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Emilia Duarte
Annalisa Di Roma *Editors*

Developments in Design Research and Practice II

Best Papers from the 11th Senses and Sensibility 2021: Designing Next Genera(c)tions

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Editors

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Preface

Design is a relatively young discipline with a strong propensity for change. The constant failed attempts to find a consensual definition for this discipline reflect this, as do the keywords commonly used to define its goals, e.g. transformation, innovation, future scenarios. Some see in this inconstancy a disciplinary fragility, a possible sign of immaturity and instability. But this can also be seen as an asset, in the sense that this state can endow design with great flexibility and plasticity, capable of easily moulding it to new realities and contexts, making it able to cope with the various complex problems we currently face, such as those related to climate change, pollution and health crises, among others.

This constant metamorphism and plurality could not fail to be reflected in the numerous design research activities, such as conferences, which work in numerous fields of action, sometimes operating at the most diverse crossroads between disciplinary territories, seeking unlikely synergies. But like in other areas of knowledge, design research practices are also inscribed and moulded by philosophical thinking, which influences the problems chosen, the questions posed, the objectives set, the methods applied and the data collected, resulting in discoveries of their own. Critical design, dialogic design, people-centred innovation, design with nature, to mention only some of the most recent approaches with international recognition by the design community, are transforming the focus of design practice and research, moving it from things to artefacts or systems, from products to processes or systems, from interaction to interconnection, from users to humanity, from societies to the planet, from functions to gestures or from desires to needs, in order to build a more inclusive paradigm, centred on sustainable innovation, connecting generations and actions.

Likewise, an increasingly inquisitive and critical attitude, combined with a speculative and participatory practice, is reconfiguring the field of design, leading to the development of new approaches, methods and techniques, increasingly concerned with the impact of design. Their focus is not so much restricted to the quality of the immediate or short-term user experience but expanding that focus to encompass wider groups and times, seeking inclusive, ethical and sustainable social innovation. Thus, there is a sustained encouragement in the adoption of increasingly holistic approaches, more concerned with promoting the flourishing of humanity, respecting diversity, in harmony with the natural ecosystem, to the detriment of visions of assisting a capitalist world motivated by the profit of parasitic practices on the planet. Ultimately, this paradigm shift is derived from and supported by the adoption of collaborative practices.

In a socially responsible approach, design assumes that the project will not be exclusively aimed at creating things and/or services but will be at the service of causes and missions, seen as a kind of "matter of concern", generated in a certain place and time, through rituals, modalities and cultural schemes, which are expressed in specific contexts. Therefore, designers will be more than mere translators of an aesthetic into a technology, assuming the position of citizen-designers, activists in favour of a common destiny,

shared with other human and non-human entities, responsible and accountable for their decisions, reason why they should assume themselves as guardians or gatekeepers of the built world.

The period between the 10th edition of the international conference Senses & Sensibility'19: Lost in (G)localization in November 2019 and the December 2021 edition represented a time of significant change. The pandemic of COVID-19, which began in late 2019, produced dramatic changes in the lives of millions of people, with important economic and political repercussions that altered social contexts. The diverse responses to this health crisis revealed not only the flaws in the design of current systems, highlighting evident differences in preparedness and levels of fragility at the global level, but also highlighted important human capacities in terms of empathy, creativity, rapid reaction, adaptation and resilience. This process affected, in a transversal way, the main areas of human activity, with impact on all kinds of entities and organizations (from school to work, from the individual to the family, from the community to society, from services to governments, from industry to agriculture, from the armed forces to health care), territories, geographies and cultural contexts. Unfortunately, the insipience and randomness of design contributions during this period have revealed, in our opinion, that design is still in its infancy when it comes to establishing itself as a major discipline in responding to global crises. This is something that, in our view, deserves critical reflection from the design community, especially considering the most recent predictions of climate change ahead.

