EGE - Revista de Expresión Gráfica en la Edificación, Nº 12, 2020. ISSN: 2605-082X
https://doi.org/10.4995/ege.2020.14072
APEGA, UPV

SOCIAL SUSTAINABILITY: FROM ACCESSIBILITY TO INCLUSIVE DESIGN

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Abstract

Usually, articles and books about sustainability in building (and urban) sector are focused on environment, reuse, energy saving, solar and natural energy but the "social" sustainability is not considered as one topic for architects and engineers. But these professionals have to improve the quality of the life of the Human Being and to realize environments in which People can realize themselves safely and independently. The researches at the University of Pavia are focused on solutions to make inclusive the historical buildings and sites, looking for solutions that, at different scale, could be inserted respecting the history and the cultural environment but also improving the chance to visit and live according with the contemporary needs. The article shows the cultural approach and the method applied and some solutions that make clear this philosophy, with the awareness that each historic building and site is a *unicum* that needs answers that pay attention to the location, the history, the cultural and social background, the real needs and the aim of the complete project.

Keywords: Architectural heritage; Design for all; Inclusion; Overcoming architectural barriers.

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Received: 24 July 2020, Accepted: 27 July 2020, Published: 31 July 2020

1. INTRODUCTION

We are living in a globalized world, without many barriers, with the opportunity to move from a country to another without many restrictions, sharing culture and experiences that only fifty years ago were unimaginable. And it seems that we have the same chance to visit and appreciate historical buildings and sites, the culture and the cooking in different countries, but there is a large part of Human Being that cannot choose the restaurant where to have dinner basing on their wish to eat meats of fish; they have to select the restaurant reading on the website or the tourist guide if it is accessible or not.

Persons with disabilities (and people living with them and their friends) are not so free as it can be imagined, even if from the Seventies of the last century many conditions are improved and a different attention to their needs has been developed.

Nowadays the number of persons with disabilities is estimated between 10% and 15% (World Health Organization, 2019), and it becomes about 30% considering people living with them. But if we read the preamble of the *UN Convention of the Rights of Persons with disabilities* (2006) that change the approach to the disability, focusing on the environment and not on the person, it is possible to estimate that there are more than the 45% of persons in the world that have "other" needs.

As a matter of fact, the preamble of the *Convention* recognize "*that disability is an evolving concept and that disability results from the interaction between persons with impairments and attitudinal and environmental barriers that hinders their full and effective participation in society on an equal basis with others*"; it means that is the interaction between persons and environment that defines a disability condition, so a parent with a stroller or a pregnant woman or elderly people can become "persons with disability" if the environment in which they are living, moving or working is not able to satisfy their needs.

It is easy to understand that this is a revolution in the approach to the problems of persons with disabilities: it extends the number of persons that express special needs or require some aids, but moreover it asks that engineer and architects change their point of view in the design approach, trying to realize cities and buildings in which *all persons* can realize themselves.

Nine years later, the *Agenda 2030 for Sustainable Development* embodies some principles already defined in the *UN Convention* (universality, living no one behind, inclusiveness, etc.) and underlines with the goal n. 11 (Make cities and human settlements safe, inclusive, resilient and sustainable) the need to achieve definitively a new way to design urban spaces and buildings able to guarantee safety, health, independence, education, leisure to *all.*

Again, it is possible to say that there is a revolution, considering the 5P (People, Peace, Planet, Prosperity and Partnership) as the five dimensions of every human decision and action; the *Agenda 2030* inspires us to think creatively by leveraging innovative approaches and critically rethinking the way we live.

