS é muito intensivo em energia e, o processo em si não podia ser "verde".

Este é um importante exemplo no sentido de entender que os benefícios ambientais da tecnologia devem ser medidos em relação a todo o ciclo de vida dos produtos assim obtidos.

A fivela de aço produzida por técnicas convencionais pesaria 155 g enquanto a versão otimizada apenas 70g o que equivale a uma redução de 55% no peso. Para um avião Airbus 380, com 853lugares, a substituição das fivelas corresponderia a uma redução no peso de mais de 70 Kg. Durante a vida útil do

[70] Os parceiros do projeto foram: Plunkett Associates, Crucible Industrial Design, EOS, 3T PRD, Simpleware, Delcam e University of Exeter

avião a economia em combustível seria mais de 3 milhões de litros. A análise do ciclo de vida, para este caso, resultaria numa redução significativa das emissões de CO_2.

É na indústria aeronáutica que se está a investir mais nos processos de produção aditivos complementados pela otimização topológica de projeto. O método permite uma redução substancial do peso dos componentes garantindo a funcionalidade e resistência estrutural. Nas figuras 5 e 6 (Radny, 2010) apresentam-se as diversas fases do processo de otimização de uma asa de avião e o resultado final.

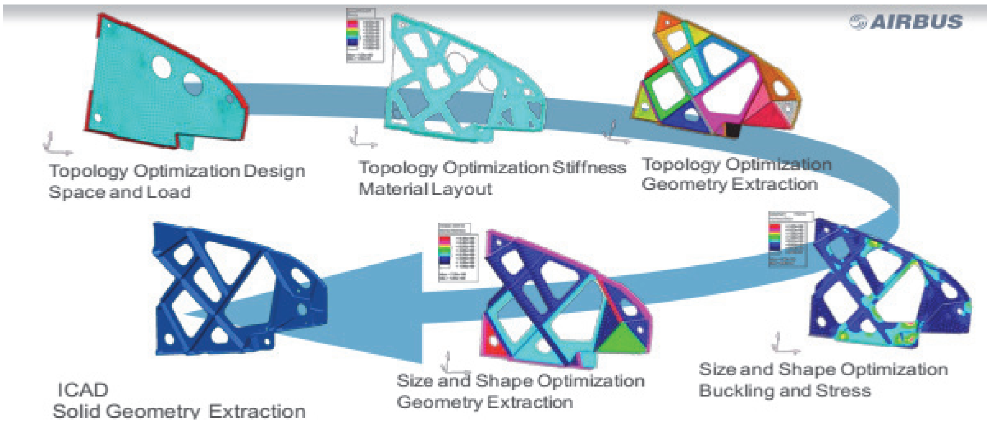

Fig. 5 Otimização topológica de asa de avião (Fonte: AIRBUS)

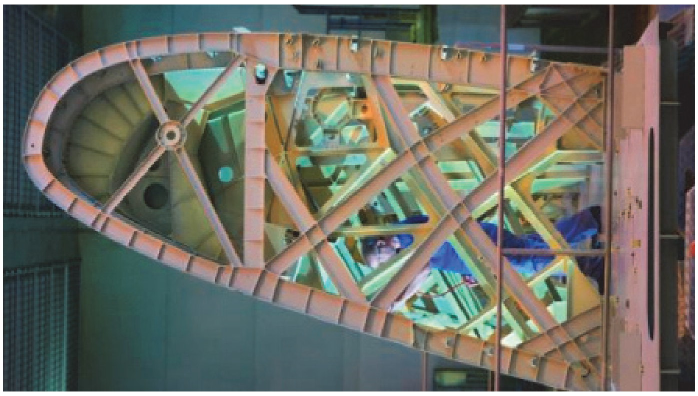

Fig. 6 Componente otimizado (Fonte: AIRBUS)

Outro método de tornar os produtos mais leves é a utilização de estruturas celulares ou em grade (*lattice*) e malhas. A forma exterior mantém as suas caraterísticas funcionais, ergonómicas ou estéticas, enquanto o interior do objeto é preenchido com uma estrutura mais leve. Na figura 7, apresenta-se um exemplo da indústria automóvel com o veículo conceptual *EDAG Light Cocoon* com uma estrutura biónica otimizada impressa em 3D.

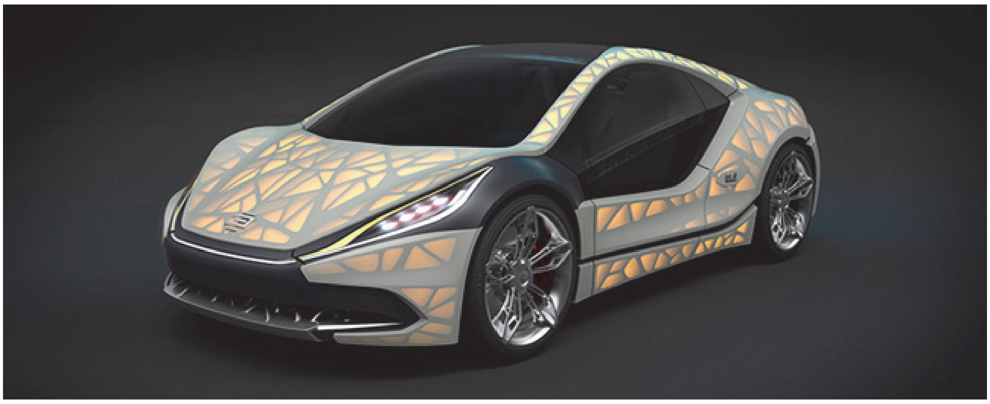

Fig. 7 "EDAG Light Cocoon": the ultimate in lightweight construction (Fonte: (EDAG. 2014)

4.4 Produção aditiva e sustentabilidade global

Os processos de produção aditiva representam tecnologia de fabrico relativamente nova, que se carateriza por potenciar fortes estímulos para o desenvolvimento sustentável. Há, no entanto, pouca bibliografia que quantifique objetivamente os benefícios da sua utilização.

Gebler (Gebler, 2014) apresenta um estudo que, segundo o autor, representa a primeira avaliação abrangente destas tecnologias a partir de uma perspetiva global da sustentabilidade desenvolvendo uma avaliação qualitativa das implicações de sustentabilidade induzida e quantifica as variações no ciclo de vida, custos, quantidade de energia e as emissões de CO2 a nível mundial até 2025. Apesar de Gebler entender que estas tecnologias funcionam ainda como um nicho de aplicação limitado e que, considerando a incerteza da sua utilização noutra escala, concluiu que em 2015, os processos de produção aditiva garantiriam uma redução de 5% nas emissões de CO_2 e no consumo de energia. O autor refere ainda que se outras indústrias como a automóvel optarem por substituir, mesmo parcialmente, as técnicas convencionais por processos aditivos de produção o potencial (teórico) da redução de emissões e de consumo de energia seria considerável.

5. Conclusões

Este trabalho permitiu, através da bibliografia e exemplos referidos, apontar um conjunto de possibilidades das tecnologias de produção aditiva que, em conjunto com o design, permitem encarar de forma positiva a evolução das tecnologias de produção no sentido de uma maior sustentabilidade dos produtos.

Extrapolando a realidade atual para aquilo que pode ser um futuro próximo, as tecnologias aditivas contribuirão fortemente para uma nova forma de pensar o projeto e o desenvolvimento de produtos, muito mais centrada no utilizador e nas suas necessidades e desejos. A capacidade de personalização precisa (já existente na área médica, por exemplo) será possibilitada por uma relação mais próxima entre o designer e o utilizador, potenciada pelas plataformas digitais colaborativas que permitirão a aquisição de dados mais precisos relativos à definição do produto na fase de desenvolvimento, e ao seu desempenho na fase de utilização.

Em termos de sustentabilidade ambiental, a tecnologia de produção aditiva possibilita uma utilização mais precisa e eficiente do material, na medida em que se ultrapassam a generalidade dos constrangimentos de forma característicos das tecnologias de produção tradicional, permitindo componentes tecnicamente mais eficientes, e simultaneamente mais leves e com incorporação de menos material. A dispensa de moldes e ferramentas complexas terá também um importante impacto, na medida em que o material necessário para obter um produto é apenas o que o constitui.

O impacto ambiental positivo das tecnologias aditivas residirá também no facto destas permitirem reproduzir eficazmente componentes técnicos de dispositivos existentes, permitindo prolongar a sua vida útil e atrasar por esta via a sua substituição. Poderemos voltar assim a obter, com grande facilidade, peças que se danificaram e que já não se fabricam.

É razoável considerar que existirão, num futuro próximo, locais onde a digitalização e impressão passarão das duas para as três dimensões. Poderemos aí imprimir uma peça da bicicleta dos anos 50 que já não tinha reparação, mas também digitalizar o nosso pé, para os próximos sapatos se adaptarem perfeitamente. Esta realidade permitirá em muitas circunstâncias aproximar o local de fabricação do local de utilização, com importantes consequências em termos ambientais.

Conclui-se ainda que o novo paradigma da produção, entendido como indústria 4.0, ou 4ª revolução industrial, implicará uma nova maneira de pensar os produtos, de forma a aproveitar todas as potencialidades da tecnologia no sentido os tornar mais sustentáveis e adaptados às especificidades de cada utilizador.

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System development for the disclosure of Portuguese digital type design

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Abstract

This study aims to cover the current development of a platform for the disclosure of the Portuguese type design community, since the beginning of the desktop revolution, until today. To deepen our understanding, interviews were made to a selected and representative group of type designers from our sample based on several criteria. The interview tested six dimensions: people, processes, products, uses, identity and platform. The results analysed in the last dimension, through content analysis and quantitative data, lead to the development of an online digital collaborative system – one of our specific objectives. Our hypothesis – that the development of a online digital collaborative system would allow further development of knowledge between products, users and authors, as well as, processes and uses – was also corroborated by the interviewers. Reviews have been made to reference international online projects to identify their purposes, areas of activity, objectives, mechanisms of interaction, usability and accessibility. This previous research brought together a set of notes that would become essential in the definition and development of our concept. The classification of typefaces is a subject of study by researchers and designers, but it is certainly not a topic for complete agreement. Organizing and balancing the content for the database was our first challenge since we were expecting users with good knowledge on the field, but also beginners. Several diagrams were put into test during the early stage of information architecture to better define categories, filters, and sorting methods, as well as users roles in the system. The items and categories chosen were redefined in a second stage, and in the third stage hi-fidelity wireframes were produced, to concentrate on design aspects and decisions, and put the system into test and evaluation. The current results on the platform development, with the improvements made through several user tests, evaluations and refinements undertaken in all phases of the project have been crucial. We are expecting to run some pilot tests, as well as usability tests prior to the full implementation to further improve the system and meet the expectations.

Keywords: *Digital type design; Typography; Platform; Process; System*

1. Introduction

The study of typefaces is a fairly recent discipline in Portugal. Apart from historical approaches, mainly focusing on printing, since the beginning of the Press until the 17th century, design related research based on the typefaces themselves, their authors and processes are, until today, very scarce.

In recent years, typography has been a topic of growing international interest, with a focus on studying foundries and typefaces that were well-received throughout history.

In the beginning, producing typefaces was a manual, complex and time consuming activity that involved several tools and mechanisms. Nowadays, thanks to the digital revolution, to the easy access to digital tools and to information sharing, all of this process can be done within the scope of a computer. Since the digital revolution, type-making has proliferated and today there is a huge growth in digital foundries, providing quality typefaces (Cahalan, 2007; King, 1999; King, 2001; Kinross, 1992; Leonidas, 2013a; Leonidas, 2013b; Middendorp & TwoPoints.Net, 2011).

Original type designs in Portugal were, until the digital realm, very little explored, and mainly based on the knowledge of foreign contributions (Anjos, 1886; Anselmo, 1981; Anselmo, 1997; Canhão, 1941; Pacheco, 1998; Pacheco, 2005; Pacheco 2013). In the field of typography and type design, the isolation was only abolished in the early 90s. In the last two decades teaching of typography in schools was promoted, specific subjects were created in universities, and a promising generation of type designers in Portugal started to emerge (Chaccur & Amado, 2010; Quelhas, Branco & Heitlinger, 2011).

Typefaces firstly designed by Mário Feliciano and Dino dos Santos, and later on by Ricardo Santos, Rui Abreu, Susana Carvalho, Hugo d'Alte, among others, started to achieve a notable presence in Portugal and abroad, being distributed and recommended in the main digital type foundries around the world. Although their work has been recognized with prestigious awards, honourable mentions, and also with international projects commissions, little is known about their path, processes, products and uses.

This paper addresses the systematic approach underpinned in the design and development of a digital web platform for the disclosure of Portuguese digital type design. This project has been conducted as part of a broader research that aims to analyse, describe and identify the factors that contributed to the continuous growth of the digital type design production and community in Portugal.

The platform aims to tackle the lack of systematization and relevant information about authors, products, uses and distribution, contributing to the awareness and expansion of its national and international visibility. It also intends to contribute to understanding the history of type design in Portugal, providing theoretical and practical knowledge.

2. Study framework

A mix of research methods has been used to gather as much information as possible to inform and reveal the necessity of this project. Soon we have realized that studies in our field, Portuguese digital type design, from 1990 until 2010, were scarce or very lightly explored, and the information looked scattered, both in the national and international literature available. Due to the contemporaneity of the research, our main references to similar investigations came, as expected, from the academic community, mainly in the form of master dissertation or thesis (Cahalan, 2007; King, 1999).

Information about Portuguese digital type designers is hard to find. It is also very hard to determine what constitutes nowadays to a renown or professional type designer. If that can be true at an international level, in the national scale, the lack of an institutional organization or association that centralizes this data, makes the task of collecting it extremely challenging and it was only possible through the pioneering work of Luc Devroye. In his website[71] Devroye keeps an online archive with references of type design from all over the world. Although his selection is not classified, this resource lists exhaustively type design creations from Portuguese authors, professionals and amateurs.

Iconographic data on the typefaces were in first place gathered from the type designers personal, professional, or promotional websites, from previous versions of their websites through the Internet Archive, from Devroye list of collected material on Portuguese type design production, from social networks, blogs and forums, from foundries and distributers, as well as from printed sources, mainly catalogues and type specimens.

The form chosen to complement this collection was the use of a survey in the form of interview, as this instrument allows to obtain qualitative data related to values, attitudes, opinions and preferences of the interviewed, as well as the collection of quantitative data whenever deemed necessary (Patton, 2002).

To deepen our understanding on the typefaces, their authors, processes and uses, a series of semi-structured interviews were conducted to a selected and representative group of type designers from our universe based on a set of criteria built upon the contributions of related previous researches, mainly King (1999), Cahalan (2007) and Gomes (2010). Each author should at least meet three of the criteria listed below:

· Designers with published typefaces or custom types;

· Designers with typefaces awarded in renowned competitions;

· Designers invited for lectures and conferences;

· Designers cited or distinguished in magazines or related websites;

· Designers recognized by their peers.

Based upon these criteria, ten designers have been selected in order to pursue with the interviews (listed alphabetically): Dino dos Santos; Jorge dos Reis; Hugo d'Alte; Manuel Pereira da Silva, Mário Feliciano; Miguel Sousa; Ricardo Santos; Rui Abreu; Rúben Dias; Susana Carvalho.

The interview was conducted to all these designers, except Manuel Pereira da Silva who unfortunately was no longer with us, tested six dimensions: people, processes, products, uses, identity and platform.

In the first dimension our objective was to better know the author and his work. This part of the questionnaire was focused on training, professional activity in general, the influences and references to national and international levels; the second dimension focused on the process of designing typefaces, trying to understand the relationship between authorship/technology/program (Providência, 2003); the third dimension focused on their perceptions related to the typefaces themselves, the sales rank, awards, and also on perceiving the organization of their typeface production; the forth dimension focused in the uses concerning features such as language expansion for international markets, and understanding theirs opinions on the impact of technologies in their typefaces uses. It was also focused on understanding the gaps in the promotion and uses of national typefaces; the fifth dimension tried to evaluate the perception of each author in relation to the identity of Portuguese typefaces, cultural traits and the differences of their products in the national and international market; and the last dimension was directly related to the need

[71] Luc Devroye Type in Portugal webpage: http://luc.devroye.org/portugal.html

of creating a platform for the disclosure of Portuguese digital type design, one of our research specific objectives that will be detailed in this paper.

The interview was truly a necessary step to engage with the most relevant authors, understanding their needs and expectations. Involving them in the decision making process was part of our methodology.

2.1. Organizing and classifying typefaces and related information

The classification of typefaces is a subject of study by researchers and designers, but it is certainly not a topic of complete agreement. Over time, several methods were designed based on morphologic aspects (BS 2961, 1967; Thibaudeau, 1924; Vox, 1954; Willberg, 2001), historic movements (Bringhurst, 2004 [1992]), mixed classifications (Bauermeister, 1987; Dixon, 2001; Mundie, 1995) and later on with tags (Dixon, 2012). Nowadays, the amount of variables in typeface design and production makes the classification field a very difficult task.

Shaikh (2007) researched also this topic and concluded that “the lack of uniformity among the experts makes it difficult to definitively choose one classification system as the most representative” (p. 11). However, she noted that, the classification system proposed by Spiekermann and Ginger (1993) is comprehensible for beginners: Serif, Sans Serif, Script, Display, and Symbols.

The article *25 Systems for Classifying Typography: A Study in Naming Frequency*, by Childers, Griscti and Leben (2013), retrieved the most frequent classification words from a total of 25 classification systems published in the last century, ranging from typographic experts such as Theodore Low De Vinne and Maximilien Vox and ending with contemporary type and design researchers such as Ellen Lupton and Robert Bringhurst, in a new map, divided in three main branches of type design: Serif, Sans Serif, and Topical (for a subdivision of non-text faces) (Fig 1).

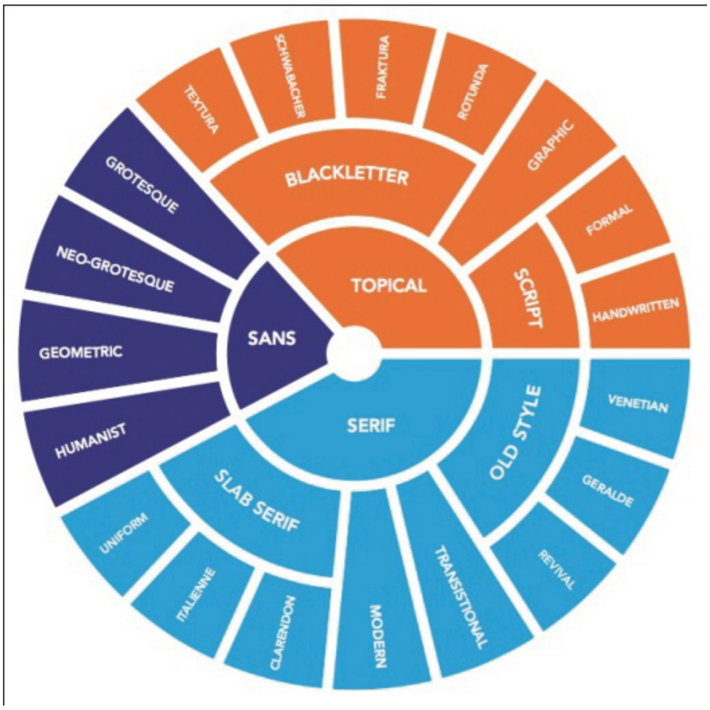

Fig. 1 Taxonomic model for Typeface classification. Source: Childers, Griscti and Leben (2013).

Childers, Griscti and Leben (2013) refers that, “It is felt that a very high level of specificity is achieved with this model without becoming overtly caught-up up in unnecessary jargon. It is therefore more usual than over-simplified orders and viable for extensive typeface class naming uses.” (p. 19).

Merging the frequency of words within the study of Childers, Griscti and Leben (2013), with Shaikh (2007) suggestion of a simplified classification based on Spiekermann and Ginger (1993), with Bringhurst (1992) unique historical approach, and Vox-ATypI morphologic classification, and confronting those findings with the information gathered into similar classification systems in international web platforms, from the most representative type foundries and distributers, a selection of terms were put into test. This helped us to understand the many possible ways to organize, filter and sort typefaces. Organizing and balancing the content for the database was our first challenge since we were expecting users with good knowledge on the field, but also beginners, the amount and ways of sorting and filtering were striped down to the essential jargon. Although we have started with a dozen terms, soon we have realized that it was best to start with a small amount of categories before adding a lot of subclassifications to cover all the typographical details. For the platform we decided to classify typefaces in a cross categorization and flexible system, according to availability (published; custom; unpublished), style (serif; sans serif; handwritten; display; symbols) and function (text; title; web; decorative; non-latin). To facilitate the access, other features and sorting methods were also included (free; families; awarded; order by AZ; most recent). To define the typefaces more specifically other descriptive components were also added to the typefaces in the form of additional searched tags.

3. The platform

3.1. Concept definition, objectives and targeted users

The results analysed in the last dimension of the questionnaire, both content analysis and quantitative data, was an encouraging footstep that led to the development of an online digital platform.

Our hypothesis – that the development of an online digital collaborative system would allow further development of knowledge among products, users and authors, as well as processes and uses – was also corroborated by the interviewers. This positive feedback encouraged us to continue our research with the development of a project based approach delivered through action-research methodologies.

The main goal of this project is to research and develop a prototype that merges information on digital typefaces, providing room for several ways of organizing them, selecting and deepen our understanding on their authors, their process of development and uses. Currently, the most recent books, blogs, or foundries websites deliver a couple of information regarding a particular typeface, such as the authors name, year, foundry, classification, brief context, purpose of creation or use, among other details. But it is hard to retain and sometimes find those details.

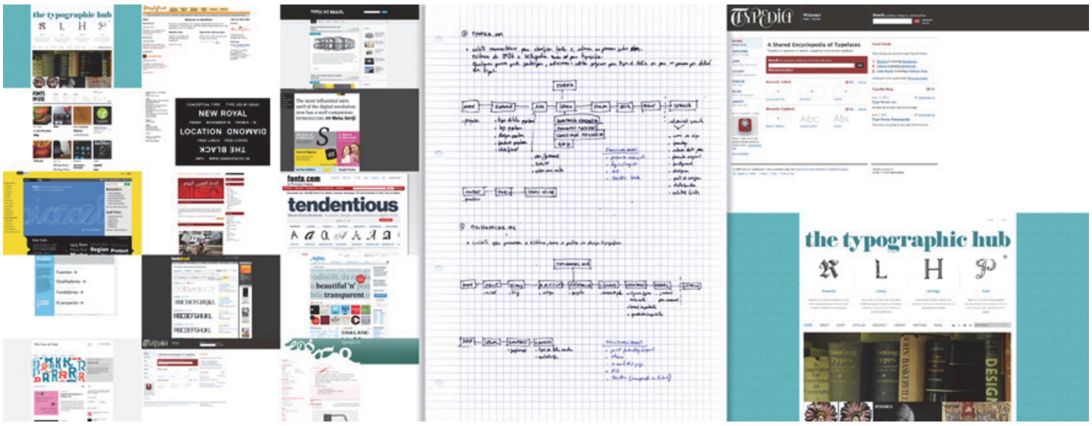

Fig. 2 Previous research and analysis to related international platforms

Studies have been made to similar international online projects to identify their purposes, areas of activity, objectives, mechanism of interaction, usability and accessibility (Fig 2). This previous research brought together a set of notes that became essential in the definition and development of our concept, specially in regard to the classification and sorting of typefaces.

The platform named Portype is developed with two different approaches in mind: first deliver a curated and detailed gallery of typefaces and their authors, from selected experts (the process described in this study); and secondly create the basis for an open version, dedicated to all those interested in showing and sharing their typefaces, whether free, academic or professional scopes, that don't meet the criteria to take part of the curated version (the same criteria adopted above to select the sample for interviewing). This last version (still in study) is expected to bridge the gap between experts and initiates, contributing in a collaborative and pedagogical form, not only as an observatory of the type design community, but also hopefully serving as an incubator for the development of type design practices in Portugal.

Independently of the version, special focus was put on the potential users, exploring the many possible scenarios – the design students, professional designers, and in a broader sense all of those interested in the fields of type design and typography.

3.2. Navigation structure, contents, links and workflow

Several diagrams were put into test during the early stage of information architecture and database structure to better define categories, filters, and sorting methods, as well as users' roles in the system and workflow (Fig 3).

Fig. 3 The design process: Diagrams, sketches and first digital wireframes

In the first version, the prototype would allow users to view, search and identify typefaces based on a multitude of filtering and sorting methods, show detailed information of a typeface (name, author, year, availability, style, function, tags), through text descriptions, specimen images and examples of the type in use. Regarding the authors, the users could see an overview of the most relevant authors, access to the author specific information showing their biography, contact details, and their work organized according to the availability of their typefaces: published, custom, and unpublished typefaces. Users would also be allowed to contribute with more information, suggesting typefaces, authors or new examples of type in use.

Since the platform aspires to appeal to a wide audience, from design students to professional designers, and, in a broader sense, to all of those interested in the field of type design and typography, the amount and ways of navigating, sorting and filtering were striped down to the essential. We have tried to guide the user, even those who are new to the field, through a set of perceptible steps, according to the scenarios and user's role previously defined.

However, its features were not only based on the input received from the data previously obtained through the review of similar projects, neither from user's needs and desires, but also on the conventions and best practices within the field of design and interaction.

3.3. Interaction design

From the beginning, our approach to the interaction design pursued simplicity and easy to use, since it was mainly intended to be used specially by designers. We also knew the importance of ensuring that the interface presented to users from a non-technical background needs to be straightforward and easy to use. In interaction design, usability is a key concept when it comes to achieve these goals: effective to use (effectiveness), efficient to use (efficiency), safe to use (safety), have good utility (utility), easy to learn (learnability), easy to remember how to use (memorability) (Nielsen & Tahir, 2002; Preece, Rogers & Sharp, 2011).

Hence it was necessary to ensure that the right amount of decisions, as well as functionality was provided to users.

From the information gathered previously a few items were considered a priority for the platform: the typefaces page, the typeface specific page, the authors page and the author specific page. In a first stage sketches were done in paper. The items and categories chosen were redefined in a second stage, where a series of alternative designs were experimented and tested to meet those requirements, but now with digital wireframes to test and evaluate again. In this phase we were not only concerned with the content, but also with technical issues since we wanted the platform to work well on several devices, meeting a responsive design. Most of the decisions were taken during this stage. In the third stage hi-fidelity wireframes were produced (Fig 4), to concentrate on design details and decisions, and put into test and evaluation.

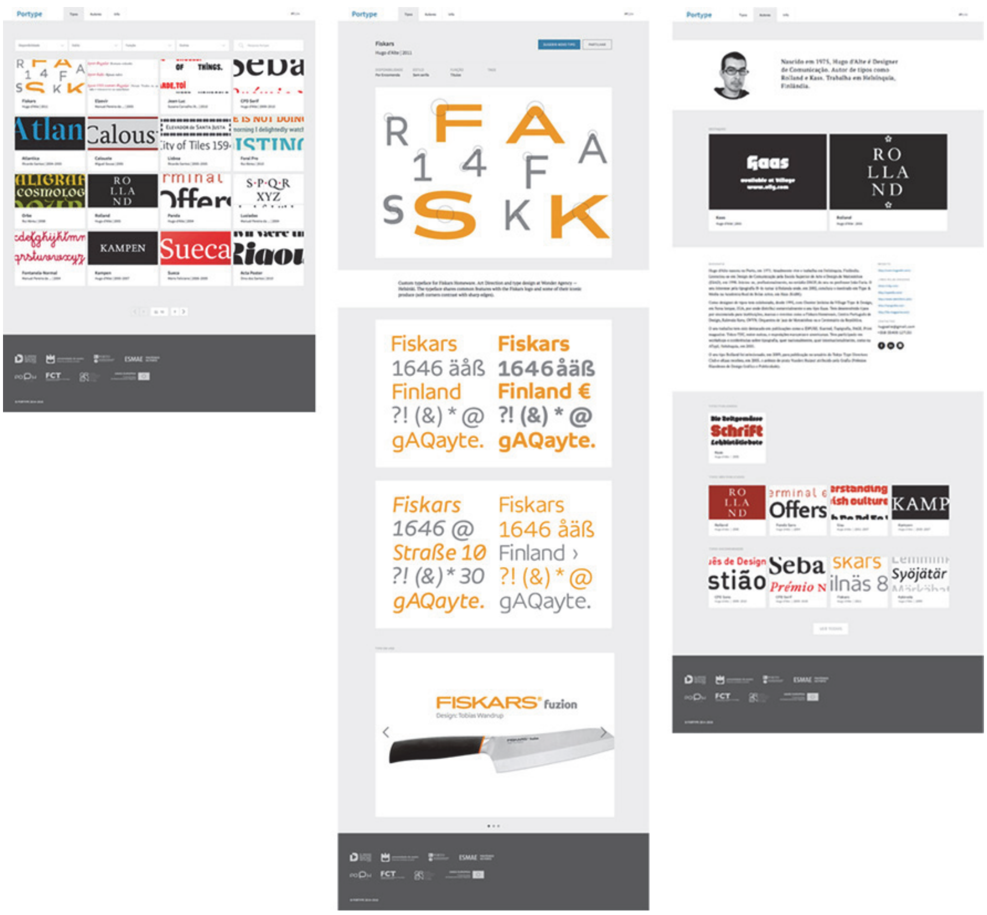

Fig. 4 Hi-fidelity digital wireframes: The typefaces page, the typeface specific page and the author specific page

3.3.1. Brief description of the main functionalities

For this version of the prototype the main functionalities tested were the homepage, the typefaces page, the typeface specific page, the suggestion page, the authors page and the author specific page.

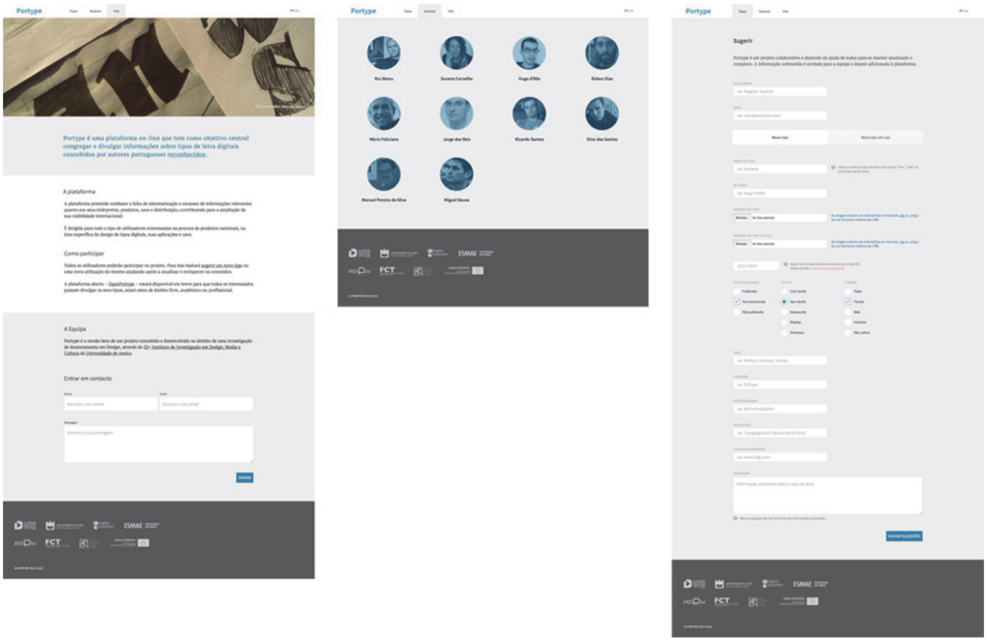

Fig. 5 Info, authors and suggest new typeface pages

The homepage shows the project general information (Fig 5) presenting at the top the main menu and the language selector. Then a slideshow is displayed followed by the project aims, a brief description on how users can collaborate, the team and ends with a brief contact form.

The typefaces page displays the curated grid based gallery of Portuguese digital typefaces (see Fig 4). Each typeface is represented with a specimen image, followed by the typeface name and year. At the top the system is divided into selection filters (availability; style; function; others), sorting methods (Order AZ; Most recent) and a search form, if user want to search a typeface based in other criteria, such as tags.

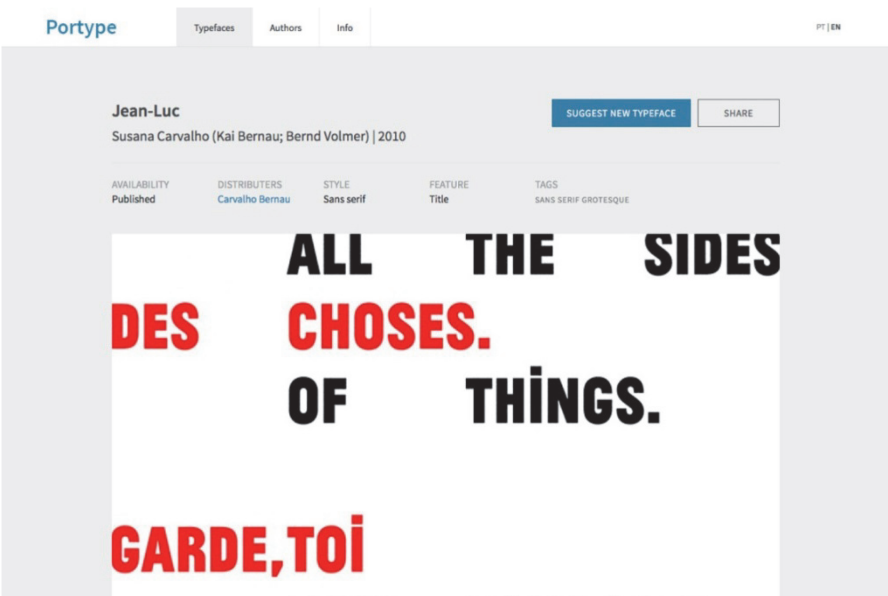

Fig. 6 Detail of Jean-Luc typeface specific page

The typeface specific page retrieves the description topics from the database regarding the availability, distributers, style, feature, and tags (Fig 6). Several specimen images are displayed showcasing the typeface diversity and overall features followed by a scrolling gallery of the type in use. It ends with a suggested gallery of other typefaces from the same author. It's also possible to share the hole page or suggest a new typeface from the top links.

The suggestion page (see Fig 5) is divided into two options that the user needs to specify: suggest a new typeface or a new type in use. After specifying their choice, the form adapts to the information needed. In this curated version, all suggestions are recorded by the system and put on hold for further revision and approval.

The authors page, similar to the typefaces page, shows the selected type designers in a four column grid based layout (see Fig 5). Each author is displayed by a circular image that also represents the link interactive area.

The authors specific page holds complete information on each author (see Fig 4): highlighted and brief description of the author; two highlighted typefaces; biographical data; website; related links; contacts and social media. Then a gallery of typefaces organized by availability is displayed: published; custom; and unpublished typefaces.

4. Implementation and evaluation

A prototype was built from scratch to test the platform functionality, both through technical compliance tests, and user tests. Evaluating what has been built is very much in the center of interaction design (Preece, Rogers & Sharp, 2011). It is important to develop a method for measuring user satisfaction with prototypes of future systems (Lewis, 1991).

In this phase we have conducted a questionnaire to measure user attitude and satisfaction with the first version of the prototype. The inquiry questionnaire was divided in three sections. The first section gathered information related with the characterization of the respondents (genre; age; professional activity; and the level of self awareness as a typography user). The second section recorded the agreement of users' opinions and attitudes according to three major dimensions: Overall Design, Interface and Contents. For that purpose, Osgood's semantic differential scale were used (Osgood, Suci & Tannenbaum, 1957). A list of opposite adjectives gathered through contributions in the literature (BBC, 2002; Chin, Diehl & Norman, 1988; Lewis, 1992; MacGregor & Lou, 2005; Shaikh, 2009; UX for the masses, 2010) was developed in order to measure the platform connotative meaning in a seven-point scale. For the Overall Design dimension, these six opposed items were assessed: unpleasant/pleasant, traditional/contemporary, amateur/professional, unfriendly/friendly, confusing/clear, vulgar/elegant. In the Interface dimension: inadequate/adequate, inefficient/efficient, fragile/solid, complicated/simple, decorative/functional, difficult/easy. And in the Content dimension: common/rare, useless/useful, not recommended/recommended, irrelevant/relevant, insignificant/significant, general/specific. The third section measured the users' attitudes towards the prototype with four statements scored along a range of a five-level Likert scale (Strongly disagree; Disagree; Neither agree nor disagree; Agree; Strongly agree). The main focus was on ensuring that the project was useful and usable. We have adapted some of the contributions based in the literature from other surveys to meet our needs (Brooke, 1996; Davis, 1989; Lund, 2001). Thus, the range captures the intensity of the respondents feelings towards that aim.

The inquiry was applied to three groups of users (311 answers were considered valid): design students (95,2%), teachers (2,6%) and professionals (2,2%). With the design students our focus was to evaluate the perceptions of beginners, usually with an incipient background on type design and typography in general, and with teachers and professionals the perceptions of experienced users.

Design students were obtained from the universe of Portuguese higher education institutions that offered a subject on Typography (5 universities and 3 polytechnic institutes). A total of eight institutions distributed all over Portugal, with both undergraduate (74,2%) and master's courses (25,8%), constituted the most significant part of our population sample (95,2%).

Prior to the distribution and completion of the survey, a brief presentation of the researcher, the purpose and context of the research was conducted, as well as a demonstration of the functional prototype.

In the end, respondents could test themselves the prototype and filled out the anonymous survey. In the end some of the respondents shared their thoughts and suggestions, through a spontaneously conversation. All were noted down for future consideration.

Data was processed through statistical analyses, descriptive and inferential analysis, and were conducted to test for significance of the quantitative findings using IBM SPSS 22.0.

The sample revealed that the majority of the respondents were women (63,3%), with an average of 21,67 years of age and a medium self perceived level of typography usage.

The output from the second section revealed that there is a good overall evaluation of the prototype.

Content was the dimension that met the highest classification (M=6,39), followed by Interface (M=6,33) and Overall Design (M=6,10).

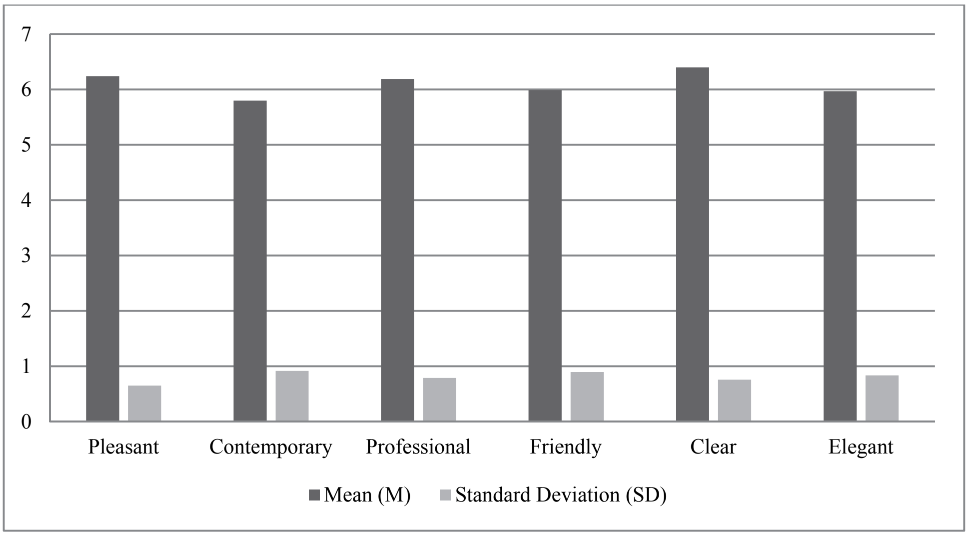

Chart 1 Overall Design (M=6,10)

In the Overall Design dimension, the item Clear is the one with the highest average (M=6,40) and the Contemporary item is the one with the lowest average of (M=5,80; SD=0,917). Although that result represents a good average score, it denotes little agreement among respondents attested by the standard deviation which is also the highest in this items dimension. All other items are between 5,97 to 6,24.

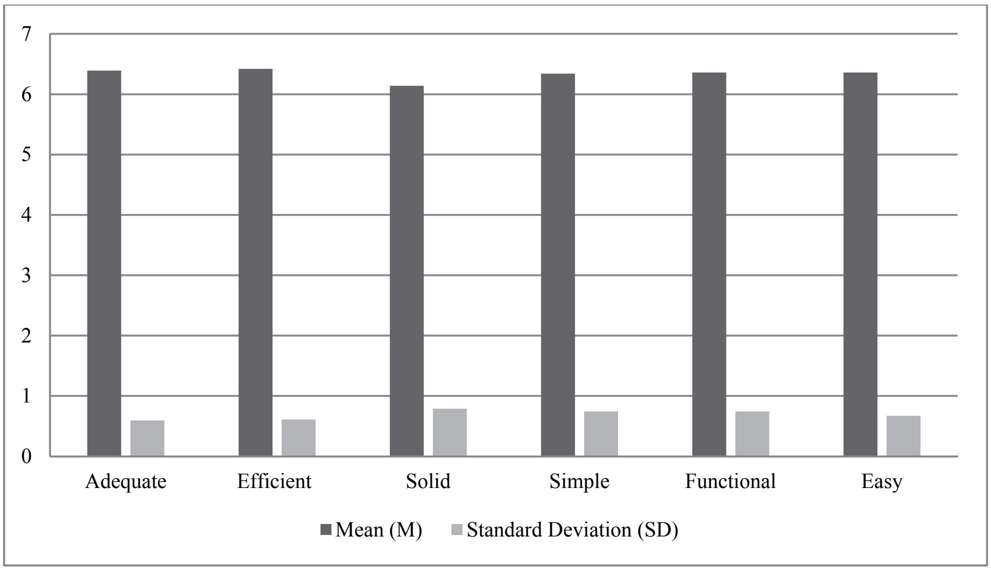

Chart 2 Interface (M=6,33)

In the Interface dimension, the item Efficient has the highest average (M=6,42) and the Solid item is the one with the lowest average of (M=6,14; SD=0,789).

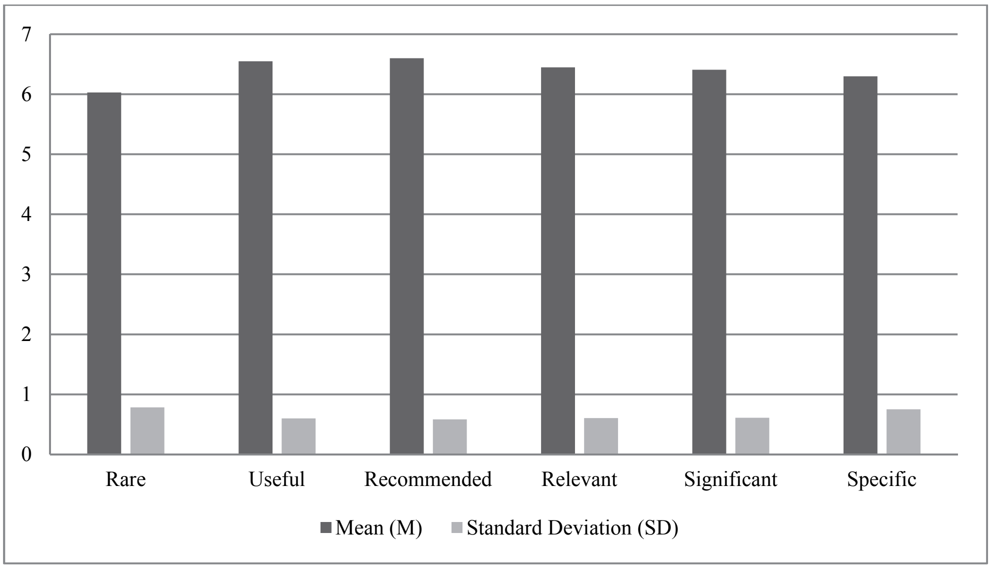

Chart 3 Contents (M=6,39)

In the Content dimension, the item Recommended has the highest average (M=6,60) and the Rare item has the lowest average (M=6,03; SD=0,784), but the standard deviation of this item shows the lack of consensus in the responses. All other items are positioned from 6,30 to 6,55.

In regards to the third section, respondents were especially in agreement with the fact that the project could bring more visibility and quality to national projects (Strongly agree: 59,6%; Agree: 35,6%). In general, the sample seems to agree that the project would take more authors to participate and motivate them to quality (Strongly agree: 42,9%; Agree: 43,3%), the regular usage of the project (Strongly agree: 36,2%; Agree: 58,3%), and with the recommendation of its use (Strongly agree: 19,9%; Agree: 66,3%).

With this data in hand we also wanted to test if there was significant differences in the evaluation of the Overall Design, Interface and Content according to genre, degree of study, and different professional activities. We have found that users from the master's courses evaluate the Overall Design and the Interface with lower classifications, but the inquiries with more than 35 years old have a better average evaluation.

Teachers revealed a statistically significant higher score in the evaluation of the platform interface. Users from 26 to 30 years old and with more than 35 years old recorded the highest scores in assessing the platform interface. Regarding the Content, respondents from the universities are the ones that better evaluate it .

These results are consistent with the hypothesis that the development of an online digital collaborative system would allow further development of knowledge of products, users and authors, as well as processes and uses. The questionnaire was a relevant tool to capture information regarding the system usefulness, information quality, interface quality.

5. Conclusion

This paper addressed the current system development of a platform for the disclosure of the Portuguese type design community, focusing on a group of selected type designers, from 1990 to 2010.

The systemic approach was revealed from the beginning of our research, where we had to find out the best possible ways to select the typefaces and their designers. The interviews conducted in the first stage of our study were crucial to deepen our understanding of their work and attitudes toward the development of the platform.

Review of the literature showed that there was a lack of uniformity among several authors which made it difficult to definitively choose one classification system as the most representative. This led us to systematically search for the most comprehensible terms, by studying different classification systems, comparing them with our research among the most representative type foundries and distributers, helped to gather information and refine our strategy towards the classification system used in the prototype, since we were aiming to appeal to a wide audience.

With that in mind, we have started to organize the information structure of the platform in order to fulfil the users' needs and expectations. For that purpose, after several tests during the initial phases of development (sketches; wireframes; hi-fi wireframes) the structure of the prototype was adjusted for a first test. Putting the users in the center of our approach was a very important step to inform us of their perceptions and needs. Evaluating systematically what was being built throughout the process was crucial (and still is). Searching the attitudes and behaviours of users is relevant especially for the development and improvement of the prototype.

The questionnaire developed to test the perceptions and attitudes of potential users made us aware of their needs and behaviour, highlighting how they perceived the prototype in the Overall Design, Interface and Content dimension, as well as their opinions regarding the usefulness of this project. The results revealed that users had a very good evaluation of the prototype rating all the dimensions with high values, highlighting the clarity of the design and that it is efficient and easy to use, which corroborated the hypotheses that the development of an online digital collaborative system would allow further development of knowledge between products, users and authors, as well as processes and uses.

One important finding of this study is that there was a good perception of the prototype aims, with the majority of users agreeing with the fact that the project could bring more visibility and quality to national typography taking more authors to participate and motivate them to quality. Most users agreed that they would regularly use the project and recommend its use to others.

Performing this test with the majority of respondents being students of design all over Portugal had an enormous impact in our research prospecting that the project will be well welcomed. Despite the positive feedback, it is still a prototype, with some improvements to make in the future to meet the users' expectations, mainly with issues related to both usability and contents. With the collaborative input from the users, we hope that the project contents become even more complete and up to date.

The project contributes to knowledge by presenting the methods and reasoning that support the design of digital typefaces while recording information from the past until the present. From the compilation of information on the subject, to the simplified classification mechanism; from the search, filtering and sorting capabilities, to the collaboration of users to increase the systems information. In short, involving the users as part of our research methodology turned out to be a valuable tool in the development of a platform for a wide possible spectrum of users. The current results on the platform development, with the improvements made through several user tests, evaluations and refinements undertaken in all phases of the project were crucial.

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Materials to boost companies innovation. Systemic production network and technological crossbreed

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Abstract

The origin of resources and location of suppliers and manufacturers are key elements in environmental sustainability. Equally important are the potential new areas of application and the development of further production. The aim of this article is to investigate how designers can help manufacturing companies providing sustainable solutions that envisage a future beyond processes, by considering the complexity of a territory and its production system. The creation of "zero-km" contacts network among companies, dealers, producers and suppliers could be useful for Small and Medium Enterprises (SMEs) in order to improve their production in a sustainable way. Moreover, developing new products and investigating on new potentialities of the currently produced series drive manufacturing companies towards (eco) innovation. Doing so through envisioning unconventional interpretations for materials, semi-finished products and components alike, through technological crossbreed.

This is the direction through which material libraries should seek to progress: in fact on the one hand today's materials and production/finishing processes are smart and encase performance and functionalities that require complex systems. On the other hand the origin of resources and localization of local suppliers and manufacturers are key elements when it comes to environmental sustainability.

The article presents an analysis of the potentialities of material libraries and the activity of an academic material library, conceived not only as an archive but also as a support to boost companies' innovation management. In this last case, the support offered to firms is characterized by a strong design slant and ensures the methodologies and principles of Eco-Design, Exploring Design and Advanced Design (ADD) paths: following these methodologies, solutions related to firms productive district are defined, taking into consideration materials/semi-finished products that can be renewed by transferring them to different manufacturing cycles.

In material libraries the designer's role is to transform the intangible aspects associated with territorial and technological dimensions into tangible solutions. This article will present case studies of SMEs working in different fields, which started to produce new objects and updated their production using new materials and semi-finished products.

Keywords: *Materials libraries; sustainable strategies; companies' innovation; design research; Advanced Design.*

1. From the materials' hyper-choice to the materials archives: Their role in a local context

Currently, around the world, there are millions of different materials and new ones are constantly springing up: "the proliferation of new materials and the enormous technical and expressive possibilities offered mean designers must keep continuously updated on their properties and possible applications" (Langella, 2003); in fact the designer and manufacturer are faced with a huge and growing scope of possibilities, in which the choice of materials and the transformation processes can be combined, giving rise to what is known as "hyper-choice" (Manzini, 1986).

In order to search for and classify innovative materials and products for the world of architecture, design and industrial production, "material libraries" have been created; real and virtual archives of indexed material samples that are offered to designers as research tools in an attempt to increase awareness of all the materials available (De Giorgi, 2012). The term "material library" is a neologism, coined to identify physical or virtual places in which technical information is collected and made available in relation to a wide range of materials, particularly in the world of architecture, design, fashion and industrial production in general (Lerma, De Giorgi & Allione, 2013). "For some designers, material libraries are primarily centres in which to find inspiration for new projects; there are people who consider them as places to visit, like a contemporary sculpture exhibition or a 'documentary' of current affairs, in which 'curious' simple materials with an extra-terrestrial aspect become major protagonists or collector's items [...]. For others, they are considered places in which to work, to conduct in-depth research on a specific component with the possibility of drawing upon the expertise of consultants [...]" (Campogrande, 2009).

As Dehn underlines (Dehn, 2014), materials have become "more sophisticated in appearance and performance and most of them were in production": the possibility to give access to samples and information on a variety of materials and technologies has become fundamental for students, professionals and companies in order to be up-to-date in terms of material and technology innovations. In fact, material libraries are not just born from the need to assist the designer in gathering information on new materials, but also to help companies promote their products on the market, to become part of a community and thereby gain contact more quickly with other organizations, to build solid collateral and publicity and to meet potential new customers or partners: creating a network of contacts in the territory facilitate the manufacturing companies, particularly the Small and Medium Enterprises (SMEs), while selecting their suppliers or researching and evaluating local partners for processing operations. This is the direction in which material libraries should seek to progress in order to support SMEs innovation.

1.2 Materials for sustainability dimension: Supply chain and production systems

When it comes to environmental sustainability, opting for the use of materials and semi-finished products sourced from areas comparable to that where the company operates is strongly advisable (Lerma, 2014); in fact, planning and organizing a short production chain is akin to keep down logistic costs, harmful emissions (e.g. CO_2) to the air, distance to move goods within, thus resulting in an improved quality of the distribution chain (Marino, 2013). On the other hand, the sustainable supply chain requires conscious choices to be made at all industrial stages: from the purchase department, through to product development, Marketing, Transport and Logistics organization" (Colicchia, 2012). According to the

Cluster Theory, a.k.a. conglomerate theory or cluster (Lanzavecchia, Barbero & Tamborrini, 2012), the local economy could greatly benefit from companies part of the same cluster that share and interconnect raw materials and suppliers. Conversely, companies have instead a scarce knowledge of who their neighbours are and what their productions are all about, so much so, that they end up liaising with faraway suppliers and transformation partners: the logistics activity, referred both to distribution chain and the actual/organizational product management, gets tangled, hence, it weighs more on environment.

Local SMEs and manufacturing companies will be able to reduce waste and consumption and optimize the use of resources, as well as encouraging the pre and post consumption use and re-use of waste throughout the production process, by adhering to a sustainable logistics, that is more efficient and sensitive to the ecosystem requirements (Aguiari & Provedel, 2013).

1.3 MATto materials library of Politecnico di Torino: A consultancy service for SMEs of the Piedmont Region

MATto materials library of Politecnico di Torino (Design and Visual Communication Degree Course) is a material archive, which includes more than 700 samples of new generation materials, particularly used in the field of design and architecture. MATto has been developed in the Politecnico di Torino Design Course, also with the help of the students, in order to keep designers up to date about the latest materials available for their projects. Up to now, for each MATto material samples, an analysis sheet is arranged, which reports the technical (physical-mechanical) properties of the materials, its applications, the available format and a cost estimation (Ashby & Johnson, 2002). MATto is aimed at becoming a support tool for the problem setting, by which the designers (and the other figures involved into the product development) are assisted for identifying which material parameters influence the product eco-performances. Consequently, a multidimensional profile is provided and the several parameters are not averaged in a unique performance indicator (Graedel, 1997). At the same time, another important information provided by MATto material library is the sensory profile, which could be useful for considering the human perception of materials too.

Fig. 1 MATto material library in Politecnico di Torino: the exposition and a phase of the consultancy service

In 2010, it has become a consultancy service (fig. 1) supported by Torino Chamber of Commerce for the SMEs of the Piedmont Region in Italy (De Giorgi, 2012). The innovative aspect of MATto is to provide meta-project solutions, in other words some indications to the design process without the specific solutions that will be subsequently implemented, by identifying new materials or semi-finished products suitable for every specific need or request of each project, based not only on the technical and economical performances: also the sensory and environmental material properties are considered.

The MATto_Materials for Design consultancy service organized by MATto materials library aims to address companies' needs related to critical product, materials, processes, environmental sustainability of materials, semi-finished products, innovation in their field and new markets for businesses. Materials are identified in order to help companies to develop new products and explore new potential products on the basis of their specific requests. Since 2010, more than 150 firms have taken advantage of the consultancy service and their production fields are various: from the automotive field to jewelry, to packaging to lighting, to technical textiles, to personal accessories, etc.

2. The research question: How to support SMEs towards a progressive innovation?

The search for innovative materials and, in particular, for innovative production processes, is fundamental and crucial for every enterprise. Innovative enterprises in fact are constantly looking for new ideas, for a new future product, to obtain improved solutions for a product already in the design process or obtain solutions for a product already in production.

For SMEs, this issue is far more crucial. In fact, they are the most disadvantaged realities specifically concerning environmental innovation, basically because they cannot invest in, and consequently benefit from, a Research and Development unit (De Giorgi, Dal Palù & Allione, 2015); furthermore, no permanent educational tool has as yet been provided in support both to the managerial level and to the innovators involved in the enterprises (Halila & Tell, 2013; Le Pochat, Bertoluci & Froelich, 2007).

Moreover, revolve around innovation issue is not easy: innovation both in terms of materials and production processes and technologies, is defined not only by applying high innovative materials/technologies/semi-finished products, but also through using "traditional" materials in an innovative way or/and in a new context. Developing new products and investigating over new potentials of the currently produced series drive manufacturing companies towards (eco) innovation through envisioning unconventional interpretations for materials, semi-finished products and components alike, through technological crossbreed.

Both the facts that in SMEs very often there is not the culture of innovation research, as well as the time to do research or people trained to do it, lead these companies in a standstill situation. Design, instead, can supply the drivers to define innovation strategies, in order to obtain concrete results starting from researches: in these terms materials research in MATto is a support to boost companies' innovation management. Researches about innovative materials and production processes are, for designers and researchers of MATto materials library, a median to intervene in design and production processes.

2.1 Overview of the adopted research methods

In MATto, the consultancy service MATto_Materials for Design is organized for firms, and especially for SMEs, following some specific methodologies adopted in Politecnico di Torino and typical of the design process, such as: the Advanced design, the Exploring design and the Eco Design guidelines.