In this context, in an almost premonitory way, the Design course of the ArCoD Department (Dipartimento di Architettura, Cos-truzionee Design) of the Politecnico di Bari, and UNIDCOM/IADE, the Design and Communication Research Unit of IADE, European University, joined forces to organize the International Conference Senses & Sensibility'21: Designing Next Genera(c)tions, which challenged the international design community to question possible future scenarios. Because we considered this a transdisciplinary field of research, the conference tracks were not given by the organization in a pre-established scheme but were the result of a co-generative approach, created based on the areas of interest given by the participants. The best original and cutting-edge contributions from researchers, practitioners, students and academics, focusing on intergenerational relational dynamics and the role of activating inter/transactions in design, useful for building long-term scenarios, have been compiled in this book. The ambition is to activate a new perspective in which the internal problems of the different areas of design are approached with a new co-evolutionary responsibility that, through research, acquires new determinations. "Interactions" and "transactions" become two possible strategies to activate processes that can involve design practices and enable multiverse design capabilities.

Over the last hundred years, even when motivated by positive intentions, designers have been active promoters of ideas of well-being and ways of life that we have recently and dramatically discovered to be unsustainable. In other words, designers have been an important part of the (social and economic) problems we now must face. But on the assumption that it is their will to become part of the solution, as active agents in the transition to sustainable ways of living, designers will need to make a profound change in their culture and praxis. New conceptual and methodological tools need to be developed.

New ideas, solutions and overviews need to be conceived. And an effort must be made to engage in the social territory on how to imagine and build a sustainable future.

Although the post-pandemic scenario is not yet fully defined, it becomes obvious that there will be no time to make a soft, and safe full transition to new paradigms, so it is urgent to start working on survival plans at the same time as mitigation and adaptation actions are accelerated, to increase resilience to face the next crises. In this context, design reflections should be directed towards a new transition and a planned flexibility. The post-pandemic transition presents itself as a task of high complexity. Firstly, because it is expected to last a long time, and secondly, because it will be a pot for the most forceful issues coming from the past, on instances for many years in the European and trans-European agendas, such as fair climate, digital transition, health recovery and resilience, biodiversity protection and gender equality. The political interest in these topics, together with new reflections on concepts such as exaptation and dark ecology, are signs of a new awareness in which the means and forms of knowledge are placed at the centre of research, in a new context that is no longer spatially static and temporally measurable, but in a continuous variation of solution and complication, according to a principle that we could define as “transaction”.

Annalisa Di Roma
Emilia Duarte

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Design for Social Innovations, Sustainability and Circular Economy

Design for Digital Interaction and Communication

Design for Territories and Cultural Contexts

Tourists' Current Sensory Experiences of Bazaar Atmospheres in Istanbul

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Abstract. This study focuses on tourists' sensory experiences of traditional, touristic bazaar atmospheres in Istanbul, Turkey and changes experienced after the COVID-19 pandemic, with a specific focus on the sense of smell. The fact that research regarding the effects of the pandemic is relatively new and thus lacking in terms of a comprehensive understanding, and that the topic requires an interdisciplinary approach are the main arguments of the paper. In the paper, the aim is to discuss existing literature on the topic and means by which it can contribute to newly developed research, and utilizing the Peak and End Theory in a touristic environment, focusing on further advancing experiences in these environments.

Keywords: Sensory Experience · Sensory Walk · COVID-19 Effects · Tourist Experience · Bazaar Atmosphere

1 Introduction

The research aims to understand and analyze the sensory experience through touristic atmosphere, the Spice Bazaar in Istanbul. In this context, the Spice Bazaar is a great example of functional, environmental, cultural, social and economic features. The Spice Bazaar is still the only spice bazaar in Istanbul. The objectives of this research are to figure out to contribute multidisciplinary by exploring how the touristic atmosphere is perceived by the five senses. In addition, it is planned to explore the tourist experience and the sensory experience aspects of tourist preference and to reveal new predictions for design and improvement studies for touristic atmospheres and their environments. The proposal involves the use of the Peak and End Theory by Fredrickson and Kahneman (1993) that asserts the importance of the intensity and duration of experiences on memory. It is believed that there is potential in relating this theory to the five senses and the experience of the Spice Bazaar environment. It is predicted that awareness will be raised by investigating how the disciplines interact with the touristic experience and the touristic atmosphere. Each experience in the atmospheres in terms of sensory; and examining and measuring with scale, eye, ear, nose, skin tongue, skeleton, and muscle. The human determines the atmosphere, and objects outside with his body. If any input is missing