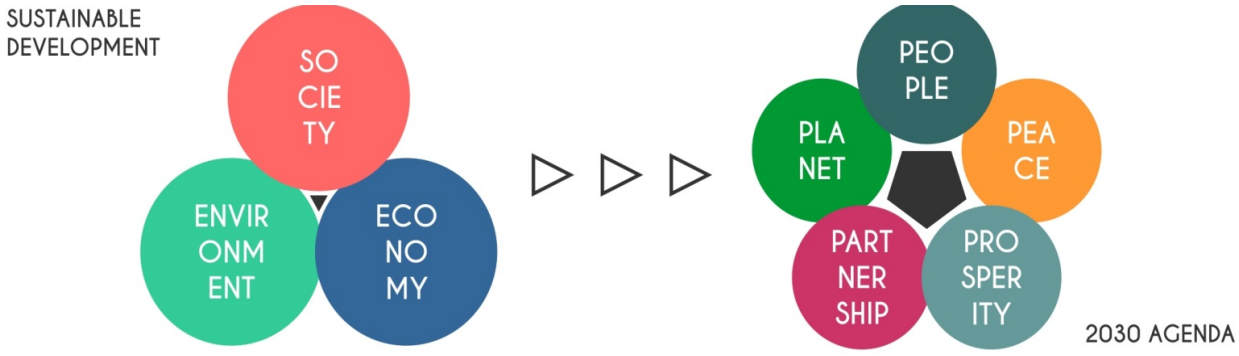

Fig. 1. The transformation of the sustainable development presented by the *Agenda 2030 for Sustainable Development*. Valentina Giacometti, 2020. (Source: Auricchio F., Greco A., Alaimo G., Giacometti V., Marconi S., Mauri V., 2020. "Innovation for inclusion: the 3D Printing Technology to enjoy the cultural heritage". Proceedings *Colloqui.AT.e Nuovi orizzonti per l'architettura sostenibile*, being printed).

In this context the "social sustainability" has to be reached not only through actions and measures to end poverty and hunger or to ensure healthy and education but also through a design approach that affects different scales (urban, building, detail) and different dimensions (new construction and reuse and restoration) in order to create an environment in which all persons can find the right dimension to be independent and safe.

2. UNIVERSITY OF PAVIA: RESEARCH AND METHODS

Starting from the *UN Convention of the Rights of Persons with disabilities* (2006), the researchers of the University of Pavia opened different activities focused on the accessibility and usability of the cultural heritage with the awareness that the period of removing the architectural and sensorial barriers was ending and a new approach has to be developed in order to satisfy the needs expressed by the *Convention* and then emphasized by the *Agenda 2030*.

The researches of the University of Pavia are based on the same approach:

- Knowledge and analysis (figure out needs, regulations, history, etc.);
- Design (finding the best solution according with the urban and building dimension of intervention);
- Defining a method (make clear in each project the objective choices and the specific ones, that cannot be replied in different context) in order to suggest a way to make inclusive heritage.

This method was defined at the end of the first approach and experience developed in 2006/07 in the project "Pavia per tutti" (Pavia for all) that was managed together with the Municipality.

It was clear that the *UN Convention* was at the same time the synthesis of twenty years of changes and the starting point of a new approach.

Before, the aim was to remove and overcome the barriers (architectonic and sensorial) setting aids (ramps, elevator, handrails, ⋯) at the end of the design process, applying the regulations at a project in which the 90% of solutions were already defined.

The *UN Convention* is a leap ahead that asks architects and engineers to design an environment in which the solutions for weak users are included, thought at the beginning of the design process in the same way in which structural, distributive and plants are considered in order to realize a full project.

The contribution of the University of Pavia is to define an approach that, at the different scales (urban, building, detail), offers to the professionals some objectives matters that have to be considered in order to make inclusive the heritage.

In these activities there is the awareness that it is outdated the prejudice that there is contrast between the accessibility and inclusiveness requests and the needs of conservation, reuse and restoration of the built heritage.

The efforts of the research group, both in the design activities for the University and the town of Pavia and in the didactic and educational courses and workshop managed, are addressed to realize inclusive environments, in which the needs of the largest part of the society are satisfied so that not only the three core elements of the sustainable development (social inclusion, economic growth and environmental protection) are reached but also the partnership (through a participating design process) and the peace (that means respect and assistance between the different members of the society) are considered on the same level, according with the *Agenda 2030*.

So, while the design process to remove the architectural barriers is focused on immediate results, sometimes for a specific need (i.e. a ramp to overcome a step), the inclusive design wants to satisfy the different needs that the contemporary society expresses; this means that also the aesthetic aspects and the final quality of the environment are considered during the design process, whose final aim is to diversify the enjoyment considering the different abilities of the users (children, adults, elderly, ⋯).

The principles of the *inclusive design* are:

- provide comparable experience – ensure that the interface provides a comparable experience for all, so people can accomplish tasks in a way that suits their needs without undermining the quality of the content;
- consider situation – people use the interface in different situation; make sure chosen interface delivers a valuable experience to people regardless of their circumstances;
- be consistent – use familiar conventions and apply them consistently;
- give control – ensure people are in control. People should be able to access and interact with content in their preferred way;
- offer choice – consider providing different ways for people to complete tasks, especially those that are complex or not standard;
- prioritise content – help users focus on core task, features and information by prioritising them within the content and lay-out;
- add value – consider the value of features and how they improve the experience for different users.