In the absence of market, for example, the Exploring Design path allows designers to generate system-product, process, service design projects that are always original and innovative, capable of leading quite easily to new methods, business ideas and spheres of activity in which customers can become involved later on. More in details, adopting the Exploring Design path (Germak & De Giorgi, 2008), a background analysis of the product pointed out both the stereotypes and new possible options representing an innovation (Lerma, De Giorgi & Dal Palù, 2014). This overview which we call it "scenario analysis", focusses mostly on materials, processes, environmental and social sustainability, and relationships with the productive district, in particular on materials used in the current production system. The research team defines a process scenario that takes into account key details such as company history, currently used technologies, flow of materials and adopted strategies in order to assess the company's starting level of innovation and ecological mind-set (De Giorgi, 2014). In particular, the actual production of the company-case study is analysed, as well as the competitors' products, in terms of innovation, materials, sustainability and processes. Moreover, according to the Eco Design guidelines (Vezzoli & Manzini, 2007; Tamborrini, 2009; Lanzavecchia, Barbero & Tamborrini, 2012; Lerma, De Giorgi & Allione, 2013), focus in particular on the resources of the territory (in particular, the Piedmont Region). As defined by Advanced Design (ADD) discovery and new degree of knowledge can turn into continuous innovation, contributing to create new producers, new production processes, new users and new markets to spread innovation (Lerma, De Giorgi & Dal Palù, 2014).

Moreover, in MATto, the researches are organized ad hoc for each firm, adopting the Design Thinking, a complex problem-solving method based on analytical phases, multidisciplinary research, brainstorming and the creation of ad hoc strategies; in fact, this method is applied more and more often to business in general: as Branzaglia underlines (Branzaglia, 2014) ADD is aimed to translate technological innovation into behaviour innovation. Moreover, this method defines two specific working sectors to designers: defining a context for a new product and a new semi-finished product, and redefining the relationship between different production chains.

2.2 The technological crossbreed key concept

"An innovation, originally conceived for a specific production process, subsequently enters products and sectors often far from the expectations of economic promoters" (Penati, 2004). The cross-fertilization phenomena may be a stimulus to the introduction adoption of innovations in companie's production (fig. 2).

Innovative materials come from highly specialized, if not niche sectors; such materials, along with semi-finished products, components and surface treatments traditionally applied to sophisticated, high-tech content items, are also used for producing everyday, ordinary utility objects. Companies can find then "new raw materials" for their productions by researching materials and semi-finished products that can be renewed by transferring them on to further manufacturing cycles.

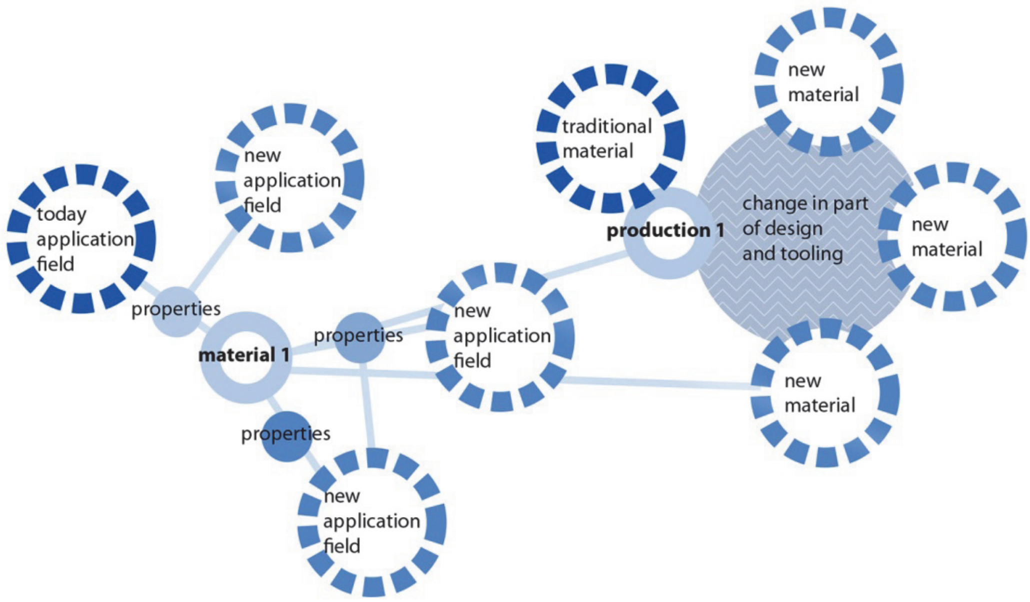

Fig. 2 The technological crossbreed: from a traditional application field to an innovative one

Developing new products and investigating over new potentials of the currently produced series drive manufacturing companies towards innovation through envisioning unconventional interpretations for materials, semi-finished products and components alike.

The technological crossbreed represents then a cross-feritilization approach often adopted by the MATto researchers. Thanks to this approach, the firm can take advantage from the experience already reached in a specific context in which that specific technology or material was traditionally adopted, and move those expertise into its new productive context. In the next paragraphs several results generated by the disclosed research methods applied to the MATto_Materials for Design consultancy service will be presented.

3. Results

Over the past six years, more than 150 firms have taken advantage of the MATto_Materials for Design consultancy service. The production fields of the supported companies varied from time to time: they ranged from the automotive field to jewellery, packaging, lighting, technical textiles, personal accessories, etc. Each researches was organized ad hoc for each firm, following the specific needs and requirements in innovation. Several case studies could be presented in order to show the results reached thanks to the support of the consultancy service. In this contribution, two meaningful examples will be disclosed.

3.1 Case study #1: New materials for sustainable luxury

The role of designers of MATto material library in this case was to investigate how sustainable design can help a prestigious goldsmith company which faced financial difficulties in identifying new strategies in selecting materials for their jewelry creation. Therefore helped the firm to preserve their luxury levels and their market positioning, as well as retaining their target audience, and focusing on new more eloquent and environmentally bearable opportunities (Lerma, De Giorgi & Dal Palù, 2016, in press) (fig. 3).

The proposals defined by the research team were linked to environmental and material lightness, territory and different productive chains. More in details (De Giorgi, 2014), the choice was about light alloys used in the aeronautics and aerospace fields (aluminium and titanium alloys); in fact, the goldsmith company territorial location also housed an international outpost of aerospace fields.

According to previous background analysis about jewels and company production, the recently soaring price of gold and the considerations following the eye-tracking analysis (on jewels and other products) about the importance of elegance (Buiatti, 2013), the research group defined several ways in which gold can coexist with other metals: the main proposal focused on the surface finishing, which can transform the visual perception of the material, while retaining its intrinsic characteristics. In particular, the defined finishing colour was black: this colour, in fact, is generally linked to semantic areas of elegance and preciousness. This solution was defined in order to maintain the company corporate identity and elegance: the focus was then placed on surface finishing available with a specific advanced finishing technique (DLC), similar to PVD, but more performing, used in healthcare and automotive fields and able to ensure biocompatibility, wear and corrosion resistance and availability to carry both a matt or glossy finishing.

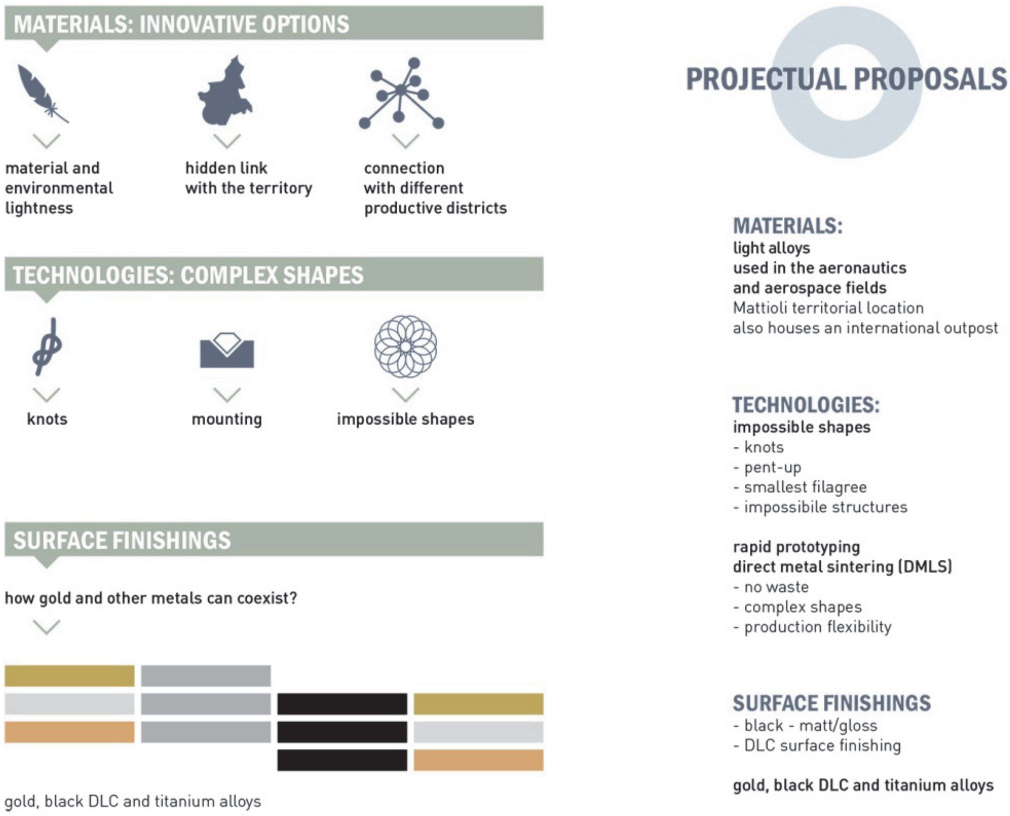

Fig. 3 Innovative materials and projectual proposals for jewellery case study (credits: De Giorgi, 2014)

Specifically, the hypothesis of black finishing was tested by the firm through a prototyping phase and several mechanical tests (Maleck De Oliveira Cabral, 2013). The DLC process is a plasma-assisted chemical vapour deposition (PACVD) technology used to apply the diamond-like carbon to the watches; moreover, Diamond-like carbon, or DLC, is amorphous carbon plasma - a material that exhibits astounding properties whose, for years, have benefitted a variety of industries including aerospace, military, medical and automotive industries that constantly demand new heights of material innovation.

The cross-fertilization operated thanks to a technological crossbreeds from aerospace, military, medical and automotive sectors to the jewelry sector could provide some alternatives to the traditional materials, in order to emphasize the "project value" and the "innovation value", instead of the traditional gold preciousness. The goldsmith company introduced this technological innovation in several of its jewels collections and are currently on the market. Furthermore, they benefited of several advantages: thanks to the "black gold" they strengthened the brand identity, the perceived luxury of the product as well as the market positioning; at the same time, minimizing the gold quantity usage and they also controlled the costs of this new environmentally friendly collection.

3.2 Case study #2: The innovative dimension of digital decoration

In 2015, MATto started a collaboration with a SME, leader in digital decoration located in Piedmont Region, looking for new commercial partners. The collaboration with this company was conceived as a new opportunity offered by MATto to the Italian and international productive firms of materials and semi finished products to experience for free the potential of the digital decoration, directly on their products, adopting a win-win strategy.

The digital decoration process is proposed for reproducing every graphic idea (pictures, patterns but also flat colours) on a wide rage of materials, going from wood to glass, paper, textiles, aluminum, steel, copper, ceramics, stone, leather, PVC (polyvinyl chloride), PMMA (polymethyl methacrylate, i.e. Plexiglass) and many other materials; with this technique is possible to customize and tailor products and semi finished products, by realizing opaque or transparent decorations, in high definition quality and with a perfect integration colour-material (fig. 4).

Several opportunities are offered to productive firms, and right the innovative potential of this new technique was at the basis of the consultancy service. Some of the opportunities ranged from testing the monochromatic colourings, to realize vectorial patterns, decorate with bitmap images, using four-colour printing with transparent (CMYK) or opaque (CMYK-W) finishing, opaque white (the firm can control also the opaqueness gradient), transparent inks (another opportunity is to test the matte effect, with the ability to control the matte gradient), four-colour opaque (CMYK-W) printing. Moreover, it is possible to print more than 16.000.000 possible colours, in high resolution (up to 1400 x 1400 dpi), with non-toxic water-based organic inks (with an advantage given by a stronger chromatic power, and the possibility to create more details) and in absence of materiality and thickness of decorated parts (this technique generates no "gap-effect").

Fig. 4 Digital decoration on wood: Geometrico, Tulipae Gemini and Ramoscelli | DESIGN collection, by Xilo 1934

Thanks to presence of different suppliers of the digital decorative company in the Centre of Italy and in other Countries in the world (such as in Spain and in Portugal), the digital decoration could be presented not only in a local context, but also internationally.

The opportunity to test the digital decoration on its own material samples was spread through the MATto communicative channels. Companies working in different fields (from floating flooring systems, to furniture and interiors fittings, to acoustic panelling for theaters and opera house producers) and producing various typologies of materials are now testing the digital decoration with positive feedback. Paper with particular coatings that are used in furniture field, leather-no-leather, semi finished products made in wood (innovative in materials composition), wood veneers for interior applications: these are just some of the materials on which the digital decoration was tested in these months, and on which other tests, such as wear resistance and colour brilliance, are currently underway, in order to investigate and improve the technical aspects and feasibility of the adoption of this innovative process in the current production (fig. 5).

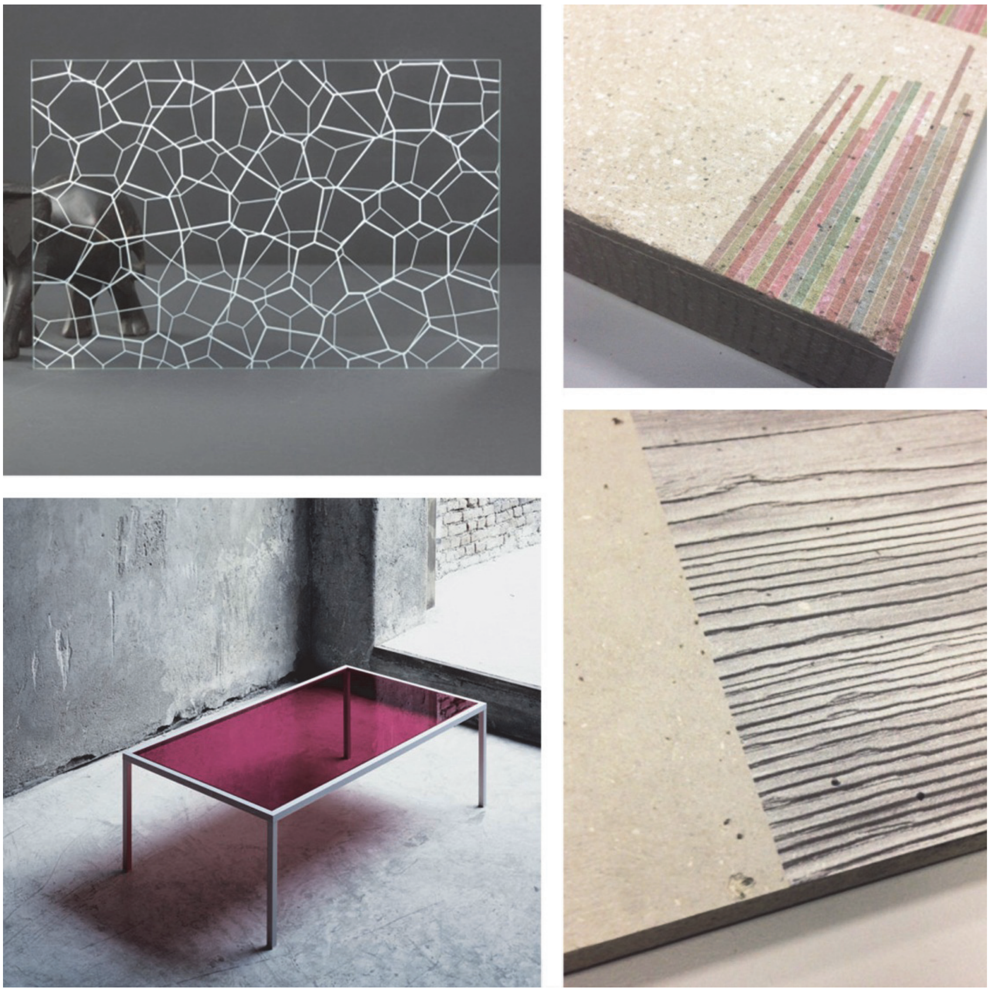

Fig. 5 Digital decoration on other materials: some examples of effects on glass (table Go on Evolution 20, by Glas Italia) and on composites

In this case, MATto played the role of a connection between a company that offers a specific technology and its new possible clients: MATto identified new possible fields of interest for the current technology object of the research, and focused the firms interested in innovate their production by using a specific innovative coating system. With this aim, thanks to the collaboration with MATto, new high technological level productive synergies were created. National and international productive firms had the opportunity to test the technology for free, and the digital decoration firms obtained new commercial contacts, possibly interested in exploiting its technology.

4. Conclusion

The results of the experiences disclosed in the article are useful to provide insights for further applications to small and medium enterprises, researchers, designers and other innovation practitioners. Moreover the researches and consultancy activities in MATto are characterized by a very good satisfactory level. In fact, results presented to SMEs are easy-to-use: MATto materials library is focused on applied research (on-demand researches for each company) to obtain expandable results, such as specific contacts of productive companies in order to apply innovative materials and technologies in productive process.

MATto consultancy service aims to define new possible fields of interest for firms, in particular SMEs, and to create new high technological level productive synergies: reaserches in MATto seek to organized an activity that can't be performed within SMEs.

The case studies previously presented provide examples of firms working in different fields, which started to produce new objects and updated their production using new materials and semi-finished products, thanks to the consultancy service provided by MATto materials library. Moreover, the adopted methodologies could be applied in different productive fields: developing new products and investigating the new potential of the current ranges drives manufacturing companies towards eco-innovation by envisioning unconventional interpretations for materials, semi-finished products and components (Lerma, 2014). Thanks to this approach, the solutions presented to firms are not far from to be applied, because in many cases these are already adopted, as traditional materials or technologies, in other specific context.

MATto researchers and designers are able to design the tangible and transform intangible objective into products: the territorial and technological dimensions of researches developed are transformed into tangible solutions thanks to the ADD and Exploring design approaches and the problem solvers designers' ability to identify innovative solutions and strategies useful for companies' production.

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Designing in the IoT Era: role and perspectives in design practices

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Abstract

In the IoT Era technology is ubiquitous (Kuniavski, 2010) and redundant; in 2009 for the first time in history the number of devices connected to the internet surpassed the number of humans on earth initiating Internet's first true evolution (Evans, 2011).

New waves of tech gadgets populate the global markets and the big players are competing with startups and DIY people to commercialize the most innovative and efficient gear.

Thanks to digital fabrication and open source culture smart connected objects can be easily prototyped and sometimes crowdfunded (Jenkins, Bogost, 2014): yielding a Babel of black-boxed, plastic, gadget-like products and services, a first experiment of what is possible and feasible, that in some ways could be defined as an avant-garde trend.

But what about users and their lives? What about the utility and meaning of these objects in real life, with their material qualities and agency of interactions?

This paper, with a bottom-up approach, reflects on a case study in which we started to analyze connected products, reflecting on how technology can "enchant" (Rose, 2014) and augment a smart object while giving value to its tangible part.

The results demonstrates that design can define a balance between tangible and intangible functions of IoT devices, making them desirable, providing new meanings and functions through its physicality, and reinterpreting traditional artifacts.

Some consumers/prosumers are progressively accepting these new connected devices, monitoring health, behaviors and the environment around us, creating big data and modern scenarios for products and services (Acquity Group, 2014).

Physical products pervasively gain a new dimension made of intangible digital avatars (Semmelhack, 2013) able to be freely updated and offer different experiences.

However, technology is often seen as the core of these smart products, resulting in first naive solutions that merely apply electronic components and wireless capabilities to existing objects and in which designers, if present, only manage the aesthetic part. This is an opportunity to apply Design methods and tools to create advanced desirable scenarios for technological objects, bringing users and their interactions back to the core the product development.

Design practices are applied to mediate between users' behaviors and technology, generating devices that leave the gadget-dimension of useless accessories and create more involvement.

This means changing the actual design perspective adding new skills and attitudes useful to design research, design education and for professional practices.

Keywords: *Internet of Things, design, research, human centered design, tangible interaction, metadesign*

1. The big world of IoT: from infrastructures to everyday lives

In 1991 Mark Weiser, coiner of the term Ubiquitous Computing, and his team at Xerox Palo Alto Research Center, were already wondering what it would be like to live in a world where computers are seamlessly embedded in all kinds of everyday objects (Weiser, 1991). With the Internet of Things (IoT), not only this is common, but connectivity is also ubiquitous, and devices become digitally identifiable, sensory and context-aware, connected and able to interact with each other in a *network of networks.* Cisco IBSG affirms that IoT was actually born between 2008 and 2009, *the point in time when more "things and objects" were connected to the Internet than people* (Evans, 2011). This can be considered as the first real evolution of the Internet, a shift from an Internet of People to one of Things. Our techno-culture crossed the *"line of no return"* (Sterling, 2005) and is now entering an *Internet of Everything*, in which People, Things, Data and Processes are connected, combined together to create new capabilities, richer experiences and business opportunities (Evans, 2012): the value of the created network is amplified with each new connection.

With IoT instead of having a small number of powerful devices is possible to have a large number of less powerful devices monitoring different aspects of everyday life (McEwen, Cassimally, 2014), and future forecasts estimates 25 to 50 billion of connected devices in 2025 (Evans, 2011). The potential economic impact is massive, $4 to $11 trillions a year in 2025 (McKinsey Global Institute, 2015) and Big Players are finally entering the Business to Consumer market with smart home solutions, wearable and nearables, competing with start-ups to commercialize new products.

Everything is Big in the IoT world: (i) the forecasted numbers of connected devices and future economic value; (ii) the size of investments impacting all vertical markets, ranging from cities that want to get smarter to enterprises that seek automatization and efficiency; (iii) data become big, fast and unstructured; (iv) the number of players developing new solutions and products, including Big Players, start-ups and DIY people; (v) and lastly the hype around IoT, which is seen as one of the most important future drivers for innovation.

Debates around IoT mostly gravitate towards two topics: technological challenges and market projections. On one hand, it is relevant to identify what will enable an IoT diffusion and how to deploy it, connecting devices together and to the cloud, achieving interoperability and energy efficiency, gathering and processing big data. On the other hand, economic forecasts help to see where enterprises and cities are investing, what the most promising markets are, and to check if people are ready to buy the newest tech solutions (Osservatorio Internet of Things, 2015).

Technologists mostly argue about privacy and security implications of cyber-physical devices, generally highlighting that the potential benefits that technology and connectivity may bring to the final users outmatch the concerns. It's evident the value that adding connectivity, sensing capabilities, "intelligence" and automation can deliver when applied at infrastructure level, in smart cities, smart building and enterprises, for smart metering, asset management, logistics, agriculture and many other applications. A better use of existing assets, saving money, resources and energy, increasing efficiency, enabling remote control and monitoring, running pattern recognition algorithms, visualizing predictive analytics in real time are clear benefits of Machine to Machine interaction.

It's less clear how exactly IoT will add worth on the smaller, domestic scale, through smart homes and cars, fitness trackers, wearables and nearables. The first waves of domestic networked products are just an example of what smart things may be; the results are often experiments in which internet capabilities are added to traditional objects, or smartphone-controlled plastic gizmos with many functions. As new connected devices appear in the global distribution and start to become mainstream, new challenges arise for product designers, who need new competences and knowledge to deal with the complexity of this kind of cyber-physical devices.

For modern designers, the IoT should be considered like a mix of enabling technologies to be applied when they are able to add a visible value, acting as an enabler, mediator or facilitator of new services (Cambridge Service Alliance, 2015). Including electronic components and network capabilities in a traditional product is not enough to make it smart, the whole system needs to be designed to ensure a clear and strong value proposition, address real user's needs and guarantee a natural and seamless interaction, so that *end users should not need to focus on its connectivity or onboard computing: it should just make sense.* (Rowland, et al, 2015)

1.1 IoT as an entropic system

Clive Humby first said in 2006 that "*Data is the new Oil*" (ANA Senior marketer's summit, Kellogg School) of digital economy as objects are connected, can gather real-time signals and accumulate Big Data. Big Data. Big Data is called such because of the large volume of structured and unstructured data that flows and inundates a business on a day-to-day basis. Like oil, it needs to be processed to reveal its true value, transforming raw fragments into useful information. Companies that will gain the most out of IoT are using mathematics (Arthur, 2016) e.g. machine learning algorithms to recognize usage patterns, identify critical situations, predict future development, and enable systems to adapt in real time. Information leads to fast, informed decisions, which can be automated or support users with objective insights. However, currently most IoT data is not used; *For example only 1% of data from an oil rig with 30,000 sensors is examined.* Data is mostly used for anomaly detection and control and not yet applied for optimization and prediction (McKinsey Global Institute, 2015).

For now, data are mostly created by things, for things, not exploited at their full potential in an entropic system in which are accumulated. Most of the value is lost without any findings. The IoT Industry itself is a self-sustained system that doesn't communicate its benefits well to end users. In an ideal process, data should be transformed into information, information into actions and knowledge, knowledge into wisdom and experience. To achieve its full potential, IoT should exit the Machine2Machine-only loop and offer ways to consume data usefully and flexibly, e.g. by delivering the right information at the right time to the right user, shifting from an "If This, Then That" approach to an "If This, Then What?" one (Biron, Follett, 2016).

Smart devices now offer an unthinkable level of Omniscience (Rose, 2014) about the world around us, our bodies and behaviors, and the full potential still needs to be grasped. When we move from an entropic system to an open -sharing- one, it is possible to envision services in which existing assets and resources can generate new businesses and opportunities. Airbnb and car sharing services are just an example of a virtuous combination of things, people, data and processes.

Instead of Oil, data should become *the new Steel* (Semmelhack, 2013), a resource used to build upon, to make products and service better and updated, *altering the traditional lifecycles to more of an ongoing flow, a kind of living relationship* (Biron, et al, 2016).

2. Designing Smart Connected products

When the word "*design*" is used in an Internet of Things discussion, it would probably be in regards of technical details and solutions. For instance, how to design a whole technological infrastructure, how to connect a great number of sensors in an efficient network or code for interoperability and so forth.

In this paper the term *design* refers to the Industrial Design discipline, as *a "trans-disciplinary profession that harnesses creativity to resolve problems and co-create solutions with the intent of making a product, system, service, experience or a business, better"*. As the International Council of Societies of Industrial Design defines it, *"it links innovation, technology, research, business and customers to provide new value and competitive advantage across economic, social and environmental spheres"* (ICSID, 2015).

Industrial Design applies methods from different disciplines with a strategic approach, to place humans at the center of the design process and to deliver solutions that are meaningful and desirable for users and for the market. Therefore, how does IoT impact the Industrial Design field? How can designers deal with modern smart products?

There are two fundamental elements that impact the traditional product design approach: first, objects become more technological and connected, and second, technologies become more accessible. The most relevant difference between traditional products and connected devices is that the latter are cyber-physical systems with a double identity: there is the tangible product and its digital counterpart, an *avatar* of the object *liberated of its material form* (Semmelhack, 2013). The digital part is often the most significant aspect, used as the main interaction interface to input and visualize data and access all services; tangible interaction is often set aside except for notification purposes. In this scenario the design of products' intangible *avatars* acquires great importance, to shape the User Experience and plan customer's journey through different media, as users must be free to access the product's functionalities through different touch points in the easiest way. At the same time the physical qualities of materials and analogic interactions must not be left behind in the development of a smart solution.

Another important change is that users now expect connected objects to follow the rules of mobile applications: from products to *app-products* (Vitali, 2015), platforms for services. Apps are not static, they are usually upgraded with new functions, so products should improve in time too. In the app stores developers are free to market their own solutions. Likewise products should be open platform so that any developer or start-up could extract data and information to build something new. With these changes the nature of the product-consumer relationship will shift deeply: products will evolve even after their shipping through data analysis and continuous user feedback (Biron, Follett, 2016).

Technological components are frequently economical and easier to use. Thanks to prototyping boards, affordable microcontrollers and microprocessors, a huge number of online resources, shared knowledge and communities, makers and designers are able to prototype and develop their own solutions freely. Even manufacturing technologies are conveniently available and allow an almost effortless shift from bits to atoms.

Given this panorama, what is the role of product designers?

We believe that to grasp this complexity designers need to apply a Metadesign approach to understand technologies, markets and users in order to define products and services that may have a value. Giaccardi and Fisher reflecting on Creativity and Evolution stated that *Metadesign is a unique design approach concerned with opening up solution spaces rather than complete solutions (hence the prefix meta-), and aimed at creating social and technical infrastructures in which new forms of collaborative design can take place* (Giaccardi, 2008). In our vision this is achieved by evaluation of: (i) Technologies: know what can be developed and humanize technology to build seamless and natural experiences. (ii) Markets: to make the product attractive from an economic and productive point of view, with the right price, positioning and a sustainable, defined production model. (iii) Users: to identify new needs and delineate new meanings. This approach could be compared at the human-centered design process (IDEO, 2015) and is a way to ensure that the final solutions remain connected to the people whom are designed for and for this *desirable* at the human level, *viable* at the business level and *feasible* at the technological one. Metadesign is a design research activity fundamental to identify new subtle unspoken dynamics and achieve *meaning-driven innovation* (Norman, Verganti, 2012). The output of a Metadesign phase gives designers a broad context in which to define a project brief that will be used to design and test different solutions.

After that will be added: (iv) Product System Service elements, including service and communication aspects, to gain a clear overview of the system complexity, with its stakeholders, touchpoints and relationships. (v) It is also considerably important to design interfaces and the whole *phygital* interaction (physical and digital) for technological products. (vi) An understanding of manufacturing dynamics and production methods (e.g. DIY, self-production, digital fabrication, mass production).

All above elements frame a wider and complex scope for design. This dimension is also treated on the *Advaced Design* definition where is stated that *Advanced Design is not just highly developed design, but also design which anticipates, which sees before others* (Celi, 2014). It is not expected of a single designer to master all those aspects, in fact interdisciplinary collaboration is fundamental in Design and specially in Design for the IoT. Reflecting on the current dynamics of education and professional practices we applied the Metadesign approach in a case study in which, by mapping IoT products and with exhaustive case studies research, we identified a “new” need, a meaning change, that led to the development of a connected product.

3. Mapping The IoT: research phase and design of InTune - a connected product

The “Mapping the IoT” project was born as a Master’s thesis research at Politecnico di Milano. Our approach was to read the existing Business to Consumer market from a designer point of view, analysing products and trying to find correlations to extract elements that can be later used to design new devices. Since existing classifications are usually generic and mostly focus on market and technological segmentations we felt the need to apply a bottom-up approach inspecting existing consumer solutions to gather data from the market, without imposing any solution. Through the analysis of 107 case studies of smart connected products an Analysis Tool was developed.

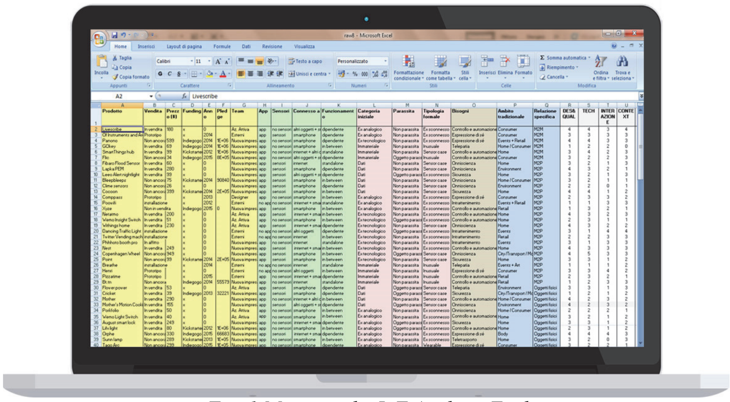
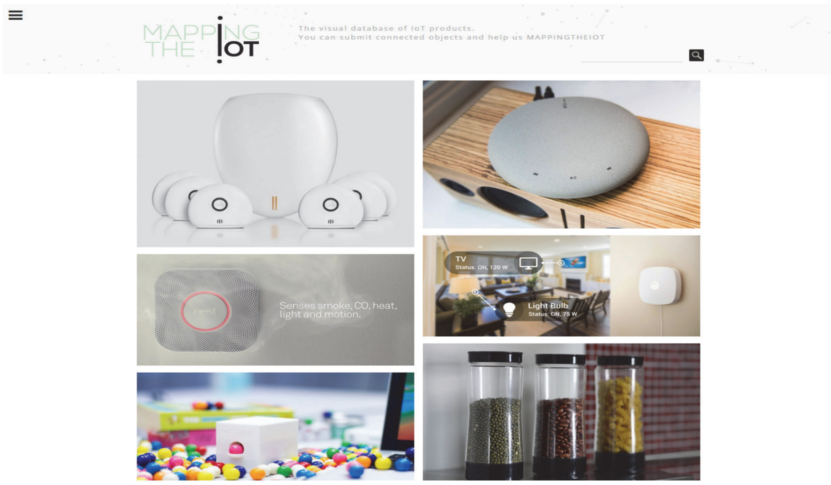


Fig. 1 Mapping the IoT Analysis Tool



The tool then evolved into an online platform (mappingtheiot.tumblr.com*)*,that can be used as an open research tool, since it simplifies the mapping process through the use of selectable tags and anybody can submit new cases to be reviewed.

Fig. 2 Mapping the IoT, home

summarized as follows: (i) Technological point of view: features and specifications (e.g. sensors, apps, what the product is connected to, relationship and dependence between the product and its apps/the need of connectivity), degree of innovation, area of application. (ii) Financial point of view: e.g. price and perceived value, exploited funding method. (iii) User point of view: what fundamental needs does the product try to fulfil, e.g. omniscience, safety (Rose, 2014), intended user and context (e.g. degree of definition, value of the solution), frequency and quality of interaction. (iv) Design-thinking point of view: conceptual qualities (e.g. is it a new artefact? What is its aim? Can be traced to an archetypical shape/typology of artefacts?)

Of an initial sample of 400 cases, 107 were selected and analysed using the tool. An analysis card was made to map each case study, and data were recorded.

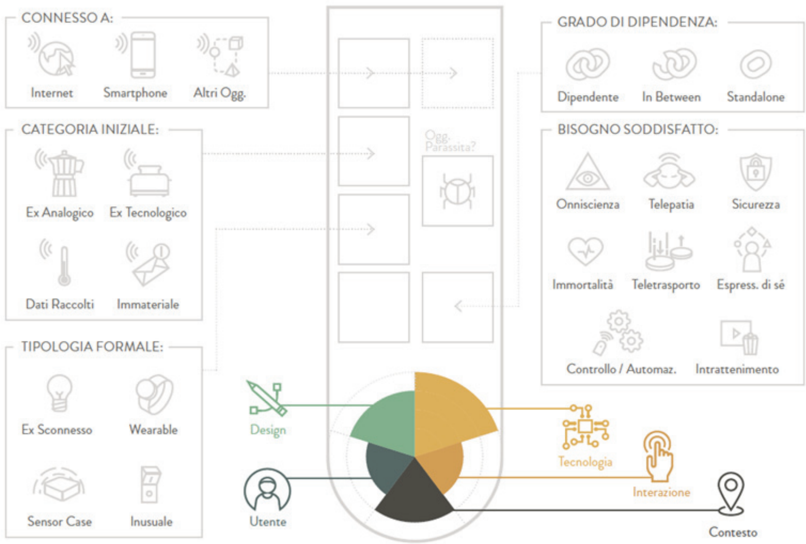


Fig. 3 Legend used to map each case study. Icons and graphs highlight the main characteristics

The gathered data were processed using Raw (raw.densitydesign.org) a versatile online tool that enables data visualization and clustering. The results were summarized in a final report and a set of infographics.

Fig. 4 Mapping the IoT Infographics

From that it was possible to identify features and common characteristics (e.g. the need of omniscience, telepathy, control and automation those products fulfil, the idea to materialize intangible content) that were used as a starting point for the brief definition of InTune, the developed product.

InTune reflects around the topic of time in our digital modern society. Modern time is managed through shared digital calendars, smart alarms, notifications, personalized objectives and deadlines. In this technological era clocks are not enough to express this complexity and seconds are not the most relevant means of measure. Depending on what users consider important *progress* may be used as measurement unit; how many calories were burnt today? How many followers are left to reach 1000? How many to-dos remain in the Trello list at the end of the day? How much until your product gets funded on Kickstarter? How long until summer? Personal time is multi-channelled and punctuated by activities, events, tasks, future plans and self-set objectives that may be physical or digital, offline or online. Following the MappingTheIot analysis framework we understood the fundamental needs the product would have had to fulfil: the need of Omniscience (know everything), Telepathy (see only what is important) and Entertainment (keep users motivated, challenging themselves).

The concept of modern time was linked with progress bars and seek bars, two common elements in the digital UI panorama, with visual properties and intuitive use. Thus the idea was to make the bar tangible, connected and reprogrammable, able to interact with online services and existing applications, showing intangible data with a physical medium.

InTune has three different functions: (i) It is a tangible and connected progress bar, compatible with different services and applications (e.g. digital calendars, fitness tracker apps, IFTTT). It uses its own app to add personal objectives and challenge other people, and it can be used as an alarm clock. In this case the smartphone is used as a data input interface. (ii) It is a timer. No app nor smartphone are needed for this function. (iii) It is a Bluetooth enabled speaker: the motorized progress bar moves in sync with the music and it is possible to physically interact with the played song, going backwards or forwards.

Fig. 5 InTune mockup: display the description of an ongoing progress

All these functions were defined considering the degree of dependence between the product and its app. Connected products often lose functionalities when the smartphone is out of battery: by augmenting a traditional object (speaker) InTune offers more features. The smartphone is used only to create, save, and send new tasks to InTune. To change mode, visualize the progress of all ongoing objectives, the interaction is completely physical and designed to put the smartphone away.

InTune was one of the winners of "Next Design Innovation", an open call promoted by Regione Lombardia and Polifactory, the makerspace of the Politecnico di Milano (www.polifactory.polimi.it/), and was prototyped and exhibited at Milan Design Week 2016. The product was partially functioning: due to time, components availability, and knowledge limitations only the speaker function was implemented. In order to assemble a working prototype many compromises had to be reached and, although the final result was well manufactured, the object was changed and detuned.

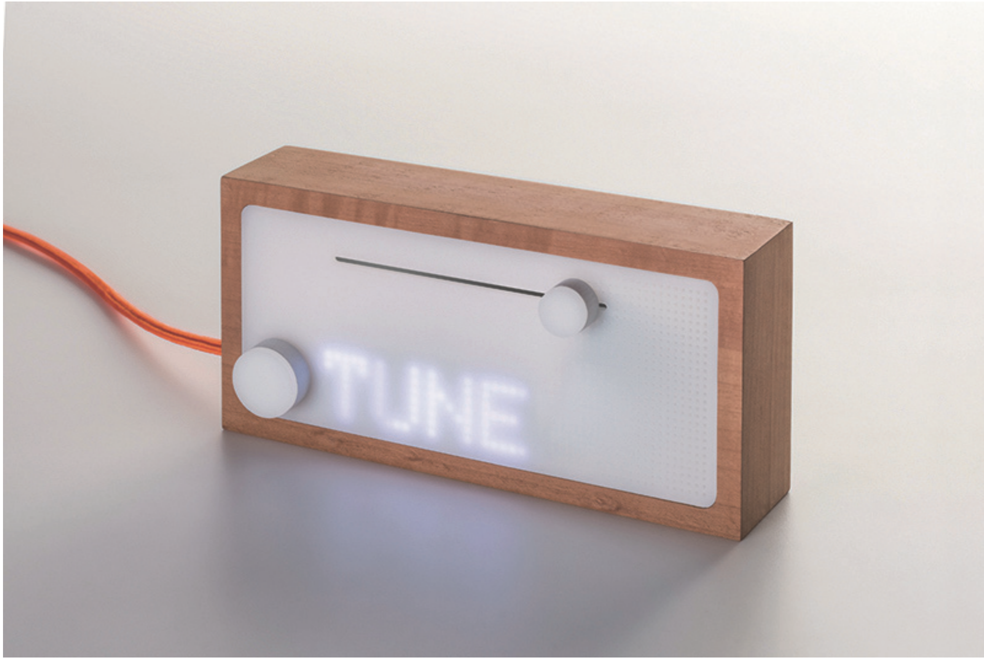


Fig. 6 Next Design Innovation: InTune was prototyped by Polifactory - Politecnico di Milano in collaboration with Regione Lombardia - photo by F. Villa

From this experience we reflected on the topic of prototyping. Designers are given tools to prototype even advanced technological solutions and autonomously materialize their own ideas in new places (Fablab, Makerspace ecc.) where they can also become really *Designer=Enterprise* (Bianchini, et al, 2014 - Arquilla, et al, 2011). We observed that while talking about the Internet of Things it may be an opportunity but also a substantial limitation because designers may be aware of a given conventional technology but unable to put it into practice. Hence the "functioning prototype" self-production threatens to impoverish the concept and qualities of the design scenario, approaching oversimplified solutions but with an acceptable technological complexity. We believe that a line needs to be traced between knowledge and execution, and designers need to focus on the phases in which they can add more value. Technological awareness eventually enables designers to act as "headhunters" and understand what are the needed competences and skills to form a multidisciplinary team to implement any solution, while completing execution

3. Role and perspectives in design practices

With the IoT, network technologies are accessible and applicable, the delicate move is to use them consciously, when are really able to add value and innovate. Knowledge is the first step towards consciousness: being aware of what exists and what is feasible empowers designers to conceive new scenarios, finding new applications for consolidated technological solutions and generating meaning-driven innovation. The design discipline contributes to give signification to products and services, humanizing technologies, placing people at the centre of the process and exploring their needs to allow a meaningful cultural interpretation and to build compatible captivating services and business models. Hence the IoT could turn into a new important resource in the designers' set of skills.

From our experience we experimented that following a Metadesign approach before starting the design phase may prove an effective way to tackle the design complexity of connected products since both technology, market and user needs are strongly bound together. After our research we constructed a list of guidelines that can be followed while designing for smart connected products, and that frame future perspective in design practices.

(i) Connected products are augmented products: adding network capabilities and sensors, several functions and big data is not enough to make them smart. Meaning needs to be added. From our research it strongly emerged that in the proliferation of technological performance-driven products (Morozov, 2013) there is substantial space to build sense and acceptance, defining innovative dynamics where objects enable services and new interactive interactions.

(ii) Therefore having an app linked to a product is not enough. Applications, network capabilities and sensors are just tools to be wisely exploited: inevitably adding them to any object means to potentially offer a new service. In "Designing for connected products" the authors (Rowland, et al, 2015) state that there may be *service-enabled devices* and *device-enabled services*. In the first case *the device is seen as the most salient part of the service,* central to the overall User Experience (e.g. Nest thermostat); in the second case users just want to benefit from specific functionalities and services (e.g. an alarm service). In both situations there will be tangible objects with both physical and digital aspects. The intangible, digital part may improve flexibly over time, extending the purpose of the tangible product and engaging the final users and it developers in a relationship. It is again crucial to underline that adding connectivity must augment a given object. A notable example of a smart IoT device is Amazon's Kindle, since it augments a traditional artifact (the book) amplifying its strengths and decreasing its weaknesses (one "smart-book" has multiple texts, fast translations, smart notes …), and connectivity enables a new service: instant book purchase and delivery. Therefore with IoT, objects may not be just bought but have different business models, inspired by digital business models (e.g. freemium and premium model) or service ones (e.g. sharing). It is evident that connected devices are strongly linked with the *servitization* phenomenon, which is *the process of creating value by adding services to products* (Cambridge Service Alliance, 2015).

(iii) The value proposition of complex product has to be clear: users need to perceive how connectivity can unlock new services and meanings. Performances may be simpler or limited but designers need to create beneficial and appealing use scenarios that clearly communicate the worth of a proposed solution. It is then interesting to point out that early adopters of IoT solutions are enjoying their wearable devices more than the apps they use in conjunction with (Breitenfeld, 2016) because there is a gap between what objects pledge and what they really deliver. Therefore creating a scenario is not enough, designers must supervise and ensure that there is consistency between the value proposition and the effective execution. This also means trying to design how users can truly make use of the data that many smart devices produce.

(iv) Connected products are *phygital*, but that does not mean that screens and smartphones should be the only way to interact with them. Depending on the project one aspect may be more relevant than the other, still we advise to design for balance between tangible and intangible features. Since functions often become intangible it is indeed important not to overlook material and sensorial qualities and physical interaction with artefacts and devices. The physicality of products has to be managed with quality and regain its centrality.

Going back to Weiser again, he stated that "*the most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it"* (Weiser, 1991). Thus the role of design is supporting this seamless combination, using design-related tools and practices, specially the Metadesign one, to envision and materialize novel products and processes giving them quality and meaning.

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Systemic Design for a sustainable local economic development: Lea-Artibai case study

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Abstract

The Systemic Design approach provides a methodology to define complex territorial network of companies with reduced environmental impact. This method defines a way of analysis to understand and map the complexity of current issues addressing them at different levels, in order to design appropriate and long lasting solutions mainly based on the increase of relations between the involved actors. The creation of a network of connections permits to obtain several positive outcomes that involve both the territory and the society that lives in it and it also makes the system more resilient. An holistic diagnosis is the starting point for the identification of different areas to develop a systemic project.

This methodology was applied to Lea-Artibai, a department of the Basque Country. Its economy is historically based on forestry and fishing that are currently facing a long-lasting crisis and it is difficult to intervene in these sectors for the complexity of the regulatory system.

The holistic diagnosis highlighted other territorial potentialities of the area, mainly the agri-food sector (with traditional products and dishes) and the deeply rooted culture of cooperation. As a kick-off for the creation of the net between the different actors of the department was chosen the creation of a 'Systemic Buying Group (SBG)'. It enables to start the cooperation between the partners for the success of the pilot project: a large cooperative with its employees as potential clients, a cooperative of local producers and transformers, a little shop working as the bridge of communication between them. At their side operate AZARO Fundazioa (a private non–profit centre for entrepreneurship and innovation that promotes the creation of new businesses and the competitive improvement of the business network) as the coordinator of the project and the Systemic Design Group of Politecnico di Torino in the role of project leader.

The project underlines the role of design as a deeply interdisciplinary field of work that is able to talk and cooperate with different disciplines to reach a collective goal: the environmental, social and economic sustainability.

The SBG becomes the driver of change for the enhancement of the territory and the implementation of systemic design in the area, for an economy based on the quality instead of the quantity. A concrete action that acts on a small scale permits to manage the transition from the design of intangible to tangible.

Keywords: *systemic design, local development, buying group, cooperative, business*

1. Introduction

The purpose of this paper is to present the project developed by the Systemic Design Group of Politecnico di Torino in collaboration with Azaro Fondazioa, focused on the application of the Systemic Design (SD) to the territory of Lea-Artibai in the Basque Country. The collaboration was born with the goal to find together long lasting solutions for a Sustainable Local Economic Development (SuLED) of the area.

The topic of SuLED in the last year has emerged starting from the concept of Economic Development (ED) and gaining progressively more characteristics like sustainable (Su) and local (L).

The concept of Sustainable Development (SuD) has appeared in the 1970s from the report of the Club of Rome *The Limits to Growth* (Meadows et al., 1972), as J. Pezzey suggested in 1989 (Miltin, 1992), where the methodology of the System Dynamics Group was applied to demonstrate the consequences of pursuing an infinite growth within a finite World.

The 1980s saw a dramatic debate around the combination of the concepts of ED and SuD. The question being asked was no longer "Do development and environmental concerns contradict each other?", but "How can sustainable development be achieved?" (Lélé, 1991). The debate culminated in the prediction by Lélé in 1991 that "the ecodevelopment was poised to become the developmental paradigm of the 1990s".

The definition of SuD involves two components: the meaning of development and the conditions necessary for sustainability (Mitlin, 1992). In the report of the World commission on Environment and Development of 1987, *Our common future*, SuD is defined as "....to ensure that it (development) meets the needs of the present without compromising the ability of future generations to meet their own needs" (Mitlin, 1992).

The 2000s have showed how SuD starts to become a base for a new developmental paradigm (The World Bank, 2004) (The World Bank,2007) (The World Bank,2009). This change in the paradigm was also supported by various scientific reports indicating that the climate changes are real and the human activity is one of the responsible

The 2010s are demonstrating how the development, based on the sum of sustainable and economic concepts, has become effectively the developmental paradigm. Two main things prove it: the United Nations Sustainable Development Summit in New York in September 2015 and Horizon 2020, an EU Research and Innovation Programme that aims to be a financial instrument to drive smart, sustainable and inclusive growth and jobs.

Recently another adjective was added to the concept of ED: local. "The purpose of local economic development (LED) is to build up the economic capacity of a local area to improve its economic future and the quality of life for all [..] It offers local government, private and not-for-profit sectors, and local communities the opportunity to work together to improve the local economy. [..] It focuses on enhancing competitiveness, increasing sustainable growth and ensuring that growth is inclusive" (THE WORLD BANK). LED therefore includes the concepts of ED, SuD, but also the one of territory that becomes another protagonist in the debate around the concept of 'development'; this led to focus the attention on it and on the valorization of its resources.

The same focus is shared by Systemic Design (SD) that, through the creation of systems generated from the valorization of outputs of a process as inputs for another one, aims to develop a new productive, economic and consumption model deeply rooted in the territory where it is located, enhancing its potentialities and tending to zero waste (Bistagnino, 2011).

In SD discipline, design shifts its attention from products to production processes, services and the entire system that is linked to them. The designer assumes the role of "designer mediator: […] his/her aim is to build or consolidate the team and the mediated integration between different types of knowledge and different specialism" (Celaschi et al., 2013). Designers are changing their focus and are approaching different disciplines for the contribution they can offer to the construction of a more sustainable future development. A Systemic Designer aims to facilitate the relations between society, production/economic model, and environment/context that influence the quality of our life (Bistagnino, 2011).

Lea-Artibai offered a suitable context for the application of SD. The territory, rich of natural and cultural resources, has been historically linked to forestry and fishing that are currently experiencing a period of crisis. The success obtained by various projects already developed was limited by their being confined to one single aspect/sector/activity of the area. The need for a systemic approach to the area clearly emerged and was taken by Azaro Fundazioa, a private non –profit centre for entrepreneurship and innovation that promotes the creation of new businesses and the competitiveness improvement of the business network. It has recently created a Blue Lab, an initiative based on the principles of SD and Blue Economy (Pauli, 2010) aiming to create projects for sustainable local economic development.

The project discussed in this paper was developed in line with this vision and underlines the role of design, and especially of SD, as a deeply interdisciplinary field of work that is able to talk and cooperate with different disciplines to reach a collective goal.

2. Methodology

The term Systems Thinking refers to a wide range of approaches that differ in the methodology but share the same purpose: to address problems in their wholeness and complexity as systems, focusing on the interactions of their components, in opposition to the reductionist scientific paradigm (Sposito and Faggian, 2013). The methodology developed by the Department of Architecture and Design of Politecnico di Torino was born from the same premises and has been applied in the context of design with a particular focus on production processes. The *Systemic Design* developed by professor Bistagnino is built around the principle that the material and energy output of a production process can become input for other ones generating new products, a new economy, wealth for the society and for the environment, aiming at generating zero emissions and waste (Bistagnino, 2011).

The methodology of SD is divided into six main steps: holistic diagnosis, definition of problems and leverages for change, design of a system, theoretical study of the outcomes of implementation, implementation, analysis of results and feedbacks. The Holistic Diagnosis (HD) aims to investigate the research topic according to four axes (anthropic, natural, social and economic contexts) through desk research, field research and research synthesis (Barbero, in press).

The HD permits to reach a holistic vision of the specific field of study. The next step consists in the individuation of the main problems of the context taken into consideration. They are considered as leverages for the change and enable the individuation of potentialities that represent the elements for further studies. Starting from them and from the information gathered in the HD, a new system that answers to identified problems is designed. The theoretical outcomes and benefits generated are studied; the system is then progressively implemented and results are monitored (Barbero, in press).

2.1 The Holistic Diagnosis

The HD of Lea-Artibai started with the desk research performed from remote. The territory was investigated analysing the use of the soil, the production activities, the dynamics of population, the main urban centres, the agro-food heritage, the culture and the traditions. The continuous dialogue with Azaro Fundazioa was crucial for obtaining and checking information. Various actors were involved in the process, depending on their roles in the project. In the first phases of HD, Azaro Fundazioa and Department of Architecture and Design of Politecnico di Torino, carried on the desk research. The field research involved mainly local actors working in the primary, secondary and tertiary sector. Mayors and politicians were consulted during the advanced phases of HD and after the development of the project proposal to discuss the possible ways of implementation.

2.1.1. Desk Research

As a result of this phase, a first picture of the territory emerged.

*Geography***.** Lea-Artibai is a *comarca* (administrative division of Spain) located in the northern part of the Basque Country and derives its name from the two rivers it hosts, Lea and Artibai. It overlooks the Gulf of Biscay; its culture and economy are closely connected to the sea, especially for the towns of Lekeitio and Ondarroa.

The territory of about 20.600 ha is mainly covered by planted woods of non local species, such as pinus radiata and eucalyptus, whereas natural woods, thicket, pasture land and meadows are a minor part of it. With 3.500 ha, the Utilized Agricultural Area (UAA) is extremely small and covers only about 17% of the territory. This is due to the geo-morphological configuration of the area, dominated by hills and narrow valleys, and to the historic predominance of forestry over agriculture (EUSTAT[1]).

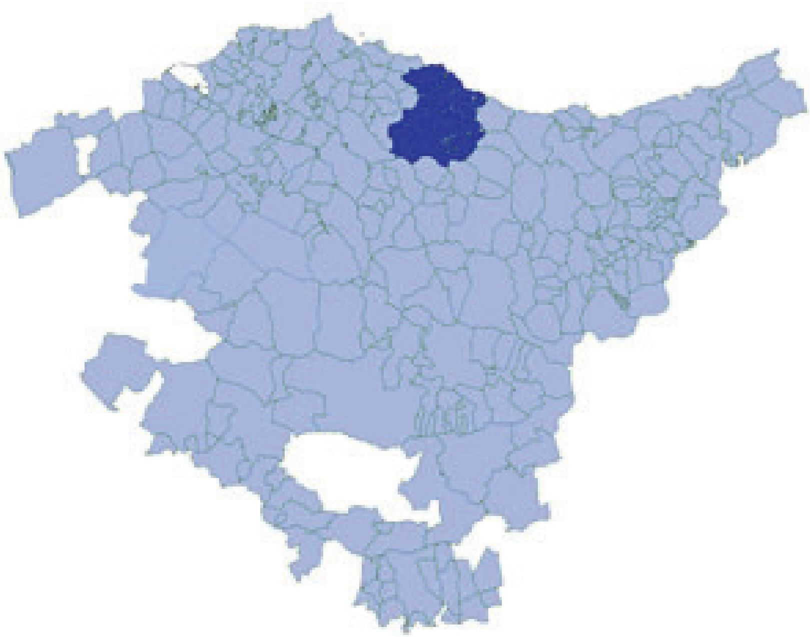

Fig. 1 Localization of Lea-Artibai.

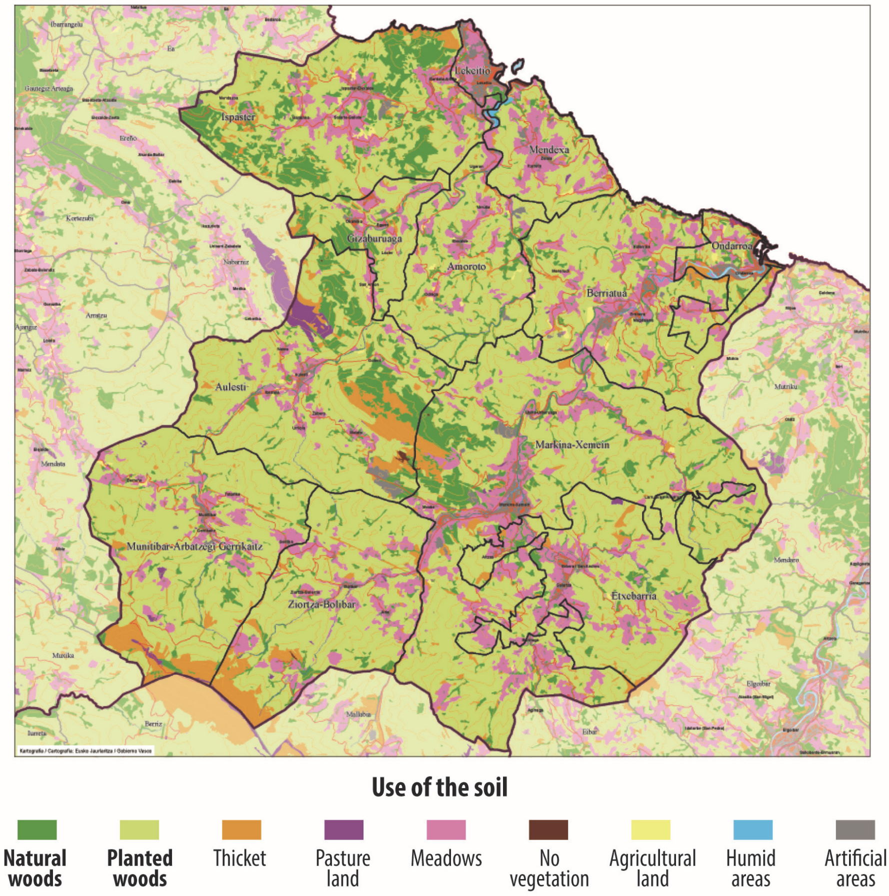

Fig. 2 Use of the soil in Lea-Artibai

*Population***.** The 26.000 inhabitants of Lea-Artibai are concentrated mostly in the three major urban centers, Markina-Xemein, Leikeitio and Ondarroa, and diffused in the many small villages in the countryside. The aging and declining population is composed mainly by people coming from Biscay and from Spain, with a small percentage of foreigners (9%) (EUSTAT[2]). The rate of unemployment is approximately 15% and unemployed people are mainly aged 25-45 (EUSTAT[3]).