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in the process, it gets clues from other senses and tries to complete the deficiency. Sensory stimuli within the atmosphere can affect and enhance the user experience. People perceive the events around them with all their senses simultaneously and therefore their experiences will be the more emotional and more interesting. Moreover, it has been found that the five senses play an important role in tourists' experiences, like destinations are mixed products that produce multiple experiences in consumption while consumers are considered consumers (Quan, Wang, 2004). Various approaches have been put forward to show multisensory issue links between environmental conditions are undoubtedly important in every aspect, and changing the atmosphere. The main issues and questions addressed in this research, a literature and theoretical model-oriented study, is aimed and therefore this study can be considered as a part of the targeted large-scale research. The next step will be to conduct a field study in the Spice Bazaar with participating tourists based with throughout this study literature and method synthesis and evaluation, by making use of the Peak and End Theory, by Frederickson and Kahneman (1993). In addition, it is aimed that the contribution of this study to the literature and that the results of the study or the data to be obtained will be beneficial in interdisciplinary areas so that it can be evaluated cooperatively in itself. There is a need for the human senses to be investigated in terms of all the experiences and perceptions of tourists in the touristic environment using qualitative and quantitative methodologies.

1.1 Sensory Experience

The movement of the body alone does not make sense, together with the five senses one perceives the movements and senses the environment. The things seen and experienced are there to position one in a community, with everything related to one another within it (Pierre, 1990). The study by Nghiem-Phu (2017), provided that the information about sensory inputs could be used by researchers with the following statements: people have five senses: sight, hearing, smell, touch and taste. Designers and marketers use the information encoded by these senses to communicate with target users (Nghiem-Phu, 2017). In this context, it can give significant information to analyze how tourists communicate with the touristic environments in which they interact in terms of five senses (Krishna, 2011). Fragrances are one of the top ten trends followed by the Advertising Age (Soars, 2009). Sight; vision, color is an integral part of products, services, designs. The colors of the brand and accurate images formed in the minds of customers and environmental views are very important. The images they create in their minds can match the visuals (Madden, Hewett, Roth, 2000). Taste; It is a sense that has emerged as a result of researches showing that consuming sweets makes people feel good. Thus, offering dessert at Helm bank in Colombia has been successfully tried as part of a sensory marketing strategy (Spence, Puccinelli, Grewal, Roggeveen, 2014). Sound; since it provides multi-source and various data input, especially in crowded environments, it may cause the users who shop in the store to be less aware of where and when the acoustics are transmitted. However, users may find the music is too loud or annoying. Researchers have shown that tempo and rhythm characteristics of music are effective for spending time for customers in the places or atmospheres (Soars, 2009). Touch; in the last two decades, it has been the subject of a significant number of studies to explore user behavior and experience within the atmosphere. These studies on the behavior and

experiences of users in the atmospheric places have proven that the sense of touch and other senses associated with it are highly effective in user behavior and experiences. It has been revealed that the users feel comfortable and safe by touching the products (Terblanche, 2018). For instance, wooden tables are often used as display items because users are asked to touch things and thus increase the likelihood of purchasing. Therefore, the sense of touch of the users plays a crucial role in decision-making and behavior in the environment (Soars, 2009). According to the study conducted by Hultén (2012), it has been revealed that the sense of touch has a significant effect on the product shopping experience of users who shop at the Ikea store. The study findings showed that sensory visual and scent cues have a positive effect on the tactile behavior and purchasing behavior of the users (Hultén, 2012).

