The pertinence of Industrial Design Engineering

A profile consistent with the challenges of contemporary design.

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Abstract: *The context in which the practice of industrial engineering is currently taking place is characterised by a substantial change in the challenges and paradigms it faces. Environmental recovery, connectivity and its associated technology, and sustainability of the proposals are some of them. With innovation at its essence, design is responsible for defining the objects and the constructed environment in terms of their relationship with people, and it has to find answers to new demands. Within this framework, the profile of the Industrial Design Engineer brings together the skills and the creativity needed to integrate technological advances and the development of advanced quality solutions.*

Keywords*: Design Engineering, sustainability, smart products, product design, materials, nanotechnologies.*

Introduction

The history of civilisation is, in some way, the history of engineering. Through its different facets and manifestations, it has contributed to the achievements of humankind. Part of those achievements are the different products and services we currently enjoy, which have been conceived in the realm of the mind and made into reality by designers.

The Degree in Industrial Design Engineering and Product Development (IDE-PD) offered at the Escuela Técnica Superior de Ingeniería del Diseño (ETSID) of the Universitat Politècnica de València (UPV) provides future professionals with technical and scientific training that will enable them to lead and manage the entire life process of a product, from generating

ideas (market analysis, marketing, basic design...) through producing, manufacturing and launching a product, to assessing the environmental impact at the end of its service life.

The basis for establishing this degree programme was the experience of 17 years teaching Industrial Design Technical Engineering, and the White Paper on the Industrial Branch of Engineering Bachelor's Degrees. This document favours industrial design as a part of marketing (design management) like at MIT, leans towards processes and technology, like Westminster University, links it to specific sectors, like Central Saint Martin´s School of Art and Design, and emphasises communication, like the Politecnico di Milano.

According to the quality management policies of the European Higher Education Area (EHEA), university degree programmes must undergo a periodic accreditation process[1]. The IDE-PD offered at UPV's ETSID has undergone this evaluation to obtain the reaccreditation that guarantees its continuity. It has also been granted the EUR-ACE© quality certificate for European engineering programmes, which puts it on same level as other industrial engineering degrees (although it does not include professional competences). The EUR-ACE© certificate is granted to a university by an ENAEE-authorised agency, regarding a Bachelor's or Master's degree in engineering, which is evaluated against a set of defined standards based on the principles of quality, relevance, transparency, recognition and mobility contemplated by EHEA.

It is important to stress that, since this degree was placed under the framework of engineering, these engineers have been finding themselves in an uncomfortable situation because they are undervalued. Whereas in the field of engineering this degree could be regarded as excessively creative and vague due to the diversity of project typologies it addresses, for Design in the broad sense (product, services and/or experiences) it probably does not take sufficiently into account the sensibility or the communicative aspect, in terms of people and culture, which are characteristic of this activity.

It remains surprising that throughout its relatively short life, all attempts to define the specific profile that characterises design engineering have been met with permanent controversy. Discrepancies regarding design/social responsibility and design/science/technology, have also dragged on since the beginning, and they were already summarised by authors such as Maldonado[2] and Bonsiepe[3].

However, it is generally accepted that design requires multidisciplinary knowledge, which implies a deep integration of economic, technological, aesthetic and cultural demands. This wide range of facets embraced by the term *design* has given rise to different profiles which, certainly, can be complementary from an educational viewpoint in order to better achieve its goals, always within the time constraints involved in a curricular programme. In this case, the engineering approach focuses on certain aspects that identify this profile, and contributes technical skills which are particularly important within the framework of post-consumer society and technological advances. According to the International Council of Societies of Industrial Design[4] (ICSID), design is one of the main factors for humanising technologies through innovation, and a key factor for economic and cultural exchange.

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[1] ROYAL DECREE 1393/2007, of 29 October, regulating official university studies.

[2] Maldonado, 1977. T. *El diseño industrial reconsiderado*. Barcelona, Ediciones Gustavo Gili, 1977, p. 77.