The inclusive approach can be fulfilled only with an approach able to overcome a manual attitude and the regulations application. A design process in which there is a large participation of the users, to know and to understand their concrete wishes, preventing useless costs.

In the following paragraphs there are some examples of this approach at the different scale.

3. URBAN APPROACH

The researches at the urban scale are developed on the historic downtown of Pavia but the same method can be applied in all the towns with the same origins, dimension and heritage, stratified through centuries. The same characters can be met in a large part of Europe.The researches at the urban scale were developed following some inputs of the Municipality and in different part of the town, but always with the same attitude and aim, in order to define the level of accessibility and inclusiveness and how to improve this level.

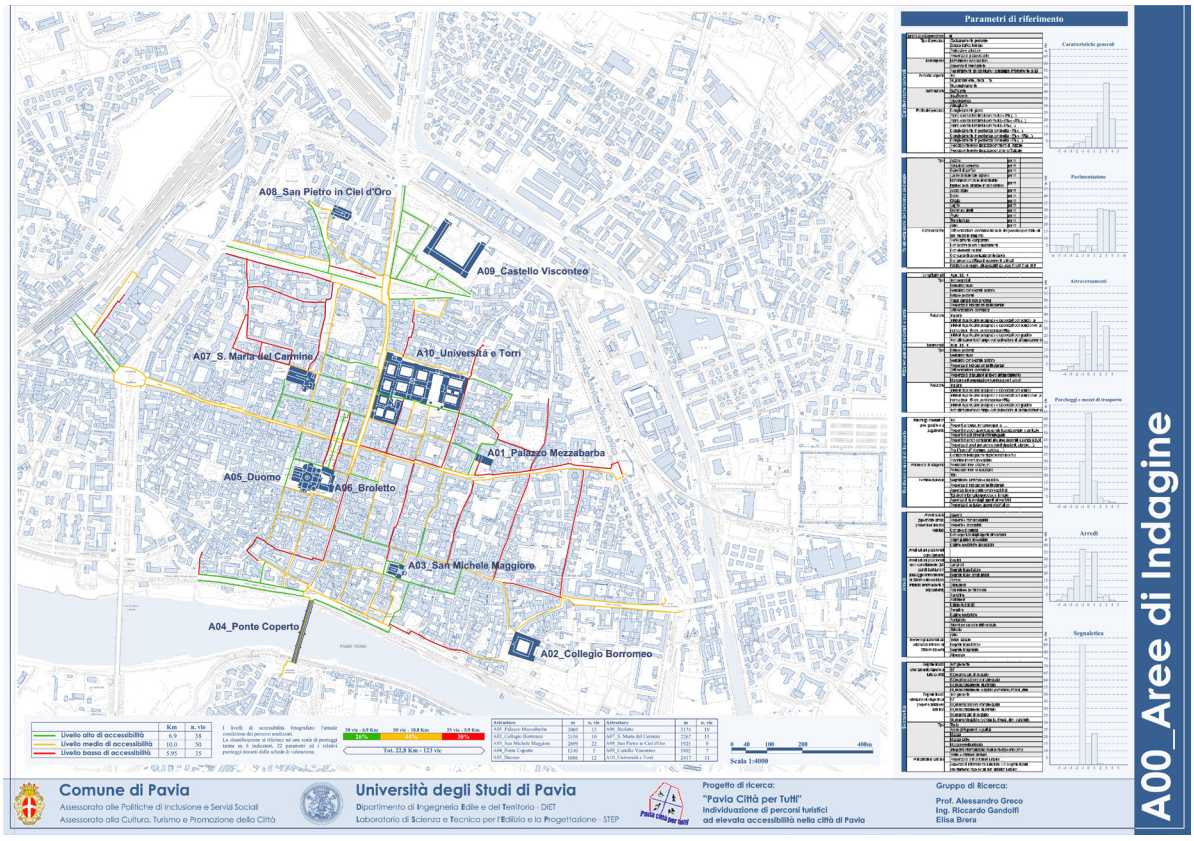

Fig. 2. Map of Pavia in which it is possible to see the synthesis of the research at the urban scale: the green streets are accessible and inclusive, the yellow ones can be used only when the weak users are going with someone that can help them, the red ones are street that need an intervention in order to be used safely and independent. (Source: Greco, Alessandro and the *Architettura Tecnica* Group in the Department of Civil Engineer and Architecture of the University of Pavia)

The researches can be synthetized in these steps:

- developing assessment tools able to investigate the accessibility of urban spaces;
- numerical, material and photographical surveys;
- digitization of the survey and database organization;
- identification of the most critical points;
- development of synthesis' boards to understand the level of the accessibility and inclusiveness;
- proposal for architectural and technical solutions to update the urban environment, maintaining the historic and social value.