1.2 Atmosphere

Each experience in an atmosphere can be analyzed in terms of sensory experiences; examined with scale, eye, ear, nose, skin tongue, skeleton, and muscles. Existential experiences create and strengthen the atmosphere, in fact, one's sense of being in the world, and this actually creates a self-experience. Along with only sight or five classical senses, design and architecture involve and interact with these various sensory experiences (Pallasma, 2012). The human determines the atmosphere, and objects outside his body primarily based on sight, touch and hearing. If an input is missing in the process, it gets clues from other senses and tries to complete the deficiency. Fragrance-taste mixtures need to be considered as a whole, not as separate perceptual values (Stevenson and Boakes, 2004). Kotler discussed the importance of the atmosphere of the store reached up to ancient times (Kotler, 1974). Following Kotler's study, (Lindquist, 1974; Tall and Rosnow, 1984; as cited in Grewal and Baker 1994), Zimmer and Golden (1988) continued research on store atmospheres. Studies have shown that the store atmosphere has a great impact on cognitive, emotional, and behavioral decision making (Helmefalk and Hulten 2017). Sensorial experience is not limited to a product or services before or after, it is a very broad concept with products and atmospheric presentations and store environment (Nghiêm-Phú, 2017). The general approach to developing more sensory contact points with the customer is, in principle, an effective idea, to create differentiation in the market. However, the environments and our perception, by nature, are very sensitive (Spence, Puccinelli, Grewal, Roggeveen, 2014). Degen (2008) and Degen and Rose (2012) state that sensory urban experience should address diversity better and explored paradoxes of different experiences and perceptual memories of the environment or atmosphere. In terms of the relation between sensory experiences and design, it has been revealed by psychological research that the five senses for users have a very strong influence on physical, cognitive, social, and emotional effects. Sensory stimuli within the atmosphere can affect and enhance the user experience. Chosen sensory stimuli, if appropriately administered in an environment, can have calming effects and influence relaxation, relieving of stress, energizing, improving mood, and being effective in decision making (Bakker et al., 2014; Puccinelli et al. 2009).

1.3 Covid-19

This being the case, experience of spaces has largely been altered due to the effects of the COVID-19 pandemic. Recent analysis of global problems reflects socio-economic crisis, psychological distress, anxiety, and depression in the entire world (Serafini et al. 2020). Pandemics, natural disasters, and other diseases have existed for centuries and have observed many pandemic conditions until today also foreseen that similar pandemic situations may continue (Finsterwalder, Kuppelwieser 2020). With the COVID-19 pandemic currently at the center of everyone's lives, it is essential to carry out studies to understand its various effects on diverse aspects of life; an important one significantly affected being tourism. COVID-19 has had sensory influences, both in terms of the illness affecting the sense of smell and also due to wearing masks and distancing to prevent the spreading of the virus. In this context, studies focusing on sensory multimodal stimuli are additionally significant, as sensory stimuli are not just from one sense, but brought about by many of our senses (Coppin, 2020). Chaaban et al. (2021)'s research found that the majority of Danish adults, who experienced changes in appetite, sensory perception, and/or food-related pleasure due to COVID-19 disease, also experienced problems and sensory perception changes due to their sensory function (Chaaban et al. 2021). Despite the fact that these results belong only to changes in the sense of taste, many studies have estimated that sensory experiences may be changed by the COVID-19 outbreak (Lixing 2020). Some of these changes are short and some are long term in adapting to the new normal order in accordance with these conditions. A significant question guiding research might be, "which senses have changed with COVID-19, and what are the associated behavioral changes within this new normal process?" Understanding the decrease in the effectiveness of the senses may enable making long and short term predictions and changes in procedural experiences within bazaar environments. Using the senses in heritage and cultural studies not only helps to connect people in the past, but also the present, in the sense that it contributes to a wide variety of unique knowledge, and a more complete understanding of the lived heritage of people and places (Puccinelli et al. 2009).

1.4 Spice Bazaar

There are many spice markets in the world. Spice markets are seen as a reflection of cities and cultures and are frequently visited by tourists. These market areas, which are usually full of local and rich spices, also display many local products and cultural values. The common areas of a city are not only belonging to the city with their physical features but also reflected in its culture and soul and bear the traces of different representations. The Spice Bazaar is also a cultural heritage in the heart of the city with these features (Özgüven, Durhan 2010). This touristic place, which has a wealth of data that can feed every sense, offers many opportunities to research on sensory experience. For instance, the presence of birders and the other animals at the entrance of the bazaar enriches the sense of sound, spices and herbs fragrance and visual sense, touristy and historical décor can contribute the visual sense, treats and all kinds of product options enhance taste and touch sense. It can also contribute to the richness of the data of the study by hosting a very intense and very different socio-cultural tourist visit (Figs. 1 and 2).