[3] Bonsiepe, 1985. *El diseño en la periferia*. Mexico, Ediciones G. Gili, 1985

[4] ICSID [online] [Consultation: 17 Dec 2015]. Available at: http://www.icsid.org/about/about/articles31.htm

In this context, the technological development over the last decade, and the inherited, unbridled consumerism, which has had practically irreversible effects on the environment, have led to the idea formulated by Ortega y Gasset in his meditations of technology, "Technology, whose mission is to solve the problems of mankind, has suddenly become a new, gigantic problem."[5] With this situation as the starting point, the training received by design engineers provides an intelligible view of technology that leads them to a detailed materiality of many products and services. This training, which is more rigid regarding the analysis methodologies and the mastery of industrial processes and materials, offers them an approach to design projects that is less speculative or original, but more critical and sustainable regarding some types of projects.

This article looks into the suitability of the Design Engineer profile, in view of the challenges posed by design and society, as an engineer who is permeable and aware of the critical value[6] of the emotional aspects of the product (aesthetic, formal and symbolic), and who is also familiar with creativity and cultural factors. In particular, two new areas for wide and versatile products can be identified: the so-called smart products, in which new technologies play a prominent role, and products that respond to environmental issues and recent laws, where material engineering and nanotechnology play a key role, and which must cater to new consumers who are more demanding and have a higher level of training.

The hypothesis we formulate states that these areas are new opportunities for industrial design and product development engineers. Capable of acknowledging the prominence of the communicative aspect of the product, these engineers acquire a versatile, integrating training; they know how to apply the principles of *green engineering*[7]; they have the skills needed to develop complex projects, to integrate quantitative research and qualitative tools, and they can act as mediators in work teams where the technological, economic, functional an stylistic aspects come together to define an industrial product.

The exponential incorporation of technology into products and services, as well as the increasing complexity of mechanisms and structures, emphasise the precise level of involvement which is required of design. In this context, designers need to have the scientific and technical knowhow that will allow them to develop products and optimise their use, while also being able to meet the technical and economic conditions required by advanced industrial production.

Design Engineer vs. Designer, a question of educational background

[5] The author considers technology as a mediating factor between the enterprising nature of man and the achievement of a better quality of life, and the risks resulting from excessive prominence. Ortega y Gasset, J.: *Meditaciones de la técnica y otros ensayos sobre ciencia y filosofía*. Espasa-Calpe, S.A. (First edition) 1982, Alianza Editorial, 2004.

[6] Rasoulifara G., Eckertb C. & Prudhomme, G.; "Supporting communication between product designers and engineering designers in the design process of branded products: a comparison of three approaches". *CoDesign: International Journal of CoCreation in Design and the Arts*, Volume 10, Issue 2, 2014.

[7] Anastas, P. T.; Zimmerman, J. B. "Design Through the 12 principles of Green Engineering", *Environmental Science & Technology*, Eds.; American Chemical Society: Washington, DC, 2013, p 95-101.

According to Löbach[8], design is the process of adapting the objectual environment to the physical and psychological needs of people in society. To further specify its scope, the designer's task focuses on those products users experience in their day-to-day, products with an interface, according to Bonsiepe[9].

Its direct association with the industrial process characterises it as industrial design. It also specifies the production aspect of design, the industry, and therefore the development of a productive model we cannot disregard. Going back to Löbach's conceptualisation, Industrial Design refers to the process of adapting consumer items, which are ready to be manufactured industrially, to the physical and psychological needs of users and groups of users[10].

The essential features of design, in its current sense, emerged from the industrial approach: a preliminary project, mechanical production and repeatibility. Industrial procedures and serial production drew the limits between industrial design and the applied arts or crafts, leaving out the specifically manual skill of the "craftsman" or author, as well as the notion of "uniqueness", which was the basis for assessing art objects. Industrial design emerged and developed as a result of the division of labour, and its most intrinsic aspect is not a specific type of objects, or the different ways of producing them, but rather the methodology used for their formalisation[11]. Industrial design, therefore, focuses on the project preparation activity, which defines the formal properties of objects that can be reproduced in series. Formal properties are not only the outside features of the objects, but also, and particularly, the functional and structural relationships that make an object stand as a coherent unit, from the point of view of both the producer and the user. Therefore, formal properties are always the result of integrating different factors: functional, cultural, technological and economic.