*Towns***.** Each urban center has its own characteristic feature and history. Lekeitio is the most touristic town in Lea-Artibai; its economy, traditionally based on fishing and wood industry today in crisis, relies nowadays mostly on tourism and on the preservation of its cultural heritage. Ondarroa, thanked to its strategic location on a small bay at the mouth of Artibai river, based its development and economy around fishing and canning activities. Markina-Xemein is the political center of the comarca. It is famous for the quarries located next to it from which the precious black marble is extracted and for the Camino de Santiago crossing the town. Along the three urban centers, the town community of Lea Ibarra was created in 1980s: it involves 5 small villages that decided to share their resources and services to overcome economic crisis, emigration and decadence of their towns (Lea Ibarra).

*Economy***.** The production sector of Lea-Artibai is characterized by micro (<10 employees) and small enterprises (<50 employees) organized in cooperatives, a typical feature of the Basque Country, related to the history of Mondragon Cooperative (Fernandez, 2014).

The primary sector is mainly related to breeding rather than to agriculture. Poultry breeding is the predominant one; whereas sheep, cattle and goat breeding are a minority but are important for the production of traditional cheese. The analysis of the use of the UAA highlighted the disproportion between arable land and grazing (310 ha over 3.200 ha), the presence of fallowed land as an indicator of respect of natural rhythms, the lack of variety of cereals cultivated and the rich heritage from natural woods (i.e. berries, nuts, game) which is currently not available (EUSTAT[1]). The area is distinguished by the high-quality of its food resources, products and dishes diversified between the coastal and the inner mountainous areas.

The fishing sector is mainly related to Lekeitio for the artisanal and coastal fishing and to Ondarroa for offshore fishing and canneries. After the great development of the Basque fleet in 1960s-1970s that enabled the flourishing of canning industries (Uranga, 2002), the sector is now undergoing a long lasting crisis related to the running out of local fishing resources, the competition from abroad and the lack of modern structures in ports (Mar tín, 2010).

The industrial sector is characterized by rubber, metal and equipment industries that import raw materials and export finished products, with no relation to the territory. Food processing industries, mainly related to fishing activities, are also diffused, especially around Ondarroa.

The tourism is an important resource for the territory that has many different types of experiences to offer: touristic routes, cultural and natural heritages, food excellences, religious sites and the route of Camino de Santiago.

*Culture***.** The analysis of cultural aspects highlighted a vivid and strong connection of the people to the territory. Besides the language spoken, this attachment to the territory is also visible from the numerous traditional festivals related to religion, animals, food, music and carnival taking place all along the year.

The first step of desk research was concluded by a review phase. Lea-Artibai appeared as a territory characterized by *many strengths*: the abundance of natural resources and heritage; the high quality of local food products; the know-how related to their production; the strong feeling of belonging to the territory; the high potentialities for tourism; and the attitude to work in cooperatives. However, some *criticalities* were outlined: the predominance of non local woods that impoverish the soil; the small land left for agriculture; the industrial production not related to the territory; and the crisis of the wood and fishing sector on which the economy of the area had been traditionally based. The framework outlined so far was discussed together with Azaro Fundazioa to check information and identify possible gaps in the research to bridge with a further analysis.

2.1.2. Field Research

The field visit to the area aimed to verify and complement information gathered through desk research. The goal was mainly to collect qualitative data and to get a more real perception of the area, difficult to obtain from remote. Various visits to production processes and interviews to people working in the primary, secondary and tertiary sectors were performed. Visits to market places, ports, local traditional festivals, museums, religious centers and sport grounds were crucial to deeply understand the everyday cultural aspects of the people, their attitudes and habits.

The information gathered through the field visit complemented and widened the research. Five topics emerged as more characteristic of the area and were further investigated through desk research: agriculture and breeding, fishing, forestry, production activities and tourism.

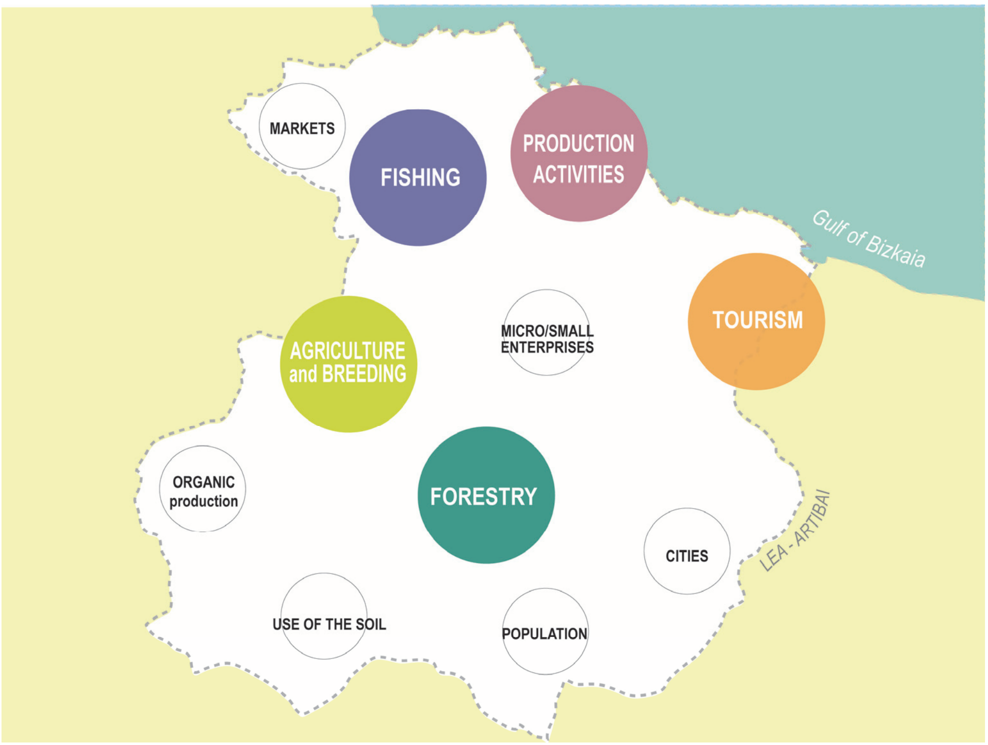

Fig. 3 The five main fields of research.

2.1.3 Desk Research Integration

The analysis of *agriculture and breeding* sector was focused on the combined study of diet and use of the soil in the area, to understand how this use should change to answer to balanced dietary needs of the population. The problems at the basis of the current small land destined to agriculture are not only related to the predominance of sloping grounds, they are also influenced by the diffusion of supermarkets, competitors of local producers, and by the abandoning of agriculture in favor of forestry which in the past was a more profitable activity. However, promising trends are emerging, such as the diffusion of biological production (ENEEK), the recovery of abandoned land and the conversion of land from forest to agriculture. Local marketplaces represent the main channel of distribution for the little local food production. There are three major marketplaces in the main urban centers: even though they present various problems (related to the opening hours that coincide with working hours, to the small quantities of products sold, and to the lack of advanced services, i.e. home delivery, credit card payment) their importance lies in their being places of socialization.

The analysis of the *fishing sector* underlined the complexity of the topic and the difficulties to investigate it for the presence of many competing actors. Nowadays the majority of the catching is fished offshore, discharged in Lea-Artibai and quickly leaves the comarca to be sold in Spain or abroad. The whole system of catching and payment is based on quantity rather than on the quality of the fish: this causes the use of unsustainable fishing techniques that damage animals and the environment (Calaon, in press).

The analysis of *forestry* highlighted the differences between planted and natural woods. While the former, characterized by non local trees that are more productive for the wood sector, but alter the local ecosystem and impoverish the soil, caused a loss of biodiversity, of know-how related to the management of woods, and led to the abandon of the countryside and the creation of a weak ecosystem, in the natural woods the preservation of biodiversity creates a strong ecosystem and ensures the possibility to perform different activities related to woods (i.e. honey and wax production, grass, herbs, mushrooms, berries and snail picking, pasture) providing also various sources of income.

From a further focus on *tourism*, trends and fluxes of tourists emerged. The area, especially the town of Lekeitio, experiences a boom of touristic presences during the summer season with a peak in the use of services. Other occasions for tourists to visit the area for a shorter period are cultural and sportive events or excursions (Garapen Agentzia, 2013). The presence of the town of Lekeitio, of the Camino de Santiago route and of a rich cultural and natural heritage represents a collection of valuable potentialities for Lea-Artibai. However, the concentration of services only in Lekeitio and the lack in the other cities together with the under-valued heritage related to maritime culture, *pelota basca* (traditional local sport) and touristic potential of various areas represent the major criticalities of the territory.

Production activities are extremely differentiated but share some common features: the micro-small dimension, the tendency to be internally organized as cooperatives, the use of non local inputs, the under-valued outputs and the lack of relation between them and with the territory. For most of them, the only output left in the territory is waste and pollution, whereas products and profits leave the area.

2.2. Individuation of area of work

Besides the potentialities and criticalities related to each single topic, the HD revealed the presence of an underlying problem: the lack of relations between the activities and between them and the territory. This lack prevents potentialities of each sector to be developed and reduces the effectiveness of any possible solution.

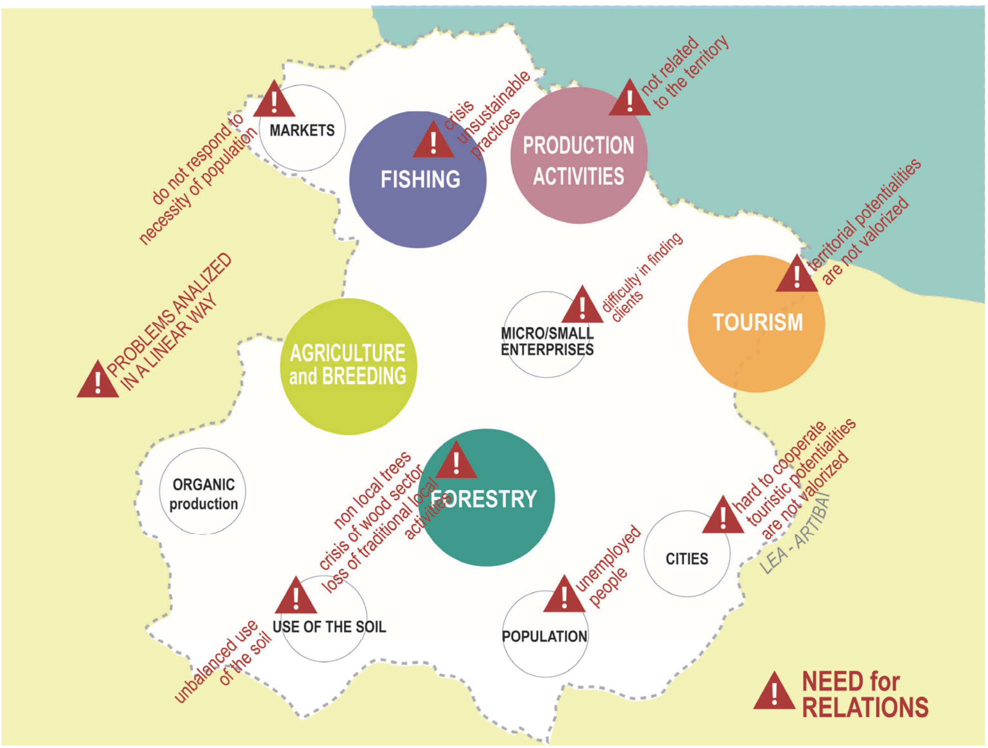

Fig. 4 Main fields of research and criticalities.

The most important outcome of the HD was the identification of different territorial potentialities other than forestry and fishing, in particular the rich agro-food heritage and the deeply rooted culture to work in cooperative. The result of the HD, together with the list of criticalities and potentialities, were presented to various stakeholders involved at different levels, including people interviewed during the field research and local politicians. The discussion led to the identification of the necessity to design a project to promote the development of local agriculture and to better link production activities and citizens to the territory. The project would then generate the activation of other related connections as a consequence.

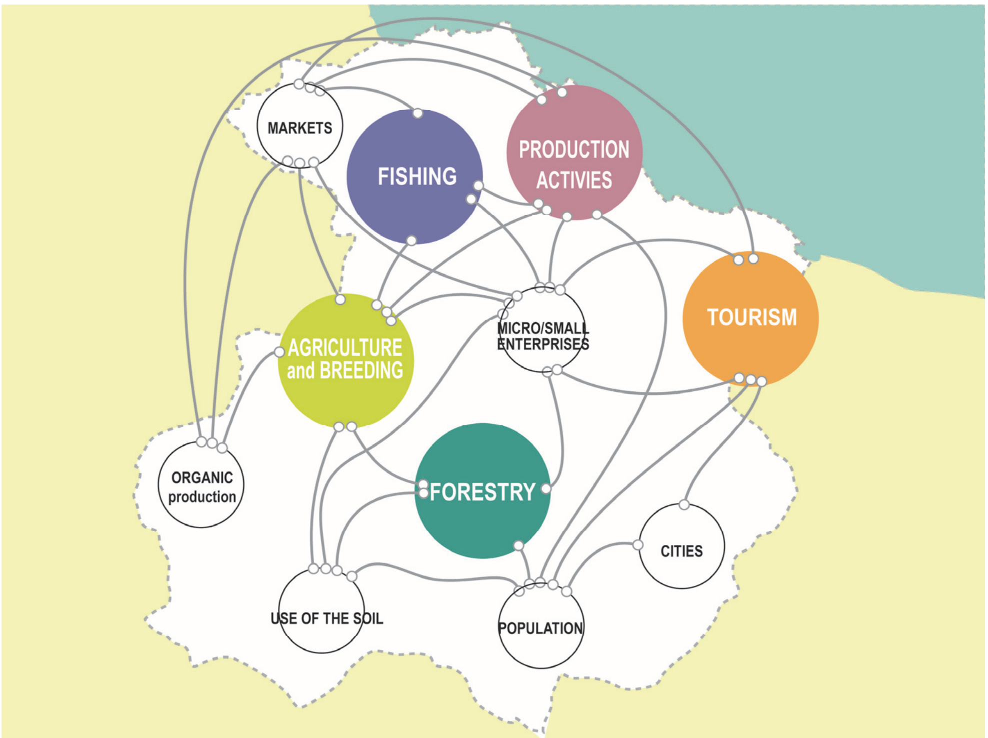

Fig. 5 Potential connections between topics.

Some fields of action were considered less feasible in the short term because of the difficulty to overcome regulatory barriers (i.e. in the fishing sector) or for the long time to establish a project (i.e. for forestry, the plantation of natural woods). Others were considered a consequence of changes established in the territory, as for example tourism. The starting point of the project was then identified in the combination of the potentials offered by cooperatives (human potential of their employees) and by local food producers (production potential of their high quality goods) to overcome the problems experienced by both actors.

The 11 cooperatives located in Lea-Artibai, currently employ about 1.400 workers. Eika Koop, a cooperative producing electric components for kitchen, is the second largest one in the area, with almost 500 employees. If we consider their families, approximately 1.500 people are directly and indirectly involved. Eika is located in an industrial area, but neither has relations with neighboring enterprises, nor with the surrounding territory. Its employees are considered only as workforce and not as a potential for other activities. Their working hours often coincide with opening hours of local shops and marketplaces; thus, to satisfy their necessity to buy food employees usually go to supermarkets, lowering the quality of their diet, consuming products coming from all over the world and giving money mainly to platforms of logistics that manage their fluxes. On the other hand, micro and small local food producers are able to offer high quality of products, but experience many difficulties in finding customers and sustain high production costs. The shop Produkt On, born to sustain the promotion of local products, is a first step to overcome these problems. It currently sells fresh and preserved food coming from local producers of Lea-Artibai and Durangaldea (the neighboring comarca), members of a cooperative named Oiz Egin. However, its opening hours coincide with working hours, a condition that limits the effectiveness of its service.

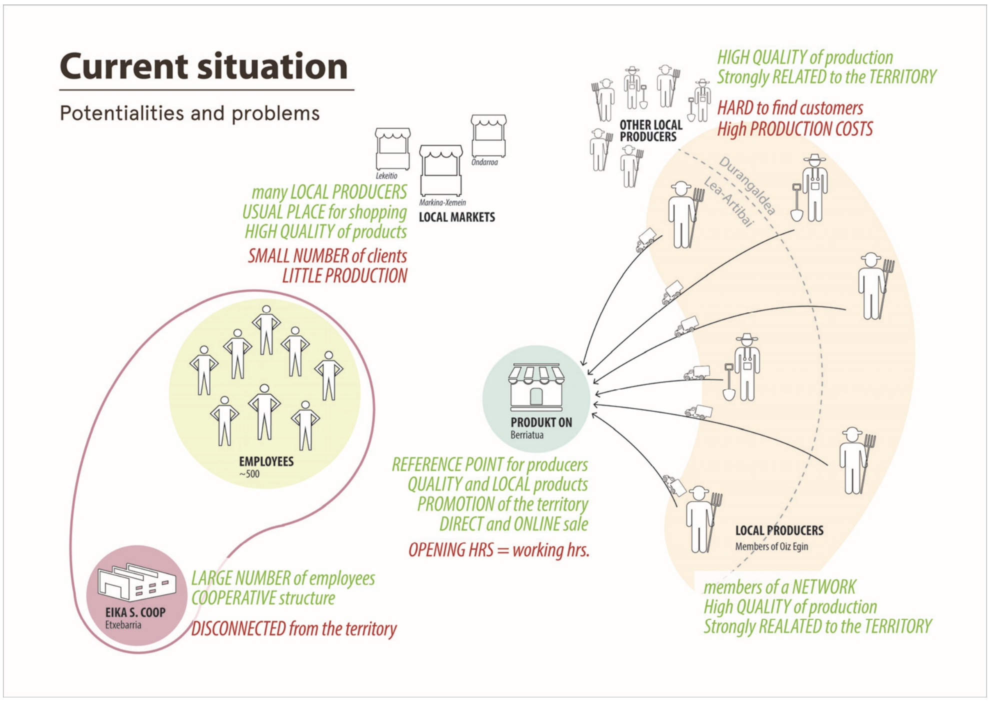

Fig. 6 Potentialities and criticalities of involved actors.

3. Results

The project focus on the creation of a *Systemic Buying Group* (SBG), identified as the appropriate model to satisfy the needs of the involved actors. The analysis of several case studies of buying groups was performed to understand the feature of each of them in relation to their context; as a result, an underlying functioning schema emerged.

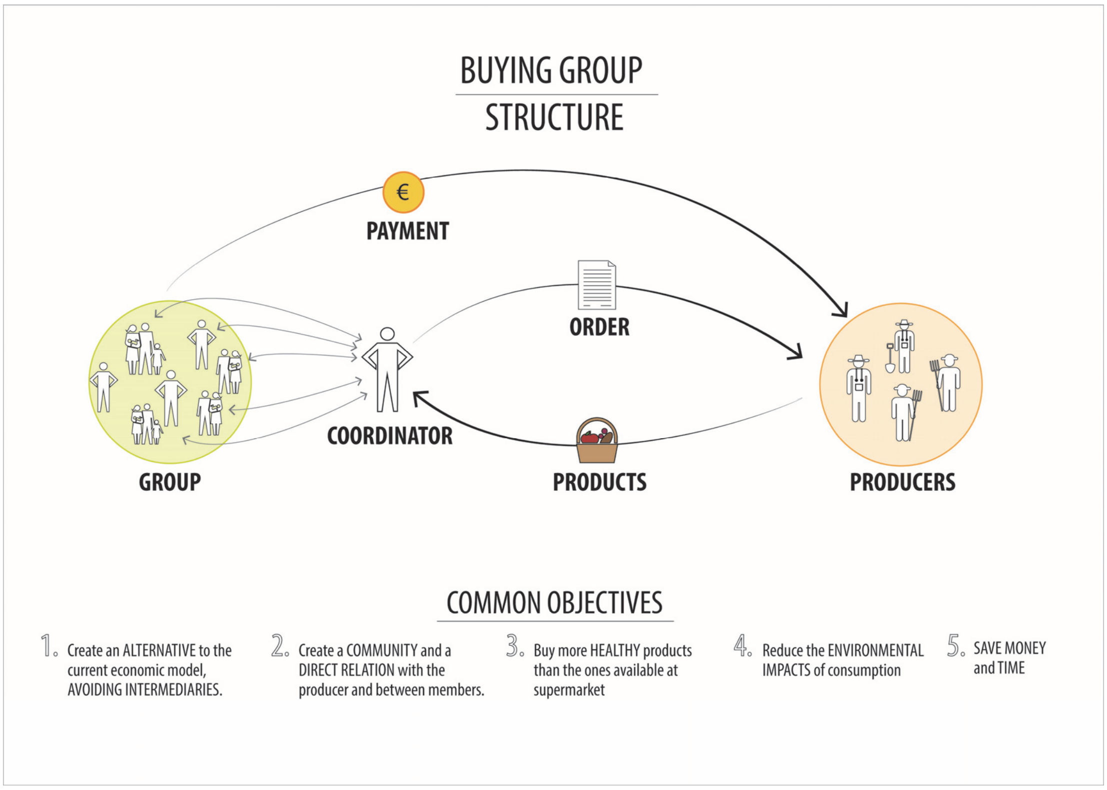

Fig. 7 Structure of a buying group.

The actors involved are: *a group of people* (buyers) interested in improving the quality of their food, reduce their environmental impacts, find an alternative to current economic model, save money and time; *a coordinator* that manages the relation between the group and the producers; *the local producers* that use environmentally friendly production techniques (they can be certified as organic or GMOs-free, but it is not compulsory).

Through the coordinator, the group periodically sends an order to producers that prepare and deliver the requested products to a defined place, where they are then divided among members of the group. The payment method changes according to the country, but goods are usually paid in advance to support the costs of the production.

This structure was adapted to the context of Lea-Artibai. The members of the Systemic Buying Group will be chosen among the employees of Eika according to their interest in the project. A pilot group of 50 employees will be formed and an internal coordinator elected. Produkt On will be the coordinator and will manage the order, organizing requests among its producers - the partners of the cooperative Oiz Egin, already linked to the shop - and assembling the baskets of products. These, will be then delivered to the cooperative where employees could easily collect them. After use, the packaging of baskets will then be returned to Produkt On and producers.

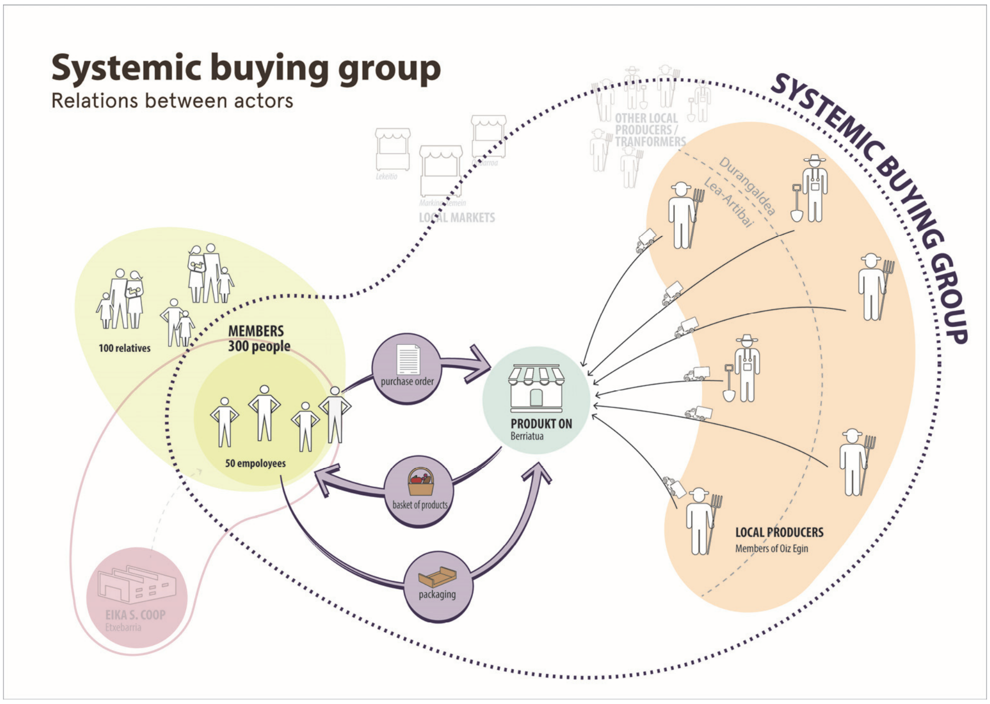

Fig. 8 Relations within the SBG.

The SBG generates positive impacts that interest all actors. Besides saving time and money, employees will improve their diet thanks to the high quality of local products; this will be reflected in a better health and reduced number of absences from work that will be a benefit for Eika. Through the project, Produkt On will gain visibility and will increase the number of producers cooperating with it. Local producers will more easily find customers and will increase their income. Globally, the project will lead to a redistribution of the wealth among the local actors of the territory, giving support to the local economy.

The SBG differs from traditional buying groups in several aspects not related to the structure, but rather to its purposes and to the benefits generated.

The relations established between the actors involved go beyond the definition of the price to create a relation of mutual faith in the production techniques and in the quality of the products offered by the producer. Without necessarily impose the farmers to convert their production to organic, SBG promotes the development of a more sustainable agriculture through the valorization of the currently unvalued outputs following the principles of SD. Lastly, the implementation of the SBG and the derived consequences promote not only a different economy but boosts the change in various cultural and production aspects of the territory.

A crucial element of the project is the system of redistribution of earnings that, opposite to the current situation, valorizes producers over intermediaries through a social pact signed by both parties. About 80% of what is paid by customers will indeed be redistributed among producers proportionally to their involvement in the production, whereas about 20% will be assigned to Produkt On to sustain the costs of the service. The presence of Produkt On as an link between producers and consumers represents a difference compared to the usual structure of buying groups that does not imply any intermediary. Its role however is not similar to the one of current intermediaries in the food sector; it is rather a facilitator of the practical operations of management of the group and its role is similar to the one of the coordinator in current buying groups. Moreover, its percentage of earnings will be defined and agreed by all the partners of the social pact and it will not be imposed. Compared to a common buying group, the role of Produkt On is also important in relation to the specific features of Lea-Artibai: the reduced number of infrastructures and the long distances between producers and consumers would make difficult for the latter to reach the former ones.

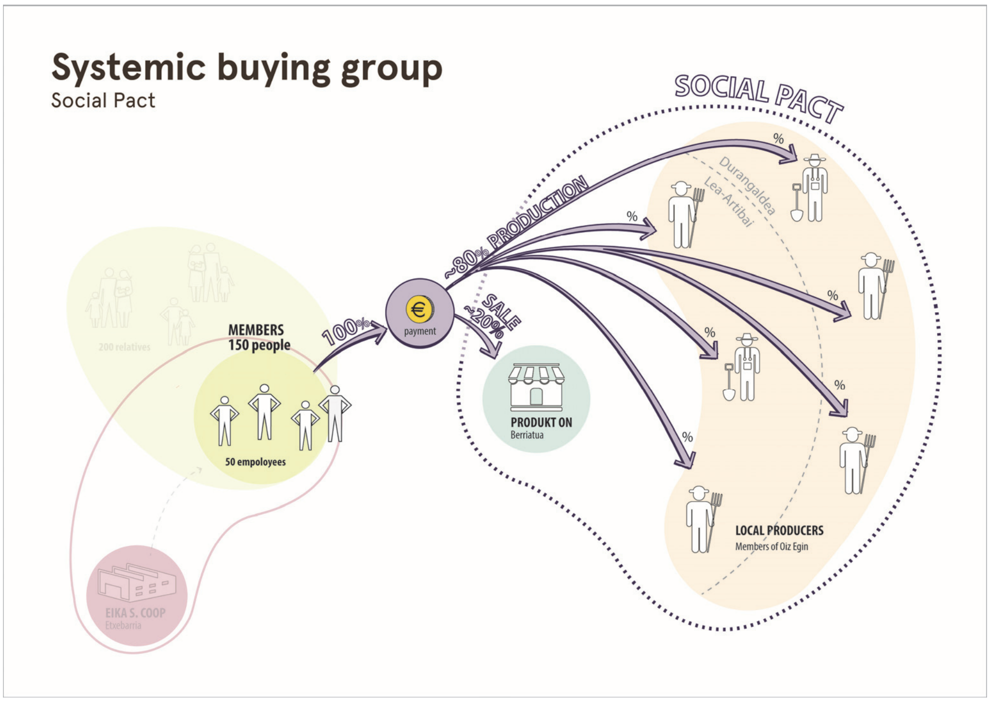

Fig. 9 Relations within the social pact.

The project proposal has been presented to numerous stakeholders: local producers, development agency, politicians, cooperatives and Produkt On. The positive answer of all the involved actors gave propulsion to the development of the project, whose practical implementation is currently under study.

A further extension of the project involves marketplaces where a stand of the SBG that offers the same services could be opened to the general audience and not only to the employees of cooperatives. Another possibility is to establish a similar kind of relations between producers, Produkt On and local school / company canteens. Parallel to the increase in the demand, other local producers could join the SBG. These hypotheses represent future developments of the project, whose strengths and weaknesses are currently being evaluated.

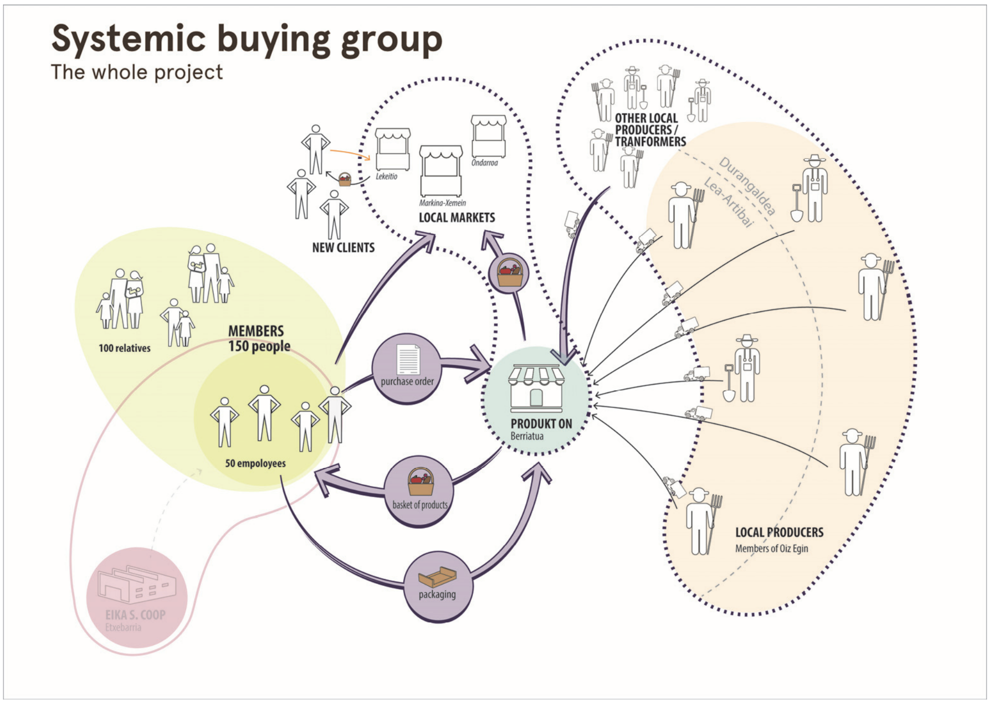

Fig. 10 Future extensions of the SBG.

3.2. Roles of actors

The implementation of the project will be made possible only by the cooperation between the involved actors. Azaro Fundazioa will be the coordinator of the project: it is the revitalising agent of the territory, it fosters cooperation between the public and private stakeholders and performs an educational role towards other partners. The Department of Architecture and Design of Politecnico di Torino will lead the project and follow the development of further steps. Eika Koop is the practical activator of the project that informs and support the SBG. It will also provide appropriate areas for the collection and withdrawal activity of the SBG baskets. Produkt On acts as a bridge to link producers and consumers. Besides the concrete assets represented by the shop and the possibility to store fresh and preserved food, the resource of Produkt On most relevant for the project is the network of farmers, breeders, chefs and restaurants related to it through Oiz Egin. Lastly, producers and consumers are the main actors of the project: they commit to the social pact and adapt production and consumption methods to requirements.

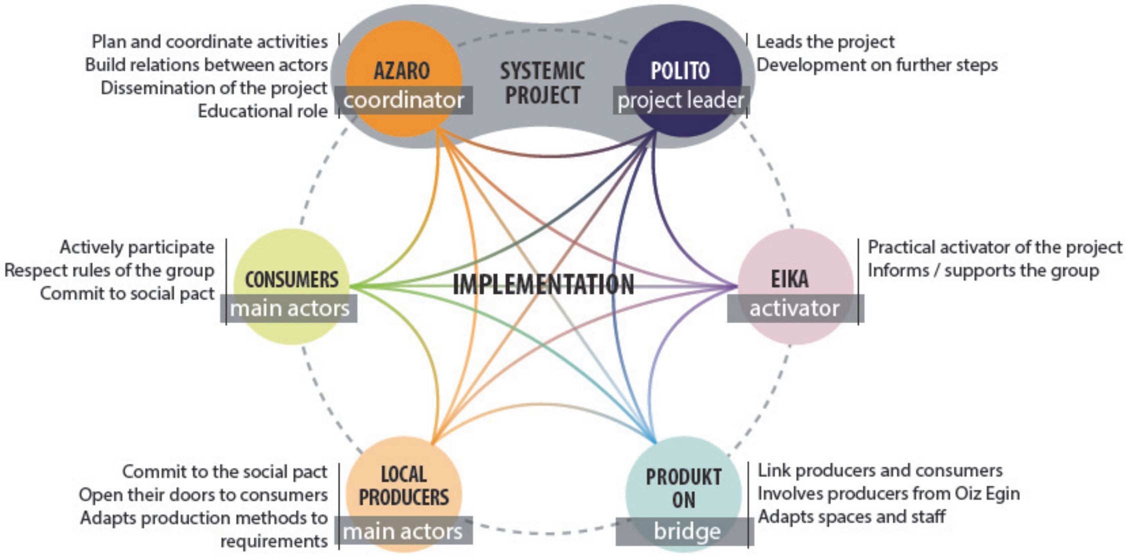

Fig. 11 Roles of involved actors.

4. Conclusions

The system created with the SBG generates economic benefit at different levels. Through the connection created, producers strongly enlarge the number of their clients, increasing their earnings. A raise in their income enables them to invest in their activities and to sustain the costs of implementing a systemic design approach to their own production processes: through the optimization and valorization of the outputs of matter and energy, savings can be achieved and new sources of income can be generated through the selling of a range of new products made from matter that was previously considered waste (Bistagnino, 2011). On the other side, consumers will reduce their expenses for food thanks to the savings they will obtain by buying together large quantities of products. Lastly, by supporting the micro-small enterprises of the area, SBG reinforces the economic tissue of Lea-Artibai (Bistagnino, 2014).

The Systemic Buying Group does not aim to be confined within itself, but to act as a seed in the territory to promote relations between different actors and changes also in the other related fields of actions defined in the HD.

The increased demand of local food will boost the change in the use of the soil that will need to be redesigned especially in the proportion between land for agriculture and forestry. The direct dialogue between producers and consumers will increase the demand for products cultivated through environmentally sustainable techniques and for organic productions. The following steps of the project that will consist in the application of SD to production processes of activities can create a local development based on:

- environmental sustainability, with the tend to zero emissions;

- economic sustainability, for the creation of a new economic model;

- social sustainability, for the new equal relations established between actors and for the benefits interesting employees.

The valorization of the local agro-food heritage and the changes in the territory promoted by the project will also provide a new resource and a new type of tourism: the inner part of the comarca will become an additional point of attraction, i.e. for trekking in the nature or for a tour to discover the different farms and the know-how related to the production of local food products.

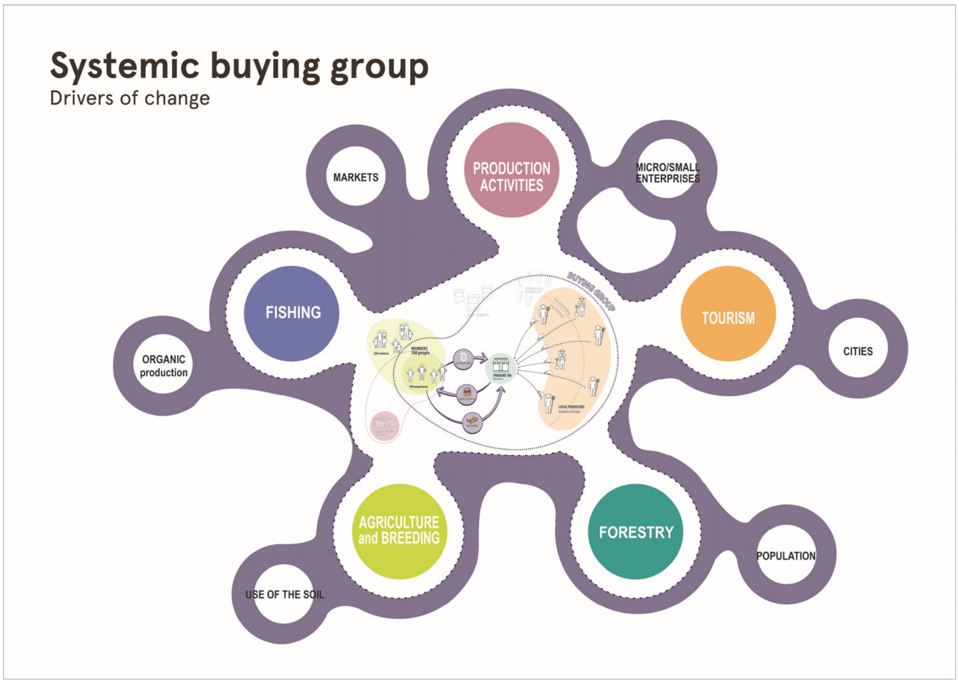

Fig. 12 The SBG as the driver of change.

The focus on local production does not aim to reach oligarchy in the territory. The purpose is to focus first on the resources that the environment locally offers to the area and to use them, instead of importing them from elsewhere, increasing the environmental impacts generated by products and damaging local economy. As the geo-morphology of Lea-Artibai is particularly adverse to agriculture (even though not to breeding), the area will never be able to completely satisfy the nutritional requirements of its inhabitants. The relation with neighboring areas thus becomes crucial for the exchange of food resources and for the mutual enrichment of territories.

The project proposal developed for Lea-Artibai aims to become a driver for the change of a territory where the crisis of the wood and fishing sectors has highlighted the necessity to rethink the basis of the LED in the long term starting from the enhancement of the territorial potentialities.

The Systemic Design methodology applied to the project enabled the transformation of the intangible aspects analyzed through the Holistic Diagnosis into the tangible result of the project, the Systemic Buying Group. The goal of the SBG is however not only to offer a service, but rather to activate changes in the social, cultural, economic and productive dimensions of the territory, in a process that move from tangible to intangible.

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Emotive Qualities of Parametrically Designed and 3D Printed Surfaces

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Abstract

Surfaces play a crucial role in design. Constituting a physical and visual interface of an object, a surface not only reveals important information about the identity of the entity it encloses but also determines impressions, evaluation, and expectations we have about the object. Despite their significance, surfaces have long been considered to be a subordinate part of form rather than an independent design element, especially under the reign of mass production. This paper challenges the conventional hierarchy and demonstrates a systematic and customisable process of creating purpose-specific, context-oriented surfaces which provide their own set of form and function.

Various digital technologies, including parametric modelling, geometric alteration, and 3D printing, were employed as main tools and thoroughly utilised across creation, modification and fabrication of surfaces. Through experimentation with software and mechanical configurations, a series of high-resolution surfaces with different parameters were produced. Furthermore, the potential for direct digital manufacturing (DDM) and its practical penetration was investigated by producing all surfaces directly from a 3D printer without the use of post-production processes, which provided an understanding of the restrictions and opportunities of the technology.

User testing was carried out over participants who observed and interacted through touch with each surface. With each interaction the user was asked to populate a questionnaire form that asks them to identify their interpretation of the surface on a spectrum. The questions were devised to explore three distinct areas of inquiry geometry, physical properties and emotive responses. The results were then analysed using the method of design of experiments (DOE) in order to identify parameters that are responsible for arousing specific visual, tactile, and emotional qualities and explore how these surfaces can be interpreted emotively, physiologically and aesthetically by the user.

Keywords: *Surface, Parametric, Digital, Design, 3D printing*

1. Introduction

The surface of a designed object is our first point of contact that forms our first impressions of the object. In particular the interaction with the tactile qualities of the surface create the initial sense-data that we use to attribute value and desirability to reassure what we see (Jansson-Boyd, 2011). From childhood touching and holding an object is an important part of acquiring and structuring haptic knowledge that forms later experiences and expectations (Piaget, 1952). Beyond being a sense that we use to experience objects, touch is also a sense that is instinctive. When we touch a warm, moist and smooth surface we often have the response of disgust as an instinctive response to detect and avoid pathogens that could be passed onto us. (Oum et. al., 2011). Such an instinctive response is indicative of a catalogue of hard-wired responses that designers can use to communicate with the user through surfaces. Yet due to materials and surfaces often being a consequence to the manufacturing process rather than a deliberate decision there has been little research conducted within the field of design on pinpointing these responses.

Mass manufacturing has created a hierarchy within the design process when it comes to material selection. Due to this hierarchy the surface of the material is subordinate to the processes used to form that material. For example, when machining aluminium the mill can only access the surface of the metal and onto this apply surface roughness. The finer the surface roughness the more time it takes and therefore more associated cost. It is possible to machine small details onto the surface but this will inflate the cost as the tooling will need to be replaced more frequently. This balance of detail and cost the process has over the past decade been circumvented with the introduction of 3D printers that are able to print the finished product directly. Direct digital manufacturing (DDM) is a natural progression of additive manufacturing (AM) that allows designers and engineers to create complex forms through CAD and have them printed ready for use directly from the machine. DDM works in stark contrast to the economies of scale that drives mass manufacturing in that it allows detailed and complex forms to be produced without the tradeoff between detail and cost (Wohler, 2009). Already we see within the grassroots maker movement inventors' 3D printing complex components and on-selling these as finished products. As the resolution for consumer 3D printers increases and are able to be printed directly the surfaces of these objects is no longer over shadowed by the hierarchy imposed by mass manufacturing.

Alongside the ability to directly digitally manufacture products is the ability to form the surfaces of the objects parametrically. Parametric design is the ability to drive the form or surface of a product with an algorithm or set of instructions that respond to a set of values that define the parameters of the design. Parametric design is used within architecture, a style called parametricism, to create the designs for buildings that are responsive and dynamic as opposed to the traditional regular format that is often attributed to architecture. A style exemplified by architects such as Zaha Hadid, Frank Gehry and Greg Lynn. The combination of parametric design and DDM represent the ability to create objects that are responsive, sometimes purpose built to a specific user at no extra cost. The potential for parametric design with 3D printed surfaces is that a designed object will be able to have different surfaces that respond to user depending where they interact with the object. The design potential for being able to illicit certain responses for example temperature, direction or pleasure would represent a shift in what the designer would be able communicate to the user and how. As well as this the attention to the surface of the object will give a much needed sense of value between 3D printed objects, between a quickly printed part and a much considered and highly designed object.

3D printers are diverse in their range and applications though can be divided into three main groups, selective laser sintering (SLS), stereolithography (SLA) and filament fused fabrication (FFF) each with their own strengths and weaknesses. SLS printing is achieved by pushing a fine layer of powder across and using a laser to melt and merge the powder particles together. While this process affords the greatest versatility in materials in that it can fuse both plastics and metals it is also the most prohibitive as it requires specific material compositions and equipment to extract the parts from the powder. SLS is used as a DDM process and used for aeronautical and automotive applications. SLA a process that is able to reach the greatest resolution as it prints by using a photosensitive resin that hardens when light bonds the molecules together in a process called photopolymerisation. The drawback of SLA is that it must use specific resins to produce the models and this relegates this process to prototyping and rarely are the finished parts functional. Some SLA processes require time consuming cleaning of the parts after completion. FFF is the most accessible of the 3D printing processes as it is the simplest. A small nozzle heats up a filament of what is typically a plastic and extrudes the melted plastic layer by layer to create a form. FFF in terms of materials is the most versatile of the methods and is able to print in rubber, wood, plastics and most materials that are able to be heated and extruded. This also makes it the cheapest and is themes commonly seen consumer model 3D printer. FFF lacks in resolution compared to the other processes though with advancements in the resolution of the motors that drive the extruder head greater resolution is able to be achieved. Another restriction of the FFF printer is that it is the only methods that must compete with gravity. Support structures are often constructed as part of the printing process but are generally undesirable. Each of these methods are becoming widely available and are already becoming common place within universities and industry alike.

As 3D printers decrease in price they will become more viable for more producers. Eventually we will see 3D printed products more frequently within our daily lives but our current approach to 3D printing by focusing solely on form creates the potential for homogeny of surfaces. Surfaces of 3D printed objects are currently defined by the process used. For example, with SLS creating a granular surface and FFF creating easily identifiable ridges from the layering. These default surfaces for these processes, while currently novel, will eventually become homogenous. Like the association created between smooth surfaces of injection moulded plastics and plastic toys (Karana et. al. 2008) so too will associations be constructed with 3D printing. This presents a problem for designers looking to make use of the versatility of the process but unable to create designs that have surfaces that can be differentiated from every other 3D printed object. Yet consumer 3D printers now feature motors that are able to create a layer resolution of 50 microns meaning that there is an opportunity to create previously unobtainable fine geometries to create intentional surfaces.

While the area of 3D printed parametric design is relatively new there is much interest in the potential of its applications. Notably architect Neri Oxman of MIT is undertaking research into the potential of growing materials and structures through 3D printing that respond to load as opposed to rigid preformed materials used for construction (Oxman; Rosenburg, 2007). Her *Carpal Skin* (2010) design is a prospective design to explore the use of 3D printing in the creation of biomimicry surfaces that can be utilised to treat patients who suffer from carpal tunnel syndrome. Oxman's work to date is a good example of how surfaces can be driven through algorithms and the visual outcomes and complexity that is possible.

This paper explores the relationship between computer generated parametric surfaces and the interpreted emotive responses from the participants. This is a short but necessary explorative study that will give direction for future research that will delve deeper into the surfaces that elicited consistent results. This initial systematic research will create a frame work for what surfaces are possible to print, at what scale and start to give meaning to the digital surfaces that are being created. The future application of these considered surfaces onto products has the intention of adding emotive value to objects that are created using a method that treats each print alike. Furthermore, this research looks to bring more focus on a new realm of design opportunity and the possibilities that are presented when designers are not restricted by mass manufacturing methods to apply surfaces to their design.

2. Methods

2.1. Software

Many different geometries and printing methods were explored to discover what surfaces were possible to print. Through the explorations it was found that printing the details of a surface was accompanied by a different set of difficulties than that experienced when focusing solely on form. From this initial foray into the design of parametric surfaces we found that most the common 3D modelling software such as Solidworks and Rhino were ill-equipped to process the small details applied onto a surface. Instead an open source 3D modelling program OpenSCAD was found the most successful in creating digitally created surfaces as it is driven by code as opposed to a graphical user interface (GUI).

2.2. Hardware

For this research three FFF printers were tested for suitability, the Micro 3D (M3D), 3D Printing Systems Up Box and Up Mini. The UP Box featured fast operation, temperature controlled cabinet for optimal layer adhesion during the print and heated platform for the model adhesion to the platform. While larger prints were of the best quality once the scale of the surfaces decreased we experienced issues with clogging of the nozzle making surface features below 2mm unobtainable. The UP Mini is a smaller version of the UP Box and featured heated platform but experienced the same issues as the UP Box with smaller details. Both the UP Box and UP Mini have a layer resolution of 100 microns and both required use of their proprietary software which didn't allow for the uploading of custom G-Code (the set of instructions used to control the 3D printer to create the 3D print). For the exploration of printing parametric geometries, we used a consumer M3D printer that was able to move along the Z-axis and lay each layer 50 microns apart, currently the higher end of resolution available for FFF printers. The M3D was an inexpensive printer that while allowing for greater detail also lacked the features such as heated platform, enclosed cabinet for temperature control and fast operation that would have allowed for consistent results. The M3D however was preferable as it allowed for importing of custom G-Code from slicer software Cura, which is a program that will read 3D models and slice it into layers and create the G-Code to run the 3D printer. This greater control allowed us to adjust finer setting to create prints that were otherwise unachievable on the UP Box or UP Mini and of surprising detail. Through testing we were able to decrease the layer resolution to 25 microns which substantially increased the print time but did not produce discernible results.

2.3. 3D Printing

We considered each of the three main processes for 3D printing SLS, FFF and SLA when engaging with the exploration process. When selecting the process to focus on we had a set of four criteria. 1) Ability to produce parts that were ready for use straight from the printer meaning no post-processes were necessary. 2) Wide range of readily available materials for wider range of experimentation. 3) The ability to upload our own custom G-Code in order to pursue different paths of enquiry. 4) The ability to produce fine detailed surfaces that have structural integrity that allow them to be handled after printing. Of the three methods we settled on FFF as these printers are readily available and not cost prohibitive. They have a wide range of filaments to choose from of different materials and some are able to produce strong fine details with no need for post processing from the printer. As these machines are able to be purchased we have been able to acquire a 3D printer that allows the uploading of custom G-Code. FFF machines however must work against gravity and in our experiments we had to create geometries that allowed us to print without the use of support material that would have made the surface details redundant. SLS printers are large and expensive machines that are frequently used as a service and due to their cost they would not have allowed for the uploading of custom G-Code. Also the process which allows for standard sized

3D models to be printed with relative ease is also brittle when the details go below 1mm. In addition to this the SLS method requires specially formed powders for sintering though they SLS method does allow for metals to be printed. Finally, the SLA method which is affordable and is able to produce parts in the finest detail requires a special photo sensitive resin restricting materiality. Some SLA printers also require time consuming removal of support material which with very fine and delicate surface features made the process unfeasible.

2.4. Parameters

The parameters used to generate the specimens used for this study were the result of an exploratory study into which geometries are able to be produced at high resolution of 50 microns along the Z-axis on a FFF 3D printer. Three sets of successful geometries were used from our initial explorations. 1) Inverted spheroids were used as they provided the greatest detail in our explorations and were able retain the sharpest form. The inverted spheroids were used to test the tactile qualities of pointed structures and were merged along the hemisphere so that when they were scaled along either axis they would produce a pillar between each iteration. The spheroids were able to be deformed along either axis and also the proximity between each feature could be adjusted. The inverted spheroids were used to test harsh pointed surfaces. 2) Spheroids were used to compliment the inverted spheroids and operated under the same set of parameters. They created rounded features that that sought to elicit less harsh tactile qualities. They were also merged along the hemisphere for consistency through scale transformation. 3) Iterative boxes were the final geometry to be tested due to the lines they produced when set alongside each other. Of the parameters were two sets *riy* and *rux* that would slightly rotate each iteration with the angle compounding. Additionally, the parameter *mi* was used to control the frequency of the iterations. If the value was lowered the iterations would occur more frequently. This allowed for strong linear forms to be produced to test whether strong direction within the surface had an effect on participants.

2.5. Survey

The survey that was undertaken was to gather initial data to give direction for future 3D printing experiments to create more targeted surfaces. Our initial undertaking was primarily based upon the work of Elvin Karana who has developed a method for gathering data that attributes meaning to materials. The survey Karana et. al. had developed asked the participants to find high quality materials and then ill out a survey with a set of questions that related to a range of sensorial properties such as elasticity, roughness and weight but required no direct contact with specific materials (Karana et. al., 2009). A similar study that is based upon the same work of Karana did require participants to directly touch samples and fill out a survey form that contained texture lexicons (Hope et. al., 2013). Our survey blended the sensorial and lexicon aspect of both aforementioned surveys. Our survey spanned three main categories of responses, physiological such as temperature, geometric such as perceived complexity of the surface and emotive based response such as attractive or traditional. Participant were asked to touch each sample and then fill out the form depending on the response they felt. Each form contained questions and also allowed the participant to describe the surface in their own way and to rate how much they personally liked the surface, this was repeated over all 16 samples (Table 1). At the end of the survey the participants were asked to fill out a final sheet which asked them to choose their favourite and least favourite sample and explain why. (Fig. 1)

Fig. 1 A typical survey setting

Table 1. Emotional qualities on a 8-point scale

1.	**[Smooth]**	**1 2 3 4 5 6 7 8**	**[Rough]**	**(SR)**
2.	[Sharp]	1 2 3 4 5 6 7 8	[Blunt]	(SB)
3.	[Hard]	1 2 3 4 5 6 7 8	[Soft]	(HS)
4.	[Warm]	1 2 3 4 5 6 7 8	[Cool]	(WC)
5.	[Fragile]	1 2 3 4 5 6 7 8	[Sturdy]	(FS)
6.	[Simple]	1 2 3 4 5 6 7 8	[Complex]	(SC)
7.	[Valuable]	1 2 3 4 5 6 7 8	[Cheap]	(VC)
8.	[Natural]	1 2 3 4 5 6 7 8	[Synthetic]	(NS)
9.	[Casual]	1 2 3 4 5 6 7 8	[Formal]	(CF)
10.	[Pleasant]	1 2 3 4 5 6 7 8	[Unpleasant]	(PU)
11.	[Modern]	1 2 3 4 5 6 7 8	[Traditional]	(MT)
12.	[Attractive]	1 2 3 4 5 6 7 8	[Unattractive]	(AU)

3. Results and Discussion

Fig 2 shows names and definitions of parameters used in this research. *r* refers to the radius of spheroid features, and *sx* and *sy* indicate scale transformation of spheroid along the X- and Y- axis, respectively. For set 3, *fx*, *fy*, and *fz* represent dimensions of box features, and *px* and *py* are used to show distance between two adjacent box features along the X- and Y- axis, respectively. Rotation of a box feature along the X- and Y-axis, respectively, in degrees is expressed using *riy* and *rux*, and *mi* is an indicator that shows how many iteration steps are in a unit length: 0.5 means 2 times as many features exist, respectively.

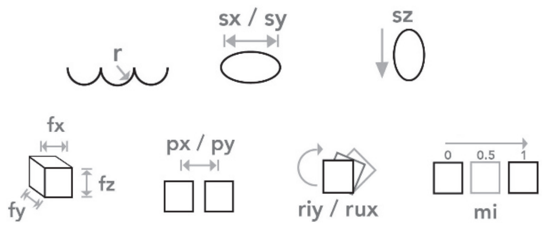

Fig 2. Geometircal definitions of parameters

Tables 2, 3, and 4 detail surface profiles belong to the three sets and combinations of parameters responsible for each of the profiles. Fig 3, 4, and 5 depict visualisations of the surface profiles.