The assessment tool defines the accessibility level of streets and squares, divided into path's sections, pedestrian crossings and pedestrian areas. The tool works through the identification of macro-indicators structured on objective parameters.

Each area of investigation includes several elements to be carefully considered and the tool is structured to give automatically a value in relation to a "tick" or "not tick" of these elements in the evaluation card. The sum of each value gives a number (positive or negative) which is the reference to assess the accessibility and inclusiveness level of the path detached.

At the end of the research, some projects were developed to offer inclusive solutions into the three main squares of the downtown. Technical drawings, referred to some critical point, show the current situation and a possible solution.

The aim of this phase was to provide to the City a few ideas for improvements of urban public space. The solutions were developed following these principles:

- attention to the context, to avoid altering the image of the medieval environment;
- economic sustainability, to enable the Municipality to realize them;
- reversible, in order to allow their removal in the future, restoring the original image.

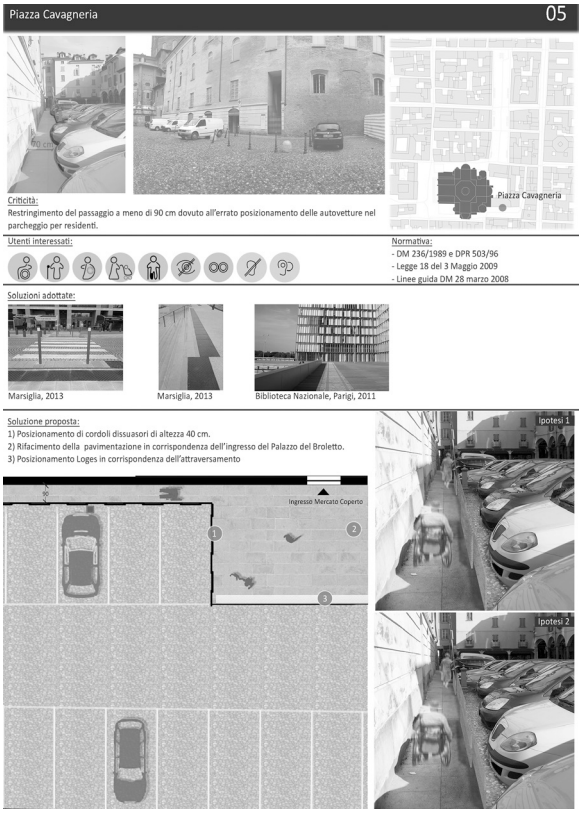

Fig. 3. One of the solutions developed for Piazza Cavagneria in order to preserve the pedestrian path from cars. (Source: Greco, Alessandro. 2015)

4. BUILDING APPROACH

A lot of historic buildings were built without any concern for persons with disabilities (estimated to be about 30% of the global population), and today they are still used by a civilization characterized by a new consideration for the weak users.

Therefore, improving the accessibility of the historic buildings, combining the instances of conservation and restoration with a more complete accessibility, should be a crucial purpose of any intervention on existing buildings. The designers (architects and engineers) must have a conscious approach to the instances of accessibility when they are working on constructions, especially those with high architectural and historical value: improving their accessibility and usability "for all", allowing to use, to visit and to appreciate.

As always it happens in the intervention on the existing, rules do not exist absolute and universally defined, but each building must be analysed and answered in accordance with the

needs defined by the different activities to be included and within the existing constraints. However, when systems and aids to overcome the differences in height are inserting to create a more usable and, why not, more enjoyable site, some general principles have to be considered: reversibility, recognition and respect for the existing, on all.

These aims are always considered by the research group of the University of Pavia, above all when a project about the academic heritage (more than 52 buildings in the town) has to be developed, as in the case of the elevator in *Collegio Cairoli*, where more than 100 students live while they are attending the University.

The project has been developed in compliance with the original features of the historic building without altering the cloister, but also with the explanation of the technological and industrial component of twenty-first century.