It can be said that, in some way, the establishment of industrial design in the consumer society of the second half of the 20th century was the key factor of the economic dynamics, and one of the main causes of environmental degradation. The current situation is so much influenced by the presence of this enormous amount of industrially produced items, and by the use of materials, processes and technologies without proper control, that it requires a revision of the design/engineering paradigm.

It is clear that both approaches must, to a greater or lesser extent, participate in and work with technology for this "humanisation" of solutions. However, the approach of design engineering can address problem-solving using a language that is closer to the rest of the engineering fields involved in product design and improvement. This lends it greater perspective and knowledge to target primary goals which are in full expansion, as we discuss below.

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[8] Löbach, B., 1976. *Diseño Industrial.* Barcelona, Gustavo Gili, p.12.

[9] Bonsiepe, G., 1985. *El Diseño de la Periferia*. Barcelona, Gustavo Gili, p.133.

[10] Löbach, Ibid. p.19.

[11] This point was clearly exemplified by DORFLES more than half a century ago, when he stated that: "Therefore, there may be a small, or even a very small series (locomotives, high-precision instruments...) in which only a few or very few units are produced; however, its serial nature will remain unchanged in terms of production. On the other hand, there will be very large series of objects (sets of china, home appliances, pots and pans, radios, etc.) for which repetition of the product will reach thousands, with each object always being faithful to its prototype thanks to the manufacturing process, which does not allow any deviation in the series." Dorfles, G., 1968. *El Diseño Industrial y su Estética.* Barcelona, Labor, p.21

The role of Design Engineers in the use of technologies and new materials

The impact of technology on today's society is the result of the application of scientific knowledge and computers, especially in developed countries, to all aspects of daily life. These applications come from the different branches of engineering and, in some cases, they are osmotically linked to design. In the realm of industry, it has transformed design and manufacturing engineering. In the realm of management, it has sped up the exchange and control of information. And, over the past decade, it has invaded homes and individual use through real-time mobile communication technologies.

In addition to the numerous, specific computer applications available to those who draft projects for different parts of the design process, the technique and the implementation of technology is a demand that must be met and put directly at the service of users.

There is no doubt that connectivity has the capability of changing the lives of individuals, in the same way vehicles did at the beginning of last century. Similarly to what happened then, series of products and services are disappearing as they are displaced by others that are more powerful and versatile. A shocking example is the mobile phone which, in less than two years, prevailed over a whole range of products used to support music, image and memory (I-Pods, CDs, photo and video cameras, messaging, etc.).

The development of the *Smart City* concept also needs holistic approaches to different types of issues and materiality which are inherent to design engineering. Within this new framework, bits converge with atoms with the goal of turning the city into an increasingly intelligent and sensitive environment.

Interrelating connectivity, energy efficiency and public-use products, power generation and charging systems for the general public, and reducing pollution through innovative devices are currently the bases of pioneering applications[12], which inevitably require the principles of *green engineering*.

Image 1. *INDURAIN_Pedal Energy, by Anne Baraja Rodríguez. Eco-friendly street furniture for the Smart City. It runs on electricity produced by the kinetic energy generated by pedalling. It offers charging electronic devices and Internet connection. Public Use Products Specialisation, ETSID (2014).*

Other approaches which are now in full swing, such as Biomimetics, take solutions inspired by nature as references for innovation at different levels (shapes, processes and

[12] Domínguez Rubio, F. & Fogué, U. "Technifying Public Space and Publicizing Infrastructures: Exploring New Urban Political Ecologies through the Square of General Vara del Rey". *International Journal of Urban and Regional Research*, vol. 37 (2013). Urban Research Publications Limited, p. 1035-1052.

structures) and find their field of operation halfway between biology and technology[13], resulting in multiple examples of applications for architecture and design. The potential for added value and functionality currently offered, in particular, by new materials and nanotechnology, is an ideal scenario for design engineering. Thanks to them, products can prolong their functionality, their appearance can be kept with fewer maintenance requirements and, therefore, they can be more environmentally friendly.

Although, as Ventura points out in "Nanotecnología ilimitada"[14], the main applications for the time being are polymer reinforcements and nanoparticle coatings (which produce striking special finishes), only the rigor of scientific research and *green engineering* will allow us to control their possibilities and manage their safe use regarding health and the environment. In order to apply them to the design of products and atmospheres, it is essential to have a chemical/technological understanding of the materials, and their development and optimisation requires proficiency in the most advanced physics/mathematics concepts.