Fig. 1. Multi choices of the spices, delights and tea (Altiparmakogullari archive, 2021)

Fig. 2. The most known Turkish Coffee Brand (Altiparmakogullari archive, 2021)

2 Design Method

Social distance imposed by COVID-19 significantly affects tourists' experiences, such as reducing social contact or travel. Moreover, social distance or a better physical distance can affect tourists' perceptions of the experiences (Sigala, 2020). Traditionally, tourism has always been a large-scale hedonic and sensory experience process. However, COVID-19 traveling and operating standards require a redesign of environments, and it is necessary to be able to redesign the experience as well, without eliminating the sensory elements. Figure 3 illustrates the structure and development stages of the method with the effect of COVID-19. Another major focus of the study, the multi-sensory aspect of Spice Bazaar, allows tourists to experience new sensory experiences in their long COVID-19 bazaar travels. The temporal dynamics of the hegemonic senses can be examined within the scope of Fredrickson and Kahneman's Peak and End Theory. The theory argues that positive or negative peak emotions during interaction and the last stage of the interaction reveal the memorable self-state (1993).

It is a cognitive bias affecting the ways in which past experiences are remembered. Positive and negative moments experienced intensely as well as the end of an experience have a particular significance on the memory. In research, Peak and End Theory involves evaluating participants' retrospective experiences in relation to an experience (Gutwin et al, 2016). Diener, Wirtz, and Oishi (2001) showed that, high pleasure levels in short durations were rated higher by participants, naming this the "James Dean effect". Baumgartner, Sujan, & Padgett (1997) stated that, experiences with high peaks and strong positive endings were preferred by participants of the study. The degree of pleasantness and duration of experiences were studied by Do, Rupert, & Wolford (2008). Inasmuch

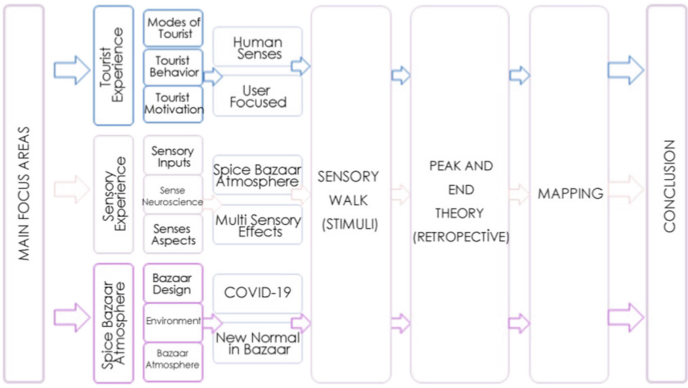

Fig. 3. Structure of the development stages of the method

as sensory experience involves a multi-stimulus process, the brain enables making sense of any stimulus. Thus, expected assumptions of the current study will arise from sensory experiences of tourists with the help of the Peak and End Theory, expected to contribute to a deeper examination of the tourists' sensory experiences changing during the COVID-19 pandemic. This framework can be used to form a base for sensory experience research in various touristic places and environments. The research provides the framework for understanding the differences in the sensory experience between tourists by using the interview technique to compare the level of these sensory experiences made under pandemic conditions in the Spice Bazaar in Istanbul with their retrospective sensory experiences in the same bazaar. Instant stimulus sensory experiences are compared with retrospective experiences, and the effect of these pandemic conditions on sensory experience is analyzed. During this experience, the happiest peak experiences and sensory experiences at the end will guide the study. The empirical research involves a comparison of routes, key reference points, and all sensory experiences during one visit to the bazaar within the pandemic conditions. Additionally, behavioral maps are used as an instrument, allowing for visual image that will allow us to see all the sensory experience intensities of the tourists in that region, which is obtained from stimuli and retrospective experiences throughout the map and to reach the sensory and dynamic experiences embedded on this touristic atmosphere. The data obtained from Peak and End Theory only may not be sufficient to give the actual values therefore, revealing retrospective experiences and stimulant experiences on a map over the touristic bazaar, where they experienced, enables a reliable result by constantly updating the data and enriching the data with more participants. Moreover, qualitative comments have provided a better understanding and elaboration of the findings. Thus, this paper presents part of a larger study that investigates the most touristic, cultural, and ethnic bazaars in Istanbul that provide an intense sensory experience, focusing on the Spice Bazaar where most of the aforementioned experiences may be heightened due to an enriched environment. As the field study, in the bazaar, it is aimed to identify the intensity of the five senses that tourists experience during their sensory walks. Findings show a difference between tourists who have suffered COVID-19 and the ones who have not, in that the sense of

smell was diminished in some tourists who had recovered but were experiencing 'long COVID'.