Table 2. Parameters and their combinations used for set 1

Surface	*r*	*sy*	*sz*
1-2	5.00	4.00	2.00
1-3	2.75	2.50	1.25
1-4	5.00	1.00	0.50

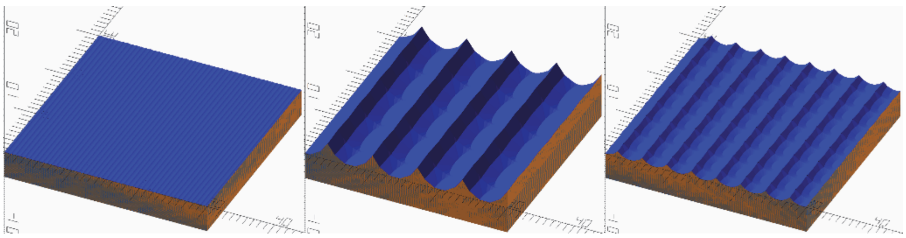

Fig 3. Visualisations of surfaces belong to set 1

Table 3. Parameters their combinations used for set 2

Surface	*r*	*sy*	*sz*
2-1	2.75	2.50	1.25
2-2	0.50	4.00	0.50
2-3	5.00	4.00	2.00
2-4	5.00	1.00	0.50
2-5	0.50	1.00	2.00

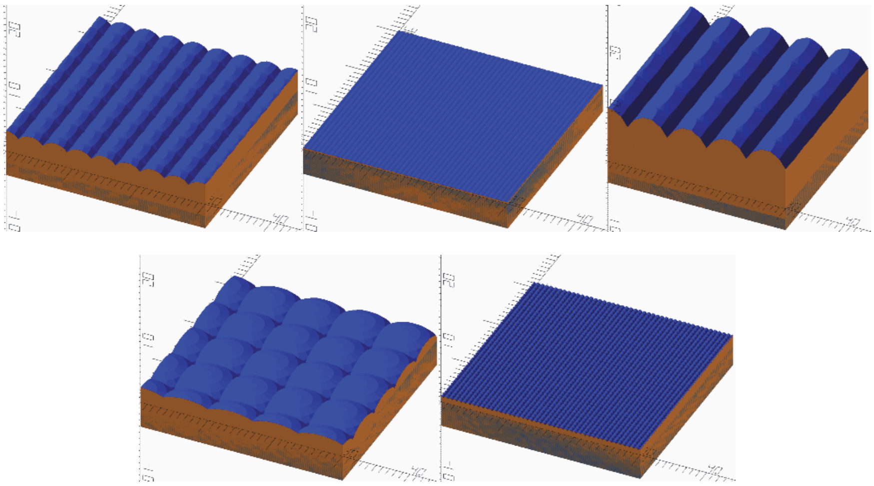

Fig. 4 Visualisations of surfaces belong to set 2

Table 4. Parameters their combinations used for set 3

Surface	*fy*	*fz*	*py*	*riy*	*rux*	*mi*
3-1	0.50	4.00	1.00	0.00	45.00	0.20
3-2	2.00	0.50	1.00	0.00	0.00	1.00
3-3	2.00	4.00	4.00	20.00	45.00	1.00
3-4	2.00	0.50	4.00	0.00	45.00	0.20
3-5	1.25	2.25	2.50	10.00	22.50	0.60
3-6	2.00	4.00	1.00	20.00	0.00	0.20
3-7	0.50	0.50	4.00	20.00	0.00	0.20
3-8	0.50	4.00	4.00	0.00	0.00	1.00
3-9	0.50	0.50	1.00	20.00	45.00	1.00

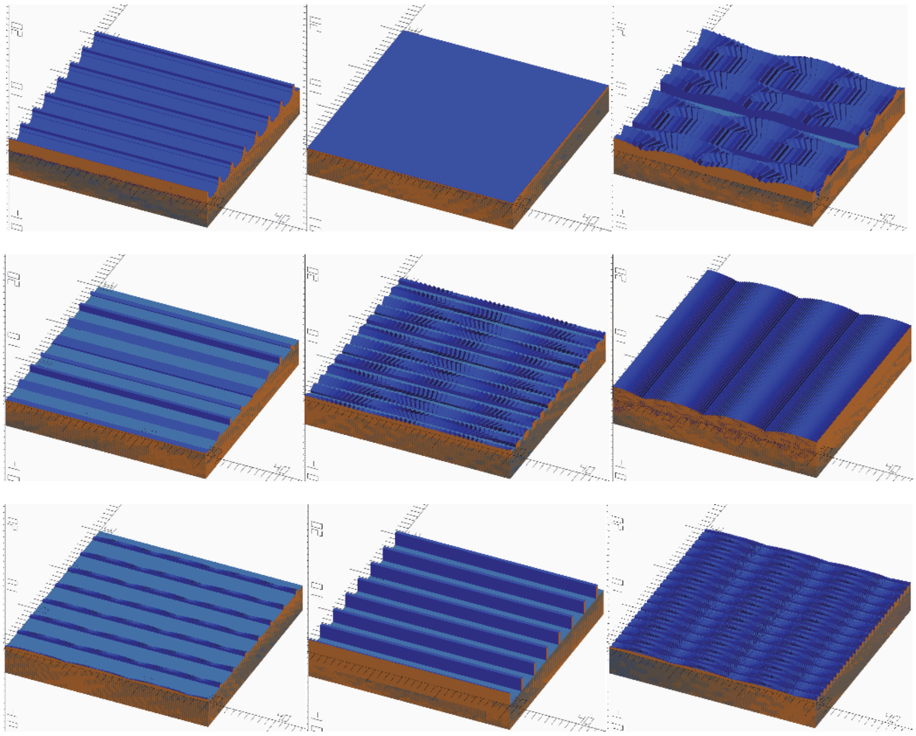

Fig 5. Visualisations of surfaces belong to set 3

The collected questionnaires were coded by assigning a number between 1 and 8 to each of the corresponding answers on the scale and the numerical values were rearranged by emotional quality. This conversion enabled statistical examination to determine whether each of the parameters has significant effect on the responses at 95% confidence level (p=0.05) by using two-way factorial analysis that processes the parameters as factors. Tables 5, 6, and 7 detail parameters across the three sets which have statistically significant effects. Interactions between two or among three parameters were observed in sets 2 and 3.

Table 5. Parameters that have significant effects (set 1)

Emotional quality scale	A	B	C
SR	V	V	-
SB	V	-	-
HS	-	-	-
WC	-	-	-
FS	-	-	-
SC	-	V	-
VC	-	-	-
NS	-	-	-
CF	-	-	-
PU	V	-	-
MT	-	-	-
AU	-	-	-

(A=*r*, B=*sy*, C=*sz*)

Table 6. Parameters that have significant effects (set 2)

Emotional quality scale	A	B	C	I
SR	V	-	V	V
SB	V	-	-	-
HS	-	-	-	-
WC	V	-	-	-
FS	V	-	-	-
SC	V	-	-	-
VC	-	-	-	-
NS	-	-	V	-
CF	V	V	-	V
PU	-	-	V	-
MT	-	-	-	V
AU	-	-	V	-

(A=*r*, B=*sy*, C=*sz*, I=intereactions)

Table 7. Parameters that have significant effects (set 3)

Emotional quality scale	Interactions
SR	C E A AF
SB	C E A AF B
HS	C AF E F D
WC	C E AF D
FS	A D C
SC	E C D AF
VC	D
NS	C A
CF	C A
PU	C D E A F
MT	E
AU	C D

(A=*fy*, B=*fz*, C= *py*, D=*riy*, E=*rux*, F=*mi*)

The subsequent analysis focused on the parameters identified as statistically significant. Fig 6 shows effects of the three parameters of set 1 on the SR scale, and the relationship depicted on the left suggests that the larger radius of spheroid (*r*) on the surface is, the rougher the surface feels, which is intuitively understandable. The graph on the right in the meawhile represents that a surface consists of elongated geometries (high *sy*), such as ovoids, compared to perfect circles, is more likely to be felt smoother. Such geometries are also responsible for making surfaces feel complex on the SC scale, which aligns well with everyday observations (Fig 7).

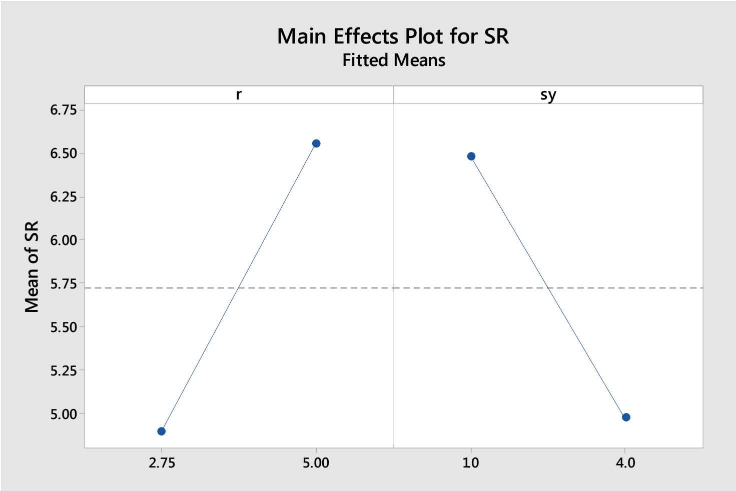

Fig 6. Effects plot for SR (set 1)

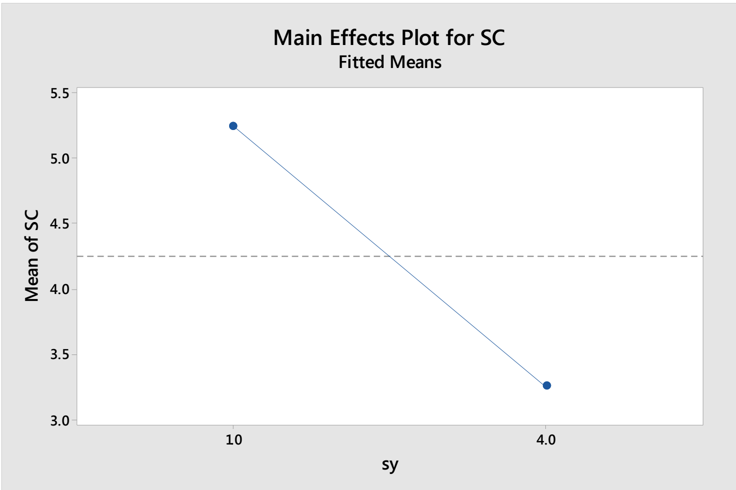

Fig 7. Effects plot for SC (set 1)

On the SB scale, as depicted on Fig 8, *r* is the only significant parameter. Low *r* values, which dictate densely packed small patterns in a unit area, are linked to surfaces that feel sharper. However, such surfaces can be seen quite unattractive at the same time (Fig 9).

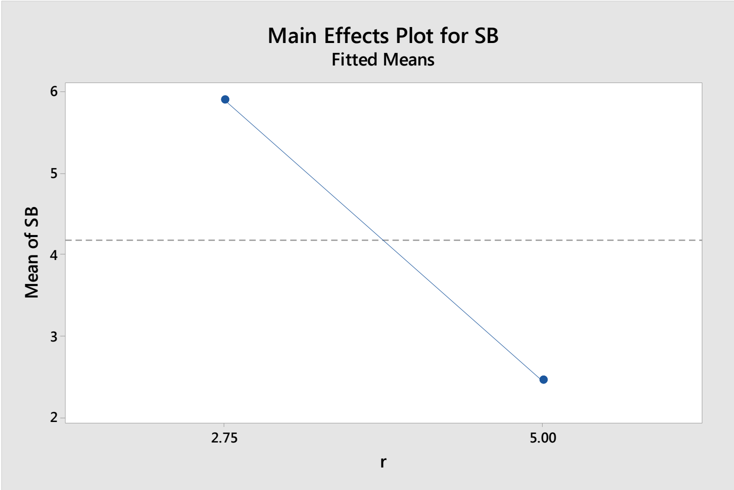

Fig 8. Effects plot for SB (set 1)

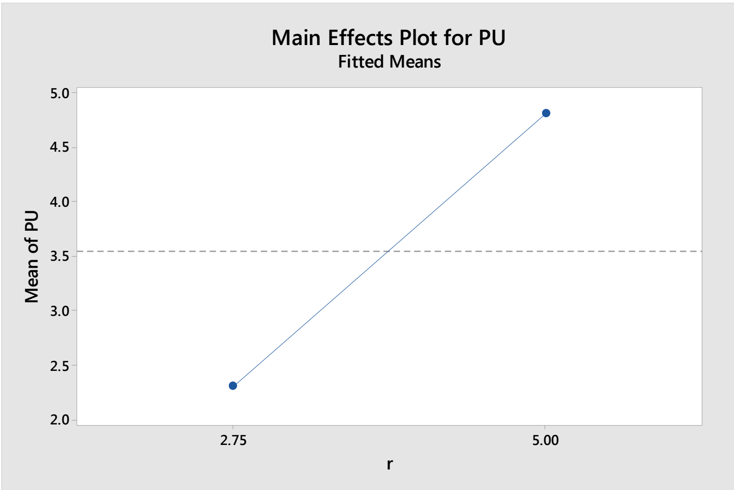

Fig 9. Effects plot for PU (set 1)

Set 2 includes surfaces that are basically inverse of the ones belong to set 1. Fig 10 clearly demonstrates why two parameters *r* and *sz*, with the exception of *sy* which has marginal effect, are flagged as having significant effects on the SR scale. While increased radius *r* makes the surface smoother (left), oblong patterns produced as a result of high *sz* values contribute to surfaces that feel rough (right). This phenomenon which responses are influenced by two or more parameters at the same time, either synergistically or attenuatively, is called interaction, and in this case it suggests an important possibility of creating highly smooth or rough-feeling surfaces by combining more than one parameters.

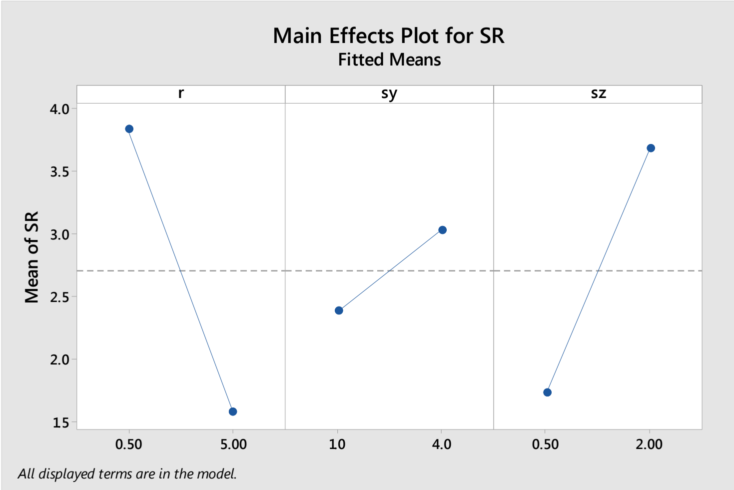

Fig 10. Effects plot for SR (set 2)

Another emotional surface quality that shows interactions is CF (Fig 11). Increased *r* and *sy* can both make surfaces feel formal, and the effect could be amplified in a synergistic manner if the two parameters are used together.

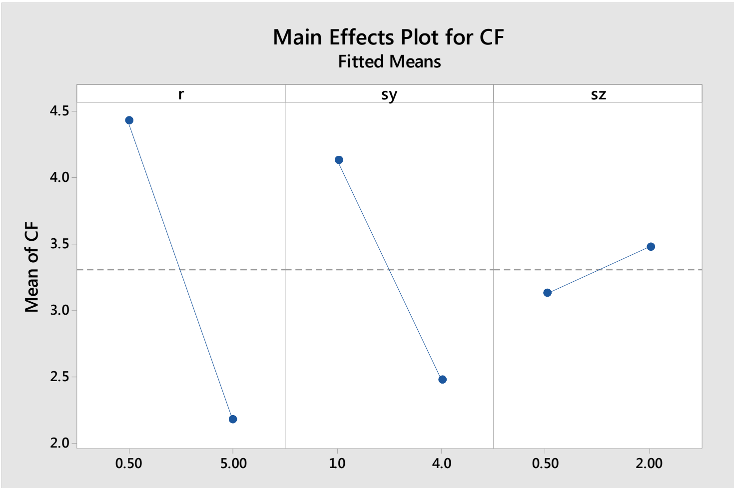

Fig 11. Effects plot for CF (set 2)

Interactions can take place in a different way. In case of MT (Fig 12), although none of the parameters were identified as significant ones, the interactions form a significant effect ($p=0.037$) and this suggests that surfaces that evoke either modern or traditional feel, even to a certain extent only, could be designed by carefully combining those parameters.

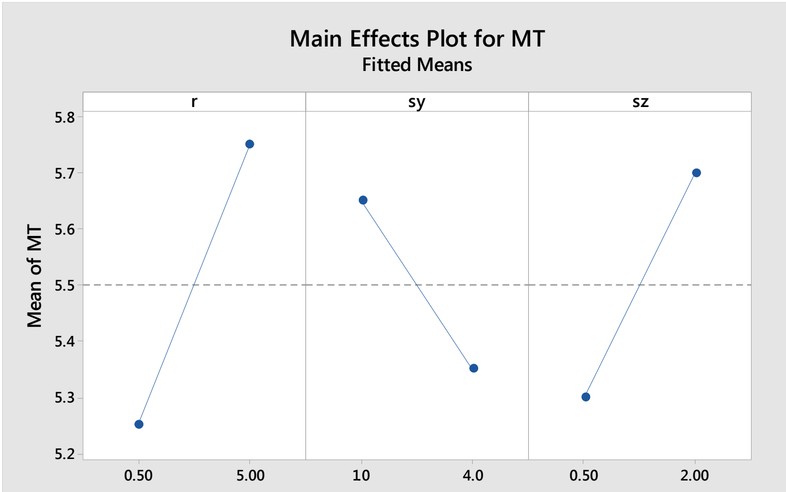

Fig 12. Effects plot for MT (set 2)

Figs 13 through 16 depict emotional qualities that *r* is the sole parameter that has significant effect. Increased diameters are responsible for surfaces that feel warm (WC), simple (SB), sturdy (FS, against fragile), and blunt (SB), in order of significance, which is consistent with common experiences.

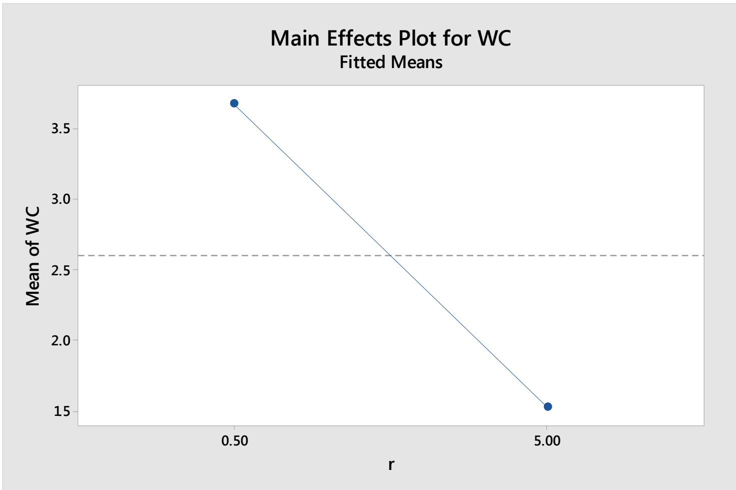

Fig 13. Effects plot for WC (set 2)

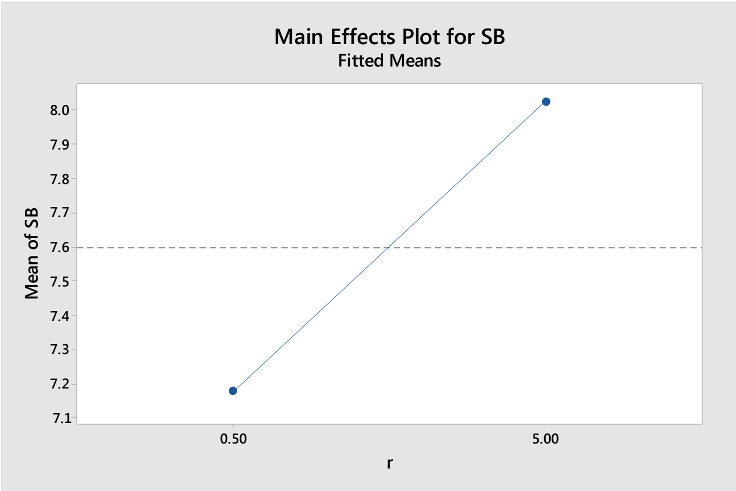

Fig 14. Effects plot for SB (set 2)

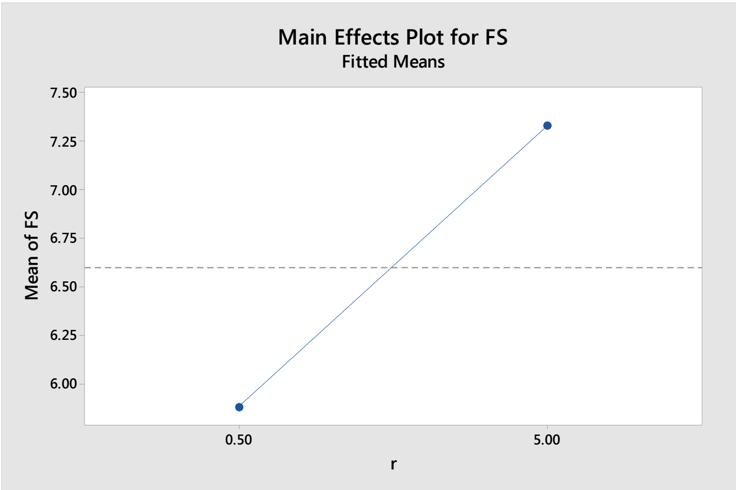

Fig 15. Effects plot for FS (set 2)

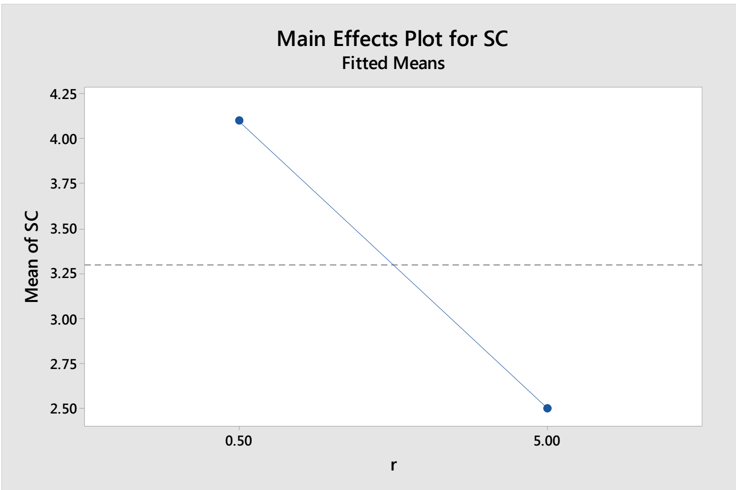

Fig 16. Effects plot for SC (set 2)

Features with high aspect ratios along the Z-axis (*sz*) have significant effects on making the surfaces unattractive (AU), synthetic (NS), and unpleasant (PU, in order of significance), and the results in unison imply that the parameter may cause somewhat negative influence on design (Fig 17-19) unless used carefully.

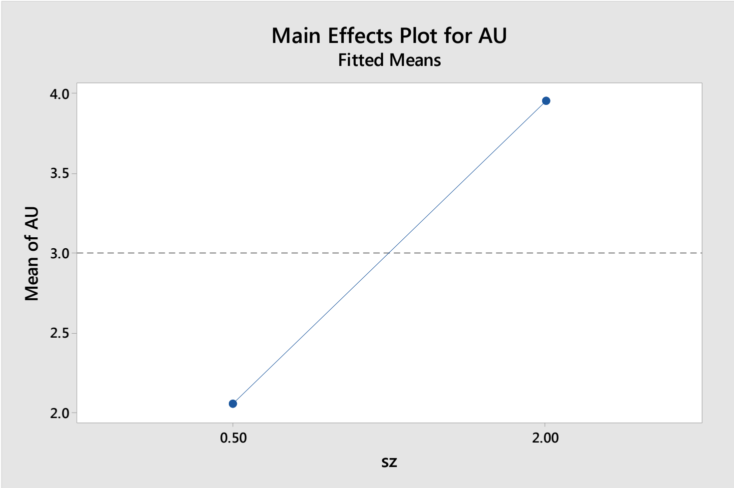

Fig 17. Effects plot for AU (set 2)

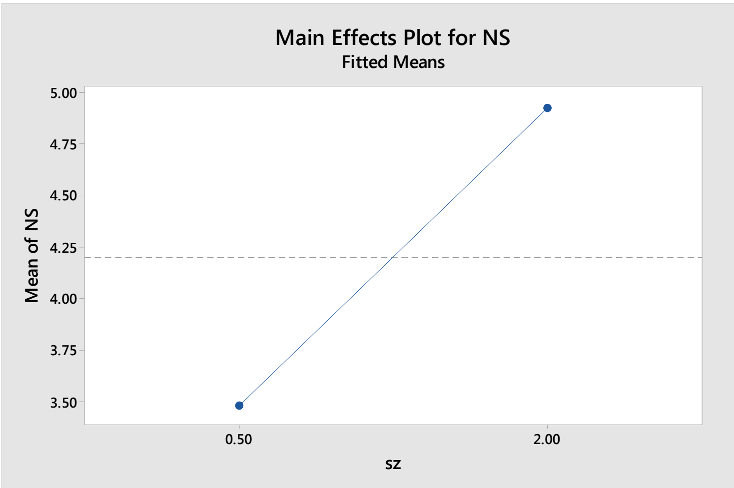

Fig 18. Effects plot for NS (set 2)

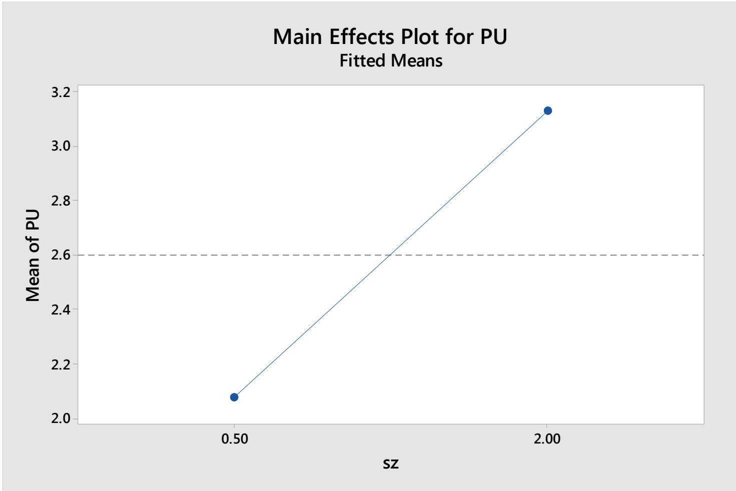

Fig 19. Effects plot for PU (set 2)

In set 3, various interactions among the parameters were observed. Figs 20 show one of the most complicated relationships in this research, which all parameters except for one (*riy*) have significant effects on the SB scale, individually or in combination with another. While higher proximity to the adjacent feature along Y-axis (*py*) plays the most significant role in making the surfaces feel sharp, probably by clearly revealing each sparsely distributed feature, degree of rotation of the features towards the X-axis (*rux*) has also significant effects, followed by length of a box along the Y-axis (*fy*), but in an inverse proportion to the former two. One remarkable factor is a combination of *fy* and *mi* as depicted in Fig 21. While *mi*, which refers to iteration steps within a unit distance, does not constitute any significant effect itself, it amplifies its impact when used in combination with *fy*, which means long box features placed at an increased interval may look blunt.

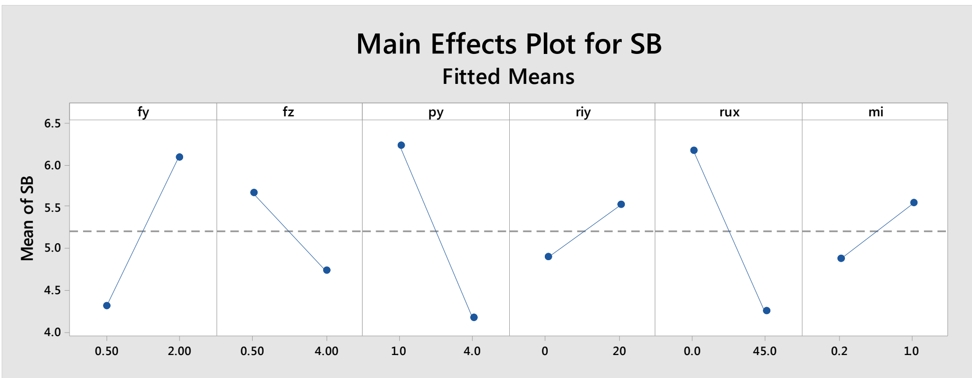

Fig 20. Effects plot for SB (set 3)

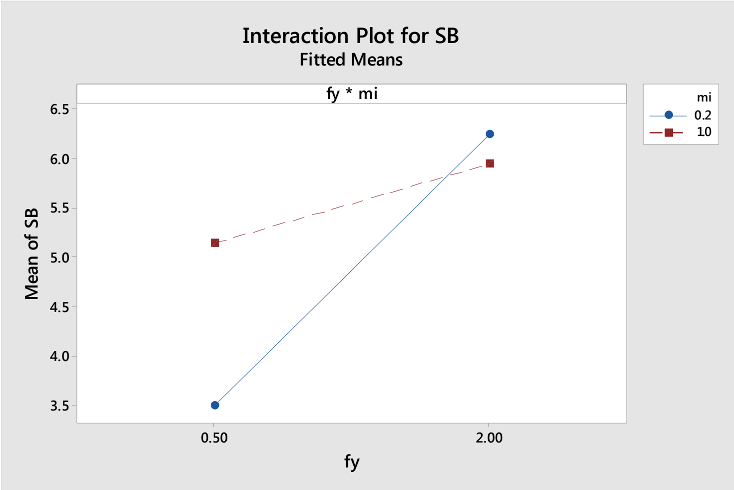

Fig 21. Interaction plot for SB (set 3)

The combination has also significant effects on other emotional qualities including SR (Fig. 22), SC (Fig. 23), and WC (Fig. 24), and the latter two show a different type of interaction, one of which has a negative slope while the other has a positive one, even though the effect of *mi* is considerably smaller than that of *fy*.

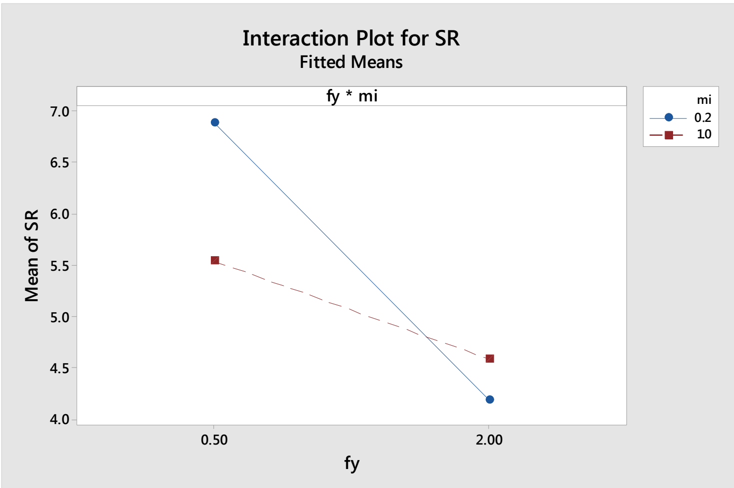

Fig 22. Interaction plot for SR (set 3)

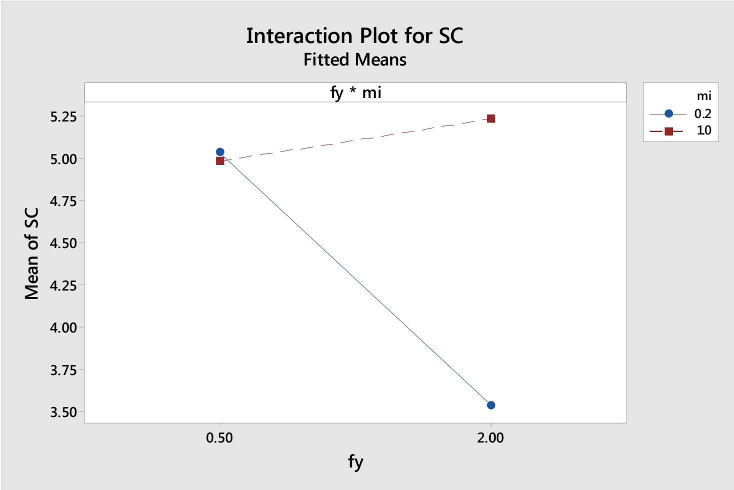

Fig 23. Interaction plot for SC (set 3)

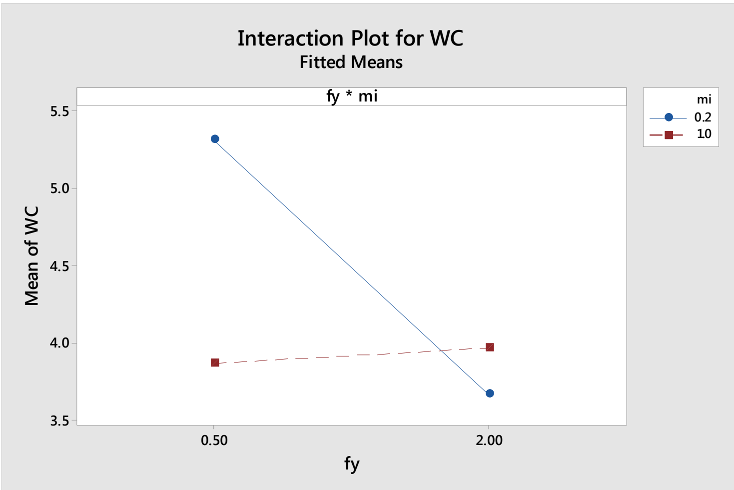

Fig 24. Interaction plot for WC (set 3)

Another interesting observation is that *riy* was identified as the sole parameter that has significant effect on VC scale (Fig 25), which hints that highly rotated boxes along the Y-axis contribute to making the surfaces feel valuable. It is considered that the rotation reveals more facets of the boxes, possibly resulting an association with typical appearance of precious items such as diamond.

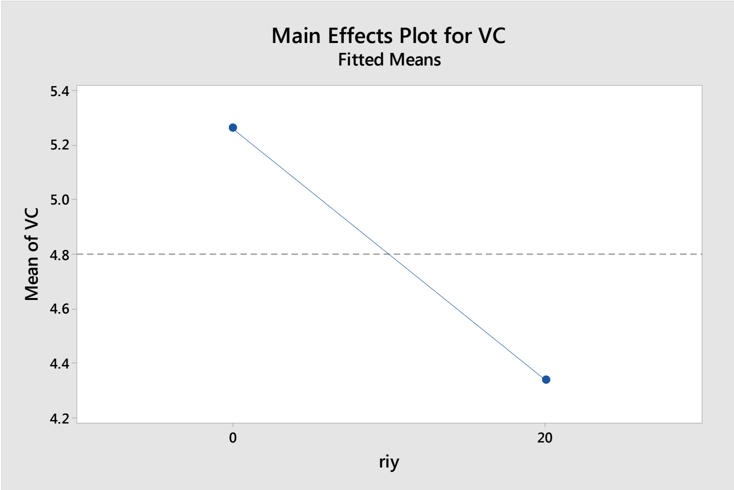

Fig 25. Interaction plot for VC (set 3)

Across the nine surfaces in set 3, length of box features along the Z-axis (*fz*) turned out to be the least influential parameter. It is quite different from the significant effects of *sz*, which dictates elongation of spheroid along the Z-axis observed in sets 1 and 2. The different geometries of the individual features can be considered part of the reason, which needs further examination.

4. Conclusion

A wholly digital design process that includes planning of experiments, systematic arrangement of design parameters, preparation and production of objects, and analysis of user testing was attempted in order to investigate whether parameters could be explored and deliberately employed as a core element of emotive surfaces which evoke desired impressions and feelings through visual and tactile stimulation. A series of surface parameters as well as their effects on various emotional qualities in different levels were identified and quantitatively analysed. The experiments were conducted in three sets, each of which constitutes a development stage. It was confirmed in the first stage that the surfaces designed by combining discrete parameters instigated clearly recognisable emotional responses from participants. The second stage then proved that parameters can be used for multiple purposes across a range of emotional qualities, and the final stage demonstrated more complex utilisation of parameters especially interactions towards analytical synthesis of emotive surfaces which would otherwise not be possible. The process showed potential for purpose-specific, context-oriented, and user-focused creation of aesthetic yet functional surfaces.

5. Acknowledgements

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Design and Digital Manufacturing: an ergonomic approach for Industry 4.0

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Abstract

The aim of the present paper is to propose innovative methods for ergonomic design of tools, equipment and manual tasks on workplaces of an automotive assembly line, in order to increase worker's welfare and system's performance by improving general safety conditions.

The manufacturing industry is heading to the ever more pushed use of digital technologies in order to achieve very dynamic production environments and to be able to develop continuous process and product innovations to fit into the so called Fourth Industrial Revolution, also identified as Industry 4.0. The main goal of Industry 4.0 is to "re-think" factories through the use of digital, to reconsider the design approach and to monitor the production process in real time.

The research addresses the evolution of industry 4.0 in relation to the discipline of "design", where the management of knowledge in the production process has led to the strengthening and improvement of tangible goods.

Starting by current ergonomic analysis models and innovative approaches to the process design of industrial production line, the manufacturing processes in the virtual environment were defined and optimized with the use of innovative 3D visualization technologies.

The constant interaction among the different disciplines of design, engineering and occupational medicine, enables the creation of advanced systems for simulating production processes based on virtual reality and augmented reality, mainly focused on the needs and requirements of the workers on a production line with the main objective of bringing out the interaction between real and virtual factory (Cyber-Physical System - CBS).

The objective is to define new models of analysis, of development and of testing for the ergonomic configuration of processes, that improve and facilitate the human-machine interaction in a holistic view, in order to protect and enhance human capital, transferring the experiences and knowledge in the factory system, as key factors for the company and for the sustainability of workers welfare levels.

Keywords: *Design, Digital Manufacturing, Ergonomics, Innovation, Virtual.*

1. Introduction

This paper provides innovative methods for improving the design of equipment and manual work stations in industrial environments, with particular focus on the global safety of the worker on the production/assembly line.

Developed activities are subtasks of the research project "DEWO – Design Environment for WorkPlace Optimization", financed by Italian Government at the Second University of Naples. The aim of this project is to identify new methods for optimization of assembly tasks in a virtual environment in terms of overall integration among materials management, working tasks organization and layout, starting from the principles of "WorkPlace Organization" and of the modern theories of "Lean Production".

The research objective concerns the articulation of operational guidelines for the design of manual workstations and tools, for simulation in a virtual environment, for verification of the ergonomic parameters and of the quality of the solutions. This objective will be pursued through the innovative use of virtual reality identified as a "tool" for innovation in automotive manufacturing context.

2. The Evolution of Automotive: from the Handicraft to the Digital Manufacturing

As a matter of fact, the manufacturing industry is heading to the ever more pushed use of digital technologies in order to achieve very dynamic production environments and to be able to develop continuous process and product innovations to fit into the so called Fourth Industrial Revolution, Industry 4.0 (Figure 1). The main goal of Industry 4.0 is to "rethink" factories through the use of digital, to reconsider the design approach and to monitor the production process in real time.

The main application field of this contribution is represented by the manufacturing industry, the major source of wealth and value for a country and for the promotion of economic development. The increase in manufacturing is equivalent to the economic growth of a country, for generating productivity gains, which then go to develop and to spread to other contexts, by creating jobs and, above all, it is the privileged place for research and innovation. For the increasing of this sector, it is essential to guess two aspects, the importance of competitiveness and the constant evolution through innovation.

As part of the manufacturing, the automotive industry plays a leading role. It's one of the main productive, representing a driving force in the economic development. The technical complexity of a car pushes the research in the direction of new productive and efficient product life and process management techniques.

Automotive field was the privileged place of experimentation, technological innovation and implementation of new forms of work organization; in the last decades it has been the field of application of new methodologies to improve the whole process, also from an ergonomic point of view, considering of primary importance the relationship between worker and machine; the human centered approach is one of the main pillar of Industry 4.0, as well as the virtual and digital factory.

In particular, during the assembly of a vehicle, the application of Digital Manufacturing leads to a series of steps forward, especially for the ergonomic aspect in relation to the work areas and equipment used by a worker.

The final assembly area is composed of a variety of sub-assemblies' cells in addition to a main line. The main line has a variety of stations that install and mount suppliers' parts and components into the vehicle shell. The final assembly area is considered a labor-driven process due to the high labor value-added work compared with other stations in the body assembly plant. [...] The greater contribution of the labor *input requires further considerations with regard to human-machine interaction in terms of safety, ergonomics, and work standards and time studies* (Omar, 2011).

The ergonomic approach highlights all aspects of the human-machine interaction process, identifies and classifies stages and individually work operations that lead to the assembly of the final product, analyzes postures and movements of the operator in order to check in as much detail as possible his psychophysical wellbeing.

The ergonomics of the assembly processes help the workers to conduct their tasks with ease and within the task time. The main ergonomics concerns in the assembly area are: installing heavy components, the frequent installation di medium to light-weight components, the installation posture, and the human hand utilization. All these aspects should be analyzed while considering that production workers are all different, they have physical and mental limitations, and humans have certain predefined reaction to certain scenarios (Omar, 2011).

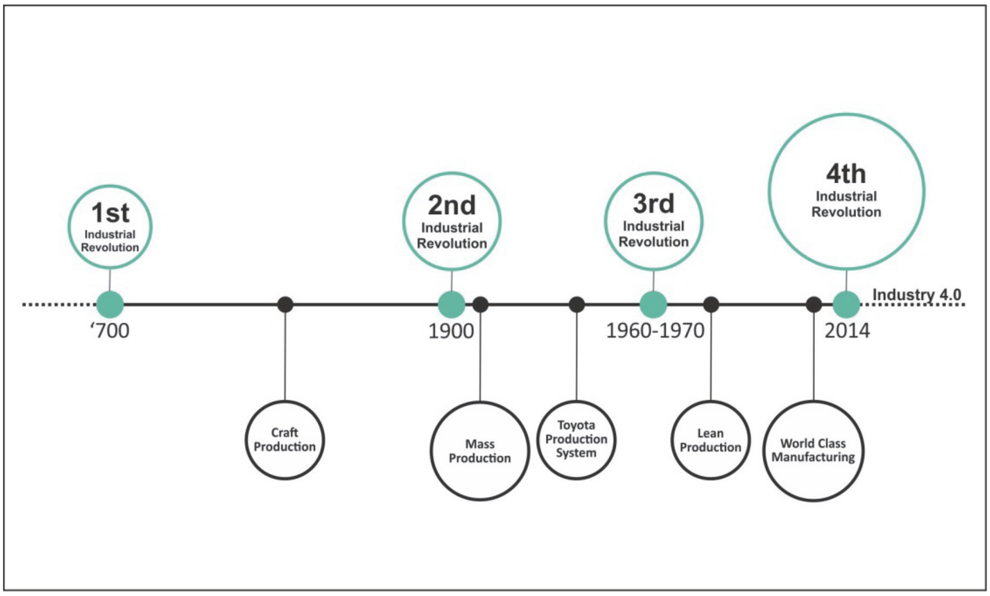

Fig. 1 Process evolution of Automotive in industrial context.

2.1 An ergonomic approach in production chain

This paper is focused on the application of a new ergonomic design approaches of manual workstations on the assembly line, of equipment and tools used by the worker during the development of the different assembly tasks.

Starting by current ergonomic analysis models and by innovative approaches to the assembly line design, the processes in the virtual environment were defined and optimized with the use of innovative 3D fruition technologies (Figure 2).

Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance (IEA-International Ergonomics Association).

The ergonomic objectives are to improve the quality of the environmental conditions, the working tools and operator performance, to prevent occupational diseases and promote the psychophysical wellbeing of worker. The science of the human factor has as its central subject the human activities in relation to environmental, instrumental and organizational conditions, in which it takes place, in order to adapt these conditions to their needs, protecting life and increasing efficiency and reliability of man-machine systems. In detail, the ergonomics of the work stations has had a strong development thanks to the thrust of the new European regulations and the progress of companies in terms of methodologies and techniques focused on improving of the safety of manufacturing plants.

Un ambiente, un posto di lavoro non debbono essere valutati solo in termini di salvaguardia da condizioni nocive, ma debbono essere giudicati validi nella misura in cui permettono il massimo grado di benessere e le migliori condizioni per l'esplicazione della personalità del lavoratore (Bandini Buti, 2008).

[An environment, a workplace don't be evaluated only in terms of protection from harmful conditions, but be deemed valuable to allow the greatest degree of well-being and the best conditions for the explication of the worker's personality].

For designing a manual workstation, it needs to consider all the possible interference of the physical and not physical aspects for the execution of work tasks, on ergonomic performance of the activity carried out by the operator.

L'ergonomia ha dimostrato di saper sviluppare teorie, sperimentare criteri e metodi finalizzati alla soddisfazione degli utenti al livello di bisogni e di desideri (consci o inconsapevoli) […] Tutti gli approcci per affrontare un problema portano ad orientarsi verso il cliente, che viene in tal modo considerato un'assoluta forza guida (Lupacchini, 2008).

[Ergonomics has demonstrated the ability to develop theories, test criteria and methods for its users satisfaction for their needs and desires (conscious or unconscious) [...] All approaches to address a problem lead to orientate towards the customer, which is thus regarded as an absolute driving force].

For the current competitiveness in industrial realities, the necessary condition is the ability to combine productivity, ergonomics, and operating models that are participative. It is essential to make a distinction of ergonomics not only from the point of view of objectives, but also as regards the different phases of "application". In this regard, we talk about preventive or conception ergonomics in the early stages of a product- process development, which reduces production costs and improves the results in terms of safety and work's quality. Corrective ergonomics, applied in the production phase, consists of an action taken for eliminating the existing not-conformities causes, defects or other undesired situations, in order to prevent its recurrence (Figure 3).

Particularly, *L'intervento ergonomico di concezione è caratterizzato dal fatto che avviene su oggetti, sistemi, ambienti e macchine ancora in fase di definizione o su attrezzature e macchine che devono essere ancora scelte. […] Non esiste alcun ostacolo concettuale affinché il progetto possa essere sviluppato tenendo conto delle prestazioni ergonomiche che si possono ragionevolmente prendere come obiettivo* (Bandini Buti, 2008).

[The conception ergonomic action is characterized by taking place on objects, systems, environments and machines during the definition phase or on equipment and machines that haven't yet been chosen. [...] There isn't a conceptual obstacle so that the project can be developed taking into account the ergonomic benefits that can be reasonably considered a gol].

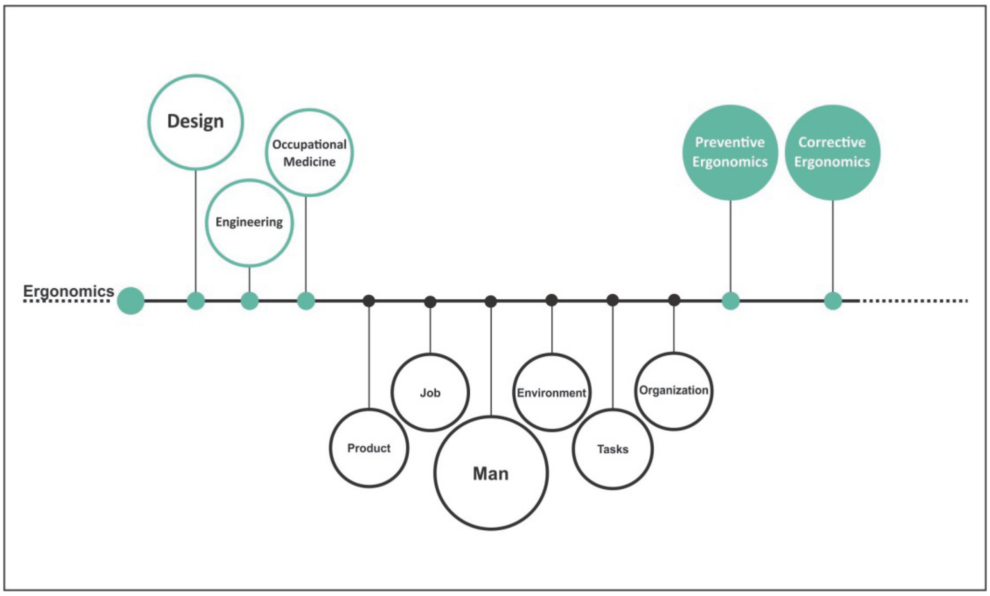

Fig. 2 Ergonomics in product-process development.

3. Industry 4.0 between real and virtual

In un contesto in cui i paradigmi del mercato mutano così radicalmente in tempi molto stretti, le iniziative delle imprese private e pubbliche devono tradursi nella rapida adozione di catene del valore digitali, come elemento strategico di ripresa, crescita e accelerazione. La trasformazione digitale non può rappresentare solo una opzione o un canale accessorio, ma un elemento centrale sui cui puntare, attraverso diffusione delle competenze, investimento nella ricerca e interventi sulle infrastrutture di connettività, data center e accesso alla Rete, evoluzione dei modelli operativi, coerente cultura manageriale e humus imprenditoriale - dalla sperimentazione alle start-up (Poggiani, Tedeschi, 2014).

[In a context where the market paradigms change so radically in a very short time, the efforts of private and public enterprices should be set in the rapid adoption of the digital value chains as a strategic element of recovery, growth and acceleration. The digital transformation can not be just an option or a second way, but a central element on which to focus, through dissemination of skills, investment in research and measures concerning the connectivity infrastructure, data center and Internet access, changing operating models, consistent managerial and entrepreneurial culture humus - from testing to start-ups].

As a matter of fact, Industry 4.0 changes the way to think factory, the relationships between suppliers, manufacturers and customers and puts in the foreground the human-machine interaction in a production system.

Oggi è in corso la quarta rivoluzione industriale: dall'inizio del 21°secolo, stiamo vivendo una trasformazione digitale - cambiamenti associati con l'innovazione nel campo della tecnologia digitale in tutti gli aspetti della società e dell'economia (Potti, 2015).

[Today the Fourth Industrial Revolution is in progress: since the beginning of 21°Century, we are experiencing a digital transformation - changes associated with innovation in the field of digital technology in all aspects of society and economy].

Industry 4.0 is the consequent evolution of the three already experienced industrial revolutions: the first revolution with the introduction of water power, the use of steam power and the development of machines; the second revolution characterized by electricity and the advent of mass production; the third revolution, more recently, based on the use of electronics and information and the application of automated production.

Lo sviluppo tecnologico e la crescente maturità culturale verso l'utilizzo di dispositivi informatici sta alimentando la trasformazione "digitale" di abitudini e pratiche consolidate sia in ambito privato che aziendale. Anche nel settore manifatturiero l'onda di tale trasformazione sta modificando significativamente il modo di pensare, progettare, realizzare i processi produttivi e di supporto alla produzione. La rilevanza dell'impatto presente e atteso di tali innovazioni in questo ambito ha generato l'opinione sempre più diffusa di trovarsi nel mezzo di una vera e propria nuova rivoluzione industriale (Poli, Martini, Petronio, 2014).

[Technological development and the growing cultural maturity towards the use of computing devices is supplying the digital "transformation" of established habits and practices in both private and business field. Even in manufacturing the wave of this transformation is changing significantly the way we think, design, implement the production process and production support. The significance of the present and expected impact of such innovation in this area has generated the widespread opinion of being in the middle of a real new industrial revolution] (Figure 3).

Industry 4.0 is a social and economic challenge that rethinks the factories through the digital, how to design objects, to create prototypes, monitoring the assembly line in real time. It has the main objective to boost the economy, offering innumerable opportunities to the manufacturing system and a new life and identity to the factories through the connection between the real and the virtual world.

At the center of the great digital revolution there is the "Man" with his needs and requirements. Man and machine work together but the user centrality is the main guideline for digital transformation, demonstrating the superiority of man work on the machine.

Quando si riflette sull'impatto della tecnologia sull'impiego, e sulla perdita di posti di lavoro, è importante cercare una complementarietà fra persone e macchinari, affinché gli individui possano svolgere mansioni che aggiungano valore agli ambienti di lavoro sempre più automatizzati. Molti compiti "non trasformabili in routine", cioè che richiedono creatività, comunicazione sociale, empatia e il trattamento di informazioni nuove e non formalizzate, difficilmente saranno automatizzati nel prossimo futuro (European Schoolnet, Digitaleurope, 2014).

[When we reflect on the technology impact on employment, and the loss of jobs, it is important to seek a complementary relationship between people and machines, so that individuals can perform tasks with add value to the automated workplace. Many tasks "not convertible into routine", that require creativity, social communication, empathy and the treatment of new and not formalized information, are unlikely to be automated in the near future].

Sensors, machines, real operators and IT systems will be connected to each other along the same value chain, giving rise to countless technical and economic benefits. The new "factory" system is characterized by the presence of technologies linked to each other and generate a change of the production paradigm, dictated by the actual technological advances.

Among the different technologies developed in an Industry 4.0, simulation and virtual reality are the main areas in which the contribution fits. To play a production process in a virtual environment is a strong potential for innovation, and even more the opportunity to immerse themselves and experience the virtual world in the most realistic possible way. To live a productive process means reducing time and costs for inspections related to the product itself or the manufacturing process (Figure 4).

The digital revolution is identified as a pure and real innovation that will change the nature of same manufacturing, turning every link in the production chain, taking into account all the stages: from the supply chain to manufacturing operations, from marketing to services. Thanks to new digital technologies, enterprices will be able to put together the physical aspects with "virtual" aspects (Cyber-Physical Systems).

L'impatto delle tecnologie emergenti (informatica, telecomunicazione, bioingegnerie, robotica e tecnologia dei materiali avanzati) porterebbe a un progressivo assottigliarsi della materialita del mondo, ad una dematerializzazione della nostra realtà nel suo complesso. In altre parole, si sarebbe ormai avviata una contrazione dell'universo degli oggetti materiali, oggetti che verrebbero sostituiti da processi e da servizi sempre più immateriali (Maldonado, 1992).

[The impact of emerging technologies (IT, telecommunications, bioengineers, robotics and advanced materials technology) would lead to a progressive narrowing of the world materiality, a dematerialisation of our reality overall. In other words, it would now start an universe contraction of material objects, objects that would be replaced by processes and increasingly intangible services].

Industry 4.0 considers the virtual reality as an innovative tool to manage and optimize a production process, taking into account every aspect. The enjoyment of a virtual environment has the purpose to increase the productivity of a production plant.

Da un punto di vista puramente tecnologico la VR è costituita da una serie di strumenti in grado di acquisire informazioni (strumenti di input) attraverso i quali l'utente diviene in grado di fornire al computer molteplici dati in ingresso, che verranno integrati e modificati in tempo reale dal calcolatore in modo da fornire una immagine 3D in movimento. Queste saranno restituite all'utente attraverso più o meno sofisticati strumenti di fruizione dell'informazione (strumenti di output) (Morganti, Riva, 2006).

[Since a purely technological point of view, the VR consists of a set of tools able to acquire information (input devices) through which the user becomes able to provide the multiple incoming data computer, which will be integrated and modified in real-time by the computer so as to provide a 3D moving image. These will be returned to the user through more or less sophisticated information access tools (output devices)].

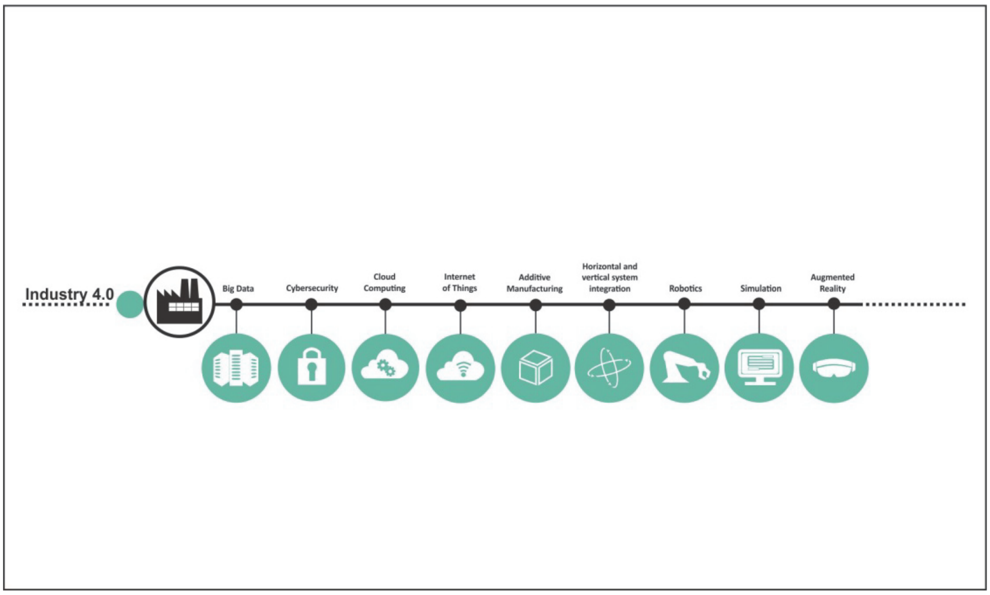

Fig. 3 Digital technologies in Industry 4.