***Image 2**. The development of new materials and their application to the field of design is currently associated to numerous production technologies [Materfad, Barcelona]. Materfad showcases all material families (biomaterials, ceramics, composites, polymers, etc.) Its transversal approach makes it into a catalyst for innovation among universities, technological centres, enterprises, designers, industrialists, engineers and architects .*

***Image 3.** Application of locally produced recycled materials in street furniture components. Project WAW What a waste! E. Vento, M. Kurz, M. Sarv,E. Mutlu, R. Evans and N. Christer. European Project Semester ETSID, 2011.*

The contribution of design engineers to creativity, innovation and entrepreneurship

Another noteworthy aspect of the curriculum for industrial engineers is the training in methodology, which helps them to face problems of different nature and encourages their entrepreneurial initiative.

[13] Benyus, J., *Biomimicry: Innovation Inspired by Nature*. Harper Collins Publishers, NY, 1998; Perennial, 2002.
[14] Ventura, H. "Nanotecnología ilimitada". *Temes de disseny* [online], no. 28 (2012), p. 67-75.

Industrial engineers are, indeed, in a privileged position to communicate the importance of creativity, and they can easily empower themselves to think about creating new ways to share their points of view with others, and to inspire others to think about how they can apply creative methodologies to all aspects.

Design engineers are destined to play an extremely important role in innovation, because they are already identified as innovators, as key individuals in the economy of knowledge.

Their skill to produce instruments for observation and measurement, which is applicable to many fields and in a multidisciplinary fashion, makes these engineers proceed analytically regarding studies and comparisons, as well as obtained results, since their methodology is closer to that of scientific research[15].

They also have a favourable disposition and the appropriate skills for analysing the production of solutions and alternatives, for validating results, and for implementing environmental regulations with expertise[16].

Image 4. *Actively, an interaction platform for learning and accessibility. Belén Reig Segrelles. Graduation thesis, ETSID, 2013.*

In the context of a growing interest in user participation techniques and co-design, the design engineering approach facilitates integrating field work through quantitative tools that can simplify interaction with user groups, as well as synthesising data and obtaining interesting results.

Design engineers have much to offer to creative processes because they have a different way of thinking, and they are very valuable for identifying business opportunities and undertaking new goals because they approach problems in a different way. They can help to formulate the questions that lie at the starting point and throughout the entire process of product design and its continuity in society. It is, therefore, essential that they participate in the work teams from the beginning, since the manner in which a problem is approached at the onset is extremely important.

A bright-looking future

[15] Pedell, S., Vetere, F., Miller, T., Howard S., & Sterling, L. "Tools for participation: Intergenerational technology design for the home". *International Journal of Design*, 8 (2), 1-14. 2014, Australian Research Council 'Socially Oriented Requirements Engineering-Software Engineering meets Ethnography'.

[16] Kudrowitz, B.M. & Wallace, D. "Assessing the quality of ideas from prolific, early-stage product ideation", *Journal of Engineering Design,* 24:2 (2013), p. 120-139.
Ping Ge, C. & Wang, B. "An activity-based modelling approach for assessing the key stakeholders' corporation in the eco-conscious design of electronic products" Journal of Engineering Design, Volume 18, Issue 1 (2007), 55.

Everything around us is design; therefore, it is important to be design-minded. Within an eminently technological environment, the demand for contributions that guarantee the sustainability of products requires a permeable and flexible approach that is inherent to the industrial design engineer.

The evolution of technology and the awareness of environmental requirements call for a multidisciplinary approach to design, with a relevant technical base.

The development of numerous computer applications specific to different parts of the design process, as well as the implementation of new information technologies, is having a decisive effect on the conceptualisation and the development of products and services. The availability of immediate information regarding the market and the recipients of the products facilitates and speeds up participation in the preliminary stages of the formal definition of the products.

Lastly, the development of numerous design techniques in virtual presentation and representation of products, and in 3D printing, with many areas of application, has opened up the field of collaborative design, in which multidisciplinary teams work internationally. These teams are already being implemented in various complex product sectors, such as aerospace engineering and biomedical engineering.

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