In 2013, the Rector of the *Collegio*, in cooperation with EDiSU (special agency of the University of Pavia for the students' services and accommodations) Administration, decided to solve the accessibility of the first floor of the building (where the Aula Magna and most of the public and socialization rooms are, including the library) at least, because a greater offer of cultural activities to the city and a message of inclusion were in his intentions.

The project was developed using an approach respectful of the existing, it tended to keep complete the historical structure of the building, looking for the best location to avoid tackling the historical walls, to minimize structural impact and get a reversible element.

During the preliminary surveys it was decided to make the project in an area that would allow to intervene with an addition, avoiding demolition and invasive interventions.

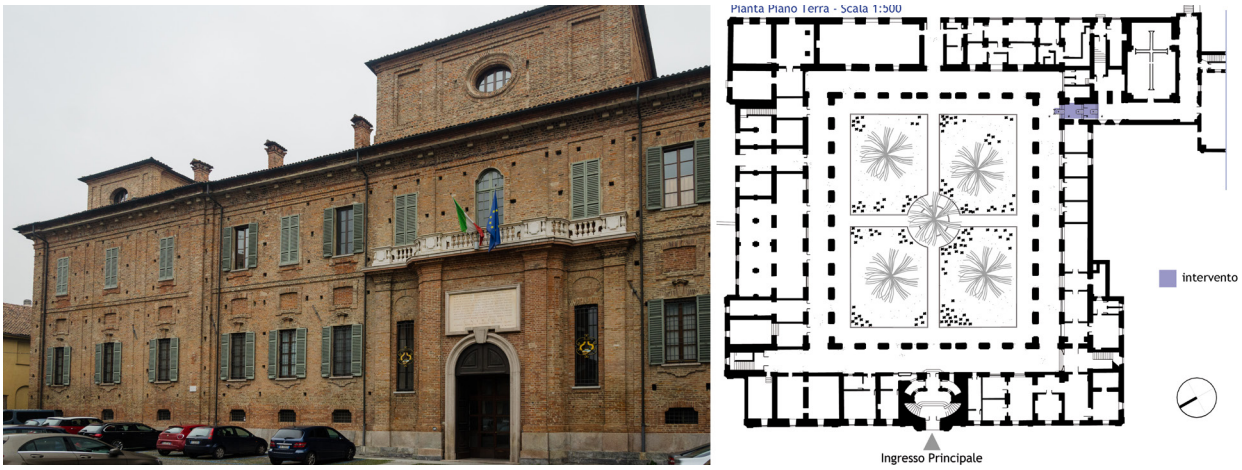

Fig. 4. *Collegio Cairoli*: main façade and ground floor of the *Collegio* with the position of the elevator (Source: Greco, Alessandro and the *Architettura Tecnica* Group in the Department of Civil Engineer and Architecture of the University of Pavia. 2015).

The area corresponding to the former double-height entrance hall on the south, near the chapel and this appeared immediately the best solution, although it would allow the access to the elevator directly from the porch to the portion of the inner courtyard. On the ground floor, the elevator is set back from the existing porch and "lands" on the first floor in front of the entrance to the billiards room of the College, again back from the distribution porch of the first floor.

The elevator shaft is made of steel and glass, materials that give lightness to the structure and allow to perceive lighted interior of the elevator immediately.

This choice of materials has made it possible to satisfy the principle of the recognisability of the intervention: in a such important building as the *Collegio Cairoli*, the presence of a steel structure and glass is declared so obvious as an element made of historical period different from that original.

The issue of recognition of operations for the disposal or the elimination of architectural barriers is widely debated in the literature; some

consider that the appropriate solutions to overcome the differences in height is to integrated new elements in the existing building, to camouflage and blend in with what has been achieved in the previous phases of intervention, becoming an integral part of the building complex; others believe instead that the new intervention must be recognizable in a clear and immediate connection systems vertically, reading them as the attachment of a new layer with respect to the different layers made during the past. In this case the choice of the designers, approved by the Superintendent, has been to make the most recognizable intervention possible.

Fig. 5. Collegio Cairoli: entrance of the elevator at the ground floor of the building. (Source: Greco, Alessandro. 2015)

The project respects the signs of DM 236/89 the elevator on the minimum size (120 x 80 cm), however the requirements of the legislation were taken as a starting point to define a functional solution to the needs of the *Collegio* and not as a fixed indication. Given the context and the existing window on the first floor, it was decided to keep the width equal to half of the window (the one removed, equal to 130 cm) and to exploit the full depth possible (about 160 cm).