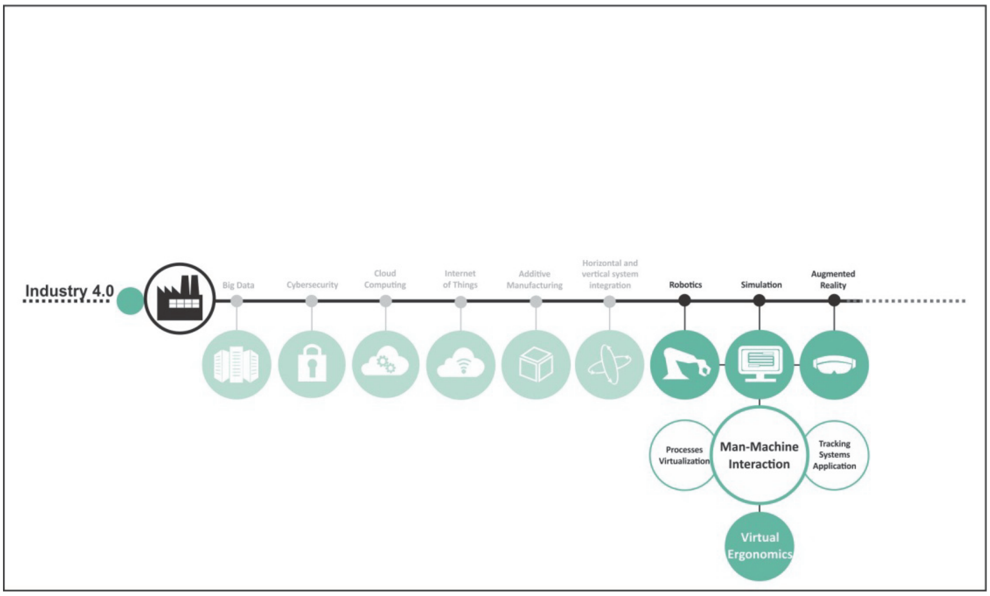

Fig. 4 Simulation and virtual reality in Industry 4.0.

3.1 Immersive Reality for Design

The constant interaction among the different disciplines of design, engineering and occupational medicine, enables the creation of advanced systems for simulating production processes based on virtual reality and augmented reality, mainly focused on the needs and requirements of the workers on a production line where it is possible to bring out the interaction between real and virtual factory (Cyber-Physical System).

The manufacturing landscape will evolve and create huge value through constant interconnection between the different expertises from various professional fields in a expressly collaborative vision.

Interdisciplinary use of advanced digital models is indispensable competences to approach the innovation of the product / process design.

I modelli di simulazione possono essere ricavati velocemente , altrettanto rapidamente, essere osservati da ogni angolo e all'occorrenza modificati. È significativa, perciò, la positiva incidenza sul miglioramento di un prodotto, tant'è che, grazie alla biomeccanica, designer, ingegneri e altri specialisti sono in grado di condurre uno studio particolarmente approfondito di ogni singolo aspetto del progetto nelle sue capacità e potenzialità. La biomeccanica dunque è una delle componenti dell'ergonomia ed è intimamente connessa al fattore umano del design; mentre il comun denominatore delle tre discipline può essere rinvenuto nella tecnologia (Lupacchini, 2006).

[Simulation models can be quickly obtained - be viewed from every angle, and modified if necessary. It is significant, therefore, the positive impact on the product improvement and thanks to the biomechanics theories, the designers, the engineers and other specialists are able to develop a deep study of every aspect of the project in his abilities and potentiality. Biomechanics theory is one of the components of ergonomics and is intimately related to the human factor design; the common denominator of the three disciplines can be found inadvanced technologies].

The research addresses the evolution of innovation within Industry 4.0 in relation to the discipline of design, where the management of knowledge in the production process has led to the strengthening and improvement of tangible products. The discipline of design takes on a fundamental role in the definition and design of tools and manual workstations through a highly ergonomic and innovative approach.

Design è un'attività creativa il cui scopo è di definire le molteplici qualità degli oggetti, dei processi, dei servizi e dei loro sistemi nell'intero ciclo di vita. Il design è quindi il fattore centrale per l'uma-nizzazione innovativa delle tecnologie e il fattore cruciale per gli scambi culturali ed economici (Verganti, 2008).

[Design is a creative activity whose aim is to define the multiple qualities of objects, processes, services and systems during the entire life cycle. Design is therefore the main factor for innovative human-harmonization of technologies and the crucial factor for the cultural and economic exchanges].

Therefore, as part of the research, new models of analysis, of development and testing were classified for configuration of ergonomic processes, that improve and facilitate the human-machine interaction in a holistic view, in order to protect and enhance human capital, transferring the experiences and knowledge in the factory system, key factors for the company and for the sustainability of workers welfare levels.

In order to identify these models, during the initial phase of the research, it was carried out a "virtual scenario" of a work place with the presence of 3D models related to equipment and a virtual anthropomorphic dummy that interacts with the environment (Figure 6). The virtual dummy can be manipulated according to the required needs, customized and changed for the posture to be taken in certain work activities, generating as much as possible realistic behaviors. The virtualization process determines preventively the possible discomfort associated with selected positions and eventually proceed to improve them in terms of re-design of a particular work tasks or of tools and equipment.

The main benefits gained from the simulation of the manual tasks during a work activity are the reduction of accidents risks, the improved communication of the problems identified in the process, an increase of the quality of a process and the reduction of times for assembly processes planning and validation (Figure 5).

I modelli informatici possono offrire alla ricerca scientifica e alla progettazione in tutti i campi possibilità mai avute nel passato. Al posto del tradizionale modo di affrontare i problemi percorrendo un lungo e defatigante itinerario di prove ed errori, subentra ora un metodo nel quale prove ed errori richiedono un investimento di tempo e risorse sostanzialmente ridotto (Maldonado, 1992).

[The IT models can provide the scientific research and design in all possible fields. Instead of the traditional way of dealing with problems along an exhausting itinerary of trial and error, now a method takes over in which trial and error require an investment of substantially reduced time and resources].

Afterwards the virtual context was explored from the "immersive" point of view through the use of tracking systems with digital dedicated software which allows to relate the virtual and physical world (Figure 6). A tracking device enables to capture in real-time the user movements that moves in front of system, turning them into gestures and actions into virtual environments (Figure 7). The realism of the captured movements by a tracking device produces an immersive experience of user, originated from the use of innovative technologies of Industry 4.0.

Il fatto che, per esempio, mettendoci una cuffia oculare (eye-phon), infilandoci un guanto intelligente(data-glove) e indossando una tuta intelligente (data-suit), siamo in grado di entrare in una realtà illusoria e viverla come se fosse reale (o quasi), è un passo evidente in questo senso. Ora siamo in condizione di perlustrare dall'interno una realtà che è la controfigura della nostra. Il che sarebbe, in pratica, come proiettarsi dentro un videogame. E ciò senza rischio alcuno per noi stessi, in quanto la nostra azione in tale spazio si combinerebbe solo con la vicaria complicità di un nostro sosia, di un alter ego digitale (Maldonado, 1992).

[The fact that, for example, putting an ocular element (eye-phon), inserting a smart glove (data-glove) and wearing a smart suit (data-suit), we are able to get in an illusory reality and live it as if was real (or almost), is an obvious step in this direction. We are now able to reconnoiter from inside a reality that is the stunt of our reality. Which would, in practice, as projected in a videogame. And this without any risk to ourselves, because our action in this area will only combine with the vicarious complicity of our double, a digital alter ego].

Through immersive reality, the real user is synchronized with the virtual dummy. The user can move in real space and his movements are recorded by the tracking device and transferred to the virtual dummy that moves, creates paths and navigates into the virtual scene. In addition to a primarily visual aspect, the ability to look at a 3D scene, the interaction has the main purpose to identify methods and procedures to perform ergonomic analysis in an innovative way and in less time.

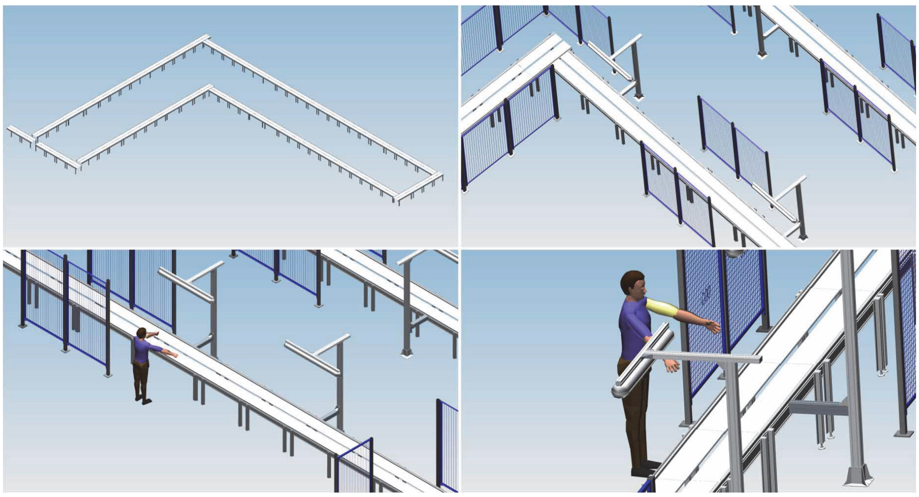

Fig. 5 Virtual Environment creation with Digital Software

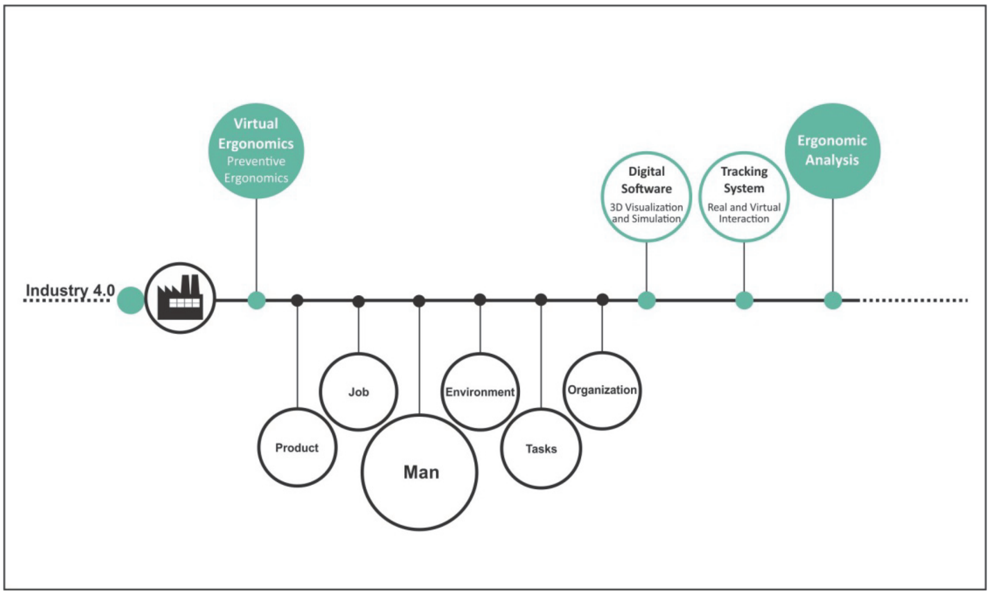

Fig. 6 Virtual Ergonomics in Industry 4.0

Fig.7 Interaction interface between Real and Virtual World

4. Conclusions

Within manufacturing applications, the use of virtual reality is an innovative and intuitive tool that facilitates the global design process. This new approach is validated through the continuous interaction between real and virtual. Its main ability is the easy and fast detection of ergonomic indexes and their management in order to solve expected and unexpected criticities on the production line.

Through the use of tracking systems, it was possible to bring out a number of advanced features and to improve current ergonomic standards. With the aid of such devices, the real user allows virtual dummy the quick and flexible navigation of the virtual scene; time reduction for placement in a particular work area and a more realistic setting of postures in order to perform a particular task is also allowed. At the end, the reachability of a working point or of a tool, dynamically acquiring ergonomic measures in relation to different movements of the dummy is possible (Figure 8).

The quickness of the ergonomic analysis allows the identification of innovative methods and procedures to design general equipments which a production operator uses. The procedure for ergonomic checks will bring an increase and a radical innovation in the production process of Automotive. Through technology transfer, this procedure can be applied to different production sectors to implement the general manufacturing environment.

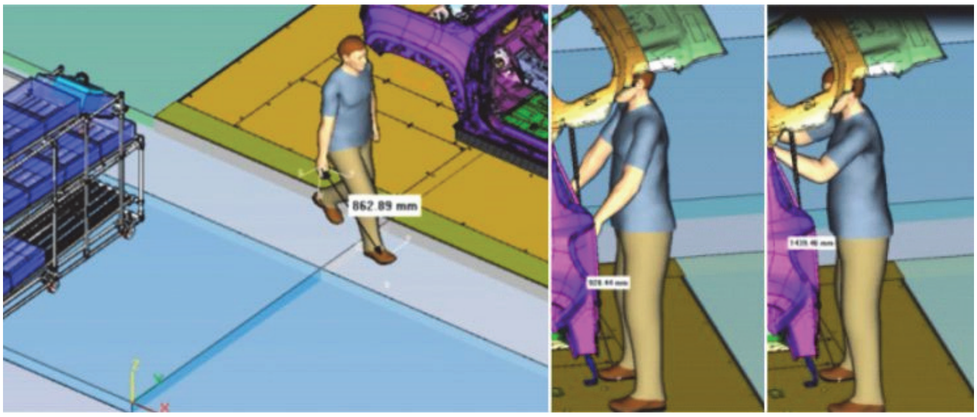

Fig. 8 Virtual dummy navigation and dynamic measurements detection with Tracking Systems

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Design para saúde e qualidade de vida: desenvolvimento e avaliação de requisitos de projeto para fone de ouvido inclusivo

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Resumo

Os casos de Perda Auditiva Induzida por Ruído (PAIR) entre crianças e adolescents aumentaram 30% nos últimos 30 anos, segundo Shargorodsky (2010). Algumas pesquisas (ZHAO et al, 2012. HODGETTS; RIEGER; SZARKO, 2007) indicam que esse aumento pode estar relacionado ao uso de dispositivos pessoais de áudio (Music Induced Hearing Loss (MIHL), como fones de ouvido, que associado a outros fatores, como o tempo de exposição e a intensidade sonora, elevam o risco de perda auditiva. Associado a este problema identifica-se a exclusão vivenciada por usuários de aparelho auditivo que tem dificuldades de utilizar fones de ouvido, devido à inadaptabilidade dos produtos à utilização simultânea.

Objetiva-se com esta pesquisa definir os requisitos de projeto que possibilitem a criação de um produto (fone de ouvido) que atenda também os usuários de aparelho auditivo. Para esta finalidade foram consideradas as áreas de ergonomia, usabilidade, design inclusivo para um projeto centrado no usuário que vise proteção da saúde e melhoria da qualidade de vida dos mesmos. Como forma de verificar a viabilidade dos requisitos foi desenvolvido um protótipo funcional, submetido a testes de ruído para aferir sua performance.

A pesquisa foi dividida em duas etapas, uma de cunho teórico que buscou levantar e analisar na literatura os temas relacionados e uma segunda etapa, de cunho prático, onde foram definidos os requisitos e realizado o teste com o protótipo funcional. Em relação a etapa prática, foi utilizado como referência o GODP (Guia de Orientação para o Desenvolvimento de Projetos).

A partir da definição dos requisitos foi desenvolvido um fone de ouvido que, potencialmente, limita a intensidade sonora do som reproduzido e possibilita também a utilização por usuários de aparelho auditivo. Por meio de um protótipo funcional realizou-se uma avaliação de nível de pressão sonora do fone de ouvido projetado, onde obteve-se o máximo de 73dB nas frequências entre 1300 e 1400Hz, na reprodução de ruído branco. Considerando os tons puros, o nível de pressão sonora atingiu seu maior valor na frequência 1000Hz, sendo 96,92 dBa. Estes resultados demostram que os requisitos, bem como o produto desenvolvido apresenta um desempenho adequado atendendo as exigências dos usuários.

A pesquisa possibilitou demonstrar o potencial do design quando aplicado para melhoria da saúde, bem-estar e qualidade de vida das pessoas. Salientando a importância de projetos centrados no usuário, que consideram as pessoas com suas diversas habilidades e capacidades para a geração de produtos que satisfaçam as reais necessidades dos usuários.

Palavras-chave: *Fone de ouvido, Perda auditiva, Saúde, Design, Ergonomia.*

Abstract

The number of cases of Noise Induced Hearing Loss (NIHL) among children and teenagers increased by 30% over the past 30 years, according to Shargorodsky (2010). Some researches (ZHAO et al, 2012. Hodgetts; RIEGER; SZARKO, 2007) indicate that this increase may be related to the use of personal audio devices (Music Induced Hearing Loss -MIHL), such as headphones, which together with other factors such as exposure time and sound levels, increase the risk of hearing loss. Associated with this issue, is identified the exclusion experienced by hearing aid users who have trouble using headphones due to the products inadaptability for simultaneous use.

The purpose is to achieve with this research the definition of project requirements that enable the creation of a product (headphone) that also meets the users of hearing aids. For this purpose we have considered, ergonomics, usability and inclusive design for a user-centered product aimed at hearing healthcare and improving the users quality of life. In order to check the requirements feasibility, it was developed a prototype, subjected to a sound pressure level evaluation to measure its performance.

The research was divided into two stages, a theoretical one which sought to address and analyze the literature related themes and a second stage of practical nature, where the requirements were defined and the test with the prototype was performed. Regarding the practical stage, it was guided by the GODP (Guidance for Project Development) methodology.

Based on the requirements was developed a headphone that potentially limits the sound level of the reproduced sound and also allows the use for hearing aids users. The prototype was submitted to a sound pressure level evaluation, where the maximum of 73dB at frequencies between 1300 and 1400Hz was obtained, during the reproduction of white noise. Considering the pure tones, the sound pressure level was reached in its highest value with the frequency of 1000 Hz, being 96.92 dBA. These results show that the requirements, and the product had a satisfactory performance, meeting the users demands.

The research allowed to demonstrate the design potential when applied to improve the health, well-being and people's quality of life. Highlighting the importance of user focused projects, who consider people with their diverse skills and capabilities to generate products that meet the users real needs.

Keywords: *Headphones, Hearing loss, Health, Design, Ergonomics.*

1. Introdução

A comunicação entre os seres humanos é o que impulsiona o desenvolvimento da sociedade desde os tempos antigos; a linguagem oral foi o modo mais rápido encontrado pela civilização para a troca de informações, esta envolve dois sentidos, a fala e a audição. A audição é o sentido responsável pela recepção dos sons, é o sentido que possibilita a aquisição da língua oral, fisiologicamente é a consciência da vibração interpretada como som pelo ouvido humano.

O ser humano mesmo antes do nascimento, é exposto à diversos fatores de risco que podem ocasionar a deficiência auditiva. Segundo Shield (2006), as perdas auditivas estão entre as deficiências crônicas mais comuns, atingindo uma em cada 6 pessoas.

Cerca de 15 milhões de brasileiros possui alguma deficiência auditiva. Segundo Palma (1999), a Perda Auditiva Induzida pelo Ruído também conhecida como PAIR é uma das causas mais comuns de perda auditiva sensorioneural encontrada na prática clínica.

A PAIR, segundo o Ministério da Saúde (2006) é definida como a diminuição gradual da acuidade auditiva decorrente da exposição contínua em níveis elevados de pressão sonora.

No Brasil cerca de 1 milhão de crianças e jovens de até 19 anos possuem deficiência auditiva parcial (SBO, 2014; IBGE, 2010). Segundo pesquisas, o aumento do número de casos de PAIR entre crianças e adolescentes é relacionada ao uso de fones de ouvido (ZHAO et al, 2012. HODGETTS; RIEGER; SZARKO, 2007. HAINES et al, 2011. LEVEY; LEVEY; FLIGOR, 2011). Referindo-se recentemente à nomenclatura específica, Perda Auditiva Induzida pela Música (*Music Induced Hearing Loss*- MIHL) (MORATA, 2007).

Segundo a OMS, 1,1 bilhão de jovens estão em risco de adquirir perda auditiva devido ao uso indevido de dispositivos de áudio. Esse aumento pode ser atribuído também ao crescimento da indústria de dispositivos pessoais de música (personal listening devices- PLDs) e desenvolvimento de tecnologia na área (SHARGORODSKY, 2010).

A perda auditiva induzida por música em volume elevado, segundo Vogel et al (2008), pode estar se desenvolvendo para um problema social e de saúde pública. Os níveis de som dos fones de ouvido da maioria dos dispositivos comercializados, são altos o bastante para prejudicar a audição com algumas horas de uso (KIM et al, 2009).

Diversos fatores relacionam-se diretamente à MIHL, como a intensidade sonora, o tempo de exposição e o dispositivo utilizado (Liang et al, 2012). Consequentemente, o tipo e a configuração do fone de ouvido utilizado afetam estas variáveis (HODGETTS; RIEGER; SZARKO, 2007; LIANG, 2012).

Os efeitos da exposição à sons em volume elevado são cumulativos e podem ocorrer após anos de exposição contínua, por isso a dificuldade de conscientização dos jovens para a mudança de hábitos, as consequências não são notadas imediatamente (ZHAO, 2012).

A tecnologia assistiva pode ser definida como uma esfera do conhecimento interdisciplinar que envolve produtos, recursos, metodologias, práticas e serviços que possuem como objetivo promover a funcionalidade de pessoas com deficiência ou incapacidade, oferecendo bem estar, autonomia e qualidade de vida (BRASIL, Comitê de ajudas técnicas, 2009). O design, juntamente com a ergonomia, envolve-se no projeto de tecnologias assistivas partindo da relação da pessoa com deficiência e o objeto assistivo, buscando projetar produtos que satisfaçam as necessidades e desejos do ser humano, sendo assim um Projeto Centrado no Usuário. (MAIA; NIEMEYER; FREITAS, 2010).

Inclui-se como tecnologia assistiva, os aparelhos auditivos. Inserido neste aspecto, pontua-se a incompatibilidade do uso de aparelho auditivo concomitantemente com fones de ouvido. Sendo assim, são privados do uso de fones de ouvido, usuários de aparelho auditivo.

Pontuam-se assim as problemáticas em questão:

- O uso de fones de ouvido como fator de risco para a perda auditiva.

- A impossibilidade de uso de fones de ouvido por usuários de aparelho auditivo: a privação de uso de um produto de acordo com as capacidades do usuário vai contra os preceitos de design universal e inclusivo.

Determina-se como objetivo geral da pesquisa, a definição de requisitos para o desenvolvimento de um produto que reduza os riscos à saúde do usuário, prevenindo danos ao sistema auditivo, e permita sua utilização pelo utente de aparelho auditivo. Especificamente:

- identificação das problemáticas relacionadas ao uso do fone de ouvido com a perda auditiva, por meio do levantamento bibliográfico;

- identificação da relação entre usuários de aparelho auditivo e a utilização -ou impossibilidade- de fones de ouvido;

- definição dos requisitos de projeto com foco no usuário, para o desenvolvimento de um produto que evite o dano a audição do utilizador e possa ser inclusivo para usuários de aparelho auditivo;

- realização de teste com protótipo gerado a partir dos requisitos.

2. Procedimentos Metodológicos

Considerando a caracterização geral da pesquisa, quanto a natureza pode ser configurada como teórico-aplicada, em relação ao conteúdo, pode ser classificado como artigo de análise onde os elementos são analisados em relação ao todo (MARCONI, 2003).

Referente aos objetivos, a pesquisa pode ser caracterizada como exploratória, constituindo um aprimoramento de ideias sobre o assunto em questão (GIL, 2002). De acordo com os procedimentos técnicos, caracteriza-se como pesquisa bibliográfica, (GIL, 2002).

Divide-se a pesquisa em duas etapas principais:

Etapa 1: etapa teórica onde apresenta-se a fundamentação, com relação aos métodos pode-se descrever, pesquisas nas bases de dados Science Direct, PubMed, Web of Science,

Google Acadêmico, Periódicos Capes e Biblioteca Digital de Teses e Dissertações, durante o período entre 2014 e 2015, utilizando as seguintes palavras-chave e as correspondentes em inglês: audição, perda auditiva, ruído, fone de ouvido e combinações das mesmas.

Etapa 2: etapa aplicada onde tem-se o desenvolvimento por meio de análise das informações coletadas. Esta etapa é subdividida em 3 momentos, de acordo com o Guia de Orientação para o Desenvolvimento de Projetos (MERINO, 2014).

O GODP apresenta uma metodologia configurada por oito etapas que se fundamentam na coleta de informações pertinentes ao desenvolvimento da proposta, ao desenvolvimento criativo, a execução projetual, a viabilização e verificação final do produto. Estas etapas estão distribuídas em 3 momentos:

Inspiração: Identificação da oportunidade, análise da problemática e levantamento de dados. Como parte do levantamento de dados, inclui-se o uso de técnicas de observação direta extensiva, neste caso por meio de questionário composto por perguntas abertas e de múltipla escolha (MARCONI, 2003). O mesmo foi disponibilizado online onde os respondentes o fizeram de forma voluntária.

Ideação: Organização e análise dos dados, geração de alternativas de projeto. Neste momento definem-se os requisitos de projeto, estes foram determinados de acordo com os fatores de risco identificados na revisão bibliográfica e desenvolvimento, e divididos em três blocos de informação (produto, usuário e contexto) de acordo com Merino (2014).

Implementação: Especificação e materialização, verificação e testes. Durante este momento realiza-se a avaliação do nível de pressão sonora do protótipo preliminar gerado a partir dos requisitos de projeto definidos. A avaliação foi aplicada no Laboratório de Vibração e Acústica da Universidade Federal de Santa Catarina, o profissional que auxiliou na aplicação foi o doutorando Júlio Alexandre Teixeira. O equipamento utilizado foi o HMS HEAD Measurement System Head Acoustics, instrumento que simula a audição humana. Os softwares que auxiliaram no processo foram: Head Acoustics Recorder, HMS III digital, Head Artemis 10.

3. Fundamentação Teórica

3.1 Audição

A audição é uma das principais capacidades sensoriais do ser humano, é a consciência da vibração interpretada como som. O ouvido humano possui como função converter a vibração física em um impulso nervoso, que é então interpretado pelo cérebro (ALBERTI).

A grande maioria dos jovens é exposto ao risco de perda auditiva utilizando fones de ouvido, sendo que uma porcentagem significante utiliza os dispositivos de maneira inapropriada (FLIGOR, 2010). Estudos atuais comprovam que o uso abusivo de dispositivos pessoais combinado aos fones de ouvido é muito difundido e será a causa de uma epidemia da chamada perda auditiva induzida pela música (MIHL) (VOGEL et al, 2008; FLIGOR, 2010; TORRE III, 2008; FIEDLER; KRAUSE, 2010).

Os níveis de saída do som dos dispositivos portáteis de áudio são suficientemente elevados para prejudicar a audição do utilizador, no entanto dependem ainda de variáveis como tempo de exposição, volume e o próprio fone de ouvido. Segundo estudos de Portnuff, Fligor e Arehart (2011), os hábitos de grande parte dos usuários são suficientes para causar a perda auditiva, e estes não possuem consciência destas consequências, o que dificulta a mudança de hábitos.

Nos Estados Unidos, o NIOSH (National Institute for Occupational Safety and Health) define como som prejudicial aquele que excede 85dB em um turno de trabalho de 8 horas. No Brasil a NR 15 (1978), determina limites de tolerância do nível de ruído de acordo com a máxima exposição diária (Figura 2).

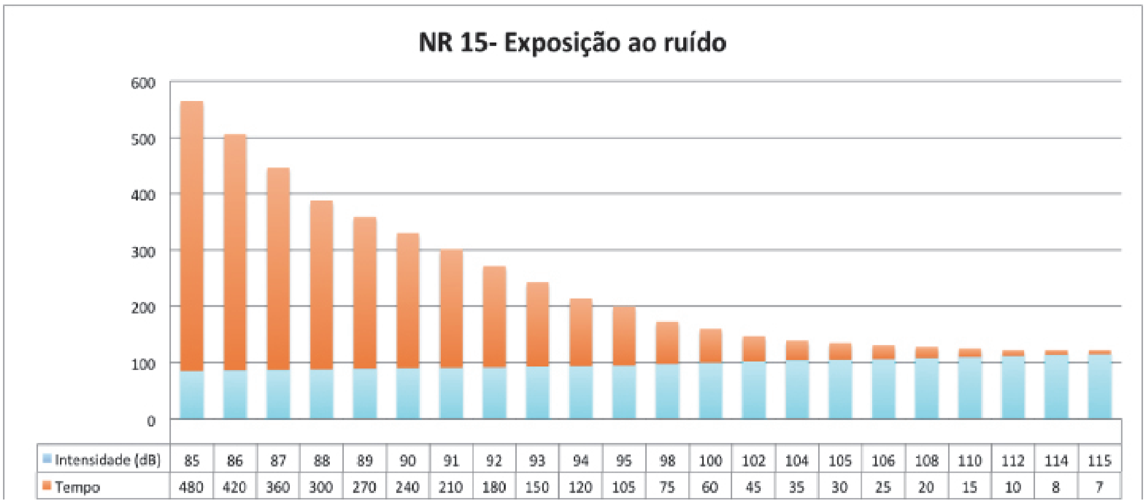


Fig. 35- Recomendações da NR 15 quanto exposição ao ruído

Em uma avaliação dos dispositivos pessoais de áudio mais populares realizada por Keith, Michaud e Chiu (2008), na configuração de volume máximo, o nível sonoro dos dispositivos atingiu uma faixa de 101 à 107 dB. Considerando os hábitos comuns entre os jovens e a NR 15, verifica-se que, neste nível, o tempo de exposição máxima deveria ser de 20 minutos à 1 hora.

O mesmo estudo afirma que o nível sonoro pode chegar a 125 dBA, considerando as variáveis do fone de ouvido e da voltagem do dispositivo. De acordo com Liang et al (2012), tanto as condições do ambiente externo quanto o fone de ouvido podem influenciar o nívelsonoro dos dispositivos.

Uma grande parcela dos usuários jovens afirma ser consciente quanto aos malefícios de seu comportamento para sua audição, e afirmam que a responsabilidade pela proteção da mesma é da indústria (DANIEL, 2007; VOGEL et al, 2008; MCNEILL et al, 2010). Salientando o potencial do design para interferir no segmento, uma vez que este ao ser inserido no projeto, pode considerar os aspectos da interação humana com o produto, compreendendo as necessidades dos usuários e buscando satisfazê-las.

3.2 O uso de fones de ouvido

Os fones de ouvido em geral são dispositivos para reprodução individualizada do som. Este possui diferenciações quanto à forma, segundo a ITU (International Telecommunication Union, 2011), dividindo-se em, circumaural, supra-auricular, auricular e intra-auricular. Conforme ilustrado na figura a seguir (Figura 3).

Fig. 3- Modelos de fones de ouvido.

Segundo Fligor e Cox (2004), a configuração de volume selecionada pelo usuário depende de diversos fatores, entre eles, o ruído do ambiente, as características do fone de ouvido utilizado e preferência do usuário quanto a razão ruído externo-intensidade sonora. Fones de ouvido que atenuam o ruído externo tendem a reduzir a configuração de volume selecionada pelo usuário (FLIGOR; COX, 2004).

Experimentos de Fligor e Ives (2006), demonstram também que o gênero é um fator influenciador, homens tendem à ouvir música em volume mais elevado que as mulheres.

Quanto à variável tempo de exposição, em uma pesquisa realizada em 2009 com 2500 sujeitos, 25% afirmaram ouvir música com fones de ouvido por cerca de 15 horas semanais. Na mesma pesquisa, 75% dos sujeitos afirmaram utilizar earbuds (auriculares ou intra-auriculares), que costumam oferecer maior risco à audição do usuário (QUINTANILLA-DIECK; ARTUNDUAGA; EAVEY, 2009).

Em geral, fones de ouvido do tipo concha (circumaural e supra-auricular) possuem cancelamento de ruído passivo devido à suas propriedades formais. Para referência, estes modelos de fone de ouvido, em sua forma básica podem ser divididos em concha; posicionada sobre a orelha, onde o som é emitido; e arco, suporte que é posicionado na parte superior da cabeça (Figura 4).

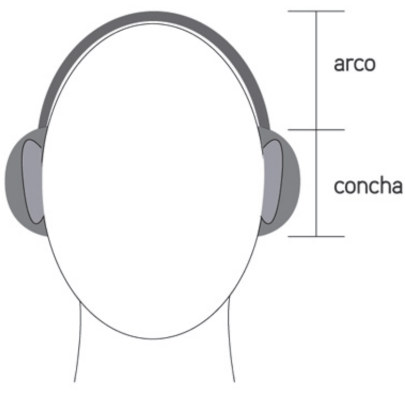


Fig. 4- Forma básica dos fones de ouvido tipo concha.

3.3 Design, ergonomia e tecnologia assistiva

O design por definição é o ato de projetar, independente da nomenclatura específica um projeto é para pessoas (DESIGN COUNCIL). Pessoas possuem diferentes habilidades, capacidades e necessidades.

A ergonomia como disciplina científica trata da interação entre o ser humano e demais elementos em um sistema (IEA, 2000). Esta, inserida na prática projetual, considera as variáveis desta relação; tais como antropometria, alcances, ambiente de interação, entre outras; buscando adequar o produto ao usuário, para que o *output* gerado dessa relação possa ser positivo.

O design, assim como a ergonomia, pode ser inserido no contexto das tecnologias assistivas atuais. A grande maioria dos produtos voltados para pessoas com deficiência no mercado atualmente, são projetados para serem camuflados durante o uso, gerando um princípio de exclusão social e colocando a deficiência como sujeito necessitado de camuflagem (PULLIN, 2009).

Esta característica de produto projetado para ser escondido pode ser exemplificada pela evolução dos aparelhos auditivos que se observa na figura 5. Além do tamanho, que diminuiu significativamente ao longo dos anos, as cores oferecidas tentam aproximar-se do tom de pele.

Fig. 5- Evolução dos aparelhos auditivos[72]*. Fonte: <http://museudoaparelhoauditivo.com.br/>*

Entende-se que o design e a ergonomia possuem potencial para o projeto de tecnologias assistivas que considerem, em primeiro lugar, o ser humano para o qual se está projetando, buscando como resultado produtos que promovam melhoria na saúde e bem-estar, consequentemente favorecendo a qualidade de vida dos usuários.

O design inclusivo, segundo Pereira (2009), dentro da prática projetual é o desenvolvimento de algo que possa ser utilizado por todos, a pensar num público específico com deficiências ou mobilidades reduzidas.

Partindo deste princípio, segundo o mesmo autor, o design inclusivo deve ser um imperativo social, uma necessidade de todos os cidadãos e um contributo para a igualdade de direitos. Imrie e Hall (2001) reforçam ainda a ideia de que ao design inclusivo pode também ser atribuída a responsabilidade de

[72] Para fins de exemplificação, os modelos apresentados são aparelhos auditivos retroauriculares

promover o desenvolvimento de sociedades mais tolerantes, cooperantes e equilibradas, respeitadoras do conceito dos direitos humanos.

A privação de qualquer pessoa de um hábito, ou uso de qualquer produto devido à uma deficiência afeta diretamente sua relação com a sociedade. Quando refere-se às crianças a exclusão pode afetar diretamente seu desenvolvimento. Como ressaltam Rui e Steffani, a respeito da relação da musica com o desenvolvimento infantil:

> "A música faz parte do dia a dia de todas as pessoas desde a mais tenra idade. È aliada importante especialmente na educação infantil, pois através da vivência musical procura-se desenvolver habilidades diversas nas crianças e, ao mesmo tempo, promover a sociabilidade no grupo" (RUI; STEFFANI)

A adequação do fone de ouvido dimensionado para possibilitar o uso com o aparelho auditivo, promove a inclusão e reflete diretamente no bem estar dos usuários, independentemente da deficiência.

Importante pontuar que, considera-se o modelo de aparelho auditivo com as maiores dimensões, para que assim, ao adequar o fone de ouvido ao mesmo, os demais modelos sejam atendidos. Sendo este o modelo BTE ou retroauricular.

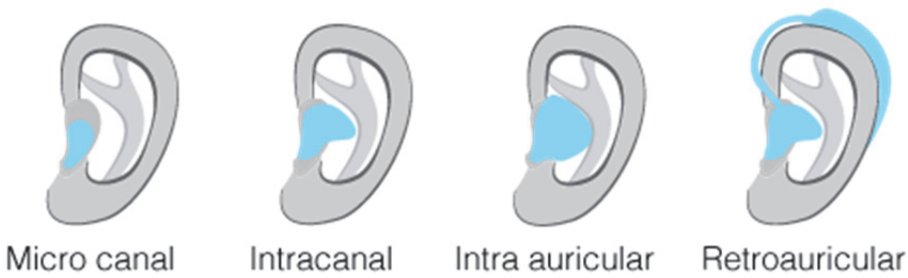
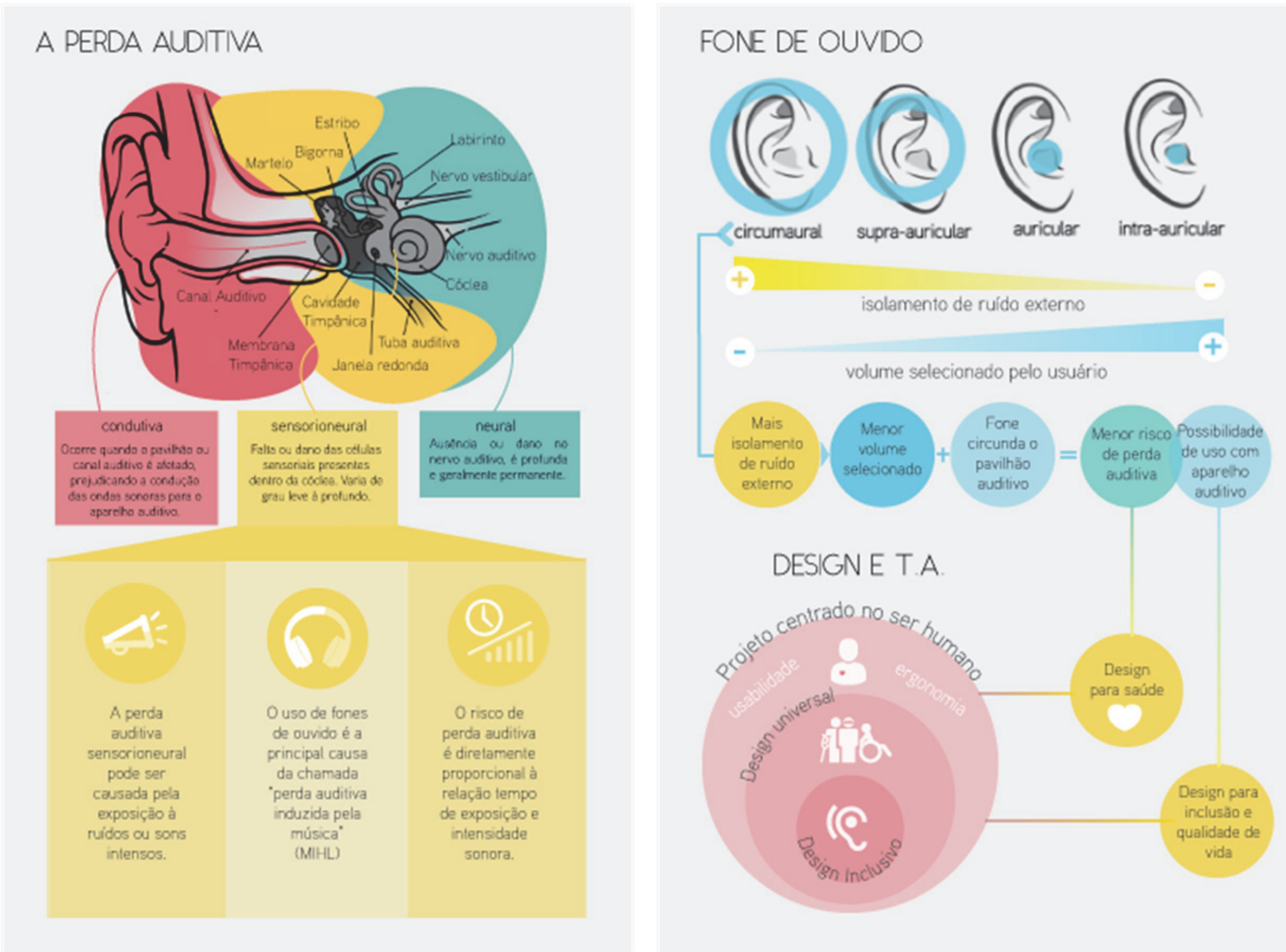


Fig. 6- Ilustração dos quatro principais modelos de aparelho auditivo

3.5 Síntese da Fundamentação Teórica

Apresenta-se na imagem a seguir, em formato de infográfico, a síntese da fundamentação teórica (Figura 7).

Fig. 7- Infográfico de síntese da fundamentação teórica



4. Pesquisa Aplicada

4.1 Inspiração

A oportunidade de projeto surgiu da observação da dificuldade de usuários de aparelho auditivo possuem em usar fones de ouvido. Observou-se que para utilizar fones auriculares ou intra-auriculares é necessário retirar o aparelho auditivo o que pode acabar prejudicando ainda mais a audição do usuário, uma vez que sem o aparelho auditivo a configuração de volume selecionada pelo usuário tende a ser ainda mais elevada, por outro lado, fones circumaurais ou supra-auriculares podem causar desconforto por não possuírem dimensões compatíveis para uso simultâneo com o aparelho.

Concomitantemente, constatou-se que o fone de ouvido pode causar perda auditiva quando combinados alguns fatores de risco, assim como apresentado na fundamentação teórica.

O design atua nos dois argumentos, buscando como resultado um produto voltado para a inclusão dos usuários de aparelho auditivo e a proteção da audição de usuários de fone de ouvido.

Assim durante a etapa de inspiração, buscam-se informações sobre o ser humano para o qual se está projetando, por meio de pesquisa de campo e síntese das informações coletadas.

4.1.1 Pesquisa de Campo

Para identificar os usuários e consequentemente, características do fone de ouvido a serem melhoradas, realizou-se uma observação direta extensiva, por meio de questionário.

Direcionaram-se as perguntas do questionário para os hábitos dos usuários ao ouvir música utilizando fones, sua consciência com relação à perda auditiva, com perguntas abertas e fechadas de múltipla escolha. Também questões que definem o perfil do usuário. Em um primeiro momento o questionário é direcionado a relação entre produto, usuário e contexto, apresentadas sob a forma de gráficos nas imagens a seguir (Figuras 8 e 9).

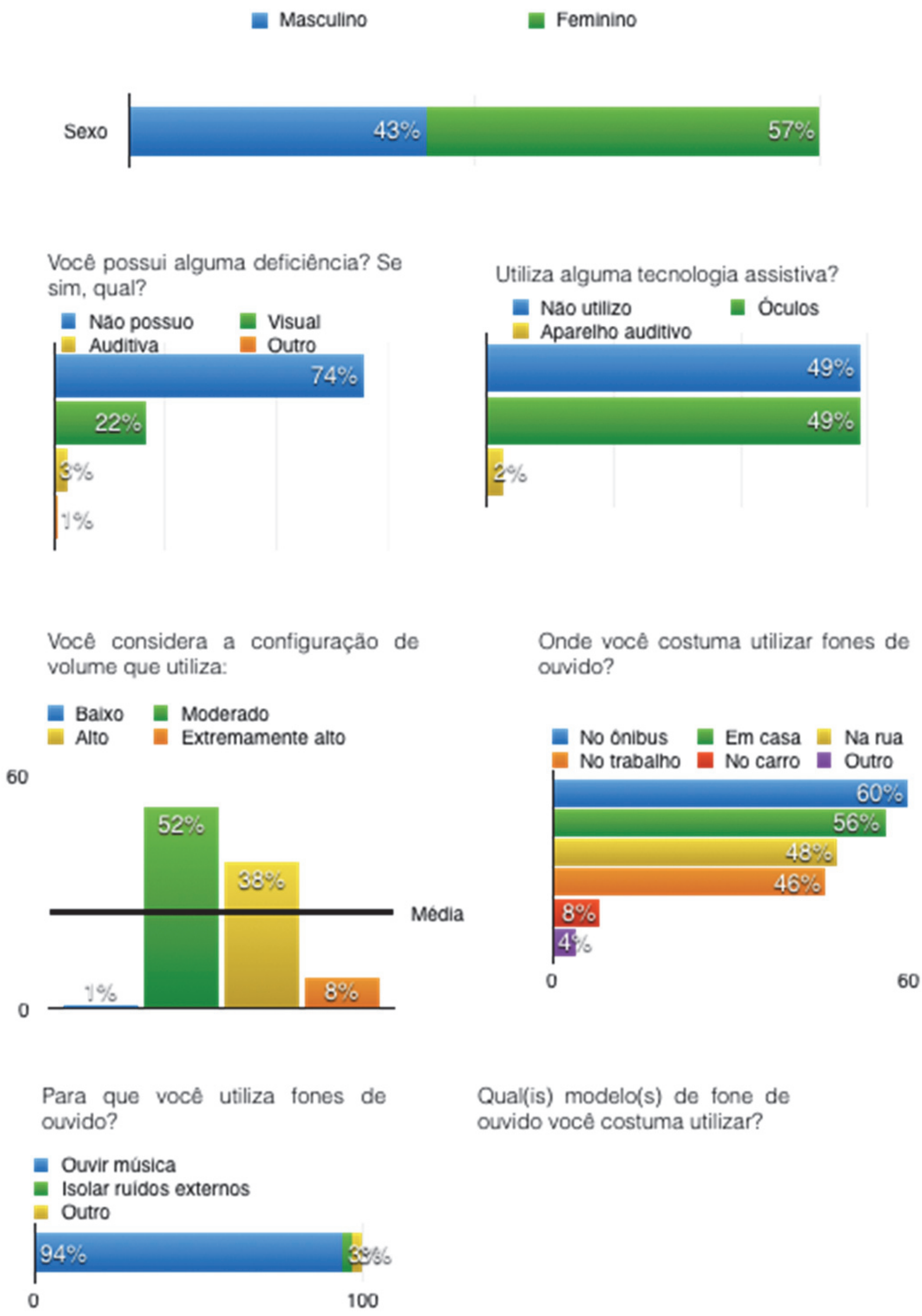


Fig. 8- Gráficos resultantes dos questionários aplicados

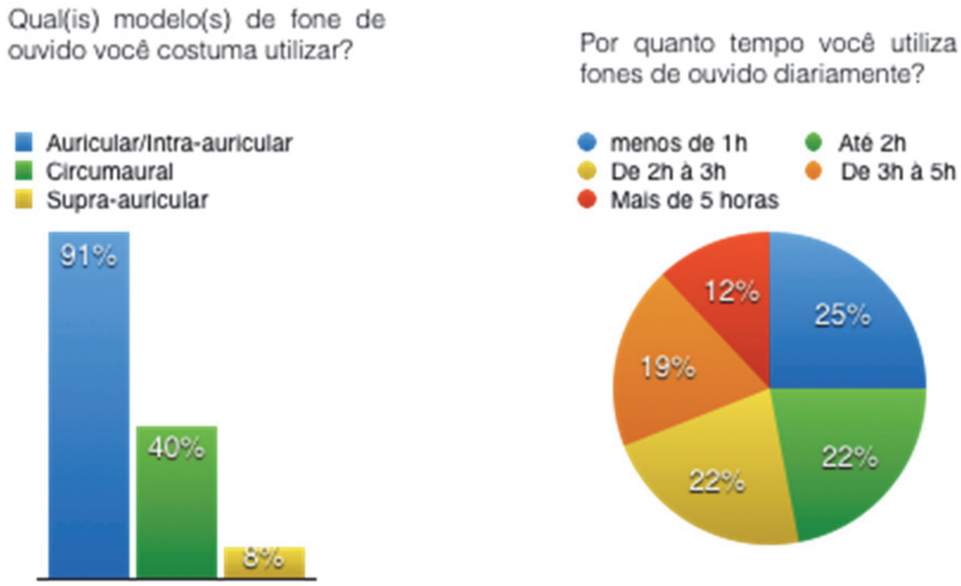


Fig. 9- Gráficos resultantes dos questionários aplicados

Em um segundo momento, as questões abertas são relacionadas aos hábitos dos usuários.

Quando perguntados sobre qualquer conhecimento ou preocupação relacionada ao risco do uso de fones de ouvido para audição, cerca de 80% dos respondentes afirmam possuir consciência quanto ao risco do uso de fone de ouvido para a audição, destes, 21% afirmam que não tem cuidado nenhum e não possuir pretensão de mudar os hábitos ainda que possa ter sua audição prejudicada.

Além das características citadas relacionadas ao som, 37% salientaram o desconforto ou dor devido ao contato do fone com a orelha, e 38% citaram o incômodo quanto ao fato dos fios ficarem "enosados". Os respondentes citaram também a impossibilidade ou desconforto de uso simultâneo com os óculos, sendo que 49% dos respondentes os utilizavam.

Com base nas informações levantadas na etapa de inspiração foi possível determinar o modelo do fone de ouvido a ser projetado, sendo este o circumaural, que circunda o pavilhão auditivo, em razão das características pontuadas:

-cancelamento de ruído passivo;

-tendência do usuário de selecionar uma configuração de volume menor, se comparado aos demais modelos;

-possibilidade de adaptação ao uso simultâneo com aparelho auditivo

4.2 Ideação

Na etapa de ideação, as informações coletadas foram analisadas para a geração dos requisitos de projeto e consequentemente a geração de alternativas.

Assim, destaca-se a escala de influência das variáveis de risco pontuadas durante o levantamento de dados, na figura a seguir (Figura 10).

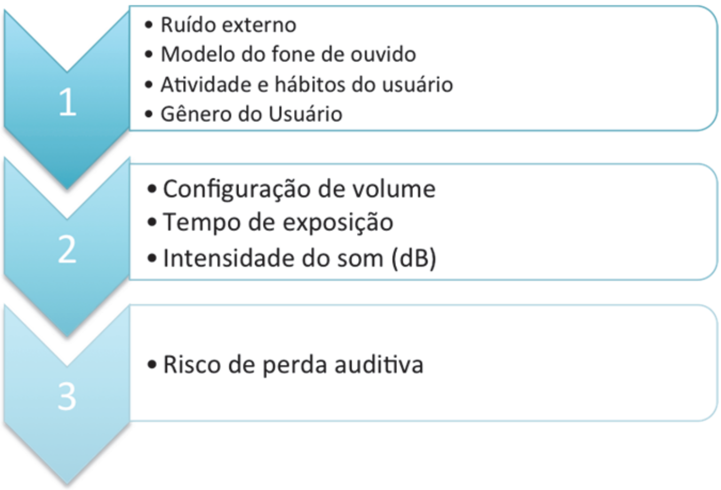


Fig. 10- Influência das variáveis no risco de perda auditiva.

Também com base nas informações apresentadas, analisa-se o perfil do usuário extremo apresentado na Figura 11, este representa o usuário que tem a sua audição exposta à um risco extremamente alto, devido aos seus hábitos e características, considerando também os usuários de aparelho auditivo.

Fig. 11- Representação de intersecção de conjuntos referente às variáveis de risco

Quanto às características e hábitos do usuário extremo justificam-se:

- O tempo elevado de exposição aumenta o risco de perda auditiva;

-O usuário que não tem pretensão de mudar os hábitos depende de influências ou controles externos para proteger sua audição;

-A configuração de volume selecionada afeta diretamente o risco de perda auditiva;

-Jovens tendem a utilizar fones de ouvido com maior frequência;

4.2.1Requisitos

Constata-se que, um produto que previna ou diminua o risco da perda auditiva independente dos hábitos dos usuários, é mais eficaz do que a conscientização dos riscos, uma vez que ainda consciente o usuário demonstra relutância quando a mudança de comportamento. Reforçando o princípio ergonômico de adaptar o produto ao usuário.

Um produto centrado no usuário deve considerar as possíveis condições de uso, relacionadas às capacidades do usuário e sua interação com o produto, assim como o contexto em que está inserido (Tabela 1).

Tabela 1- Requisitos de projeto segmentados nos blocos de informação

PRODUTO	USUÁRIO	CONTEXTO
Limitar a intensidade sonora: <85 dB	Proteger a audição independente das configurações escolhidas.	Cancelamento do ruído externo passivo (baixo custo)
Isolamento acústico: Interno->externo Externo->interno	Arco regulável: (percentil 5 mulher- 95 homem): comprimento do arco 300-371mm	Borracha do arco antiderrapante para atividades com movimento
Formato interior da concha: côncavo	Permitir uso simultâneo com aparelho auditivo: Dimensões internas da concha: 60x70mm Dimensões externas: 70x80mm	Ventilação nas partes de contato devido à transpiração.
Estrutura dobrável, para ocupar menos espaço quando guardado.	Uso simples e intuitivo eliminando estruturas desnecessárias	
Suporte para enrolar os fios, Evitando nós.	Confortável: Arco e concha almofadados nos contatos com o usuário.	
Baixo custo: Estrutura simplificada, Mínima variedade de materiais	Acomodar óculos (permitir uso simultâneo.	

4.2.2 Geração de alternativas

Considerando o objetivo de desenvolvimento de um produto que reduza os riscos à saúde do usuário, prevenindo danos ao sistema auditivo, o produto se sustenta na conversão dos modelos intra-auriculares\ auriculares para o circumaural, permitindo ao usuário utilizar simultaneamente ao aparelho auditivo, devido as dimensões da concha, além de limitar a intensidade sonora do som e consequentemente interferindo diretamente na diminuição do risco de perda auditiva durante a utilização do fone (Figura 12 e 13).

Fig. 12- Esboços de alternativas para o arco e concha

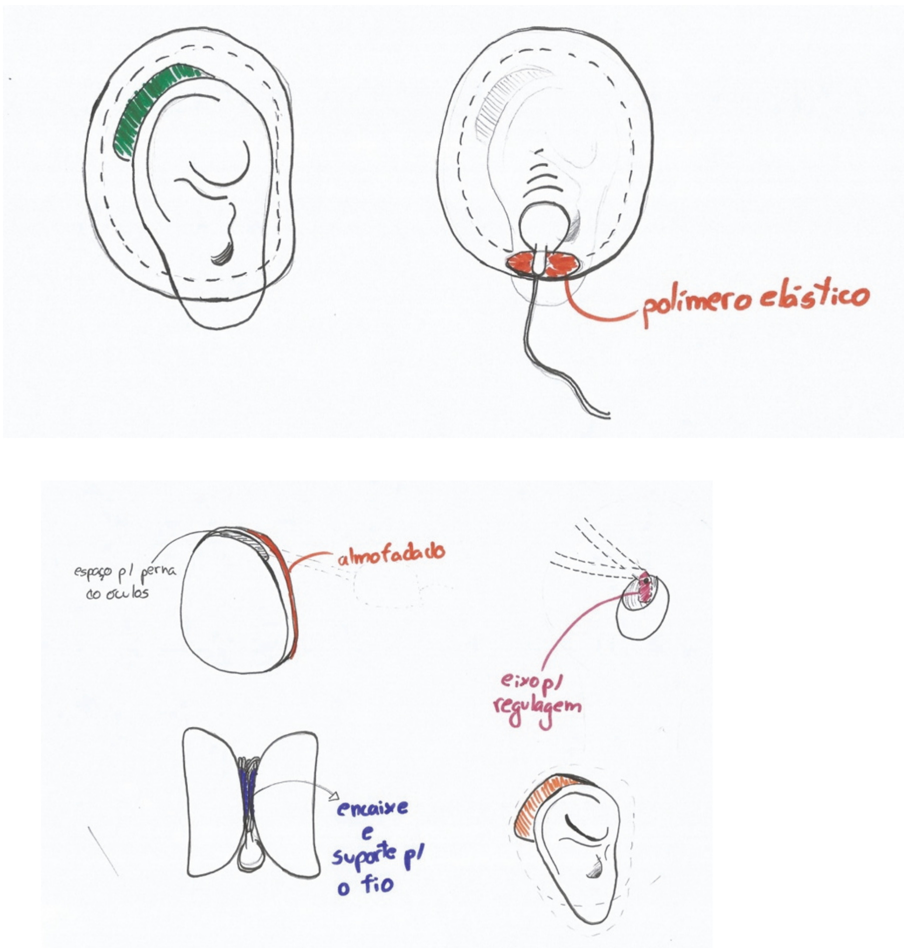


Fig. 13- Desenho esquemático do funcionamento

Assim, apresenta-se na figura seguir o modelo 3D da alternativa final selecionada com base nos requisitos de projeto definidos (Figura 14).

Fig. 14- Modelo 3D da alternativa final

4.3 Implementação

4.3.1 Protótipo

Para a realização da simulação com o fone de ouvido projetado a partir dos requisitos anteriormente apresentados, gerou-se um protótipo preliminar da concha, para o mesmo utilizou-se do dimensionamento definido.

Fig. 15- Protótipo da alternativa final

4.3.2 Avaliação do nível de pressão sonora

Como parte do processo, realizou-se um teste piloto onde foi avaliada a intensidade máxima do som atingida em dB com o fone de ouvido projetado a partir dos requisitos definidos. Esta tem como objetivo certificar a não agressão à saúde auditiva do usuário do dispositivo.

A avaliação foi aplicada no Laboratório de Vibração e Acústica da Universidade Federal de Santa Catarina, o profissional que auxiliou na aplicação foi o doutorando Júlio Alexandre Teixeira.

Os procedimentos do teste foram:

- Fixação do Amplificador para fones intra-auriculares no equipamento HMS HEAD Measurement System Head Acoustics;

- Reprodução de tons puros em 8 frequências distintas (100, 200, 500, 1000, 2000, 5000, 10000, 12000Hz);

- Reprodução de ruído branco[73] ;

- Gravação dos sons captados pela Head Acoustics;

- Medição em dB do som captado com o software HMS III digital;

- Avaliação dos resultados com o software Head Artemis 10.

Fig. 16- Avaliação do nível de pressão sonora

Nos tons puros os resultados alcançados apresentam-se na tabela a seguir (Tabela 2).

Tabela 2- Níveis de pressão sonora atingidos

Sinal	dB	dBA
100	79,92	64,55
200	91,27	80,65
500	93,41	90,16
1000	96,92	96,92
2000	86,3	87,54
5000	92,23	93,11
10000	93,88	92,14
12000	92,33	89,1

[73] Combinação simultânea de sons de todas as frequências.

Neste estudo utiliza-se o dB SPL (decibel nível de pressão sonora), e dBa, a intensidade do som filtrada, sendo esta relativa às diferentes frequências. Considera-se nesse estudo o dBa, pois adequa-se melhor ao objetivo proposto. Este definido por Fernandes (2002):

> "É a quantidades em dB medida com o medidor de nível sonoro com a incorporação de um filtro de freqüências. A curva A [dB(A)] é muito próxima da resposta subjetiva, sendo usada em medições de níveis de ruído e perda de audição induzida por ruído. " (FERNANDES, 2002)

Os resultados da reprodução de ruído branco foram convertidos graficamente, considerando o nível de pressão sonora em dB em função da frequência em Hz.

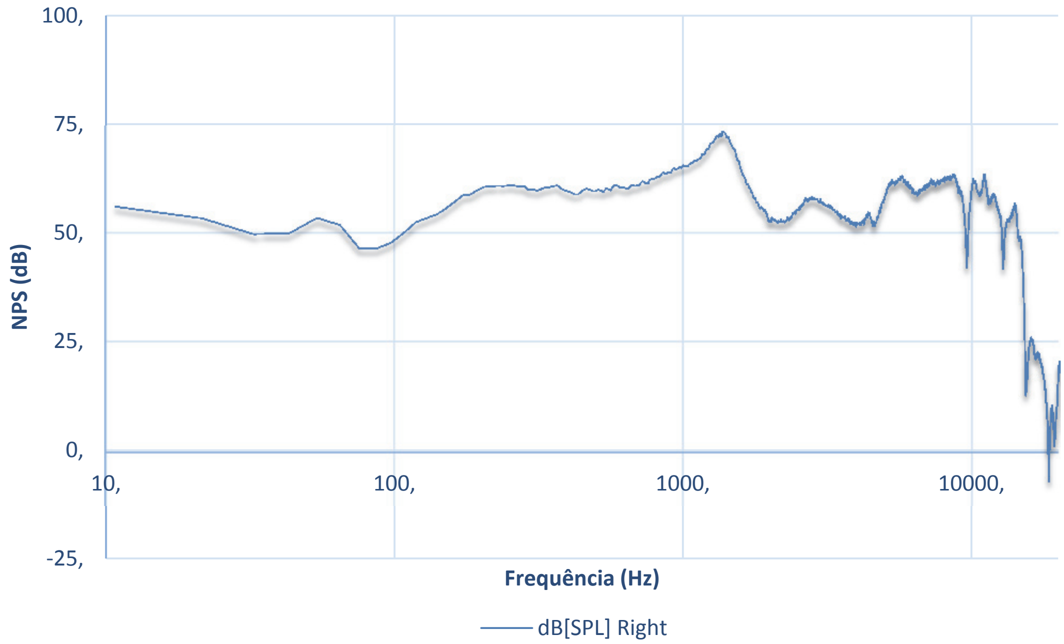


Fig. 17- Gráfico do nível de pressão sonora em dB em função da frequência em Hz.

Observa-se que entre as frequências de 1300Hz-1400Hz ocorre o máximo nível de pressão sonora, 73dB. Considerando que as músicas em geral não ultrapassam os 5000Hz.

Considerando os tons puros, o nível de pressão sonora atingiu seu maior valor na frequência 1000Hz, sendo 96,92 dBa. Nessa intensidade o tempo de exposição recomendado é de 1 hora e 45 minutos.

Considerando o ruído branco, os resultados foram considerados satisfatórios, umas vez que 73dB está abaixo do limite recomendado pela literatura, a proteção auditiva é recomendada apenas acima de 85dB. Ressaltando que seria desejável um valor menor na avaliação com tons puros, no entanto, ainda considerando o valor atingido de 96,92 dBa, este é menor que os fones de ouvido atualmente no mercado.

Assim, sinteticamente apresenta-se na imagem a seguir as principais características estruturais do produto resultante.

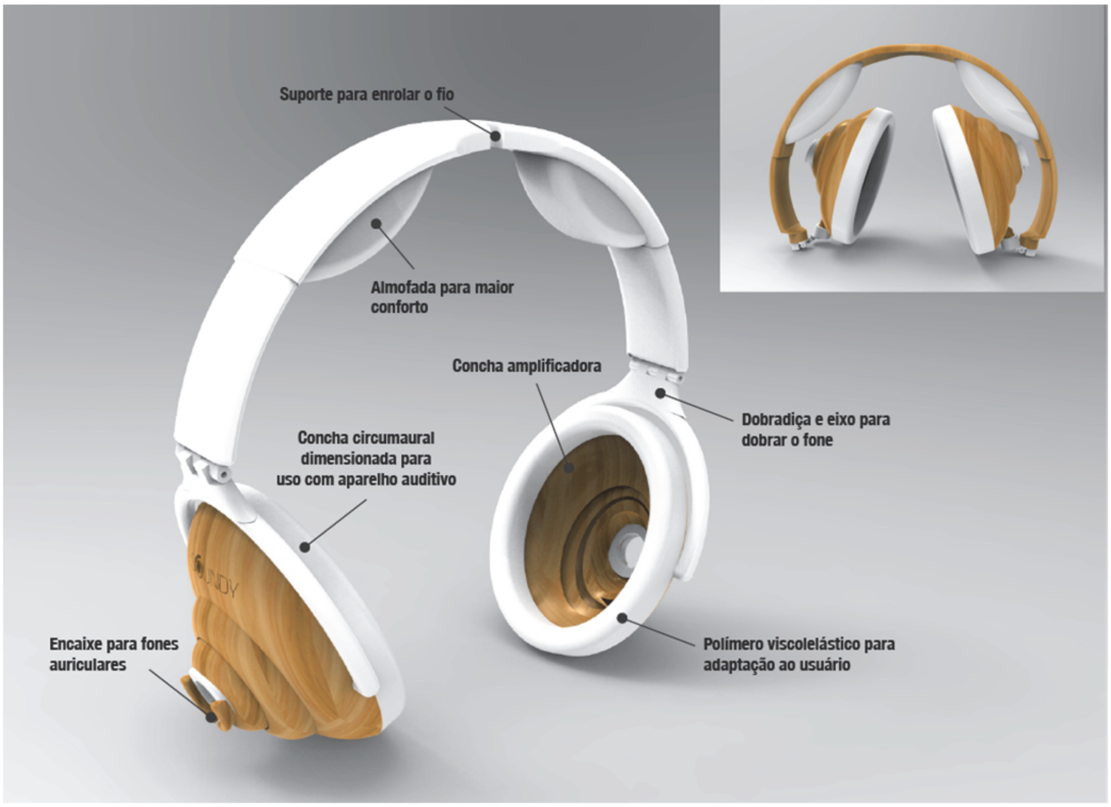


Fig. 18- Características estruturais do produto final

5. Conclusões

O resultado da avaliação do nível de pressão sonora permitiu verificar a viabilidade da pesquisa e a emprego dos requisitos gerados por meio da aplicação do design voltado à saúde auditiva. Destaca-se a problemática encontrada a partir do levantamento, sendo os hábitos dos usuários um fator de extrema relevância para a prevenção da perda auditiva causada pelo uso de fones de ouvido. Acrescendo à importância de um produto que independa dos hábitos, características e capacidades dos usuários para o funcionamento eficaz.

A pesquisa apresenta o potencial da interferência do design para a saúde, podendo contribuir com o bem-estar e a qualidade de vida dos indivíduos. Considerando os benefícios da prevenção da perda auditiva, se eficaz pode evitar o uso de tecnologias assistivas, além de reduzir significativamente os custos.

O desenvolvimento de projetos centrados no usuário permite obter como resultados produtos voltados à atender as reais necessidades das pessoas considerando suas individualidades, capacidades e habilidades e permitindo a inclusão, especificamente neste estudo, de deficientes auditivos caracterizando-se como uma oportunidade para aplicação do design com o objetivo de integração dos indivíduos independentemente de suas restrições. O emprego adequado da ergonomia como ferramenta projetual contribui profundamente para a compreensão da maior parcela de potenciais usuários de um produto. O desenvolvimento de pesquisas voltadas a este intento é de extrema importância para o bem-estar dos usuários na relação com os produtos.

Os requisitos gerados podem nortear o desenvolvimento de produtos que tenham como objetivo a prevenção da perda auditiva induzida pela música e possibilitar a utilização de fones de ouvido por usuários de aparelho auditivo. Considerando todos os aspectos mencionados e destacando a necessidade de posicionar o usuário como centro do projeto.

Como próximas etapas da pesquisa podem ser pontuados:

- Aprimoramento do protótipo com base nos requisitos gerados;

- Nova avaliação de nível de pressão sonora;

- Avaliação da adequação do fone de ouvido aos usuários de aparelho auditivo.

Finalmente, é possível concluir que existem oportunidades para o desenvolvimento e aprimoramento de produtos com base nesta pesquisa e resultados, buscando a proteção da audição dos usuários de fone de ouvido.

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Systemic model applied for the conceptual design of an abdomino-intestinal assistant.

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Resumen

El artículo describe una investigación mediante la aplicación de un modelo sistémico orientado al diseño conceptual de un producto, que actúa como asistente abdominointestinal, permitiendo reducir el estreñimiento crónico funcional en las personas, debido a la adopción de la postura de cuclillas en su uso, así como a la realización de ejercicios específicos de tonificación. La metodología de la investigación consistió en la construcción de un escenario de simulación estática mediante la implementación de un modelo de formulación por objetivos (Hernandis, 2003) en el que los parámetros y variables del sistema actúan como atributos y/o variables de diseño. El proceso de identificación de dichas variables se llevó a cabo mediante investigación exploratoria y el análisis descriptivo y cualitativo basado en las diversas fuentes documentales. Los trabajos de S. Raad (1994) sobre la variación del ángulo del músculo puborrectal (encargado de la continencia) en diferentes configuraciones posturales del paciente y el ensayo de usabilidad de I. Esnal y C. Serrano (2013) sobre el nivel de satisfacción del usuario en función de la postura adoptada, sirvieron para establecer algunos de los objetivos más relevantes de la investigación. Tras la identificación y definición de las variables, éstas fueron clasificadas en tres subsistemas fundamentales: subsistema funcional, subsistema ergonómico y subsistema formal. Posteriormente, se generaron los volúmenes de uso, las superficies de uso y los límites de contorno de estas variables mediante su geometrización. Con la superposición de estas geometrías se creó un espacio volumétrico de diseño en el que se representa el sistema en estudio, aportando tangibilidad en forma de concepto de producto. Como resultado de la investigación se obtuvo un marco teórico y el espacio geométrico de diseño único donde crear un concepto de producto capaz de satisfacer los objetivos impuestos por el sistema y por lo tanto, cumplir con los requerimientos de diseño.

Palabras clave: *Modelo sistémico, diseño, dispositivo, asistente, estreñimiento.*

Abstract

This paper describes a research by the application of a systemic model oriented to the design of a product. This device works as abdominointestinal assistant allowing reduce chronic functional constipation in people due to the adoption of the squatting posture and specific toning exercises in its use. Research methodology consisted of the construction of a static simulation scenario by implementing a goal-directed model (Hernandis, 2003) in which system parameters and variables act as attributes/design variables. The identification of these variables was carried out by using exploratory research and qualitative analysisbased on of the various documentary sources. The works of S. Raad (1994) on the variation of the angle of puborectal muscle (responsible for continence) in different postural configurations of the patients and the usability test of I. Esnal and C. Serrano (2013) on the level of user satisfaction depending on the posture adopted, served to establish the main aims of the research. After identification and definition, the variables were classified into three main subsystems: functional subsystem, ergonomic subsystem and formal subsystem. Subsequently, volumes of use, surfaces of use and boundaries were established by their geometries. By the superposition of these geometries it was created a space of design in which we can represent the system under study. This provides tangibility to the system in the form of product concept. Another result we found is the theoretical framework of design. It provides an unique three-dimensional geometric space of design in which we can generate product concepts satisfying the aims set by the system and therefore, the design requirements.

Keywords: *Systemic model, product design, constipation, squatting.*

1. Introducción

El estreñimiento (o constipación) es un problema que afecta a millones de personas en todo el mundo especialmente en países occidentales. De acuerdo con la Organización Mundial de la Salud (OMS, 2010) el 12% de la población mundial padece esta afección y en España, según la Asociación Española de Gastroenterología (AEG, 2013) el número asciende a más de 6 millones de personas.

Sólo en EEUU, en función de la definición empleada[74] se da entre el 2% y el 27% de la población (Lembo, A. & Camilleri, M., 2003), lo que conlleva más de 2,5 millones de visitas al especialista y 92 mil hospitalizaciones. Los costes totales que esto acarrea se estiman en 6,9 mil millones de dólares anuales, de los cuales 725 millones se destinan a los productos laxantes. Por otro lado, en Reino Unido en 2006 los médicos generales emitieron más de 13 millones de recetas para fármacos destinados a paliar esta afección. (OMGE, 2010).

Pese a todo esto, el estreñimiento habitualmente puede ser manejado a nivel de atención primaria con control costo-efectivo de los síntomas. Si bien esta afección no amenaza la vida ni debilita al individuo y en la mayoría de casos sólo produce molestia, en algunas ocasiones puede acarrear consecuencias de

[74] Criterios Roma III. (Zolezzi, A., 2007)

mayor gravedad derivando en otras patologías o afecciones como: la diverticulosis, la colitis, la apendicitis, el prolapso rectal o el cáncer de colon.

Una variante de éste, el estreñimiento crónico funcional, es un trastorno mecánico que posee dos fisiopatologías diferenciadas: los *trastornos del tránsito* que pueden ser causado por una disminución del movimiento intestinal (de tránsito lento) o por una disfunción del suelo pélvico (Van Endelenburg, 2013); o por *trastornos de la evacuación*, causado por la pérdida de la sensibilidad de los músculos rectales y/o del esfínter (Amir, A., 2013).

2. Estado del arte

Para llevar a cabo la investigación se han contemplado dos campos diferentes, por un lado, el relacionado con la afección mediante la profundización en el estudio, en particular, del estreñimiento funcional inducido fundamentalmente por la atrofia del suelo pélvico por ser ésta una de las causas directas de mayor influencia en este tipo de trastorno disfuncional del colon. Y por otro lado se ha considerado el estudio de los modelos sistémicos, más concretamente los orientados al diseño, en especial, al diseño de producto; como herramienta y método para la consecución del desarrollo de una propuesta conceptual de solución o paliativo de la problemática propuesta.

2.1. Estreñimiento funcional y la postura de cuclillas

Existen autores que proponen paliar esta afección de la manera más natural posible como es la adopción de la postura de cuclillas. Su visión es que la vida sedentaria y pasiva, en general, y la irrupción del inodoro de postura sedente en la sociedad moderna como arraigo cultural en particular, está afectando a muchas personas empeorando los síntomas o desarrollándolos.

B. Wallace en 2002, describe una serie de comportamientos que suceden a nivel interno a consecuencia de la adopción de la postura de cuclillas y por los cuales el autor considera que dicha postura favorece la evacuación: “El peso del torso presiona los muslos y de forma natural comprime la parte superior del intestino […], cierra la válvula ileocecal y presuriza el colon facilitando con ello el desplazamiento de la materia fecal a través del mismo […]. El músculo puborrectal, normalmente encargado de preservar la continencia, se relaja y permite la elevación del colon sigmoide aumentando el ángulo del pliegue y ensanchando la entrada del recto”. La magnitud de este reflejo fue cuantificado por S. Rad (2002) quien publicó un estudio en el cual, mediante la radiografía, midió los ángulos de los músculos de los pacientes durante la defecación. En dicho ensayo se les pidió a los pacientes que usaran ambos tipos de inodoro, el occidental (postura sedente) y el tradicional-oriental (postura de cuclillas) y poder así medir la diferencia existente entre los ángulos de los músculos que intervienen y si esto afectaba o no a la eficiencia en la evacuación. El ensayo le permitió concluir que el músculo puborrectal se relaja y aumenta el ángulo en un 40º de media entre un caso y otro.

Por otro lado, I. Esnal y C. Serrano en 2013 publican un estudio biomecánico comparativo (Esnal, I. & Serrano, C. 2013) entre ambas posturas durante la evacuación. El estudio fue llevado a cabo mediante un ensayo de usabilidad con el uso de un prototipo estático diseñado para simular ambas opciones posturales. A pesar de no poseer un número de población muestral significantemente elevado (45 usuarios, 21 hombres y 24 mujeres), concluyeron que existía cierta tendencia a la mejoría con la postura de cuclillas en determinadas alturas, asumiendo así la existencia de cierta relación entre la postura adoptaba y la eficiencia (volumen) y el grado de satisfacción (sensación de vacío) por parte del usuario. De este estudio, se extrajeron las condiciones iniciales relacionadas con la postura de cuclillas, como la posición (ángulos y longitudes) de los segmentos corporales de los miembros inferiores del usuario, implícitas en mayor medida en variables como la proporción y la usabilidad.

2.2. Pensamiento sistémico orientado al diseño de productos.

La gestión del conocimiento bajo el enfoque más amplio de la sistémica induce a considerar nuevas formas de interrelación de la información, resultando de ello nuevas posibilidades de configuración entre los elementos y, contribuyendo así, al aumento del grado de innovación en los resultados obtenidos. Este aumento de la información gestionada aporta un nuevo marco teórico de mayor complejidad, pero a su vez y con las herramientas adecuadas, de mayor grado de control, lo cual permite poseer mayor precisión en el proceso de modelización de los sistemas.

B. Hernandis (2000) publica un modelo sistémico orientado al diseño de productos industriales basado en los esquemas de control por objetivos jerarquizados de Ashby-Melèse y el trabajo de L. Ferrer, Presidente de Honor Permanente de la Sociedad Española de Sistemas Generales (SESGE). Dicho modelo propone la simbiosis entre el estudio de los sistemas y el diseño industrial, de modo en el que el producto es considerado un sistema en sí mismo. La estructuración interna que rige este modelo se representa mediante tres subsistemas fundamentales equivalentes en jerarquía o isosistemas, en el que cada uno contempla un tipo de información dependiendo de la naturaleza de ésta. El subsistema funcional recoge toda la información referida a los aspectos tecnológicos y estructurales del producto, como: la resistencia, los materiales, los procesos de fabricación, etc.. El subsistema ergonómico contempla todos los aspectos derivados de la relación entre el objeto y el usuario: la adaptabilidad, usabilidad, confort, psicología, etc… Y el subsistema formal encargado de considerar los aspectos relacionados con la visualización: proporción, morfología, color, textura, estética, estilo, etc…

El uso de esta perspectiva para el estudio de sistemas orientados al diseño, y más concretamente al de producto, se encuentra cada vez en más ámbitos de esta disciplina. Prueba de ello, encontramos autores centrados en los aspectos metodológicos como son J. Briede & Hernandis (2011) quienes estudiaron mediante la sistémica las primeras fases del proceso creativo y conceptual, orientado al diseño de producto y a la enseñanza (Briede & Hernandis, 2009). A A. Medina et al. (2012) en la extracción de los aspectos diferenciales del producto, fundamentalmente centrado en el producto joya o M. Cabello (2009), con el estudio de los factores diferenciales del diseño gráfico en el etiquetado en el sector vinícola. Estos estudios, si bien no están orientados a los productos sanitarios, sirvieron como referencia para establecer tanto los aspectos fundamentales a considerar como el grado de detalle durante el proceso de modelización. B. Hernandis y J. Bonmati (2005) mediante el uso del análisis estructural de un estudio de opinión, cuantificaron la importancia de estos aspectos fundamentales en la definición del producto. Establecieron el grado de motricidad y de dependencia de las variables como indicadores para conocer las relaciones entre ellas y su grado de participación. De este estudio se extrajo un listado de diferentes autores sobre los factores determinantes a la hora de establecer los requerimientos de diseño y que ha servido de referencia en esta investigación (Tabla 1).

Tabla1. Factores determinantes para establecer los requerimientos de diseño

G. Bonsiepe / G. Rodríguez	Gómez-Senent y Capuz	B. Munari	S. Pugh
De uso: Practicidad, Conveniencia, Seguridad, Mantenimiento, Reparación, Manipulación, Antropometría, Ergonomía, Percepción y Transportación. **De función:** Mecanismos, Confiabilidad, Versatilidad, Resistencia y Acabado. **Estructurales:** Número de componentes, Carcasa, Unión, Centro de gravedad y Estructurabilidad. **Técnicos-productivos:** Bienes de capital, Mano de obra, Modo de producción, Normalización, Prefabricación, Lay-out, Línea de producción, Materias primas, Tolerancia, Control de calidad, Proceso productivo, Embalaje y Coste de Producción. **Económicos o de mercado:** Demanda, Oferta, Precio, Ganancia, Medios de distribución, Canales de distribución, Centros de distribución, Empaque, Propaganda, Preferencia, Ciclo de vida y Competencia. **Formales:** Estilo, Unidad, Interés, Equilibrio y Superficie. **Identificación:** Impresión y Ubicación. **Legales:** Patentes y Norma	**Fundamentales:** Tecnológico, Materiales, Económico, Seguridad, Ergonómico, Estético, Mantenimiento **De entorno:** Seguridad Normas Medio Ambiente Cliente Competitividad Equipamiento e Instalaciones Volumen de producción Rendimiento de la planta Proceso de producción Patentes Riesgo del proyecto Envasado Expedición Capacidad de los proveedores Materiales Coste del producto Peso y tamaño Documentación Mantenibilidad Valor y utilidad Estética Calidad Ergonomía	Nombre del objeto Autor Productor Dimensiones Materia Peso Técnicas Coste Embalaje Utilidad declarada Funcionalidad Ruido Mantenimiento Ergonomía Acabados Manejabilidad Duración Toxicidad Estética Moda (Styling) Valor social Esencialidad Precedentes Aceptación por parte del público.	Performance Environment Life in service (performances) Maintenance Target product cost Competition Shipping Packing Quantity Manufacturing facility Size Weight Aesthetics, appearance and finish Materials Product life span Standards and specifications Ergonomics Customer Quality and reliability Shelf life (storage) Processes Time-scales Testing Safety Company constraints Market constraints Patents, literature and product data Political and social implications Legal Installation Documentation Disposal

Fuente: Hernandis, B. & Bonmatí, J. (2005)

S. Paixao et al, (2012) dirige su enfoque al estudio de los materiales, más concretamente a la piedra, proponiendo nuevos usos de los materiales naturales. Junto con E. Merino en 2009 también estudiaron la aplicación de la sistémica en el diseño concurrente, especialmente con la ergonomía como parte integrante del sistema.

J. Rivera, J. R. González & B. Hernandis. (2013) publican un estudio del contexto y las variables conceptuales para la sostenibilidad del producto dentro del modelo sistémico. Cardozo et al. (2013) por otra parte, se centra en la personalización, la variabilidad y la diferenciación de los sistemas de producto. Los mismos autores en 2015 propusieron la categorización de los sistemas de productos según el uso y la experiencia del consumidor.

Mediante el uso del Análisis de Componentes Principales realizado sobre un estudio cuantitativo de opinión a usuarios y de valoración de expertos, B. Agudo et al., (2016), confirman una vez más, la existencia de tres componentes principales en los que se pueden reagrupar los atributos de diseño: Función, Ergonomía y Forma. Además, ofrece una herramienta de garantía para el estudio de la trazabilidad en los sistemas de producto.

Teniendo en cuenta los diferentes enfoques desde los que se puede abordar el estudio de los sistemas orientados al diseño y todos los aspectos considerados por las fuentes estudiadas, especialmente las centradas en el producto, se propuso el uso de los modelos sistémicos como una metodología propicia para la consecución del cumplimiento de los requerimientos de diseño necesitados para abarcar una problemática tan compleja.

3. Metodología

La investigación realizada consistió en la construcción de un escenario de simulación estática mediante la implementación de un modelo sistémico de formulación por objetivos orientado a productos (Hernandis, 2003) (Fig. 1) en el que los parámetros y variables del sistema son interpretados como atributos y/o variables de diseño; y en donde los subsistemas no están jerarquizados, sino que son isosistemas de igual importancia.

Este escenario contempla el conjunto “Universo de posibles” (U) integrado por dos sistemas fundamentales o suprasistemas: el Sistema Exterior (SE), que actúa como *entorno*; y el Sistema en estudio (SES), referido al sistema de referencia, en este caso un producto de asistencia abdominointestinal.

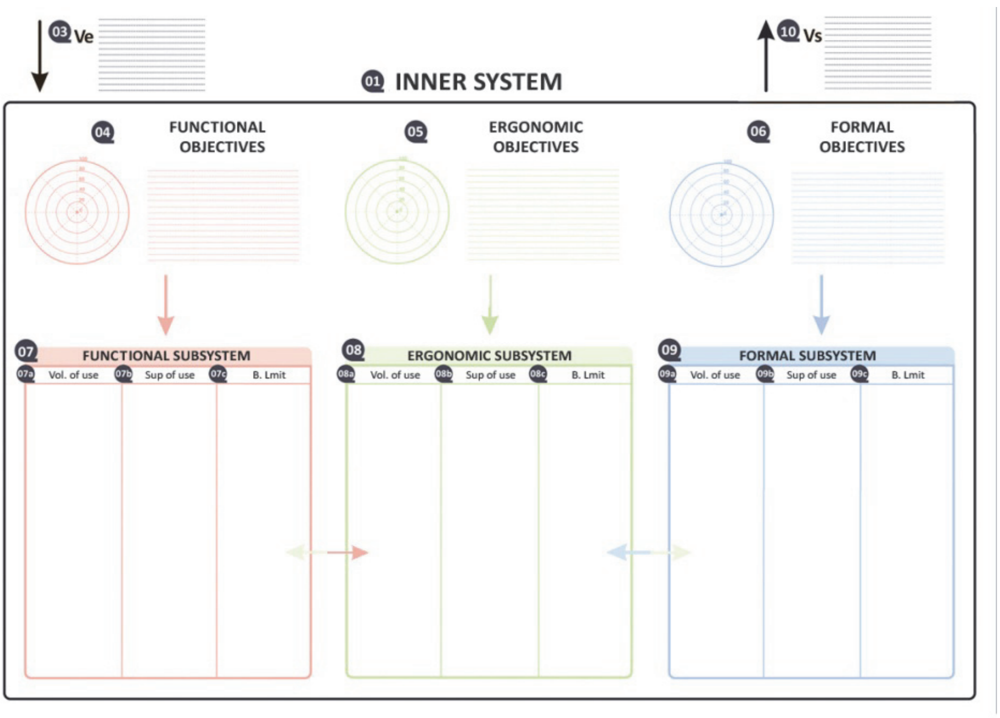

Fig. 1 Modelo sistémico de producto por objetivos. Adaptado de Hernandis (2003)

Mediante investigación exploratoria por literatura de las diversas fuentes documentales, se identificaron las variables exógenas que conforman el conjunto Sistema Exterior o entorno. Para ello se hizo especial hincapié en aquellos aspectos que poseen una mayor participación y, por lo tanto mayor grado de influencia, en el diseño y desarrollo de productos según las fuentes consultadas.

El análisis descriptivo y cualitativo de dicha información permitió la extracción, síntesis y clasificación de la misma, representando con ello la información que viaja desde el Sistema Exterior al interior del Sistema en Estudio y constituyendo así las variables de entrada necesarias para modelar dicho Sistema en Estudio. En la figura 2 se muestra la estructura interna del modelo, las trayectorias y el flujo de la información desde el Sistema Exterior o entorno al Sistema en Estudio y su comportamiento dentro de éste.

Para la identificación y constitución de las variables nos ayudamos, como se menciona en el apartado anterior, de diversas fuentes, como por ejemplo para la definición de la variable de entrada correspondiente a la proporción, derivada en parte, de la configuración postural que ha de adoptar el usuario (postura de cuclillas), fue extraída de los resultados aportados por el ensayo de usabilidad realizado por I. Esnal & C. Serrano (2013) donde estimaron una altura apropiada de elevación de los pies del usuario en función de los ángulos adoptados por los diferentes segmentos corporales inferiores. Esta estimación se reduce a un rango de entre 10 – 22 cms de los pies con el suelo en postura sedente. Para ello, se tuvo en consideración la variación del ángulo del pliegue del músculo puborrectal (encargado de la continencia), interpretado de los estudios observacionales del radiólogo S. Raad (1994) quien determinó una apertura media de 35-40 grados y en casos excepcionales de 80 grados al adoptar la postura de cuclillas. Tras definir las variables de entrada, se establecieron, clasificaron y listaron los objetivos del sistema en los tres subsistemas fundamentales: *Objetivos Funcionales*, *Objetivos Ergonómicos* y *Objetivos Formales*.

Posteriormente, se realizó la geometrización de las variables que constituyen el sistema mediante la asignación de los volúmenes de uso, superficies de uso y límites de contorno en cada uno de los subsistemas fundamentales, definiendo de este modo el rango de acción y con ello construyendo los espacios de intervención en el sistema geométrico. Se ha de mencionar, la interpretación de los volúmenes como el primer paso hacia la materialización del sistema, pero cabe destacar que de igual importancia son los espacios negativos que restringen al mismo y poseen una naturaleza de índole inmaterial. Mediante la suma de estas geometrías creamos un espacio geométrico de diseño en el que poder representar el conjunto global de variables del Sistema en Estudio y en el cual concebir un concepto de producto aportando mayor tangibilidad al sistema.

4. Resultados

Los primeros resultados de la investigación fueron los listados de las variables externas extraídas de la síntesis de la información constituyente del Sistema Exterior y, posteriormente tras su procesamiento, las variables de entrada (Tabla1).

Tabla 1 Listado de variables.

V externas	V entrada
Vex1. Usuarios	Ve1. Segmento de usuarios
Vex2. Antropometría	Ve2. Características físicas usuario
Vex3. Estreñimiento	Ve3. Estreñimiento
Vex4. Patologías asociadas	Ve4. Patologías del usuario
Vex5. Mecanismos	Ve5. Mecanismos
Vex6. Materiales	Ve6. Materiales
Vex7. Sostenibilidad	Ve7. Reciclabilidad
Vex8. Procesos de fabricación	Ve8. Procesos de fabricación
Vex9. Usabilidad	Ve9. Facilidad de uso
Vex10. Mercado	Ve10. Mercado
Vex11. Legislación	Ve11. Psicología
	Ve 12. Normativa

Como uno de los resultados principales se obtuvo el modelo sistémico de producto único para un asistente abdominoinstestinal de ayuda a reducir el estreñimiento funcional mediante la adopción de la postura de cuclillas. En él se comprenden las variables de entrada y salida, los atributos / objetivos de los subsistemas y los propios subsistemas fundamentales (Fig. 3).

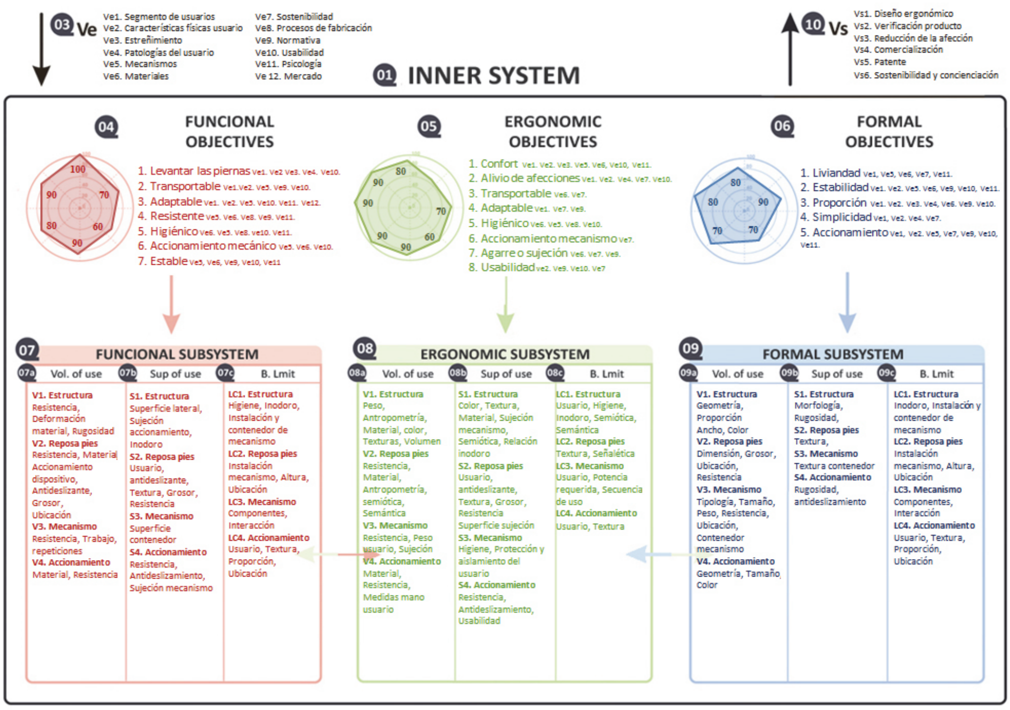

Fig. 3 Modelo sistémico para el diseño de un asistente abdominointestinal.

Para una mejor visualización de los resultados, éstos se han dividido en diferentes tablas.

La tabla 2 corresponde al listado de los atributos obtenido tras la recolección y valoración de los datos que sirvieron como referencia a la hora de establecer los objetivos principales del Sistema en Estudio.

Tabla 2 Listado de Atributos:

Atributos Funcionales	Atributos Ergonómicos	Atributos Formales
1. Elevar las piernas	1. Confort	1. Liviandad visual
2. Resistente	2. Alivio de afecciones	2. Estabilidad visual
3. Adaptable	3. Transportable	3. Proporción
4. Estable	4. Adaptable	4. Simplicidad
5. Transportable	5. Higiénico	5. Accionamiento mecánico
6. Higiénico	6. Accionamiento manual	6. Estética mimética
7. Accionamiento manual	7. Agarre o sujeción	
8. Sostenible	8. Usabilidad	
9. Seguro	9. Seguridad	
10. Desmontable	10. Fácil manipulación	
11. Fácil manipulación		

Mediante la asignación de volúmenes, superficies y límites de contorno, se obtuvo un listado (Tabla 3) en el que se muestran cada uno de estos elementos para cada uno de los subsistemas fundamentales. Así mismo se muestran también las variables involucradas directa o indirectamente con los espacios que las representan.

Tabla 3. Volúmenes de uso, Superficies de uso y Límites de contorno

Subsistema Funcional			Subsistema Ergonómicos			Subsistema Formales		
Vol. de uso	**Sup. de uso**	**LC**	**Vol. de uso**	**Sup. de uso**	**LC**	**Vol. de uso**	**Sup. de uso**	**LC**
V1. Estructura Resistencia Deformación Material Proporciones	**S1. Estructura** Sup. Lateral Sujeción Acción Inodoro	**LC1. Estructura** Higiene, Inodoro, Instalación y contenedor de mecanismo	**V1. Estructura** Peso Antropometría Material Color Texturas, Volumen,	**S1. Estructura** Color Textura Material Sujeción mecanismo Semiótica Relación inodoro	**LC1. Estructura** Usuario Higiene Inodoro Semiótica Semántica	**V1. Estructura** Geometría, Proporción Ancho, Color	**S1. Estructura** Morfología, Rugosidad	**LC1. Estructura** Inodoro Instalación y contenedor de mecanismo
V2. Reposa pies Resistencia Material Acción Antideslizante Grosor, Ubicación	**S2. Reposa pies** Usuario Antideslizante Textura Grosor Resistencia	**LC2. Reposa pies** Instalación mecanismo Altura Ubicación	**S2. Reposa pies** Usuario Antideslizante Textura Grosor Resistencia Sujeción	**S2. Reposa pies** Usuario Antideslizante Textura Grosor Resistencia Superficie sujeción	**LC2. Reposa pies** Textura Señalética	**V2. Reposa pies** Dimensión, Grosor, Ubicación, Resistencia	**S2. Reposa pies** Textura, S3. Mecanismo Textura contenedor	**LC2. Reposa pies** Instalación mecanismo Altura Ubicación
V3. Mecanismo Resistencia Trabajo Repeticiones	**S3. Mecanismo** Sup. Contenedor	**LC3. Mecanismo** Componentes, Interacción	**S3. Mecanismo** Higiene Protección Aislamiento del usuario	**S3. Mecanismo** Higiene Protección Antideslizante	**LC3. Mecanismo** Usuario Potencia requerida Secuencia de uso	**V3. Mecanismo** Tipología, Tamaño, Peso, Resistencia, Ubicación, Contenedor mecanismo	**S3. Mecanismo** Textura contenedor	**LC3. Mecanismo** Componentes Interacción
V4. Acción Material Resistencia	**S4. Acción** Resistencia Antideslizante Sujeción mecanismo	**LC4. Acción** Usuario Textura Proporción Ubicación	**S4. Acción** Resistencia, Antideslizamiento Usabilidad	**S4. Acción** Resistencia, Antideslizante Usabilidad	**LC4. Acción** Usuario Textura	**V4. Acción** Geometría Tamaño Color	**S4. Acción** Rugosidad Antideslizante	**LC4. Acción** Usuario Textura Proporción Ubicación

De la representación geométrica, y su ensamblaje por componentes, de cada elemento resultado del listado anterior, se obtuvieron los modelos conceptuales geométricos para cada subsistema fundamental (Fig. 4). Se pueden identificar los volúmenes prismáticos generados para cada uno de ellos según los diferentes aspectos. Considerando dichos aspectos las características varían, como se puede observar en la figura, de un modelo funcional puramente recto (Fig 4, a), a un modelo más suavizado, consecuencia de una mayor adecuación o adaptación ergonómica, hasta el modelo formal, el cual muestra formas más orgánicas y de mayor expresión estética.

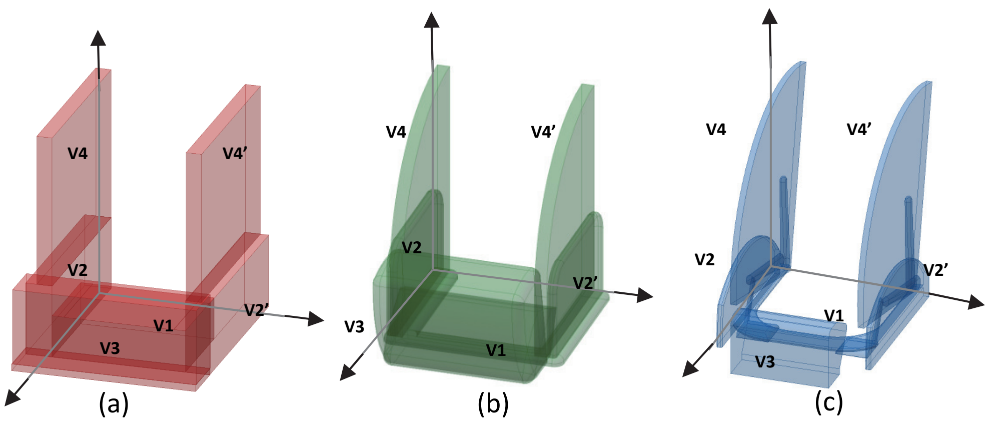

Fig. 4 Modelos conceptuales geométricos de los Subsistemas: (a) Funcional, (b) Ergonómico y (c) Formal.

La superposición de estos modelos conceptuales geométricos da como resultado un espacio de diseño conceptual (Fig. 5) que alberga toda la información de los modelos individuales anteriormente citados y de lo que se interpreta que está sometido a las mismas consideraciones y restricciones iniciales establecidas. Por lo que se puede decir que este espacio posee las características necesarias para generar en él una propuesta de diseño que cumpla con los objetivos.

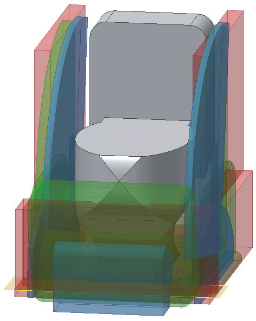

Fig. 5 Espacio de diseño para un asistente abdominointestinal.

En el espacio de diseño obtenido se generaron diferentes propuestas de diseño conceptual de las cuales se muestra una de ellas como muestra representativa (Fig. 6) para ejemplificar una de las posibles “materializaciones” del sistema.

Figs. 6 Propuesta de diseño conceptual.

Para finalizar el ciclo, el Sistema en Estudio debe devolver la información adquirida de nuevo al entorno (principio homeostático), pero ésta volverá al medio procesada por el modelo como función de transformación resultando el concepto de un producto de asistencia abdominointestinal, el espacio de diseño, el marco teórico que lo alberga y las variables que lo constituyen. Esta información de salida se representa mediante las variables de salida y son el resultado de aplicar la solución de diseño al problema planteado (Hernandis, B. 2000).

Tabla 4. Listado de las variables de salida

V salida
Vs1. Diseño ergonómico.
Vs2. Verificación del sistema producto.
Vs3. Validación del modelo
- Vs4. Reducción de la afección.
- Vs5. Patente
- Vs6. Sostenibilidad y concienciación

Estas variables, enumeradas en la tabla 4, forman parte de la información referida anteriormente que sale al entorno y como sistema que es, lo modifica; éste se reconfigura y vuelve a iniciarse el ciclo de nuevo propiciando el reajuste de la información de las variables de entrada y con ello del sistema en estudio. Estos bucles son aprovechados como retroalimentación que aporta al método la flexibilidad necesaria para que el modelo se reconfigure y adapte al medio en cada ciclo. El bucle de retroalimentación finaliza cuando se alcanza el grado de cumplimiento de los objetivos establecido por el agente decisor y se considera así que el producto posee las cualidades y atributos requeridos.

5. Conclusiones

La visión sistémica adoptada para el estudio de la problemática como un sistema complejo permitió un abordaje de mayor amplitud y profundidad de la misma. Esto conllevó, por un lado, un incremento de la información que el diseñador como agente decisor debe gestionar y además, deberá hacerlo de la manera más eficientemente posible con el fin de cumplir con los objetivos establecidos del sistema y, por lo tanto, satisfacer los requerimientos de diseño. El propio modelo dirige la información y, con ella, se establece el flujo de trabajo que ha de seguir el modelador "obligándole" a extraer, sintetizar y entender el comportamiento de dicha información. Dota, por lo tanto, de una estructuración lógica y ordenada al proceso de diseño, especialmente en etapas donde se requiere de mucha reflexión por parte del diseñador para manejar todos los condicionantes del entorno y el cual puede, pese al incremento de la información, poseer mayor rigor en las tomas de decisión. Por otro lado, el uso de esta metodología confiere al proceso de diseño y, por consiguiente, al producto, de nuevos aspectos emergentes de las interrelaciones de la información. Lo que se traduce en cualidades innovadoras y un mayor número de soluciones.

También decir, que una de las características que posee la sistémica es que permite simular la realidad con diferentes grados de precisión y generar modelos tan detallados y complejos como se desee. El inconveniente que posee este planteamiento es que el tiempo necesario de procesamiento de la información de dicho modelo podría llegar a ser tal que el propio modelo dejara de ser de utilidad (Martínez, & Requena, 1986) . Es por esto que, en aras de favorecer el proceso de toma de decisiones, debemos plantear el problema con el grado de precisión adecuada. Debemos considerar un equilibrio entre el nivel de detalle/complejidad y mayor número de soluciones, con el tiempo de modelización o de simulación. Cabe destacar en este sentido que el caso estudiado contempla un nivel de detalle propio de las fases conceptuales y es por ello que se han descartado aspectos como: materiales, procesos de fabricación, normativa, costes, canales de distribución o marketing.

Es de destacar también la analogía existente con los sistemas vivos como es el principio homeostático que caracteriza a este tipo de sistemas que dicta que para mantener el estado de equilibrio, el sistema debe permanecer en constante intercambio de energía e información con el entorno en el que existe, de tal modo se sirva de los cambios en éste para retroalimentarse y reorganizarse internamente en favor de una mejor adaptación. Esto quiere decir que el propio modelo es susceptible de cualquier variación en las condiciones del entorno y por lo tanto se puede interpretar que lo mismo sucede con el producto. Este se adapta a las nuevas condiciones como lo hacen los organismos vivos en su medio.

6. Futuras líneas de investigación

Se pretende profundizar en el estudio del sistema "asistente abdominoinstestinal" con el fin de aumentar el nivel de detalle de las variables y parámetros de diseño. En primer lugar la investigación se centrará en las áreas correspondientes a la usabilidad del producto y su validación ergonómica. Para ello nos valdremos de un prototipo del modelo técnicamente de mayor definición para su estudio con usuarios, el cual se encuentra actualmente en proceso de desarrollo.

Se realizará un estudio cuantitativo de la opinión de los posibles usuarios mediante cuestionarios y entrevistas a expertos en diseño de producto para precisar en mayor medida las cualidades y atributos más importantes y mejor valorados.

Se pretende la implementación de sistemas neuronales como medio de control en la gestión y validación de las variables; y la aplicación de herramientas de búsqueda heurística de sistemas evolutivos para la generación y optimización de las soluciones.

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Evaluación y estudio comparativo mediante modelos sistémicos de la implantación del sistema APPCC aplicado al sector agroalimentario.

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Resumen

El Reglamento comunitario (CE) nº 852/2004, relativo a la higiene de los productos alimenticios, establece que las empresas alimentarias deben cumplir con los requisitos obligatorios de desarrollar, aplicar y mantener un procedimiento permanente basado en los principios del sistema APPCC (Analisis de los Puntos Críticos de Control).

Actualmente, se encuentran implantados los sistemas basados en APPCC en la mayoría de empresas del sector agroalimentario. No obstante, en muchos casos la implantación del sistema no se realiza correctamente, siendo inefectiva y no garantizando la seguridad alimentaria. El objetivo de este trabajo se centra en demostrar que la introducción de los modelos sistémicos aplicados en la optimización de sistemas jerarquizados, puede mejorar la implantación y efectividad de los sistemas APPCC en el sector agroalimentario, así como detectar los posibles fallos en dicho sistema, y por tanto, garantizar adecuadamente la producción de alimentos seguros. Para ello, se ha llevado a cabo un estudio retrospectivo de índole cualitativo, en cuatro industrias pertenecientes al sector agroalimentario, obteniendo datos relativos a documentos y registros generados por el propio sistema de autocontrol, actas de inspección derivadas del control oficial, analíticas microbiológicas y verificaciones internas. Se ha determinado, en los casos estudiados, que se producen fallos en cuanto aplicación de procedimientos, toma de registros, interpretación de medidas correctoras a llevar a cabo y falta de vigilancia de PCC identificados, en cuyo caso perjudica los intereses productivos de la empresa alimentaria y no garantiza una correcta protección de la salud de los consumidores. Finalmente, la evaluación mediante modelos sistémicos del APPCC permite detectar los fallos de implantación en las industrias implicadas y ofrecer una herramienta, tanto para los operadores de empresas alimentarias, como para los servicios de control oficial, que permite garantizar una correcta aplicación del sistema de autocontrol.

Palabras clave*: APPCC, modelos sistémicos, seguridad alimentaria, sector agroalimentario.*

Abstract

Community Regulation (CE) No 852/2004 on the hygiene of foodstuffs provides that food businesses must comply with the mandatory requirements to develop, implement and maintain a permanent procedure based on the principles of HACCP (Hazrd Analysis Critical Control Point) system points.

Currently, are implemented HACCP-based systems in most food businesses. However, in many cases the implementation of the system is not successful, being ineffective and not ensuring food security.

The aim of this work is focused on demonstrating that the introduction of systemic models applied in optimizing hierarchical systems can improve the implementation and effectiveness of HACCP systems in the food sector and detect possible failures in the system, and therefore adequately ensure safe food production.

To this end, has conducted a retrospective study of qualitative nature, in four industries belonging to the food sector, obtaining data on documents and records generated by the self-monitoring system itself, inspection reports derived from official control, microbiological analysis and internal verification.

It has been determined in the case studied, which faults occur as application procedures, making records, interpretation of correctives to carry out measures and lack of monitoring of HACCPs identified, in which case it damages the productive interests of the food business and does not guarantee proper protection of the health of consumers.

Finally, the evaluation of HACCP by systemic models detects failures of implementation in the industries concerned and provide a tool for both food business operators and for services official control, which helps to ensure a successful implementation of self-monitoring system .

Keywords: *HACCP, systemic models, food security, food sector.*

1. Introducción

En primer lugar analizaremos aquellas cuestiones relativas a los APPCC (Análisis de los Puntos Críticos), cuyo conocimiento será primordial para el desarrollo de esta investigación en el Sector Alimentario en la Comunidad Valenciana.

1.1 Situación actual de la seguridad alimentaria o marco de referencia

En marzo de 1996 surge una nueva variante de la enfermedad de Creutzfeldt-Jacob asociada a la Encefalopatía Espongiforme Bovina, lo que provoca una de las mayores crisis alimentarias de los últimos tiempos. Éste fue uno de los factores que obligó a plantearse a la Unión Europea y a sus Estados Miembros la política a seguir con respecto a la seguridad alimentaria.

La Comisión Europea adoptó, en enero de 2002, el Libro Blanco sobre la seguridad alimentaria, con la finalidad de desarrollar un marco legislativo garante de un alto nivel de seguridad alimentaria y una elevada protección de la salud de los consumidores. En enero de 2002 se publica una importante normativa, de directa aplicación, denominado: Reglamento 178/2002, del Parlamento y del Consejo, de 28 de enero, por el que se establecen principios y requisitos generales de la legislación alimentaria, también se crea la Autoridad Alimentaria Europea y se fijan los procedimientos relativos a la seguridad alimentaria.

El Consejo y el Parlamento europeo adoptaron un conjunto de Reglamentos y Directivas que reestructuraron y actualizaron las normas de higiene de todos los productos alimenticios, incluidos los productos de origen animal. Este conjunto normativo es conocido por el "paquete de higiene" y es aplicable desde el 1 de enero de 2006.

En dichos reglamentos se obliga a la industria alimentaria a implantar un Sistema de Autocontrol (Reglamento (CE) nº 852/2004).

1.2 Sistemas de Autocontrol

Los sistemas de autocontrol son herramientas imprescindibles que deben aplicar los operadores alimentarios para asegurar la inocuidad de sus productos alimenticios (Suárez Iglesias, J.L. y col., 2012). Están constituidos por los requisitos previos de higiene y trazabilidad (RPHT) y el plan de análisis de peligros y puntos de control crítico (APPCC).

Consisten en *"un enfoque sistemático para identificar peligros que pueden afectar la inocuidad de un alimento, a fin de establecer las medidas para controlarlos"* (Martí, L.E. y col. 2012). Pueden llegar a ser más o menos complejos, desde las Guías de las Correctas Prácticas de Higiene (GCPH) hasta los manuales de APPCC.

Estos sistemas de autocontrol han de ser coherentes y adaptarse a las características particulares de cada establecimiento (Mejías Carpena, C. y col., 2009).

Evaluación del nivel de implantación de los sistemas de autocontrol

La evaluación de los sistemas HACCP son un elemento clave para asegurar la gestión eficaz de la inocuidad de los alimentos, sin embargo, según Wallace, Powell y Holyoak (2005), no existe ningún enfoque aceptado o metodología común disponible para ser utilizados por industriales, auditores u organismos reguladores (Gutiérrez, N. y col., 2011). En investigaciones realizadas por SUÁREZ IGLESIAS, J.L. y col. 2012, Suasnavas, N. y col. (2007) usaron listas de verificación/ revisión para evaluar el cumplimiento de los prerrequisitos relacionados con higiene, inocuidad y, en general, gestión de la calidad en la industria alimentaria

La legislación comunitaria en materia de higiene de los alimentos establece que la autoridad competente efectuará controles oficiales para comprobar que se cumplen los requisitos especificados, que estos controles deberán realizarse de una forma eficaz, y que uno de los métodos o técnicas a utilizar es la auditoría, concretamente "Auditoría de sistemas de autocontrol basados en los principios del APPCC" (Reglamento 882/2004 y 854/2004) (Carravilla, S. y col., 2009). Por este motivo muchos estudios para la evaluación de los sistemas de autocontrol se basan en los resultados reflejados en los formularios de inspección que utilizan los agentes de control oficial.

Toda esta legislación marca las directrices a considerar desde una nueva estrategia a considerar en la seguridad alimentaria.

2. Objetivos

En este estudio de carácter exploratorio se pretende:

- Conocer el grado de implantación de los sistemas de autocontrol de obligada exigencia dentro de las empresas alimentarias industriales

- Detectar los principales fallos en la aplicación de los sistemas de autocontrol

- Introducir los modelos sistémicos y evaluar su aplicación en la optimización de sistemas jerarquizados, para mejorar la implantación y efectividad de los sistemas APPCC.

3. Material y Método

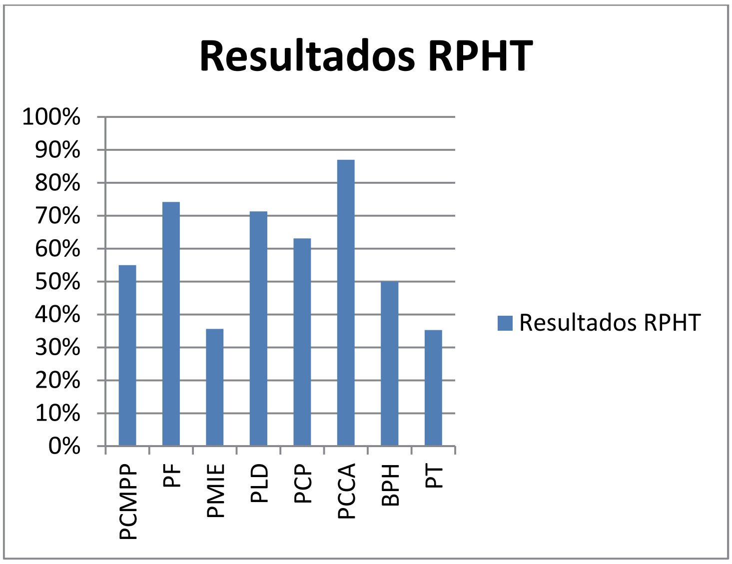
Se han revisado diversos estudios, que muestran los resultados de la implantación del sistema APPCC, siendo su interés primordial detectar las variables más significativas para realizar una correcta evaluación del sistema de autocontrol, así como para la representación del modelo sistémico.

Se analiza en un primer estudio, la valoración de la implantación de los requisitos previos de higiene y trazabilidad (RPHT) en 179 comercios minoristas (Arjona, C. y col., 2009).

Se analiza en un segundo estudio la evaluación del grado de implantación de los sistemas de autocontrol en 91 industrias de harinas y derivados (Baro Duarte, J. y col., 2009)

Un tercer estudio aporta la valoración de la implantación del APPCC en diferentes sectores alimentarios de Murcia, (González Fernández, M. y col., 2007).

En otro de los estudios se analiza la evolución de la implementación de los sistemas de autocontrol en 36 comedores colectivos, (Serrano Galán, E., 2009). Un estudio sobre 15 auditorías en actividades de restauración sin registro sanitario de alimentos en un distrito de Madrid, muestran el diferente nivel de implantación de un sistema completo de APPCC (Figuras 1 y 2)



PCMPP: Plan de Control Materias Primas y Proveedores

PF: Plan de Formación

PMIE: Plan de Mantenimiento de Instalaciones y Equipos

PLD: Plan de Limpieza y Desinfección

PCP: Plan de Control de Plagas

PCCA: Plan de Control de la Calidad del Agua

BPH: Buenas prácticas de higiene

PT: Plan de Trazabilidad

Figura 1. Resultados RPHT estudio Villar Gaspar M.R. (2009).