These dimensions have not allowed the using of sliding doors and therefore it was decided, in consultation with the Superintendent, simple doors with automatic opening, for comfort.

It can be considered as a sustainable project, not only for the low power requirements of the system, but also because we can recognize a social and cultural "sustainable" intervention of accessibility and usability: the cultural references that support the design choices in fact refer to certain principles of the Human Development and Capability Approach, concepts also included in the *Agenda 2030*.

5. DETAIL APPROACH

Working at the details approach, it is important to consider not only the solutions coming from more than 30 years of researches about the removal of architectural and sensorial barriers, but also moving to new trials, gaining materials and technologies from different settings, searching solutions that can satisfy the largest part of needs.

At this scale of intervention, we have to consider not only the construction technologies but also the different aids that we have to set both in the urban environment and building. In order to avoid mistakes in the application of new solutions it is important to develop a participating decision process, listening the opinions coming from persons with disabilities or users with special needs.

During more than 15 years of activities, the University of Pavia established collaborations with some Associations helping persons with disabilities to understand the real needs and to text the different solution applied.

This process was developed also for the first Italian tactile map realized with 3d printing technology for the Museum of Electrical Technology (MTE) of the University in 2017.

It represents a pilot project which allows the in-depth study of the application of this innovative manufacturing technology in the specific field of the production of devices for blind and visual impaired people and for their inclusive use.

The tactile map developed for MTE represents the museum plan with all the information about its structure and its exhibition path. It is the result of a multi-steps process, aimed at setting the best 3D printing profiles to meet all the requirements of the users, from the museum staff to all the visitors, regardless of their capabilities.

The MTE Museum is organized into five different sections in temporal order: (1) the origins, (2) the affirmation of electricity, (3) electricity for all, (4) electricity everywhere, (5) electricity from today to the future, and it is characterized by a one-level open space of about 5,000 sqm, of which 3,200 sqm for visitors.

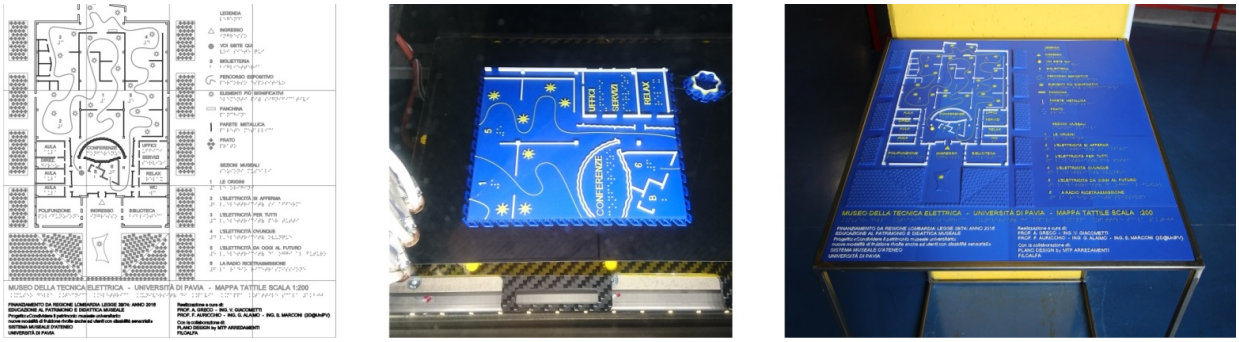

Fig. 6. Museum of Electrical Technology: scheme of the subdivision of the tactile map into 16 tiles (left), one tile during printing (middle), the final tactile map fixed on the steel inclined lectern and installed at the main entrance of the museum (right). (Source: Giacometti, Valentina. 2017)

As verified by the research team, the building is easily accessible for people with mobility impairments thanks to the lack of differences in level and a proper use of materials, shapes and dimensions, but there are no devices for people with blindness or low vision. Furthermore, there is a worrying lack of adequate communication about the structure and the museum objects, services and paths.

The realization of a tactile map is identified as the first step to improve the MTE accessibility and usability. The map has to contain information about the main elements of the building and its exhibition, to be used by all visitors, regardless of their own capabilities.

The map, including descriptions in relief and Braille, is thought to be positioned at the entrance of the Museum, near the ticket office. Its manufacturing should guarantee an adequate chromatic contrast between the background and the contents, and it should result pleasant to the touch, resistant and durable.