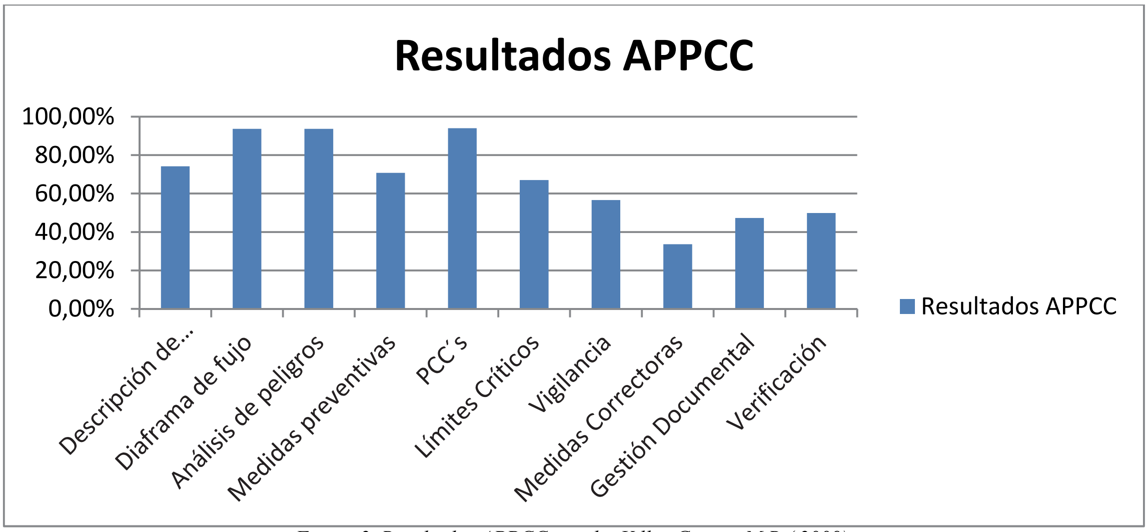


Figura 2. Resultados APPCC estudio Villar Gaspar M.R.(2009)

Utilizaremos los modelos sistémicos (Hernandis, B., 2003) en particular el Modelo de Formulación por Objetivos para analizar el cumplimiento de los planteamientos estratégicos, tácticos y operativos para la implantación de un sistema APPCC con objeto de analizar las posibles mejoras para el seguimiento y control en los planes de inspección alimentaria.

Procederemos a la revisión de los modelos organizacionales, describiendo sus características y elementos a determinar. Para ello se utilizará el siguiente gráfico desarrollado en la Escuela de Investigación Operativa y Sistemas de la Universidad de Valencia (2003)

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Figura 36. *Modelo de Formulación por objetivos, Hernandis B. (2003)*

Para la aplicación de estos modelos el primer paso consiste en definir los límites del sistema y analizar tanto los elementos integrados en éste, como los elementos que influyen sobre el sistema en estudio y que no pueden ser controlados por éste.

El sistema en estudio se subdivide para su análisis en varios sistemas o niveles, los cuales serán a su vez subsistemas del anterior. La aplicación de los modelos sistémicos, permite un seguimiento y control de los sistemas en general independientemente de la disciplina objeto de estudio. Esto es lo que nos ha inducido a pensar en ellos, como es un modelo adecuado que permita la implementación del APPCC y su seguimiento y control posterior. El uso de estos modelos ha permitido en el campo del diseño la implementación y modelado en múltiples casos (citar algunos modelos) comprobando por tanto que desde la investigación cualitativa esta nos permite por analogía evidenciar su utilidad en esta investigación.

5. Resultados y discusión

En el primer estudio sobre la valoración de la implantación de los requisitos previos de higiene y trazabilidad (RPHT) en 179 comercios minoristas, se observa:

Que el 46% de los establecimientos estudiados no poseen documentación RPHT, un 39% poseen documentación pero esta no se encuentra implantada, y tan solo un 10% tiene documentación desarrollada e implantada. De ello cabe deducir que con el fin de adaptarse a estos pequeños comercios el sistema de autocontrol enfocado y adaptado a ellos ha de ser simplificado para su correcta implementación (Arjona, C. y col., 2009).

Del estudio realizado sobre la evaluación del grado de implantación de los sistemas de autocontrol en 91 industrias de harinas y derivados (Baro Duarte, J. y col., 2009), se obtienen los resultados representados en la tabla 1:

Tabla 1. Resultados estudio Baro Duarte, J. y col. 2009.

	Implantados	No implantados
Plan de Control de la Calidad del Agua	71	20
Plan de Limpieza y Desinfección	67	24
Plan de Control de Plagas	58	33
Plan de Mantenimiento de Instalaciones y Equipos	68	23
Plan de Trazabilidad	**30**	61
Plan de Formación	**37**	54

Fuente: Baro Duarte, J. y col.(2009)

Como se puede observar en la tabla, se muestra que existe una mayor dificultad en la implantación del Plan de trazabilidad y el Plan de formación, siendo mayor el número de establecimientos en los que no están implantados de los que sí. Esto se debe a que el plan de trazabilidad entraña mayor grado de complejidad, y las empresas en las que se pretende implantar constan de pocos recursos. En cuanto al

Plan de formación, su falta de implantación radica en el hecho que los operarios entienden este plan con la mera obtención del Certificado de Formación en Higiene Alimentaria. El Plan de Control de Plagas también encuentra inconvenientes en su implementación, debido al concepto erróneo de vigilancia de plagas. Los restantes planes presentan un grado de implantación muy similar debido a su fácil ejecución y vigilancia (Baro Duarte, J. y col., 2009).

Un tercer estudio sobre la valoración de la implantación del APPCC en diferentes sectores alimentarios de Murcia, muestra los siguientes resultados: deficiencias detectadas en planes de trazabilidad de un 29% y documentación o registros no idóneos en un 44%.

Los problemas de trazabilidad se atribuyen a la diversidad de la cadena alimentaria distribuidora, y la inadecuación del APPCC, es debida, entre otros, a la carencia de documentación idónea, revela dificultades para gestionar las auditorías externas (González Fernández, M. y col., 2007).

En otro de los estudios sobre la evolución de la implementación de los sistemas de autocontrol en 36 comedores colectivos, se puede observar que en el 2003 sólo 12 centros disponían de RPHT, y en 2007 la totalidad disponían de los requisitos previos, siendo el 28% de estos completo (APPCC y prerrequisitos) y el 72% sólo disponía de prerrequisitos. Dentro los requisitos previos, el Plan de Trazabilidad y el Plan de Mantenimiento de la Cadena de Frío no eran verificados. Por lo tanto, se concluye que en la actualidad los comedores colectivos disponen de Documentos de Autocontrol, no obstante, existe una gran variabilidad en el grado de implantación (Serrano Galán, E., 2009).

En general, tanto los resultados obtenidos a nivel de los planes generales de higiene y a nivel del APPCC fueron favorables. No obstante se observa que hay planes generales mejorables como: el plan de mantenimiento y la trazabilidad; y en el sistema APPCC: la gestión documental y la verificación (Villar Gaspar M.R., 2009).

Se ilustra un estudio en un matadero de ganado bovino (terneros) y porcino. En cualquier caso, son mayoritarios los fallos relacionados con la "Limpieza y desinfección" (de 14 fallos a 3) y "Mantenimiento de instalaciones y equipos" (de 13 a 2), refiriéndose en general al mal estado de conservación de las paredes interiores del matadero con defectos en el esmaltado, equipos con mantenimiento deficiente, con pérdida de galvanizado y óxido, superación de valores microbiológicos permitidos en tripería, esterilizador de cuchillos y paredes de la zona de sangrado así como en el mobiliario y en las canales (Suárez Iglesias, J.L. y col., 2012).

6. Conclusión

A modo de conclusión final, cabría resaltar que en el caso de los comercios minoristas son escasos aquellos que poseen sistemas de autocontrol, por lo que sería conveniente establecer criterios de flexibilidad en estos casos concretos. Por otra parte, en la mayoría de los casos estudiados (Baro Duarte, J. y col., 2009; González Fernández, M. y col., 2007; Serrano Galán, E., 2009; Villar Gaspar M.R., 2009), se evidencia que el plan de trazabilidad es el que presenta más complejidad a la hora de su desarrollo e implantación, debido a la limitación de recursos que presentan algunas empresas. En cuanto a la aplicación del propio sistema APPCC, es deficiente el punto de verificación y adopción de medidas correctoras ante desviaciones de PCC´s. Por lo que sería recomendable un análisis profundo y el establecimiento de modelos que mejoren las garantías actuales. La aplicación de los modelos sistémicos podría ser una respuesta a las carencias detectadas. Los estudios emprendidos actualmente desde esta perspectiva deberán validar la propuesta sistémica y corroborar mediante resultados esta posibilidad.De forma global, los sistemas de autocontrol se encuentran, por tanto, dentro de los estándares de conformidad necesarios para cubrir la exigencia legal impuesta por los Reglamentos Comunitarios en su aplicación.

Con todo esto, se pone en antecedentes la situación sobre la implantación de los sistemas de autocontrol en establecimientos agroalimentarios, y se procede a la recopilación de datos en algunos establecimientos que deberán mediante casos de estudio evaluar la implementación y resultados comparativos mediante el uso de modelos sistémicos.

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Ecodesign assessment information an important tool for the design of new elements for building construction

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Resumen

En el proyecto que se entrega, se busca demostrar la Hipótesis que señala que es posible la fabricación de elementos constructivos, partiendo de residuos de partículas de plásticos expandidos y fibra de agave como agregados, todos conglomerados en una pasta de yeso. Se ha llevado a cabo un proceso investigación de materiales, de diseño y desarrollo de producto, que propone la aplicación de los resultados de este proyecto de investigación, en un sistema constructivo para particiones interiores y techos falsos. Una de las metas principales para este proyecto es la de ofrecer un elemento constructivo con menor impacto medioambiental. Aquí se muestran algunos avances sobre la valoración de impacto ambiental del nuevo sistema constructivo y que permiten observar una mejoría, comparado con algunos sistemas ya disponibles.

Palabras clave*: Ecodiseño, Reciclaje del plástico, Elementos de construcción*

Abstract

A new wallboard panel has been developed. The flat panel is manufacturated mainly with a nucleus of gypsum plaster and enriched with agave dry fiber and expanded plastic particles, both agave and plastic are recovered materials and they cooperate to produce a light and resistant flat building construction product. Wallboards samples were produced according several formulas and under different conditions, then they were tested in materials labs. Today most of project stages are close to be finished and the research team works on a whole new building construction system design. One of the main objectives for this project is to reach a better ecological impact than other similar systems, in order to verify those benefits an Ecodesign assessment has been carried on. In this paper some important information and data about the assessment are shown.

Keywords: *Ecodesign, Plastics recycling, Building construction elements*

I. Desarrollo

1.1 Diseño del Proyecto de Investigación

El proyecto de investigación que se muestra: Diseño de elementos para un sistema constructivo basado en innovadoras placas fabricadas con yeso, fibra de agave y partículas de plástico expandido; incluye 6 fases:

(1) Antecedentes, (2) Trabajos previos, (3) Etapa experimental I, (4) Etapa experimental II, (5) Diseño y desarrollo de producto y, (6) Evaluación de ecodiseño.

2. Hacia la disminución del impacto de los productos al medioambiente. El ecodiseño.

El Ecodiseño analiza las relaciones que mantienen el medioambiente y un producto a lo largo del ciclo de vida de este último, al tiempo busca que las funciones propias del producto sean las más eficientes. La mayoría de los objetivos del ecodiseño sólo se pueden lograr si son incorporados durante la fase de diseño. Una herramienta valiosa para mejorar el desempeño ambiental de productos es la Evaluación de ecodiseño (Rieradevall, 1999).

3. Trabajos previos de investigación

Los trabajos previos del proyecto (fases 1 y 2) permitieron analizar información de dos de los componentes usados para la fabricación de placas; yeso y partículas de plástico expandido. Durante las fases se obtuvieron datos del amasado de pastas y de la integración de los residuos de plástico en esas pastas. Se determinaron proporciones de los componentes, viscosidad de las pastas, tiempos de fraguado, endurecimiento, y densidades aparentes obtenidas.

4. Etapa experimental 1

4.1 Selección de mezclas

La etapa experimental 1 dio inicio con el diseño de un árbol de combinaciones de los diferentes materiales organizados en grupos de trabajo, en total 68 mezclas, y de todas ellas se produjeron muestras. Además, se fabricaron dos grupos de muestras que no incluyen partículas de plástico, y que funcionaron como materiales de comparación. Todas las muestras (12.5 x 300 x 400 mm) se recubrieron con papel grueso en sus 2 caras y fueron sometidas a los siguientes ensayos: absorción de agua por inmersión total, determinación de densidad laminar, ensayo de flexión, ensayo de reacción al ataque directo de flama y resistencia al impacto. Las normas empleadas, los procedimientos detallados y los resultados de los ensayos se encuentran disponibles en otras publicaciones (González, Madariaga: 2006)

5. Etapa Experimental 2

5.1. Fabricación de nuevas probetas

En la Etapa Experimental 2, se seleccionó y fabricó un nuevo grupo de muestras que posteriormente fueron sometidas a ensayos para su caracterización. Para mejorar su desempeño a esfuerzos de flexión, las mezclas incluyen ahora un nuevo componente: fibras cortas de agave.

Las normas empleadas, los procedimientos y resultados detallados de los ensayos se encuentran disponibles en otras publicaciones (González Madariaga: 2012a) .

5.2 Caracterización. Aplicación de usos similares a la placa de yeso estándar

Los ensayos para caracterización de placas son los mismos en las dos etapas experimentales (punto 4.1), esto permite establecer una comparación entre ambos trabajos de laboratorio. Los resultados de los ensayos se resumen así:

5.2.1 Resultados de los ensayos

5.2.1.1 Ensayo de absorción al agua por inmersión total de las placas

De los datos se puede extraer que se obtuvieron resultados favorables en donde las muestras registraron un menor porcentaje en absorción de agua, lo que nos indica que la inclusión del plástico EPS como segundo material, ayuda a disminuir los niveles de absorción. Sin embargo esta característica disminuye con la presencia de fibra de agave donde se da una mayor absorción de agua.

5.2.1.2 Ensayo de Densidad Laminar.

La densidad laminar es la cantidad de masa de una placa en función de su espesor (kg/m^2). La serie de muestras que incluyen partículas de plástico presentó una densidad laminar menor que aquellas muestras sin partículas. Por su parte las muestras que tienen agregados de fibra en su composición reportaron masas competitivas comparadas con productos similares disponibles en el mercado, de aquí se puede concluir que la composición que se necesita para obtener los resultados deseables para el proyecto se obtienen de un balance de ambos grupos: si bien la presencia de partículas de EPS disminuye la densidad de los nuevos materiales hasta en un 26%, la fibra de agave en placas produce un aumento de masa. Sin embargo el uso de fibras se justifica ya que ofrece otros beneficios, como el aumento de resistencia a la flexotracción.

5.2.1.3 Ensayo de Flexión de las placas

Estos ensayos se llevaron a cabo bajo la dirección del Dr. Francisco Javier Talavera investigador del Instituto de Celulosa y Papel del Centro Universitario de Ciencias exactas e Ingeniería (CUCEI) de la Universidad de Guadalajara, México. Los resultados del ensayo aún se analizan, pero se dispone ya de algunas conclusiones: el grupo de placas que presentó menor resistencia a la flexión fue el grupo de placas fabricadas con pastas de yeso, residuos de EPS y agua. El grupo de placas con agregados de fibra de agave presentó una resistencia mayor a la flexotracción, esto parece confirmar que los agregados de fibra de agave favorecen la resistencia de las placas a estos esfuerzos.

5.4.1.4 Ensayo de Reacción al Fuego.

De los ensayos sobre placas se obtiene que las muestras obtenidas de placas comerciales presentaron una afectación por ataque de fuego directo muy similar a las placas de la investigación. El grupo de placas con Yeso, Agua, Fibra y EPS que presentó un comportamiento desfavorable en los bordes fueron las de la serie YEP con un promedio de 10 cm^2 de área afectada, mientras que las que resultaron más favorables para éste ensayo fueron las placas YEP/E que su área afectada es 50% menor que las mencionadas anteriormente. Esto nos habla no sólo de la importancia de la cantidad de fibras de agave en las placas, sino también de la forma como se originaron las fibras empleadas. Es conveniente recordar que las fibras de agave integradas en las placas, son residuos del proceso de obtención de la bebida alcohólica denominada tequila. En la industria del tequila hay dos procesos de prensado para la obtención de mieles para la destilación; prensado del agave en crudo y otro prensado después de ser sometido a cocción. En esta investigación se emplean fibras obtenidas por ambos procesos.

5.2.1.5 Ensayo de Resistencia al impacto de las placas

En los resultados preliminares (los datos más precisos aún se encuentran en proceso de publicación) se observa que sólo un grupo de placas superó los límites marcados por la Norma. En la mayoría de los casos, las placas que contienen fibra de agave muestran resultados favorables para el proyecto, de aquí se puede expresar que la presencia del agregado de agave en las placas investigadas, mejora las propiedades de resistencia al impacto en las muestras donde participa

5.3. Conclusiones de la Etapa Experimental 2

Una ventaja principal de los nuevos materiales de placa está en su ligereza, donde una placa de 12,5 mm de uno de los nuevos materiales tiene un peso de hasta 5,55 kg/m^2 mientras una placa comercial tiene su peso entre 9,8 y 10 kg/m^2. La ventaja disminuye con la inclusión de fibras de agave, sin embargo se puede decir que esta característica facilita su manejo en producción y que puede traducirse en un beneficio medioambiental. También se añade como beneficio medioambiental la aplicación de productos revalorados (como las partículas de plástico y la fibra de agave) en las nuevas placas de materiales reciclados.

Los ensayos han confirmado las buenas características de reacción al fuego de los materiales propuestos. En varias de las comparaciones entre las resistencias mecánicas de las placas estándar y las placas fabricadas con residuos de espuma y fibra se observa un mejor desempeño de los materiales comerciales, la pérdida de resistencia en los nuevos materiales se puede explicar por la rica proporción de agua empleada en la preparación de las mezclas y a la utilización de residuos de EPS lo que resulta en una estructura ligera, pero de alta porosidad y por ello más débil.

Del grupo de ensayos aplicados a probetas de placas, se confirma que los nuevos materiales son utilizables en aplicaciones similares a las de placas estándar de yeso laminado. Sin embargo es menor la resistencia de las placas investigadas.

Se ha mostrado que las aplicaciones propuestas son una alternativa para la revaloración de residuos de espumas de EPS y fibras de agave. Se ha logrado así una propuesta de productos alternativos para la construcción, que además pueden fabricarse con procesos accesibles para una pequeña o mediana empresa.

6. Evaluación comparativa de Ecodiseño

La evaluación de Ecodiseño (en adelante ECC) es un proceso que aplica diversas herramientas de recolección de información y análisis, los resultados son especialmente útiles en la toma de decisiones durante el proceso de diseño. En este escrito, se enfatiza en la disminución de los requerimientos de energía y materiales, así como el manejo de residuos durante todas las etapas del ciclo de vida de un producto específico (González M. 2012b).

6.1. Etapas del proceso de Ecodiseño

Las etapas generales de Evaluación de Ecodiseño incluyen :

A. Creación del equipo y planificación , B. Evaluación de ecodiseño , C. Implantación de las mejoras determinadas en la evaluación, D. Seguimiento de las mejoras, E. Valoración del proyecto. La etapa B, incluye las siguientes acciones:

6.1.1 Descripción del producto

Identificación y organización de todos los elementos del producto a evaluar.

6.1.2. Descripción de materiales

Identificación de los materiales con los que está fabricado el producto por evaluar

6.1.3. Descripción del sistema producto

Esta etapa relaciona las cinco etapas del ciclo de vida de un producto con los materiales y procesos involucrados.

6.1.4. Determinación de la unidad funcional

De acuerdo a los intereses del proyecto se establece una cantidad de producto a evaluar. Es conveniente enfatizar que no se debe de confundir un lote con una unidad funcional, ya que ésta última se relaciona no sólo con la cantidad de materiales y energía requeridos.

6.1.5. Aplicación de la matriz MET

La matriz MET es una herramienta semicuantitativa de análisis de impacto medioambiental de producto, que permite organizar de manera sistemática la información ambiental relevante relacionada con la evaluación, lo que facilita al equipo de ecodiseño la posibilidad identificar amenazas y oportunidades de mejora. La matriz MET permite capturar y organizar en una tabla, información acerca de los **materiales (M)** utilizados, la **energía (E)** consumida y las **emisiones tóxicas (T)** generadas durante las diferentes etapas del ciclo de vida de un producto. La matriz MET favorece el análisis grupal.

6.1.6. Análisis de la matriz MET

De la elaboración, discusión y análisis de la matriz MET obtenida, el equipo de ecodiseño propone acciones generales de mejora.

6.1.7. Ecoperfil de producto

Con la información generada el equipo de ecodiseño evalúa el desempeño del producto. La gráfica esta compuesta por seis vectores: a. *satisfacción de las funciones* que debe cumplir el producto, b. *eficiencia de la selección de materiales* en los que está fabricado, c. *fabricación del producto*, eficiencia en la selección y aplicación de las técnicas de producción a través de las cuales se obtiene el producto, d. *comercialización y distribución*, descripción y evaluación del proceso que lleva el producto evaluado de su fabricante al usuario del mismo, e. *Uso del producto*, el equipo evalúa como se usa el producto e identifica oportunidades de mejora, f. *eliminación final o disposición*, la forma como el producto finaliza su ciclo de vida es también una fuente de oportunidades de mejora. La evaluación se practica por el equipo mediante la asignación de una calificación numérica relativo a la satisfacción que ofrece el producto en los seis vectores, finalmente los resultados se unen formando una gráfica poligonal.

6.1.8. Aplicación de ecoindicadores

Los materiales necesarios para la producción de la unidad funcional se relacionan aritméticamente con ecoindicadores. Los ecoindicadores son valores sin dimensión que cuantifican el impacto ambiental de un material y/o proceso de producción específicos.

6.1.9. Tablas de Ecoindicadores, producción , uso y disposición

En una tabla se relacionan las cantidades obtenidas para cumplir con la unidad funcional con el ecoindicador correspondiente (IHOBE:1999), esto resulta en un indicador de desempeño ambiental expresado en Mp (milipuntos); el resultado, es un elemento de comparación útil para valorar una estrategia o acción de diseño con su desempeño medioambiental.

6.1.10. Propuestas de mejora

Con base a los resultados de evaluación obtenidos, el equipo de diseño propondrá estrategias de mejora al producto relacionándolas con cada etapa de su ciclo de vida.

6.1.11. Viabilidad de las mejoras

El equipo de ecodiseño califica las propuestas del punto anterior, atendiendo criterios como: sencillez técnica, factibilidad económica y otros de importancia particular de la estrategia.

6.1.12 Propuesta de alternativas de mejora

Se comparan entre sí las alternativas propuestas y sus resultados hipotéticos.

6.1.13. Ecoperfil comparativo de resultados de ecodiseño

Retomado la gráfica poligonal (ver 6.1.7), se evalúan y comparan los resultados obtenidos de la aplicación de las alternativas de mejora al producto, con relación al estado inicial del proyecto.

6.1.14. Conclusiones de la evaluación

7. Desarrollo de la evaluación

Una vez determinadas y caracterizadas las fórmulas de las nuevas placas, se practicó una evaluación ECC; dos mezclas de las ensayadas (mezclas claves 121 y 123) contra otra placa similar disponible en el mercado. La evaluación tiene como objetivo principal validar las mejores conductas de los nuevos productos hacia el medioambiente.

Nota importante: Aquí sólo se exponen; la figura 1 y la tabla 1. Quedan para futuras publicaciones la exposición de las restantes obtenidas en el proceso de ECC.

7.1 Descripción del producto a evaluar

En el mercado se encuentran tres tipos de placas de yeso comercial: Uno, el panel laminado de yeso adherido en sus caras a dos cartones delgados. Para mejorar la resistencia a la flexión, el panel de yeso estándar contiene fibra de celulosa en su núcleo. Dos la placa resistente al fuego: contiene un núcleo reforzado con la integración de fibra de vidrio resistente a medios alcalinos, la cual le proporciona características de resistencia al fuego, y; Tres, Placa de yeso para exterior, que está formado por un núcleo de yeso reforzado con agentes impermeables, que lo hacen resistente a la humedad.

7.1.1 Principales fabricantes de placas de yeso en México

USG. (United States Gypsum Company). KNAUF, Con una capacidad superior a 1000 millones de m², KNAUF es la mayor fabricante de placas de yeso del mundo y por último, PLACA COMEX que nace de la fusión de dos industrias en México; la primera COMEX líder mexicano en la fabricación de pinturas y recubrimientos con 50 años en el Mercado y la segunda, LAFARGE, líder mundial en la industria de materiales para la construcción.

7.1.2 Proceso típico de fabricación de placas laminadas de yeso

Un proceso típico para la fabricación de placas de yeso se puede resumir así:

1.Trituración del Yeso, el yeso procedente de la cantera se reduce de tamaño, obteniéndose un producto con un tamaño máximo de 35 mm, que es el adecuado para alimentar la molienda. 2.Molienda, el yeso es sometido a compresión, entre unos rodillos y un plato de molienda reducido su tamaño progresivamente hasta unas 200 micras, que es el adecuado para calcinarlo y posteriormente formar el yeso-escayola para la fabricación de las placas. 3. Calcinación, mediante la calcinación, proceso de calentamiento del yeso a 160°C durante unos 30 min., el yeso adquiere la propiedad hidráulica, es decir amasada con agua la pasta endurece en minutos. 4. Línea de producción de placas**,** al yeso en polvo calcinado se le añade agua y aditivos con lo que se obtiene una pasta que fraguará en pocos minutos. Por medio de la maquinaria de la línea de producción, esta pasta de yeso se introduce de forma automática y en proceso contínuo, entre dos láminas de cartón, que lleva a la obtención de la placa de yeso laminado. Posteriormente esta placa se corta a la medida especificada, se seca en un horno y se embala. 5. Almacén y distribución.

7.1.3 Proceso general de instalación de placas de yeso

Los elementos que intervienen en la instalación de las placas son igualmente importantes pues forman parte del ciclo de vida del producto. En breve, el proceso consiste en colocar y asegurar las placas sobre una estructura metálica, la estructura generalmente está constituida por materiales livianos como postes y canales galvanizados.

7.2 Descripción del sistema – producto

La determinación del sistema-producto para la evaluación se decidió tomando considerando las etapas del Ciclo de Vida Simplificado (CVS) de un producto: Obtención de los materiales, Producción, Comercialización y distribución**,** Uso del producto y Fin de vida. Adelante (fig.1), se muestran los materiales considerados para valoración, relacionándolos con las etapas del CVS al mismo tiempo que se especifican los sub-procesos que han sido tomados en cuenta, en cada etapa del sistema-producto placa de yeso laminado de núcleo regular. De la información del fabricante, se tiene que el lote de producción se transportará de la planta de fabricación al centro de distribución, desde donde se surtirán los puntos de venta distribuidos en toda la República Mexicana.

Según el datos del fabricante la placa tiene una fase de vida útil de 30 años. En su fase de uso se incluye la instalación de la placa con todos los accesorios necesarios, como lo son: perfiles, tornillos, cinta y pasta para juntas.

7.3 determinación de la unidad funcional

Para efectos de este estudio se determinó que la unidad funcional será: una pared con un área de 2.4 m x 3.6 m recubierta con placas de yeso de 12.5 mm de espesor, la evaluación comprende todos los materiales necesarios para su construcción, excepto acabados.

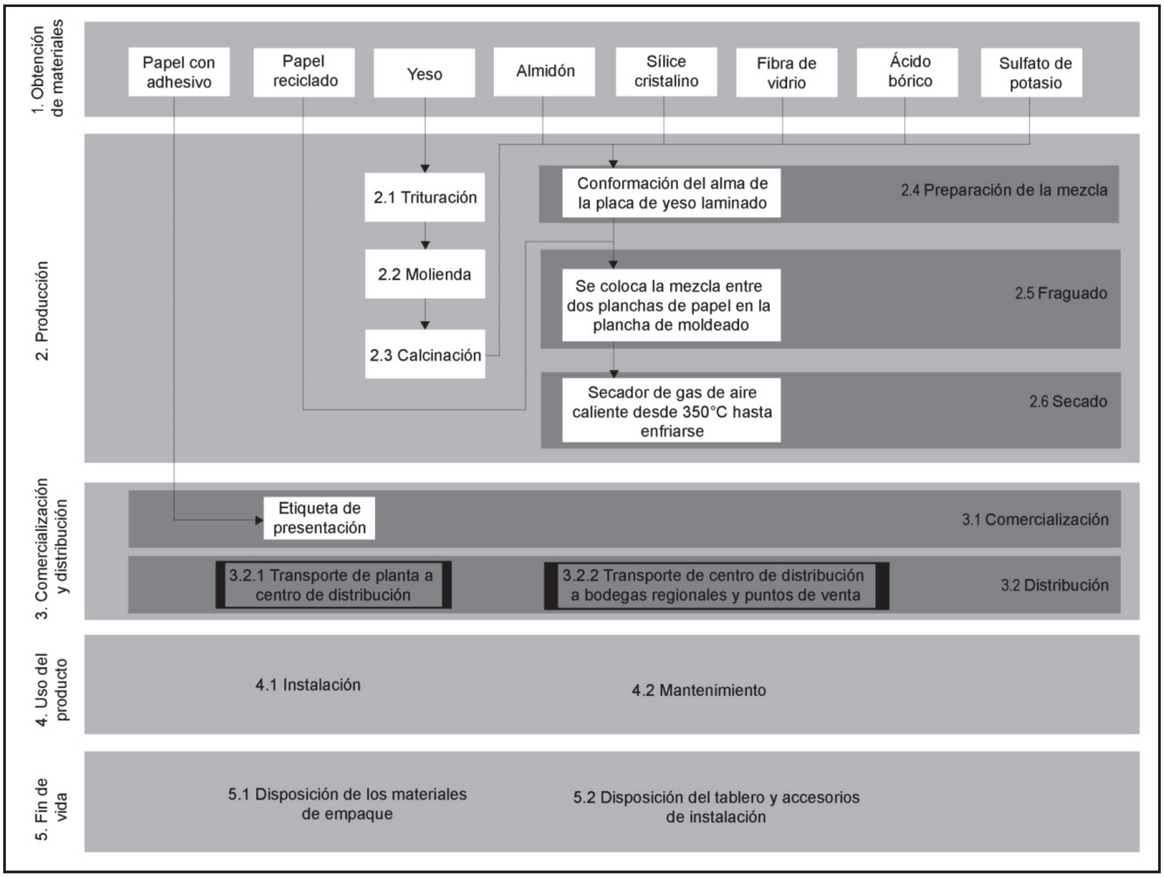

Fig 1. Sistema producto a evaluar . Fuente: Elaboración propia. Elaboración propia. G.Madariaga, Delsordo N. Selene, González Q. A. Patricia (2014)

7.4 Matriz MET

Se examinan los principales impactos detectados en la matriz MET (tabla1). Los impactos están asociados a las cinco fases del ciclo de vida del sistema-producto y se resumen así:

7.4.1. Obtención de materiales

Para la fabricación de las placas de yeso aligeradas, se necesitan 2 tipos de yeso, vulgar y fino, partículas de plástico expandido de entre 3 y 6 mm y fibra de agave seca. Se usa papel o cartón de reciclado para ambas las caras de la placa. Se requieren de distintos elementos accesorios como perfiles metálicos, pasta y cinta para poder su instalación. Todos los materiales se consideran en crudo, no se consideran para efectos de la evaluación los procesos de transformación previos

Tabla 1 Matriz met. Producto comercial

Etapas	**Impacto en los recursos materiales (M)**				**Recursos (E)**	**Emisiones (T)**
1. Obtención de materiales **Se consideran los materiales crudos, pero no se consideran todos los procesos de transformación hasta convertirse en los insumos para la elaboración de la placa de yeso laminado.**	Yeso	Yeso	59.2	kg	La energía asociada a la obtención y transporte.	Emisiones de gases invernadero asociadas a la obtención y transporte.
	Químicos	Sulfato de potasio	3.48	kg		
		Almidón	2.10	kg		
		Sílice cristalino	3.48	kg		
		Fibra de vidrio	0.70	kg		
		Ácido bórico	0.70	kg		
	Celulosa	Papel reciclado	10.4	kg		Emisiones de derivados clorados y azufre.
		Cinta de papel	7.32	m		
2. Producción **Se desglosan materiales y procesos de manera independiente. Sólo se consideran los procesos a partir de que los insumos industriales llegan a planta.**	2.1 Trituración	Yeso natural	59.2	kg	La energía asociada al proceso.	Residuos del material, emisiones por el uso de electricidad.
	2.2 Molienda	Yeso natural	59.2	kg		
	2.3 Calcinación	Yeso natural	59.2	kg		
	2.4 Preparación de la mezcla	Yeso calcinado	59.2	kg		
		Almidón	2.10	kg		
		Sílice cristalino	3.48	kg		
		Fibra de vidrio	0.70	kg		
		Ácido bórico	0.70	kg		
		Sulfato de potasio	3.48	kg		
	2.5 Fraguado	Mezcla	69.6	kg		
		Papel reciclado	10.4	kg		
	2.6 Secado	Placa	69.6	kg		
3. Comercialización y distribución	Celulosa	Papel con adhesivo (etiqueta)	7.32	m	La energía asociada al proceso de empaque y combustibles.	Gases invernadero por el uso de combustibles.
4. Uso del producto	Instalación	Canal metálico calibre 26	2	pza	La energía asociada al proceso de instalación	Residuos de materiales de instalación
		Poste metálico marca USG calibre 26	5	pza		
		Tornillos tipo S, 1”	48	pza		
		Pasta para juntas	2.10	kg		
		Cinta de refuerzo	9.60	m		
5. Fin de vida	5.1 Disposición de los materiales de empaque	Basura doméstica: papel con adhesivo	7.32	m	La energía asociada a los procesos de recolección, transporte y tratamiento de desechos.	Emisiones de gases invernadero asociados a la descomposición.
	5.2 Disposición del tablero núcleo regular	Vertedero: núcleo	3	pza		
		Vertedero: Perfiles metálicos	7	pza		
		Vertedero: Tornillos tipo S 1”	48	pz		

Fuente: Elaboración propia.: G. Madariaga, Delsordo N. Selene, González Q. A. Patricia (2014)

7.4.2 Transformación

Impacto en los recursos materiales: los principales impactos se relacionan con la explotación de dichos recursos renovables y no renovables.

Impacto en los recursos energéticos: dentro de los procesos de obtención de materiales se produce un consumo energético, principalmente el de combustibles no renovables utilizados para la transportación de dichos materiales.

Impacto por emisiones tóxicas: cada categoría de materiales tiene impactos distintos en emisiones o residuos, pero son principalmente los asociados a la contaminación del aire por partículas y emisiones de gases invernadero.

7.4.3. Comercialización y distribución

Incluye los materiales y energía de distribución del producto terminado hacia los lugares físicos del canal de distribución, así como los materiales de protección y marca (etiquetas, empaque y embalaje). No se incluyen los materiales ni energía de traslado de componentes elementales en las diferentes etapas del proceso de extracción y transformación.

Impacto en los recursos materiales: en el caso de las Placas aligeradas, para su presentación al público, son atadas de dos en dos con una cinta de papel (base de celulosa) que se retira fácilmente al momento de ser instalada.

Impacto en los recursos energéticos: este es el rubro con mayor impacto en la etapa de comercialización y distribución, ya que las distancias pueden ser grandes, y por tanto, el consumo de combustibles también. También se incluye la energía requerida para el proceso de empaque individual y embalaje, que suele ser electricidad.

Impacto por emisiones tóxicas: el impacto es principalmente al aire, asociado con la emisión de gases invernadero, y en segundo lugar a los residuos de los materiales.

7.5. Uso del producto

Para esta etapa del ciclo de vida, sólo se consideran las actividades de instalación y mantenimiento del producto.

Impacto en los recursos materiales: los materiales que se agregan en esta etapa del ciclo de vida son los que conforman los accesorios de instalación del producto, como lo son: perfiles metálicos, tornillos, pasta y cinta.

Impacto en los recursos energéticos: se considera la energía asociada al proceso de instalación, la cual suele ser la energía eléctrica utilizada por aparatos como taladro.

Impacto por emisiones tóxicas: las emisiones de esta etapa son principalmente las de residuos de materiales de instalación.

7.6 Fin de vida

Los materiales de empaque y embalaje en su mayoría tienen un final de vida previo al producto, convirtiéndose en basura doméstica e industrial, dispuesta generalmente en vertederos. Cuando el producto en sí llega al final de vida, se convierte en un residuo, que es dispuesto como escombro.

Impacto en los recursos materiales: en esta etapa no se agregan recursos materiales relevantes.

Impacto en los recursos energéticos: se considera el consumo de combustibles para la recolección, transporte y tratamiento de los desechos.

Impacto por emisiones tóxicas: principalmente el impacto consiste en la emisión de gases invernadero por el consumo de combustibles no renovables, y los asociados a la descomposición.

7.6.1. Aplicación de Ecoindicadores

Ahora, se multiplican por un indicador a través del programa Eco –it (Eco-it: 2014) las cantidades necesarias de materiales identificados en la Descripción de materiales En tablas (ejemplo, Tabla 2) se organiza esta información que cuantifica el impacto ambiental de un material o proceso de producción específico, lo cual muestra su utilidad al valorar diferentes estrategias de diseño. Para la aplicación de los indicadores se consideraron, en su mayoría, los materiales iniciales sin transformación. Algunas limitaciones a las evaluación y las tablas correspondientes se describen con detalle en el reporte de la ECC (reporte aún proceso de publicación) las limitaciones se deben principalmente a la disponibilidad de ecoindicadores más precisos.

7.7. Valoración de Estrategias de Ecodiseño

Al momento de escribir esto, las tablas restantes aunque muy avanzadas, aún se encuentran en la etapa de análisis y discusión, por lo cual se reportarán los detalles en documentos de investigación posteriores.

8. Conclusiones

Con la información disponible al momento de escribir esto se ofrecen algunas conclusiones preliminares:

Los resultados de la ECC obtenidos hasta ahora tienden a evidenciar un mejor comportamiento ambiental de las placas formuladas con pastas de yeso, partículas de plástico y fibra de agave, contra las placas comerciales empleadas para su evaluación.

Se puede concluir que los principales impactos al medio se encuentran en la obtención y procesado de los componentes, seguidos por su distribución y uso, mientras que la etapa de fin de vida reporta los menores impactos.

El modelo de ECC empleado, se ha mostrado como una herramienta de gran utilidad para los equipos diseñadores que buscan mejorar el desempeño ambiental de los productos sobre los que trabajan. Sus resultados potencian una mejor toma de decisiones en los equipos de desarrollo de productos.

La ECC es un proceso demandante en recursos humanos, técnicos y económicos esto coopera a que su aplicación sea incipiente en la industria.

La ECC es también una revisión de la calidad de las estrategias y productos evaluados, por lo cuál también puede ser aplicada como una herramienta para mejorar la competitividad de las empresas.

9. Reconocimientos

Nuestro reconocimiento a los jóvenes investigadores:

Zaira Selene Delsordo Núñez. Universidad Autónoma de Sinaloa. México.

Ana Patricia González Quiñonez. Inst. Tecnológico Superior de Cajeme, Sonora. México.

Quiénes como jóvenes investigadores realizando una estancia en la Universidad de Guadalajara participaron activamente y de manera sustantiva en la realización de este trabajo. Mil gracias!

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Interaction Design of Public Electronics Equipment: Approach to Categorization Systems and Analysis Model

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Resumo

O desenvolvimento tecnológico alterou a forma como os utilizadores se relacionam com os produtos - deixaram de ser recetores passivos de funções para interagirem com sistemas cada vez mais complexos. A presente pesquisa aborda a problemática da interação do consumidor com produtos tecnológicos eletrónicos públicos. São vários os estudos que se debruçam sobre as disciplinas que estudam a interação entre o utilizador e o produto eletrónico (Preece, 2005; Johnson-Laird, 1983; Helander, 1997, Sutcliffe, 1995; Norman, 1990; Moraes, 2001), possibilitando obter conhecimentos sobre o ser humano, a tecnologia e sobre a maneira como atuam. Esta pesquisa pretende-se identificar os domínios do design de interação que envolvem o sistema homem-máquina, designadamente as disciplinas que concorrem para uma boa usabilidade. É proposto seis tipologias que descrevem caraterísticas de interface específicas estudadas segundo o modelo de complexidade definido por Gomes Filho (2003). Realizou-se uma pesquisa exploratória em Portugal a qual identificou vinte e seis sistemas interativos. Para caraterizar os sistemas eletrónicos públicos, o estudo apresenta uma analise estruturada das variáveis atrás referidas, tanto em relação a sua confiabilidade e validade, como também, à sua funcionalidade. Os resultados são comparados com a literatura e são discutidas as suas implicações para o desenho do Modelo de Articulação Utilizador - Sistema.

Palavras chiave*: Design, Interação, Sistemas, Usabilidade, Modelo de Análise.*

Abstract

Technological development has changed the way users relate to products, they are no longer passive receivers of functions to interact with increasingly complex systems. This research addresses the problem of consumer interaction with public electronic technology products.

There are several studies dealing with the disciplines that study the interaction between the user and the electronic product (Preece, 2005; Johnson-Laird, 1983; Helander, 1997, Sutcliffe, 1995; Norman, 1990; Moraes, 2001), making it possible to obtain knowledge about human beings, technology and the way they operate.

This research aims to identify the areas of interaction design that involve the human-machine system, in particular the disciplines that contribute to good usability.

Six typologies are proposed that describe specific interface characteristics studied according to the model of complexity defined by Gomes Filho (2003).

Exploratory research in Portugal identified twenty-six interactive systems. To characterize the public electronic systems, the study presents a structured analysis of the variables mentioned previously, in relation to both reliability and validity, as well as functionality.

The results are compared with the literature and the implications discussed for the design of the User Interface System Model.

Keywords*: Interaction Design, Categorization Systems, Usability, Analysis Model, Public Equipment.*

1. Introdução

O presente estudo, pretende contribuir para um melhor entendimento da problemática da interação homem - sistema, e permitir que a usabilidade seja levada em consideração pelos *designers* deste tipo de equipamentos, designadamente, no desenvolvimento de conceitos de interação nos produtos.

Para tal, pretende-se compreender a funcionalidade exigida e as restrições sobre as quais um produto deve operar ou ser desenvolvido, por forma a passar essa informação para as atividades de *design*. Também será pertinente: identificar as caraterísticas dos sistemas interativos públicos e determinar tipologias segundo a funcionalidade e analisar o grau de complexidade; compreender os fatores humanos que intervêm na interação utilizador-sistema; identificar os pressupostos de usabilidade que poderão ser passados para a atividade de *design*; explicar os princípios do *design* de interação; compreender as necessidades dos utilizadores, as suas capacidades e os seus objetivos.

Este estudo baseou-se numa estratégia qualitativa de pesquisa, de caráter exploratório, por meio do levantamento e análise de fontes secundárias (bibliográficas e documental) e pela observação direta dos sistemas no contexto geográfico de Portugal. A metodologia utilizada no estudo considerou ainda um levantamento teórico sobre o processo de interação utilizador - sistema e as suas variáveis e a usabilidade. Para isso, foi utilizada uma abordagem indutiva, onde se tentou unir as proposições particulares observadas e analisadas, por forma, a apresentar um modelo de análise.

2. Design de Equipamentos Públicos Eletrónicos

2.1. Equipamentos Públicos Eletrónicos

No *Design*, um dos principais aspetos ligados ao uso do produto pode ser entendido a partir do estudo na relação que se estabelece entre o Homem – Máquina. Ao *designer* é dada a responsabilidade de conceber a forma como esta ligação é estabelecida.

Desde a Revolução Industrial que a produção em massa permitiu ao homem entrar em contacto com um número crescente de objetos, com diferentes funções, materiais, formas e modos de operar.

Por um lado, a disseminação de novos objetos possibilitou um maior conforto para o utilizador, por outro, aumentou-lhe as dificuldades de se relacionar com eles. Esta dificuldade é sentida com mais intensidade durante as primeiras utilizações, podendo causar nele a sensação de surpresa, confusão, dificuldade, erro e frustração.

Atualmente, os objetos estão mais tecnológicos, complexos e difíceis de utilizar, quer através da adição de novas funções quer pela redução do tamanho.

Segundo Norman (1990), sempre que o número de funções e de operações necessárias é maior que o número de comandos, o *design* converte-se em arbitrário, antinatural e complicado. A mesma tecnologia que simplifica a vida ao adicionar mais funções a cada objeto, também a complica fazendo com que cada artefacto seja mais difícil de aprender e de utilizar.

No espaço público, o utilizador vive rodeado de novos equipamentos eletrónicos urbanos altamente tecnológicos (máquinas ATM, de bilhética, de controle de acessos, validadores de títulos de transporte, de venda de alimentos, controles de elevadores, entre outros). Parte destes equipamentos apresenta um elevado número de funções, reduzida interatividade e lógicas diferentes de operar, obrigando a que o utilizador altere de modelo mental durante as diferentes interações com os diferentes dispositivos com que se confronta.

2.2. Design de Interação

Muitas das questões que se levantam ao Design de Interação estão ainda por revolver. Segundo Preece (2005), o Design de Interação tem como objetivo desenvolver objetos/produtos interativos que apoiem as pessoas no seu dia-a-dia. Por outro lado, usabilidade refere-se à fácil aprendizagem, a uma efetiva utilização, a proporcionar uma agradável experiência e ao envolvimento dos utilizadores no processo de *design*.

O objetivo do Design de Interação é pois, facilitar as interações entre os seres humanos com os produtos. Segundo Saffer (2006), este tipo de *design* deve facilitar a forma como as pessoas interagem entre si através de produtos e serviços. Num certo sentido, é também a forma como os humanos interagem com determinados produtos inteligentes que facilitam a comunicação humana.

Por outro lado, a sua aplicação visa a melhoria da relação homem-máquina (computador) já que o sucesso de um produto no mercado depende muito da experiência interativa que este pode proporcionar.

Alguns dos seus benefícios podem definir-se como:

- Adequar respostas do sistema às entradas do utilizador;
- Equilibrar a relação interação e funcionalidade;
- Prevenir erros do utilizador.

A Interação Homem - Computador é crescente e inevitável, pois grande parte da mudança da sociedade moderna assenta no seu uso. Esta não se limita à interação do utilizador com aplicações informáticas e interfaces gráficas de páginas Web. O computador apresenta-se na maior parte dos equipamentos utilizados mas é impercetível para os utilizadores. Estes não o reconhecem como tal, pois os comandos utilizados não são o *rato* ou teclado, mas comandos visuais, tácteis, vocais, gestuais ou de presença.

A questão sobre a usabilidade de equipamentos eletrónicos urbanos é pouco difundida, fazendo com que seja necessária uma maior abordagem sobre o assunto. Esta questão torna-se ainda mais premente, pois estes equipamentos estão em plena expansão. No entanto esta utilização nem sempre satisfaz o utilizador, causando nele experiências negativas que na maioria das vezes, estão relacionadas com falhas de usabilidade.

2.3. Grau de Complexidade dos Produtos

Segundo Gomes Filho (2003), os produtos podem caracterizar-se de baixa, média e alta complexidade. Produtos de baixa complexidade são aqueles que se configuram numa só peça ou que possuem reduzido número de componentes, os de média complexidade são os que apresentam uma certo carácter sistémico e uma maior quantidade de componentes e os de alta complexidade apresentam um alto grau de sistematização.

Na relação do utilizador com o produto eletrónico, o interface tem caraterísticas de particular complexidade. Por um lado, o manuseamento diz respeito à operacionalidade com o objeto e aos atos físicos que se relacionam com a ação. Por outro, está implicitamente associado ao ato de controlo.

Segundo o mesmo autor, podemos ainda dividir o manuseamento dos produtos em duas categorias: *simples e médio* e *mais complexo*. O primeiro envolve uma quantidade menor de atos operacionais (ex. ligar dispositivo, pressionar um botão, digitar um número). O *mais complexo* necessita de maior número e variedade de ações, com maior frequência, maior velocidade, maior tempo, maior concentração mental ou psicológica.

Assim, os produtos de alta complexidade, por utilizarem um elevado grau de sistematização, apresentam normalmente na sua configuração um grande número de componentes.

Neste tipo de produtos, o sistema homem-máquina-ambiente configura-se de modo completo por meio de relações ergonómicas que se estabelecem mutuamente. O manuseio destes equipamentos necessita de um número de ações precisas, sequenciais, com certa velocidade, exigindo mais tempo e concentração por parte do utilizador. Exemplos deste tipo de produtos são as caixas eletrónicas, sistemas bancários e de bilhética.

Quanto aos produtos de média complexidade são os que apresentam um certo carácter sistémico, possuem uma maior quantidade de componentes e de partes que o configuram e um maior grau de tecnologia envolvida. O seu manuseamento necessita de menor quantidade de atos operacionais.

Designam-se por interfaces de uso simples, aquelas em que as tarefas não exigem dos utilizadores grandes dificuldades de aprendizagem, destreza e experiência, assim como solicita um reduzido esforço físico e mental.

Nestes produtos, o manuseamento necessita de uma quantidade reduzida de ações. No entanto, a linguagem utilizada deve ser simples e clara de forma a proporcionar facilidade, lógica e total compreensão. Exemplos deste tipo de produtos são os videoporteiros, campainhas ou comandos de elevadores.

3. Sistemas Interactivos Públicos

3.1. Sistemas Interactivos Públicos - Tipologías

Do levantamento realizado, na literatura sobre sistemas eletrónicos interativos e ilustrado com imagens recolhidas através da observação direta e pesquisa exploratória *online*, foram identificados um total de trinta e dois sistemas (32) públicos diferentes, os quais foram agrupados em seis (6) tipologias funcionais diferentes. Através da análise das caraterísticas de cada conjunto foram definidas as seguintes designações: Venda, Informação, Acessos, Bilhética Bancários, Pagamento. Na tabela 1 poderemos ver o resultado do levantamento realizado, isto é, observar quais as áreas, tipologias e produtos associados a cada grupo.

Porém, cada sistema é constituído por um *posto*, onde se realiza a interação e onde se executa uma ou mais tarefas, com um ou mais objetivos. Designa-se por *posto*, o lugar onde alguém é colocado para cumprir uma tarefa ou uma função definida, fazendo parte de um conjunto de ações determinado em si mesmo. O *posto* é, pois, uma posição situada num dispositivo geral (sistema). Corresponde a um papel fixado comportando ordens, isto é, instruções sobre o que é necessário fazer, quando fazê-lo, e como fazê-lo.

Assim, pode-se referir que os postos de trabalho fazem parte do dia-a-dia de praticamente todos os tipos de atividades (profissionais ou outras) do Ser Humano. Segundo Gomes Filho (2003), um posto de trabalho faz parte de um tradicional sistema de produção e, de um modo geral, está inserido nas empresas (indústria, comércio, serviços...).

Dentro deste conceito encontram-se os postos de trabalho eletrónicos, considerados aqui como *sistemas interativos públicos*. Neste tipo de equipamentos, os utilizadores realizam a tarefa instruindo o sistema sobre o que fazer. O utilizador pode dar as ordens de várias maneiras, mas na maioria dos casos é feita através da pressão de determinado botão.

Tabela 1. Sistemas Interactivos Agrupados Segundo Áreas Funcionais

Área / Tipologias / Produtos/Serviços	
1. Sistemas Automáticos de Venda	
Vending Machine	Comidas Bebidas Tabaco Cafetaria Farmacêuticos Selos
2. Sistemas de Informação	
Quiosques Multimédia	Escolas Imobiliário Hotelaria Turismo Rodoviário Culturais Setor Público
3. Sistemas de Controlo Acesso	

Controlo Acessos	Campainhas Elevadores Vídeo Porteiro Obliteradores Torniquetes Biométrico
Sistemas de Bilhética	
Postos de Venda Bilhetes	Transportes Públicos Estacionamento
Bilhética sem Contacto	Cinemas Teatros Exposições Eventos Espetáculos
4. Sistemas Bancários	
Caixa Automáticas	Serviços Bancários Standard
Terminais Eletrónicos	Serviços Bancários Abrangentes
5. Sistemas Pagamento Automático	
Terminal de Pagamento Automático	Lojas/Restaurantes Serviços Diversos
Caixa Automática Self- Checkout	Pequenas e Grandes Superfícies Lojas de média/grande dimensão

Um dos benefícios deste tipo de conceito, que se baseia no fornecimento de uma instrução, é o de sustentar uma ação rápida e eficiente, sendo por isso, adequado principalmente para as ações repetitivas realizadas com objetos múltiplos como é o caso dos sistemas em causa (Preece 2005).

3.2. Sistemas Interativos Públicos - Caracterização

3.2.1. Sistemas de Venda Automática (Vending)

Fig. 1 - Máquinas de Vending.

Os sistemas de venda automática de produtos (*Vending Machine*) são máquinas que utilizam interfaces de baixa ou média complexidade (Fig. 1). Estes equipamentos localizam-se em pontos de alto fluxo e com visibilidade elevada, sendo os canais de venda de produtos de marcas de alta perceção junto ao seu público-alvo.

Os produtos oferecidos apresentam a caraterística de serem de conveniência, com os quais os consumidores não estão dispostos a gastar muito tempo e esforço para comprá-los (Beisel,1993). São produtos que tentam satisfazer necessidades fisiológicas básicas, a fome e a sede, impulsionando o utilizador para o consumo de alimentos e bebidas e tabaco.

A figura 2 mostra as imagens de duas máquinas diferentes, uma de refrigerantes e outra de vários tipos de *snacks*.

Fig. 2 - Sistemas Venda Automática. (a) Máquina de venda de refrigerantes. (b) Máquina de venda de "snacks"

A primeira, máquina foi projetada de acordo com um modelo bastante simples que se baseia numa só instrução. Há poucos tipos de refrigerantes e cada um está representado por um botão que exibe a marca da bebida. O utilizador apenas pressiona determinado botão e recebe a bebida selecionada. A segunda máquina é mais complexa e apresenta maior número de produtos.

Dado o maior número de opções, esta não pode ser instruída através de um simples toque, é necessário um processo mais complexo, que envolve os seguintes cinco (5) passos:

1. Ler o código do produto,
2. Digitar esse código no painel ao lado,
3. Verificar o preço da opção selecionada,
4. Colocar as moedas,
5. Retirar o produto.

3.2.2. Sistemas de Informação

Fig. 3 - Máquinas de Informação.

Os *sistemas de informação* são postos de trabalho que utilizam um modelo conceptual que se baseia em pesquisa e navegação (Fig. 3). Estes modelos possibilitam ao utilizador explorar e pesquisar informações valendo-se da sua experiência adquirida noutras plataformas informáticas.

Estes equipamentos disponibilizam informação institucional das organizações, dos fabricantes, dos catálogos dos produtos, eventos, marketing e promoção, em que o utilizador procura a informação disponibilizada através de pontos de acesso à Internet.

Neste tipo de sistemas, *Quiosques Multimédia,* tem grande importância a forma como se estrutura a informação de modo a fornecer suporte a uma navegação efetiva e permitir ao utilizador pesquisar, procurar e encontrar diferentes tipos de informação.

3.2.3. Sistemas de Acessos

Fig. 4 - Máquinas de Acessos.

O termo *controlo de acessos* refere-se a máquinas que utilizam interfaces de baixa complexidade e estão relacionados com segurança física, sendo uma referência à prática de permitir o acesso a pessoas autorizadas a uma propriedade, prédio, sala, instalações desportivas e de espetáculo (Fig. 4).

O controlo físico de acessos pode ser obtido através de meios mecânicos como fechaduras e chaves; ou através de outros meios tecnológicos, como sistemas baseados em cartões de acesso de leitura de fita magnética, de códigos de barras, de proximidade, da combinação do leitor e teclado, ou através da introdução de dados biométricos que identificam o utilizador

O sistema é composto por processos de autenticação, autorização e auditoria. A autenticação identifica o utilizador, a autorização determina o que um utilizador autenticado pode fazer, e a auditoria diz o que o utilizador fez.

3.2.4. Sistemas de Bilhética

Fig. 5 - Máquinas de Bilhética

Os *sistemas de bilhética* são postos de trabalho eletrónicos que utilizam interfaces de média complexidade tendo como objetivo a venda de bilhetes para os mais variados fins, entre eles, os transportes rodoviários, ferroviários e fluviais, recintos de exposições, de desporto, culturais como salas de espetáculos, cinemas e teatros (Fig. 5).

O sistema de bilhética tem a caraterística de ser um sistema que está exposto ao grande público que compra, manipula e valida os bilhetes antes de passar as barreiras de controlo de acesso. Dado ser um equipamento manipulado pelo utilizador, o fator ergonómico ganha especial importância de forma a facilitar a sua utilização.

Em geral, estes aparelhos de venda de bilhetes exigem que sejam dadas várias instruções em sequência, por uma ordem que pode ser lógica ou arbitrária, o que pode levar o utilizador menos experiente a cometer erros.

Verifica-se ainda, que as ações necessárias nas diferentes máquinas com a mesma função variam muito de marca para marca, evidenciando pouca preocupação de padronização. Portanto, o conhecimento que o utilizador adquire numa máquina durante a interação, poderá não ser muito útil ao executá-la noutra.

3.2.5. Sistemas Bancários

Fig. 6 - Máquinas Bancárias.

Os *sistemas bancários* são constituídos essencialmente por caixas eletrónicas e terminais eletrónicos (Fig. 6). São postos de trabalho informatizados relativamente complexos, inseridos nos processos de automação bancária e funcionam como uma mini agência.

Disponibiliza serviços à base de auto atendimento, tendo como principal caraterística, a prestação de serviços bancários de modo ininterrupto e a utilização pelo cliente é efetuado através de cartão bancário.

O cliente/utilizador tem acesso pronto e automático às diversas modalidades de serviços prestados pelo banco: levantamento de dinheiro, consultas, transferências de valores entre contas, depósitos, realização de aplicações e investimentos, obtenção de estratos impressos, pagamentos de serviços, de e para outros serviços.

O utilizador-cliente necessita de alguma experiência para realizar certas tarefas e evita explorar no interface novas funcionalidades dada a responsabilidade que podem acarretar as ações incorretas.

3.2.6. Sistemas de Pagamento Automático

Fig. 7- Máquinas de Pagamento

Relativamente aos *sistemas de pagamento automático* são produtos que utilizam interfaces de baixa complexidade, como um simples terminal de pagamento automático, que permite realizar pagamentos eletrónicos no ponto de venda mediante a utilização de um cartão bancário (Fig. 7). O utilizador-cliente apenas tem que verificar o valor a pagar e introduzir o código secreto.

Outros produtos de pagamento utilizam interfaces de uso complexo, como as caixas de registo e pagamento *self-checkout*. Nestes sistemas, o cliente regista todos os produtos e no final efetua o pagamento.

É um sistema complexo que obriga a uma grande quantidade de ações em sequência, sendo necessária por vezes a presença de operadores para assistir os clientes, principalmente durante as primeiras utilizações.

Estes sistemas colmatam os problemas de fluxo, principalmente dos consumidores com pequenas unidades de produtos, e privilegia a rapidez, o controlo da operação e a privacidade. Estes equipamentos estão disponíveis em bombas de gasolina, restaurantes *self-service* e em grandes superfícies comerciais.

4. Análise e Discussão dos Resultados

A análise realizada às seis tipologias reconhece que no espaço urbano público o utilizador encontra sistemas eletrónicos muito diversos (Tabela 2). A análise à complexidade dos sistemas foi realizada tendo como base a utilização de cada equipamento numa *ação standard* (A/S) (ou de “uso principal do produto” (Gomes Filho, 2006)).

Tabela 2. Grau de Complexidade dos Sistemas

Tipologias	**Produto**	**Baixa** (Simples de uso) **1-4**	**Média** (Sistémico de uso) **5-10**	**Alta** (Sistémico de uso e muito tecnol.o) **10 (+)**	**Nº Ações**
1.Sistemas de Venda Automáticos A/S: Adquirir um *snack.*	*Vending Machine*				2-8
2.Sistemas de Informação A/S: Obter informação turística	*Quiosques Multimédia*				2-8
3.Sistemas Controlo de Acessos A/S: Entrar num banco	*Controlo de Acessos*				1-3
4.Sistemas de Bilhética A/S: Comprar um bilhete	*Bilhética s/ contacto*				5-8
	Postos E. Venda Bilh.				5-8
5.Sistemas Bancários A/S: Levantar dinheiro	*Terminais Eletrónicos*				5-8
	Caixa Automático				5-15
6.Sistemas Pagamento Automático A/S: Pagamento de um produto/serviço	*Terminal (TPA)*				2-4
	Caixa Self-Checkout				12-20

Assim, tendo como base para a análise comparativa uma ação *standard* definiu-se para o caso dos sistemas:

- Venda Automático - a ação "Comprar um produto alimentar (ex. snack) ";
- Informação - a ação "Obter informação turística (ex. uma cidade) ";
- Controlo de Acessos - a ação "Entrar num espaço público restrito (ex. Banco)",
- Bilhética - a ação "Comprar um bilhete";
- Bancários - a ação "Levantar dinheiro",
- Pagamento Automático - a ação "Pagamento de um Produto/Serviço".

Conclui-se pela análise realizada, que o grau de complexidade dos sistemas é muito diverso, determinado por um conjunto de ações muito distintas e em diferente número.

Assim, relativamente aos sistemas de *Venda Automáticos* podem apresentar um grau de complexidade baixo a médio porque a inter-relação varia entre um (2) a cinco (8) ações.

Nos sistemas de *Informação,* em que a interação é baseada na dinâmica pesquisa-navegação, as ações variam entre dois (2) a oito (8) ações. Caso o indivíduo necessite de mais informação, as oito ações serão ultrapassadas.

Nos sistemas de *Controlo de Acessos*, verifica-se um baixo grau de complexidade dado que o indivíduo apenas tem que interagir com o dispositivo entre uma (1) a três vezes (3). Ou passar um cartão, ou passar um cartão e digitar um código, ou estas duas e carregar num botão.

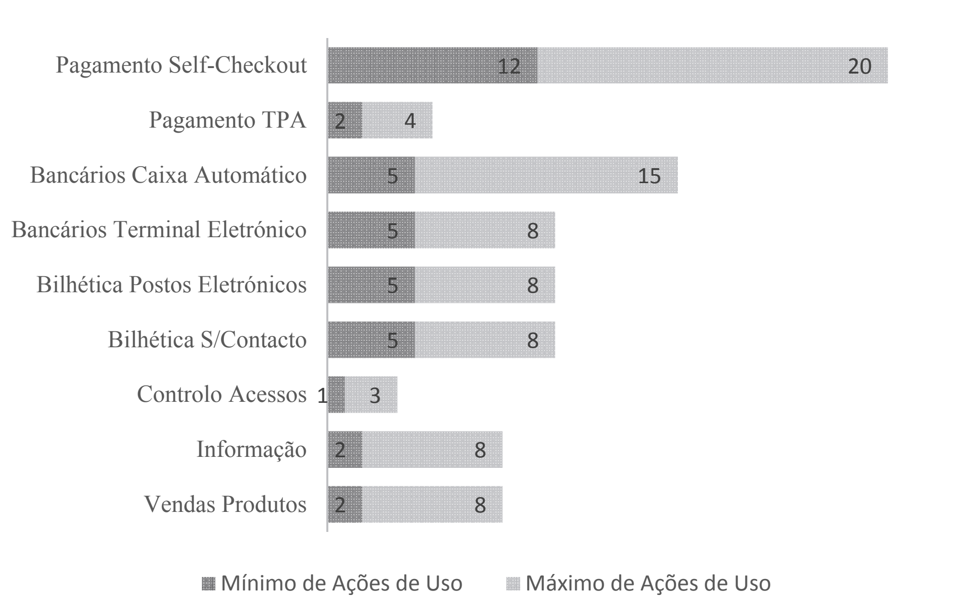
Quanto aos sistemas de Bilhética, o grau de complexidade é médio. Nos dois sistemas de bilhética analisados o número de ações varia entre cinco (5) e oito (8).

Relativamente aos sistemas *Bancários*, verifica-se um grau médio a alto de complexidade dado que o indivíduo nos Terminais Eletrónicos tem que interagir entre cinco (5) a oito (8) vezes com o sistema enquanto na Caixa Automático a variação pode ser maior, entre as cinco (5) e as quinze (15) ações.

Quanto aos sistemas de *Pagamento Automático*, verifica-se um baixo e um alto grau de complexidade dado que o utilizador no *TPA* só tem que realizar entre dois (2) a quatro (4). Por outro lado, nas Caixas Automáticas *Self-Checkout* o utilizador tem que realizar no mínimo doze (12) ações que, para o mesmo produto, pode chegar até vinte (20) ações. Nestas caixas, o utilizador tem que efetuar primeiro o registo do produto antes de efetuar o pagamento.

Tomando como referência a ação *standard* de cada sistema e por análise comparativa chegou-se aos valores muito diferenciados (tabela 3).

Tabela 3. Grau Comparativo Complexidade os Sistemas Públicos



Dos resultados apresentados verifica-se que o sistema de Pagamento *Self-Checkout* é o que apresenta o número de ações mais elevado, entre 12 a 20 ações. Outro dos sistemas que merece a nosso atenção é o

Bancário de Caixa Automático, o qual apresenta igualmente um número de ações que pode chegar às quinze (15). Relativamente ao sistema de controlo de acessos, é o sistema que apresenta os valores mais baixos entre 1 a 3.

Assim, no contexto do acesso aos sistemas eletrónicos urbanos públicos analisados, o sistema de Pagamento *Self-Checkout* constitui um problema especial para o Design. O equipamento é de uso sistémico e altamente tecnológico que sob condições de uso normal, deveria simplificar o sector do retalho no fluxo junto ao *Checkout* e facilitar o trabalho do utilizador aumentando a rapidez e a eficiência durante o ato de registo e pagamento dos produtos.

Por um lado, são vários os fatores psicológicos que interferem nesse delicado equilíbrio de controlo do sistema:

- Curiosidade
- Desafio da dificuldade
- Tolerância à frustração
- Tolerância ao erro

Por outro, quanto maior for o número de controlos, maior é a complexidade da perceção dos sistemas, obrigando o utilizador a aprender mais sobre a tarefa a desempenhar.

Para fazer com que algo pareça fácil de usar, talvez o Design tenha que minimizar o número de controlos por forma a igualar ao número de funções (Norman, 2006).

5. Modelos de Análise

Para explanar a forma como o designer vai ter que intervir, na segunda parte deste estudo debruçámo-nos sobre a noção de Modelo e Análise como forma de definir um esquema orientador da conceção teórica subsequente e a qual deve identificar os aspetos que intervêm no Design de Interação e na relação utilizador-sistema.

Primeiramente refletimos sobre os conceitos associados aos modelos teóricos, e verificámos na literatura a noção de “Modelo Mental e de “Modelo Conceptual” do ponto de vista do utilizador e do *designer*.

Seguidamente, e com base na análise global propusemos um Modelo de Análise onde se determina as relações entre os conceitos, as suas dimensões e indicadores, e onde se organiza de forma lógica e integradora as diversas variáveis e a dinâmica do assunto tratado (Sousa e Baptista, 2011).

5.1. Modelo Mental e Modelo Conceptual

Um modelo mental é uma representação de um objeto ou de um processo, sendo estruturalmente análogo aquilo que ele representa (Johnson-Laird, 1983). Embora seja incompleto e não represente diretamente a realidade, habilita o indivíduo que o possui, de fazer previsões ou de dar explicações (Kleer e Brown, 1981). Um modelo mental pode ser adquirido através da transmissão cultural, de instrução e das interações com outras pessoas e com o mundo (Borges, 1999).

Os modelos mentais são representações dinâmicas e produtivas que podem ser manipuladas mentalmente para proporcionar explicações causais de fenómenos físicos e para realizar previsões sobre o estado de coisas no mundo físico.

Muitos modelos são criados no momento da resolução de um problema específico, devido às solicitações dessa situação. No entanto, é possível que alguns modelos mentais, ou partes deles, mostraram utilidade no passado, sejam armazenados como estruturas separadas e recuperadas da memória de longo prazo quando necessário.

O conceito de *Modelo Mental* tem sido utilizado por diferentes estudos e de diferentes formas Johnson-Laird (1983), tendo tido início na psicologia e do qual a ergonomia faz várias leituras.

Para Helander (1997) é a expectativa que um utilizador tem em relação ao comportamento do computador.

Segundo Sutcliffe (1995), os modelos mentais podem ser divididos em modelos físicos e em modelos conceptuais.

- Os *Modelos Físicos* descrevem o relacionamento de objetos no mundo real em termos de distribuição espacial de eventos num dado período. Podem ser visualizados, especialmente se o problema envolve raciocínio espacial.
- Os *Modelos Conceptuais* são expressões linguísticas superficiais numa linguagem interna que, embora baseada na linguística, representa uma abstração futura. Modelos conceituais são uma espécie de linguagem mental interna que representa valores reais sobre objetos e as suas relações. A forma dos modelos mentais difere de pessoa para pessoa e depende de estilos cognitivos pessoais.

Preece et al (1994), defende que quando se interage com qualquer coisa, que pode ser o ambiente, outra pessoa ou artefato tecnológico, criam-se modelos mentais internos ao utilizador. E quando executados ou repetidos do início ao fim, os modelos "propiciam as bases a partir das quais se podem predizer ou explicar as nossas interações".

Moraes e Mont'Alvão (2000), destacam que o termo algumas vezes refere-se ao modelo que o utilizador tem do sistema, outras ao modelo que o projetista tem do sistema, e outras ainda, ao modelo que o projetista ou o sistema tem do utilizador.

Para Senge (1996), modelos mentais são feitos de premissas profundamente enraizadas, generalizações ou mesmo figuras ou imagens que influenciam como entendemos o mundo e como agimos.

Em comum a todas as definições está a ideia de que possuímos mapas cognitivos, a partir dos quais interpretamos os ambientes complexos e agimos sobre eles.

Assim, os autores atrás referidos preferem usar o termo modelo mental como o modelo que o utilizador tem do sistema. Então, modelo mental do utilizador "compreende o modelo do sistema, formado pelo utilizador, através de experiências e interações com o sistema e a partir da imagem do sistema" (Moraes, 2000).

Para Norman (2002), o modelo mental é o modelo conceptual do utilizador sobre a maneira particular como um objeto funciona, como os eventos acontecem ou como as pessoas se comportam. "Esses modelos são essenciais pois dão ao indivíduo uma visão sobre o mundo, sobre as suas próprias capacidades e sobre as tarefas que lhe são solicitadas realizar. Os modelos mentais possuem um poder de explicação e de previsão para o entendimento dessas relações - ajudam a entender as nossas experiências, prever as reações das nossas ações e manipular ocorrências inesperadas".

Para Booth (1992), esses modelos "são sempre construídos de evidências fragmentadas, com um entendimento pobre do que está a acontecer, e com um tipo de psicologia ingénua que procura causas, mecanismos e relações mesmo quando elas não existem", resultando na tendência que o ser humano tem de dar explicações para as coisas.

Em relação aos modelos mentais, Norman (1983) refere que é necessário considerar quatro elementos diferentes:

- O *sistema alvo*
- O *modelo conceptual* do sistema alvo
- O *modelo mental* do sistema alvo construído pela pessoa
- O *modelo do cientista* deste modelo mental

O sistema que a pessoa está a aprender ou a usar é, por definição, o *sistema alvo*. Um modelo conceptual é inventado por professores, projetistas, cientistas e engenheiros para proporcionar uma representação apropriada do sistema alvo, no sentido de ser preciso, consistente e completo.

Os modelos mentais são modelos em evolução, pois através da interação com o sistema, o utilizador altera o seu modelo mental no sentido de obter um resultado viável. Este modelo em evolução privilegia a funcionalidade em detrimento da precisão técnica.

Os modelos mentais são limitados pelo conhecimento técnico do utilizador, suas anteriores experiências com sistemas similares e pela estrutura do sistema humano de processamento de informações.

Norman (ibidem) concluiu que a compreensão que as pessoas têm sobre os dispositivos com os quais interagem é fraca, imprecisa e inconsistente. Os modelos contêm apenas descrições parciais das operações e uma grande área de incerteza.

Norman (ibidem) chegou à seguinte generalização sobre os modelos mentais:

1. São incompletos.
2. A destreza do utilizador em manipular os modelos é muito limitada.
3. São instáveis: o utilizador esquece detalhes do sistema, especialmente quando esses detalhes não são usados durante um certo tempo.
4. Não possuem limites rígidos: dispositivos e operações similares ocasionam confusão.
5. Não são científicos: o utilizador tem comportamentos supersticiosos mesmo sabendo que estes não resultam.
6. São parcimoniosos: O utilizador está disposto a realizar um esforço físico suplementar em troca de um modelo mental menos complexo.

As ciências cognitivas podem ajudar a entender as estruturas incompletas, indistintas e confusas que o utilizador tem sobre os produtos tecnológicos. Os *designers* têm a obrigação de desenvolver sistemas que ajudem o utilizador a conceber modelos mentais adequados à sua interação com o sistema. Ter em consideração o conhecimento do utilizador em termos de modelos mentais pode ajudar o *designer* a desenvolver interfaces apropriadas.

Norman (2002) afirma que o modelo conceptual permite simular mentalmente a manipulação de um dispositivo. Qualquer artefacto será mais simples de utilizar se tiver um bom modelo conceptual. Uma parte fundamental no desenvolvimento de um modelo consiste em determinar se as ideias criadas a respeito de como o sistema se deve parecer e se comportar, serão entendidas pelos utilizadores da maneira que se pretende.

Com base nos princípios apresentados, o *designer* deve assim construir um modelo conceptual para o artefacto que seja adequado ao uso.

Norman (ibidem) distingue três componentes associados ao artefacto: o Modelo do Designer, o Modelo do Utilizador e a Imagem do Sistema (fig.8). Os modelos do *designer* e do utilizador são modelos mentais. As pessoas formam modelos mentais de si próprias, das coisas e das pessoas com as quais interagem.

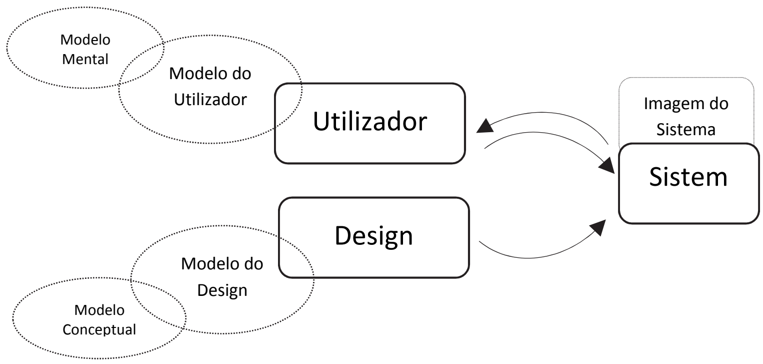


Fig. 8 Adaptado segundo o Modelo Conceptual de Norman (2002)

Esses modelos terão o poder de previsão e explicação, necessários para a condução da interação. Assim,

- O Modelo do Utilizador é o modelo mental que o utilizador desenvolve na interação com o sistema.
- O Modelo do Designer é o conceito que o *designer* tem sobre como o sistema deve trabalhar.
- A Imagem do Sistema resulta da estrutura visível do dispositivo, da sua aparência física, da sua forma de operar, de como responde..

Seria ideal, que o modelo do *designer* e do utilizador, coincidissem. O *designer* espera que o *modelo de design* seja idêntico ao do utilizador. Mas o utilizador não tem acesso direto ao *modelo do design* para compreender o funcionamento do dispositivo, ele tem que formar o seu próprio *modelo mental* através da *imagem do sistema* durante o uso.

Para tal, o designer deve assegurar que a *imagem do sistema* deixe o *modelo de design* claro, consistente, coerente, completo e sem contradições de forma a não haver dificuldades na sua utilização.

5.2. Modelo de Análise

Um modelo de análise é neste caso uma representação esquemática da realidade. O modelo de análise seguinte apresenta o esquema teórico representativo das dinâmicas que se estabelecem no Processo de Design de Interação Utilizador-Sistema e identifica ainda as variáveis e as relações que se estabelecem entre elas (Fig. 9).

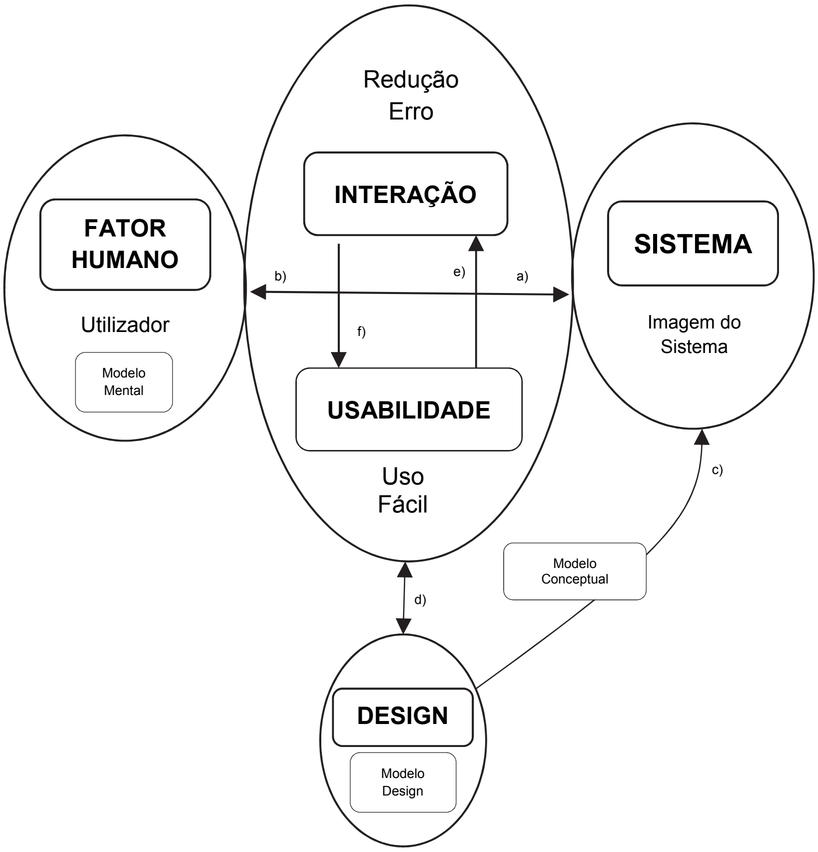


Fig. 9 - Modelo de Análise da Interação Utilizador-Sistema no Processo de Design

A partir da leitura do modelo analítico podemos afirmar que, para se estudar as dinâmicas da interação utilizador-sistema, existem quatro dimensões fundamentais: o Fator Humano, o Sistema, a Interação/Usabilidade e o Design.

Dentro das dimensões principais temos primeiramente a dimensão Fator Humano. Esta dimensão é o conjunto formado pelos utilizadores que vão interagir com o sistema e que vão adquirir experiencia pelo treino e instruções. O modelo mental a ele associado traduz como o utilizador pensa que o sistema funciona. Ele é influenciado pela interação com o sistema, pelas suas experiências anteriores e pela leitura de manuais de funcionamento. O utilizador é uma das variáveis independentes da análise dado ter caraterísticas intrínsecas ao fator humano como: sexo, idade, formação, experiência, social, cultural, hábitos, e linguística.

Na segunda dimensão temos o *Sistema*, o qual é a estrutura do dispositivo construído pela interface com as funções. A esta dimensão temos associado a *Imagem do Sistema*, onde o utilizador irá adquirir informação para formar o seu modelo de utilizador. Isso processasse através da interpretação das ações percebidas e da estrutura visível do sistema. O *sistema* assume aqui outra das variáveis da análise dado ter caraterísticas diferentes inerentes ao equipamento: dipositivo eletrónico, física da máquina (dimensão, cor, forma, corpo (sustentáculo do sistema), interface, hardware, e software) e funções (número – quantidade, complexidade, variedade).

Noutra dimensão temos a *Interação* e a *Usabilidade*. A *Interação* tem como objetivo reduzir o erro durante a utilização do sistema. Para isso, analisa a relação psíquica do utilizador durante o uso, as suas expectativas, as ações, e os aspetos relacionados com conforto e complexidade. Para além disso, identifica as necessidades e problemas traduzidos pelas variáveis: eficácia, eficiência, segurança / utilidade, facilidade de aprender e de lembrar. Diretamente relacionado com a *Interação* está a *Usabilidade*. A *Usabilidade* diz respeito ao estudo da forma como o sistema é usado. Para isso, analisa e define as caraterísticas das interfaces, os atributos e os requisitos de usabilidade, e determina as linhas guia.

A outra dimensão considerada no modelo de análise global é o *Design*. O *Design* é neste contexto desenvolvido com utilizadores e para os utilizadores. O projeto é centrado no utilizador (grupo piloto) e analisa as experiências, as necessidades e a reação ao interface. Depois é definido o modelo de design que é um modelo conceptual do sistema. Dentro desta dimensão estão incluídos diversos conceitos que são fundamentais para a definição de todo o processo como por exemplo o público-alvo. Esse público pode ser potencial, indireto/ocasional e o público que altera a decisão de compra por ser afetado pela introdução do sistema.

Relativamente às interligações entre as dimensões mencionadas, pressupõe-se que os *utilizadores* que têm um modelo mental de como o sistema funciona, ao interagir com este, vão observar a imagem do sistema, apreender e controlar (*a*).

O *sistema*, por sua vez, apresenta um modelo conceptual de utilização que deve ser compreendido pelos utilizadores (*b*).

Esse modelo conceptual é definido pelo *design* (*c*), determinado pelo modelo mental do *designer*, ou seja, de como ele considera que o utilizador vai interagir com o sistema, e pela pesquisa por ele realizada (*d*). É aplicada ao estudo da usabilidade do sistema com o objetivo de alcançar um bom nível de facilidade no uso e é aplicada no estudo da interação com o objetivo de reduzir o erro e poder fazer melhoramentos contínuos no modelo conceptual.

Por último, a *usabilidade* que define as linhas guia segundo os requisitos de usabilidade tem influência na *interação (e)*. Esta dimensão analisa as ações e a complexidade do sistema e tem como referência um guião para a usabilidade. Por sua vez, ao determinar o grau de interação do sistema determina o seu nível de usabilidade (*f*).

Do ponto de vista do *designer*, o grande contributo para o projeto de investigação do modelo de análise descrito é proporcionar um enfoque teórico no estudo a realizar posteriormente.

6. Conclusões

Este trabalho procurou apresentar a problemática da relação entre o utilizador e os sistemas eletrónicos públicos do ponto de vista do *design* de interação. Partindo de uma abordagem ao conceito de *design* de interação, passando pela análise dos sistemas eletrónicos públicos, identificou-se a existência de seis tipologias, as quais, segundo a análise do seu grau de complexidade, permitiu aferir a diversidade de equipamentos públicos com que o utilizador tem que interagir no dia-a-dia e aqueles que requerem maior aprendizagem.

Este trabalho procurou ainda apresentar os conceitos envolvidos com a análise das variáveis Fator Humano - Sistema, efetuando-se por isso, um modelo de análise que permitiu definir as dimensões, conceitos e variáveis que contribuem para o *design* de sistemas.

Neste contexto, designa-se por Design de Interfaces, a área do *design* que associa o design de produto ao design gráfico, nomeadamente equipamentos que integrem informações textuais, simbólicas, icónicas, mais a identificação de funções operacionais. Por outro lado, designa-se por Design de Interação todos os produtos tridimensionais com os quais o utilizador tem uma experiência de manipulação, e a forma como ele lida com as estruturas de ação que definem os procedimentos de uso.

Os modelos mentais que o utilizador desenvolve na interação com os vários sistemas, têm que ser simples e de rápida aprendizagem.

Por um lado, ao *designer* apresentam-se questões que têm a ver com a ideia que ele tem sobre a forma como o sistema deve funcionar e vai ser percecionado pelo utilizador. Por outro, a perceção efetiva que o utilizador tem durante o uso.

Para isso, o *designer* deve assegurar que a imagem do sistema deixe o modelo de design simples, de acessível compreensão e de fácil aprendizagem para que o utilizador não acabe com um perceção inadequada.

A questão da e interação e usabilidade dos equipamentos urbanos, compostos pela integração de várias equipamentos eletrónicos é pouco divulgada, fazendo com que seja necessária mais estudos sobre o assunto. Esta questão torna-se ainda mais premente, dado que a utilização destes equipamentos está em plena expansão.

Um *design* apropriado pode facilitar a aprendizagem e compreensão como exigir menor controlo e precisão por parte do utilizador. Pode ainda reduzir a incidência e a gravidade de erros ao eliminar as suas causas e melhorar a execução das tarefas diárias.

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Diseño de material didáctico para la enseñanza de anatomía.

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Resumen

La dirección de trabajos de grado bajo la temática de diseño y fabricación digital en la Facultad de Diseño, Imagen y Comunicación de la Universidad El Bosque de Bogotá (UEB), tiene como objetivo consolidar las habilidades del oficio del diseñador industrial en formación, con un fuerte componente tecnológico, fortaleciendo sus habilidades de interacción y comunicación con terceros, aportando en su formación cognitiva y ejecución de proyectos de diseño interdisciplinarios con otros campos del conocimiento tradicionalmente no explorados, en este caso específico en la educación en ciencias de la salud, particularmente para los procesos de enseñanza - aprendizaje de anatomía en sus diferentes ámbitos y particularidades. Como temática experimental inicial se seleccionó el desarrollo de material didáctico físico tridimensional para aportar al enfoque educativo de las clases de anatomía y morfología dental de la Facultad de Odontología, que sirvió como escenario de experimentación y que desencadenó la puesta en marcha de diversos proyectos similares con diferentes departamentos en la Universidad, pretendiendo facilitar la experiencia de enseñanza-aprendizaje, garantizando a los estudiantes una formación teórico-práctica a través de herramientas y recursos tridimensionales -simuladores de la realidad-, teniendo como característica una mejor apropiación de la información, a partir de la interacción directa con el conocimiento. El presente artículo busca ejemplificar el uso que se le puede dar a las tecnologías de diseño y fabricación digital, para expandir el abanico de oportunidades que desde la academia se pueden transmitir a los estudiantes, y puedan comenzar a permear campos del conocimiento poco tradicionales para el oficio del diseñador industrial, desmitificando su perfil como solamente configurador de la forma, perfilándose como un articulador líder de proyectos en un ámbito de trabajo multidisciplinar. Por medio de la planificación de un proyecto de diseño, profundizando el conocimiento en técnicas de modelado orgánico y escultura digital, y aprovechando el boom *de la fabricación digital. Con impresoras de modelado por deposición fundida (FDM) se pueden crear modelos didácticos complejos. Desde la dirección de trabajos de grado, con la temática de diseño y fabricación digital y como estrategia para alimentar los resultados de la Investigación Doctoral en Diseño, Fabricación y Gestión de Proyectos Industriales de la Universitát Politécnica de Valencia (UPV), denominada ¨Implementación de tecnologías de diseño y fabricación digital aplicadas en la enseñanza de Anatomía. Caso Estudio: Universidad El Bosque de Bogotá - Colombia¨, se presentan los resultados del primer año y medio de trabajo teniendo como base algunos resultados de trabajos de fin de carrera de los estudiantes bajo la dirección del profesor Juan Sebastián Ávila, doctorando de la UPV.*

Palabras clave: *diseño, anatomía, enseñanza, impresión 3D, interdisciplinaridad.*

Abstract

The present work is part of the Doctoral Research in Design, Manufacturing and Industrial Projects Management of the Universitat Politécnica de Valencia (UPV) and is incorporated in the PhD project called ¨The implementation of digital design and manufacturing technologies in the teaching of anatomy¨. It is based on the experience as a thesis director in the Design Faculty of the University El Bosque in Bogotá (UEB). The project discussed thereafter aims to strengthen the skills of students in Industrial design. With a strong technological component, the project's method relies on the elaboration of a design project,*ersity El Bosque in Bog in order to deepen the knowledge of organic 3D modeling techniques and do strengthen the skills igital sculpture, taking advantage of the boom in digital manufacturing. Thlogical component, the e project focuses on strengthening the students' communicative and inte*n project*, in order to dractive skills with third parties, it particularly empowers the cognitiques and digital sculptuve abilities needed to work in an interdisciplinary environment. Here thuring. The project focuse study case concentrates on education in health sciences, specifically the tand interactive skillseaching and learning of anatomy in different disciplines. In the initial cognitive abilities nphase of the project, 3-dimensional physical teaching materials were selected to provide the pedagogical approach to Anatomy and Dental Morphology classes of the Faculty of Dentistry.*

Said materials constituted the starting point for further experiences and indeed it triggered the implementation of various similar projects with other departments at the UEB, all aiming to facilitate the experience of teaching - learning, guaranteeing students a theoretical and practical training through three-dimensional resources. The main feature of such training consists in a better comprehension of information, thanks to a direct and concrete interaction. This article seeks to illustrate the use given to digital design and manufacturing technology to expand the range of opportunities that could be transmitted to students in academia and such process could permeate non-traditional fields for future industrial designers, demystifying their profile solely as form-esthetics configurators toward eventually emerging as leading projects coordinators in a multidisciplinary field of work. 3D printers of fused deposition modeling (FDM) can create complex didactic models. The present paper will discuss the results of the first year and a half of work based on the academic results of design students under the direction of Professor Juan Sebastián Ávila, PhD student at the UPV.

Keywords: *design, anatomy, teaching, 3DPrint, interdisciplinary.*

1. Introducción

El presente artículo busca ejemplificar el uso que se le puede dar a las tecnologías de diseño y fabricación digital, para expandir el abanico de oportunidades que desde la academia se pueden transmitir a estudiantes de carreras afines al diseño y la creación, permeando campos del conocimiento poco tradicionales para el oficio del diseñador, desmitificando su perfil como solamente configurador de la forma y perfilándose como un articulador líder de proyectos en un ámbito de trabajo multidisciplinar de base tecnológica. Por medio de la planificación de un proyecto de diseño de forma estratégica, profundizando los conocimientos impartidos en técnicas de modelado orgánico y escultura digital, y aprovechando el *boom* de la fabricación digital, con ayuda de tecnologías como impresoras de modelado por deposición fundida (FDM) se pueden crear modelos didácticos complejos para la enseñanza de anatomía en diferentes ámbitos de aplicación como puede ser medicina, odontología o biología entre otros campos de difícil acceso para un estudiante de pregrado de una carrera como el diseño industrial.

2. Enseñanza de anatomía. Antecedentes

Fig. 1. La lección de anatomía del Dr. Nicolaes Tulp - Rembrandt. El cuadro muestra una lección de anatomía impartida por el doctor Nicolaes Tulp a un grupo de cirujanos. El doctor Nicolaes Tulp está representado explicando la musculatura del brazo a profesionales de la medicina.

Desde la academia los estudiantes de ciencias de la salud (Medicina, Odontología, Enfermería, etc) orientan su aprendizaje hacia la práctica clínica, destacando la información anatómica, útil para comprender funcionamientos, procesos exploratorios, enfermedades y tratamientos.

Existen tres métodos de aproximación hacia la enseñanza de la anatomía, descriptiva, topográfica y funcional: i), la anatomía descriptiva muestra cómo es la forma y la estructura de las partes del organismo; ii), la anatomía topográfica o regional divide el cuerpo en unidades imaginarias y convencionales, con objeto de establecer las relaciones espaciales de las distintas estructuras y iii), anatomía funcional, que busca la correlación existente entre las formas del organismo y las funciones que realizan, en un intento de captar la unidad entre forma y función en la materia viva.

Según las ideas del doctor Emilio Martínez (Martínez, 2012), actualmente existen diferentes modelos de enseñanza de la anatomía. Históricamente uno de los más representativos está basado en el estudio de especímenes en prácticas de laboratorio (secciones de cadáveres conservados), de vital importancia para los estudiantes, al aproximarlos de una forma más realista a los procesos y tareas que llevarán a cabo en su vida profesional, pero que en términos prácticos son difíciles de gestionar. Esto puesto que necesitan de recursos financieros importantes para su consecución, licencias sanitarias, personal de mantenimiento específico, espacios adecuados para las prácticas, y no siempre se garantiza el buen estado de los especímenes para los procesos de enseñanza - aprendizaje que deben estar disponibles en las universidades. Por otra parte, los especímenes tienen la información real, pero no resaltan las características esenciales a estudiar, dificultando la comprensión de su anatomía.

Existe también una gran cantidad de autores y libros representativos que con gráficas de autor, dibujos o fotografías, ilustran con gran detalle y de forma extensa los sistemas anatómicos completos del cuerpo humano. En los últimos años, los modelos virtuales en tercera dimensión y aplicaciones (*apps*) educativas han incursionado con gran fuerza en todos los escenarios y experiencias de enseñanza - aprendizaje en todos los niveles educativos, lo que ha llevado a la masificación de la información, practicidad en los procesos de enseñanza, exactitud, transferencia y detalle de los elementos a estudiar.

Por otra parte, y como tema principal de estudio de este artículo, existen los modelos anatómicos artificiales tangibles, y modelos que por su origen y naturaleza de simulación son prácticos, útiles en procesos de enseñanza al segmentar con códigos de color, contrastes de material, forma o alfanuméricos, las diferentes estructuras anatómicas a estudiar, haciendo el proceso más sencillo de observar, entender y sentir su tridimensionalidad.

Fig. 2. Modelo en plastilina del Nervio trigémino. Anfiteatro Universidad El Bosque. Septiembre 2014

Aunque la conservación de estos modelos en el tiempo es larga y su mantenimiento es poco, muchas veces sus características morfológicas no corresponden a la realidad, al ser solamente modelos didácticos desarrollados sin una plataforma tecnológica adecuada, sin materiales acordes a las texturas encontradas en la realidad, y según el profesor Diego Aldana, - Odontólogo, docente y director de anatomía humana del anfiteatro de la Universidad -, principalmente, sin el apoyo de especialistas en la anatomía particular del modelo didáctico, que guíen el proceso de diseño y de representación tridimensional. Según sus afirmaciones, algunos modelos didácticos que se tienen en el laboratorio, son más decorativos que útiles, al no representar de forma fiel las estructuras anatómicas que los estudiantes deben aprender.

Bajo estas condiciones, la oportunidad de diseño se da en poder reemplazar esos modelos de aprendizaje por unos que estén fabricados con las condiciones técnicas, de diseño y calidad necesarios para su manipulación a gran escala, y con contenido educativo validado.

2.1. Modelos anatómicos, antecedentes y actualidad.

Los primeros modelos tridimensionales anatómicos se remontan al siglo XVIII, donde se documentan las primeras aproximaciones de representar estructuras a través de modelos de cera de abejas, donde médicos-anatomistas con un estricto rigor artístico y científico, construían esculturas anatómicas totalmente a mano, conocidas inicialmente como *Ceras Anatómica* (RIVA, 2001), estos primeros modelos anatómicos explicaban la evolución y las singularidades de la especie humana para poder transmitirlas a aprendices, siguiendo la tradición del humanismo científico, que consideraba que se podía mejorar la humanidad a través de la transmisión del conocimiento.

Fig. 3. Visita de estudiantes de Diseño de producto y trabajo de grado a una lección de anatomía en el anfiteatro de la Universidad. Marzo 2015.

Los modelos anatómicos, son maquetas artificiales tridimensionales que buscan una aproximación a la morfología de un cuerpo y ayuda a su entendimiento, fabricados con la finalidad pedagógica de estudiar y entender la anatomía de un espécimen. Los diversos cambios y evolución en tecnologías, materiales y métodos de fabricación han influenciado de forma directa el avance y las técnicas de investigación y desarrollo de estos modelos, que actualmente se apalancan en el diseño asistido por computador, captura de información en tres dimensiones y tecnologías de impresión tridimensional para crear modelos de fácil manipulación, resistentes y a costos razonables para las dinámicas actuales de enseñanza, en donde los estudiantes están más involucrados en procesos de interacción directa con información específica.

Fig. 4. Modelo anatómico de cuello y cabeza en polímeros de alto impacto. Anfiteatro Universidad Universidad El Bosque – Bogotá

Adicionalmente existe la plastinación, una técnica de preservación de material biológico desarrollada por el médico Alemán Gunther Von Hagens, utilizada por un centenar de instituciones y laboratorios alrededor del mundo para conservar por medio del reemplazo de tejidos orgánicos con polímeros especímenes anatómicos fieles a los originales. (LÓPEZ, 2012)

Entre los ejemplos específicos del avance en estas técnicas y ramas de estudio, encontramos diferentes referentes de trabajo en el mundo denominados *Bioréplicas*, estructuras que intentan reproducir de forma fidedigna modelos anatómicos para ser implantados en pacientes. (CALVO-GUIRADP, 2011) En un nivel inferior, encontramos los modelos comerciales que reproducen sistemas fisiológicos y morfológicos que con texturas, colores y simulación de su biomecánica no totalmente realista, se utilizan como medio para ilustrar de forma didáctica y de visualización los sistemas que componen la anatomía humana.

Los modelos anatómicos que se encuentran en el mercado, según especialistas consultados en la Universidad El Bosque tienen bastantes limitaciones en su forma de presentación y muchos de ellos no tienen una morfología apta para su estudio, sus técnicas de fabricación no los hacen aptos para un uso a gran escala, al ser manipulados por una gran cantidad de estudiantes de ciencias de la salud año a año. Aunque existe una gran variedad de modelos anatómicos que reproducen con un nivel de precisión bastante elevado los detalles de las estructuras anatómicas y de cada uno de sus segmentos, estos tienen cualidades y puntos débiles ya sea por sus relaciones de costo, oferta, precisión, o distribución, que los hacen no ser los más adecuados para adquirir por instituciones educativas.

En Colombia y particularmente en las universidades, algunos modelos son desarrollados por el propio interés de profesores e investigadores, o por los propios estudiantes interesados en alguna temática en particular, con materiales poco duraderos a través del tiempo como yeso, plastilinas, espumas de poliuretano, entre otras, con una baja o nula capacidad de reproducción serial y con una capacidad deficiente en su manipulación, en muchos casos son más objetos de decoración y ambientación, que verdaderos modelos didácticos de estudio.

Fig. 5. Modelo anatómico de un molar humano, fabricado por estudiantes y docentes de la Facultad de odontología de la Universidad.

Por otra parte, los modelos didácticos y libros de anatomía representan en muchas ocasiones conceptos errados de la verdaderas estructuras anatómicas que se pueden encontrar en un espécimen; sin embargo, estas diferencias son positivas en el sentido que ningún espécimen es igual a otro, lo que ayuda a los estudiantes a identificar elementos anatómicos generales mejorando su riqueza sensitiva; conceptos como que las arterias son rojas, las venas son azules y los órganos de colores son solamente estrategias comunicativas y didácticas que ayudan a ilustrar y reforzar los conceptos desde un punto de vista académico, enseñando que no hay estructuras perfectas ni caminos estandarizados en el conocimiento anatómico.

Aunque es de vital importancia el aprendizaje a través del contacto con órganos reales con técnicas como la disección y la prosección[75], existe una tendencia creciente en la búsqueda y desarrollo de simuladores que ayuden a mejorar las experiencias de enseñanza - aprendizaje, teniendo una alta tendencia hacia la virtualización y el desarrollo de herramientas tecnológicas de aprendizaje basados en la representación *3D* en interfaces *2D* (pantallas táctiles), que aunque tienen la ventaja de la transferencia, exactitud en la representación e interactividad, pierde en materialidad y en la aproximación a las características sensoriales en los procesos de formación teórico - práctica.

3. Diseño y fabricación digital

El auge y desarrollo de los últimos años en temas relacionados con el diseño y la fabricación digital en la academia, ha tomado mucha fuerza dada la popularización y reducción de costos en la adquisición de los dos grandes segmentos que componen esta área de desarrollo, software y hardware. En 2009 con la

[75] Prosección implica la disección de un cadáver por un profesional, para el propósito de demostrar técnicas específicas y las características anatómicas de interés particular

expiración de las patentes de tecnologías *FDM Fused Deposition Modeling* o Modelado por deposición fundida popularmente conocido como impresión *3D*, (HERNÁNDEZ, 2013) ha atraído a grandes empresas y empresas emergentes a tener su propia oferta de impresoras, escáner y software *3D* entre otros dispositivos.

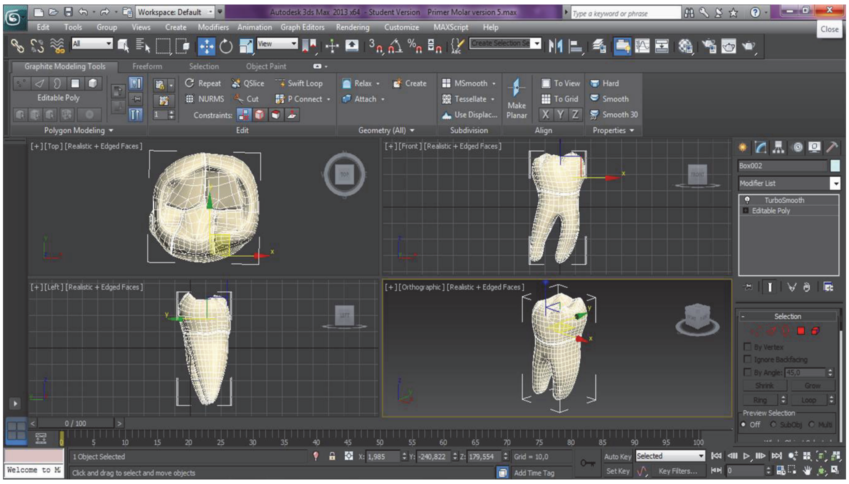

Fig. 6. Proceso parcial de modelado orgánico en 3D Max, estudiante de trabajo de grado Laura Chaparro - UEB.

Cabe aclarar que esto no significa que aún sea para uso popular como una impresora casera dada su complejidad técnica, y conocimientos específicos para poder obtener un modelo impreso, aunque el concepto de impresora *3D* personal todavía está en evolución, ha atraído a diferentes ámbitos del conocimiento a integrar estas tecnologías en sus procesos, generando espacios de trabajo interesantes que aún están en etapa de maduración.

Como resultado de estos procesos la impresión *3D* de bajo costo *FDM*, se está introduciendo en el ámbito académico, resultando en nuevas posibilidades de educación que desde el Diseño, puede ayudar a permear otras profesiones, en este caso las ciencias de la salud. Como experiencia a resaltar en la Universidad El Bosque se ha encontrado una relación directa entre la demanda de modelos didácticos para la enseñanza de Anatomía de facultades como Odontología o Medicina y los procesos de desarrollo en diseño orgánico, escultura y fabricación digital que se llevan a cabo en la facultad de Diseño y su laboratorio de modelos y prototipos donde la teoría se transfiere rápidamente a objetos físicos, que se pueden tocar y validar en un ambiente educativo.

4. Línea de investigación en tecnologías aplicadas al diseño de productos. Facultad Diseño, Imagen y Comunicación UEB.

El desarrollo de modelos, material didáctico y de simulación para áreas de la salud de la Universidad El Bosque, es algo que cada disciplina gestiona de forma independiente con sus propios recursos recurriendo a proveedores externos para adquirir materiales educativos. Actualmente con el proyecto de integración desde la Facultad de Diseño, se ha generado integrando conocimientos y oficios comenzado a desarrollar proyectos de simulación, donde la formulación de proyectos, la fabricación y la gestión inter facultades se articulan para crear interfaces de aprendizaje bajo la mirada y metodologías del diseño industrial, con la ventaja de desplegar el *know-how* en detalle para el desarrollo particular de necesidades propias de cada asignatura en los procesos de enseñanza-aprendizaje de anatomía en sus diferentes particularidades, dando relevancia a las herramientas digitales y al desarrollo integrado, donde los estudiantes de diseño asumen la importancia de su trabajo en un equipo multidisciplinar desde una etapa temprana de formación y con un escenario amplio de exploración.

Fig. 7. Profesor Andrés Rodríguez de la facultad de Odontología y la estudiante Laura Chaparro de Diseño Industrial en una sesión de retroalimentación con modelos previos de comprobación con modelos impresos en 3D.

4.1. Resultados

Hasta el primer semestre de 2016 se han desarrollado siete proyectos relacionados con la temática planteada en este artículo dentro de la línea de investigación formada a mediados de 2014 por el profesor Juan Sebastián Ávila, y para final de 2016 se presentarán cinco proyectos adicionales con un grado de complejidad más alto, al incluir temáticas de simulación para entrenamiento quirúrgico.

El primer proyecto fue presentado en la novena edición del salón académico de la Universidad El Bosque en el mes de Mayo de 2015 a cargo de la estudiante Laura Chaparro, en un trabajo conjunto entre la Facultad de Diseño y la Facultad de Odontología específicamente para la asignatura de Morfología dental a cargo del Doctor Andrés Rodríguez, docente de la asignatura y que participó activamente en el desarrollo del proyecto piloto. Resultando en el desarrolló un modelo didáctico del Molar Inferior # 36 con técnicas de diseño y fabricación digital para facilitar la experiencia de enseñanza.

4.1.1. Anatomical 3D.

Proyecto para el desarrollo de material didáctico para la enseñanza de morfología dental por medio de herramientas de escultura digital, impresión 3D con enfoque multidisciplinar.

Fig. 8. Modelos impresos finales en PLA, esculpidos digitalmente y pintados a mano, estudiante dirigido Laura Chaparro.

Posteriormente partiendo del interés de diferentes facultades por integrarse al proyecto surgieron seis proyectos más que fueron presentados en el décimo salón académico de diseño en diciembre de 2015. Lo más interesante de este proceso fue la diversidad y particularidades que alimentaron la investigación doctoral titulada ¨*Implementación de tecnologías de diseño y fabricación digital aplicadas en la enseñanza de Anatomía. Caso Estudio: Universidad El Bosque de Bogotá - Colombia*¨. A continuación algunos resultados obtenidos durante la exploración.

4.1.2. Ana-Tommy.

Análisis exploratorio de modelado 3D, escultura y pintura digital para la fabricación de productos industriales. Proyecto de diseño de juguetes didácticos para la enseñanza de anatomía a niños, con el cual se busca profundizar en técnicas de fabricación digital contemporáneas con énfasis en escultura digital.

Fig. 9. Modelos impresos con tecnología FDM, esculpidos digitalmente y pintados a mano, estudiante dirigido Felipe Fuentes.

4.1.3. Bio-Fun.

Modelo didáctico de sistemas anatómicos de la Iguana como contribución al material didáctico al Museo de Biología de la Universidad, con este proyecto se busca expandir el espectro de trabajo a la anatomía animal y vegetal, como estrategia para encontrar nuevos focos de trabajo, bajo el mismo esquema de investigación, diseño y fabricación.

Fig. 10. Modelos impresos con tecnología FDM, esculpidos digitalmente, pintados a mano y reproducidos a través de moldes de silicona, estudiante dirigido Santiago Ramírez.

4.1.4. Break - Skull.

Modelo didáctico del cráneo, corte sagital y partes internas. Proyecto con alto grado de complejidad dada las estructuras internas externas e internas en la morfología del cráneo humano. Relación profesor - estudiantes.

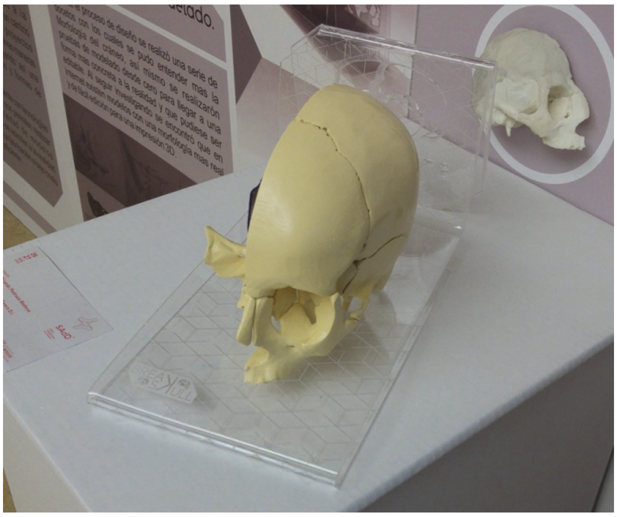

Fig. 11. Modelos impresos con tecnología FDM, de los huesos que componen el cráneo humano, ensamblados con imanes internos para no alterar la morfología real del cráneo, permitiendo ver las relaciones espaciales entre los huesos. Estudiante dirigido Daniel Pedraza.

4.1.5. Organ.

Modelo didáctico de la anatomía interna y externa del corazón humano. Proyecto bandera, con el cual se busca ejemplificar de forma clara el potencial que tiene el proyecto macro de permear diferentes profesiones desde la visión del diseño industrial. Caso estudio relación profesor - estudiantes

Fig. 12. Modelos impresos con tecnología FDM, de la anatomía interna y externa del corazón humano. Estudiante dirigido: Katherine Varela.

4.1.6. Modeumo.

Modelo didáctico de la anatomía del sistema respiratorio humano. Proyecto con alto grado de complejidad desde el punto de vista educativo, dada las estructuras tan finas y poco visibles en los especímenes de estudio reales. Caso estudio relación profesor - estudiantes.

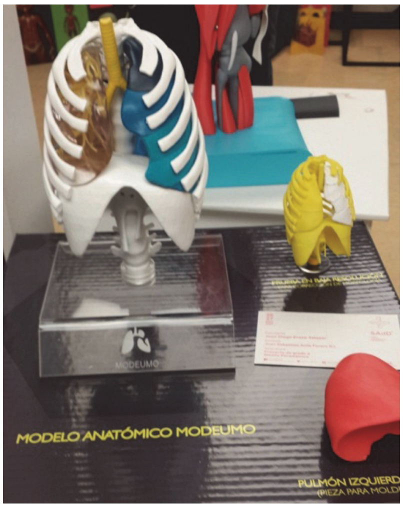

Fig. 13. Modelos impresos con tecnología FDM, estructuras encapsuladas. Estudiante dirigido: Juan Diego Erazo.

4.1.7 Knee 3D

Modelo didáctico del sistema de articulación de la rodilla. Proyecto con el cual se busca profundizar en las técnicas de producción y materiales que simulen las estructuras de una articulación. Se cambia el paradigma en la relación entre profesionales – pacientes

Fig. 14. Modelo impresos con tecnología FDM con filamentos flexibles. Estudiante dirigido: Sebastián Gómez.

5. Reflexiones sobre la experiencia de desarrollo conjunto entre la Facultades de Odontología y Medicina con la Facultad de Diseño.

Los procesos de articulación de profesiones en un proyecto interdisciplinar dentro de una Universidad, es un desafío que tiene diferentes ámbitos de trabajo que deben ser sincronizados de forma tal, que el trabajo fluya y no se pierda en un mar de ideas en el aire que se olvidan con el tiempo. Se deben tener en cuenta factores temporales, de recursos, de sincronización de actividades, de formas y posturas de abordar un proyecto que por la naturaleza misma de diferenciación en los oficios y estructuras mentales de los integrantes de un proyecto pueden causar dificultades o por el contrario, oportunidades interesantes para ser explotadas.

Durante los ejercicios de aproximación con profesores de las diferentes asignaturas de Morfología y Anatomía de la Universidad hay algunas reflexiones que son importantes resaltar y enumerar que permitieron el desarrollo exitoso de los proyectos de grado de los diseñadores industriales orientados.

- Acuerdos de objetivos comunes donde ambas partes tengan un beneficio común.
- Intereses particulares a desarrollar, con los cuales se aporte a objetivos no contemplados, enriqueciendo los proyectos.
- Disposición para trabajar a riesgo, en una actitud relajada en donde no hay mucho que perder si una idea no tiene éxito.
- Claridad en temas de derechos de autor, morales, de explotación y reconocimiento de los aportes de cada parte.

- Respeto por los procesos y estructuras mentales en la forma de abordar un proyecto desde diferentes miradas y oficios.
- División del trabajo según las habilidades propias de cada integrante.
- Interés por aprender de los procesos y particularidades de la otra profesión, sin llegar a tener un conocimiento profundo pero sí global de las actividades.
- Apertura mental para entender que no hay solo una forma de entender y hacer las cosas, y los procesos tradicionales pueden ser enriquecidos por nuevas ideas o aproximaciones para lograr un objetivo común.

El impacto del proyecto de grado denominado *Anatomical 3D*, modelo anatómico para enseñanza de anatomía y morfología dental ya se encuentra en uso y está previsto su uso para profesiones como Instrumentación Quirúrgica y Enfermería en las clases de morfología y anatomía de primer semestre, en Odontología en primer, segundo y tercer semestre en la asignatura de Básicas Odontológicas y Morfología Dinámica, y en Medicina en el curso de Premédico y Anatomía y Morfología de tercer y cuarto semestre. Trascendiendo de los métodos y medios tradicionales con interfaces tridimensionales didácticas que ayuden en la experimentación de métodos de enseñanza dentro de la Universidad. Para mediados del año 2017 se está trabajando en el desarrollo de una plataforma que cobije todos los proyectos en desarrollo con el fin de unificar métodos proyectuales, de diseño, fabricación y validación de los resultados.

Entre las oportunidades a futuro del proyecto doctoral está el estudio y capacitación de casos clínicos específicos que requieren actividades prácticas antes de su implementación real, el estudio y planeación de procedimientos quirúrgicos, la fabricación de modelos anatómicos artificiales de estructuras anatómicas que son delicados, difíciles de disecar y por tanto de estudiar. La instrucción a pacientes de procedimientos a los que serán sometidos y la posibilidad de transferir y masificar el conocimiento con modelos físicos, fabricados de forma local a un costo menor, con la posibilidad de ser replicados, modificados y con un fácil mantenimiento de las piezas.

Permitiendo la manipulación de los modelos anatómicos, sin daño de su estructura, fidelidad aproximada a los colores naturales o por el contrario la posibilidad de codificar con colores los detalles anatómicos de las piezas, atendiendo los desafíos de la educación en el siglo XXI con tecnologías contemporáneas.

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