The map (59.4 x 57.6 cm) shows the part of the museum that is open to visitors (3,200 sqm) and a portion of the external area (2,500 sqm) which identifies the main entrance and the building's borders.

Once identified the map's contents and the user's needs to be satisfied, different 3D Printing technologies available at the laboratory 3D@UniPV - ProtoLab are tested.

This is an iterative process aimed at identifying the best technology, materials, printer settings, levels, heights, shapes, positions, dimensions and textures of the elements to be included in the final map. One of the team main efforts is focused on the translation of captions and texts into Braille: its dots code dimensions and distances are standard and the pleasantness to the touch must be guaranteed. In this case, like in many others, the collaboration with dott. Nicola Stilla (regional President of the Italian Union of Blind and Visually Impaired People) is fundamental, to really understand the needs of blind people.

After different texts, the FDM technology with 3 extruders (and 3 colors) and an extrusion width of 0.4 mm - FDM.3c(C) - is chosen to build the tactile map. It is also important to underline that this technology is the most widespread, flexible and economic among the 3D printing technologies available on the market. The completely open-source nature of the FDM process allows to intervene directly on the machine code, controlling all the process

parameters. These features allowed the research team to properly set up the machine and satisfy the specific requirements. Its extreme flexibility also opens several research paths and possible applications.

The elements of the tactile map are represented with different heights in order to guarantee a reading hierarchy the reliefs heights are classified into three elevations: 2.5 mm for the main walls, 1.25 mm for the internal walls and 1 mm for the texts, the symbols and the numbers.

In addition, specific choices are developed to better define the most significant elements:

- a specific corrugated shape is used to represent the metallic wall which separates the visitors from the staff offices;
- the exhibition path is identified by a continuous yellow line, 0.5 mm height, which starts from the “you are here” point and links all the Museum sections. Before choosing to indicate the path with a raised continue line, different solutions were tested, and discarded, by Nicola Stilla (raised points, too much similar to Braille; raised footprints, too difficult to understand; 1 mm groove in the floor, too difficult to identify by touch);
- the grass around the building is created by a specific texture, also reported in the symbol legend;
- the main museum objects are identified by the symbol of the yellow star (1 mm height) and the continuos eshibition path guides to their discovery.

The final result is due to a continuous iterative process during the design and the printing phases, which combines different knowledges and experiences: thanks to the collaboration with Nicola Stilla, it was possible to confirm the proper legibility of the resulting map by blind people.

It is also important to underline that using the selected 3D printing technology, the realization costs are much lower than for maps realized with the mold matrix, which is economically advantageous only for a great number of equal objects. In fact, the 3DP technology is particularly indicated for the *on demand* manufactuing of small series of unique objects, and it is much easier to carry out partial tests.

Fig. 7. Museum of Electrical Technology: the map is set at the entrance of the Museum and its colors make it easily recognizable and appreciated also by the children that visit the MTE. (Source: Greco, Alessandro. 2017)

In addition, dividing the map into small tiles guarantees the possibility to change single parts, in case of damages, modifications or when additional information have to be inserted.

6. CONCLUSIONS

At the three different scales (urban, building, details) some easy rules have to be followed in order to realize inclusive environment:

- at the urban scale it is important to bring together again part of the town, considering new mobility systems and a new approach to the public space (considering also the pandemic emergency we are living now);
- at the building scale safe and independent have to be guaranteed through reversible solutions, that can be easily recognized in the heritage context; the right balance between the needs of the users and the conservation and valorization of the building has to found, according with new materials and new technologies (not only of the construction industry);
- at the details scale, designers have to focus on “fine and functional” solutions,

integrated with the full project, like drops that inflict the final image. It is essential to find solution able at the same time to guarantee long-lasting use but also to be easily adapted, if new functions are inserted in the building.

Working on heritage asks to architects and engineers to intervene always remembering the history, but with the awareness of our time and that the environment has to be enjoyed also by the next generations; and remembering the Jorn Utzon's teaching: "the project has to be developed for the human well-being".

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How to cite this article: Greco, A. 2020. "Social Sustainability: from accesibility to inclusive design", *EGE Revista de Expresión Gráfica en la Edificación*, Nº12, Valencia: Universitat Politècnica de València. pp. 18-27. https://doi.org/10.4995/ege.2020.14072