3 Instruments

The subjective experiences of the participants (tourists) will be revealed with the phenomenological reduction approach and schematized with the method of thematic analysis. It was planned to develop a measurement system in which the participants' data could be collected on a larger scale with quantitative methods to reveal generalizable information by using the themes obtained. The main purpose and important stage of the research is to perform a sensory experience analysis with participatory research questions and to create a map with the codes that will emerge as a result, and thus to propose an evaluation method model. The concept of sensory analysis and experience are interrelated and contextual issues. The protocol of the study will take place in three stages; after the Spice Bazaar sensory walk, demographic information is obtained from the participants in the first stage. Then, the motivations of the participants, namely the tourists, on the day of the trip will be interviewed. According to motivation, for instance, depending on the hunger state, taste can turn into an important detail in the motivational experience (Stevenson and Boakes, 2004). Therefore, in the first phase, questions will be asked to learn about their mood and motivation, and they will be asked to evaluate them on the hedonic scale. At the same time, the purpose of visiting the bazaar will be asked, and it is important to get tourist typology information. Cohen (1979) outlined five modes of tourist experience in his work; Entertainment, orientation, experiential, experimental, and existential. For this reason, participants' motivation for visiting the bazaar can be an important point (Cohen, 1979). At the second phase of the study continuing with the structured questions, Gretzel and Fesenmaier (2003) used the method that aims to reveal the sensory experiences of the users in terms of the laddering method, especially to reveal the deep sensory relationship networks in the minds of the users, to dive deeper into the mind of the participant with step-by-step questions and to delve deeper into the retrospective experiences. The respondents will be asked to compare their sensorial experience between the trip they took before COVID-19 and the trip they took field study day. In the third stage, codes will be created from the additions or specialized sensory experiences to be obtained as a result of sensory experience comparison over a scaling and a behavioral map will be created from these codes.

4 Discussion

The sensory experience has come to be used to refer to an important component of tourism experiences, as the senses make the experiences more valuable and memorable. Peak and end theory states that overall experience evaluations are best predicted by the senses in the most intense and final moments of an experience (Strijbosch et al., 2021) An important contribution of sensory experience research is to provide an important source of income for all tourism-based employers and employees, municipalities and many SMEs and companies that provide economic development-based development in that region, and to ensure that the region is remembered and positive experiences are

experienced. The purpose of this research seeks to remedy to discuss how to construct last sensory experience about their most last and peak sensory experience and also to discuss how this sensory experience has changed with the COVID-19 measures and the results. As the previous studies on the basis and origin of the subject of sensory evaluation, it is seen that it comes from physiology and psychology. The data obtained from the evaluations and studies made with the five senses of the users are closely related to the tendency of the behavioral aspects of the perceptual process (Sidel and Stone 1985). With this investigation, the aim is to assess, it can enable to make the tourist experience the most positive with a model proposal to be created, thus allowing the shaping and structuring of the tourist experience. It can be ensured that the excitement of the tourists before the trip can continue after the trip, and their sensory experiences can be unforgettable and positive over time (Stevenson and Boakes, 2004). If the participants' realization may occur in different motivation or hunger situations at that moment, their taste and smell experiences may have affected them more easily or, previous experiences or experiences from the environment may also have affected the sensory experiences of the participants and thus need to be examined at a pragmatic level all the process. The current findings add to understanding of peak and end theory that the most effective and intense moments of experience occupy an important place in our memory. Sensory experience also has an important place in terms of both memory and recall. For this reason, this theory has been chosen as a scientific hierarchical model at the points where memory and recall are most effective and most negative. To summarize, it is a fact that tourists also have a motivation and their previous experiences can also affect the process and should be take in account. In order to identify it is planned to be done empirically, there will be a chance to examine with two different approaches. Another major approach can be the sensory experience that will be measured at the last point at the highest point and behavioral will be evaluated on the map, and it will be provided to form a base for the new normal life brought by the effect of the COVID-19 effect on the subsequent design process development. It will be aimed to be a totally can be focus empirical sensory experience study with sample samples, periodical spaces and ethnographic differences that will be developed.

5 Conclusion

Examples of researches has shown that when people place an experience in the past, it has been shown in experimental studies that it takes the same event and places it in the future much more richly and in detail (Söderlund, 2003). Theoretical studies on collective memory suggest that remembering is not just an individual mental function locked in the human brain. It is stated in studies that what is remembered goes beyond individual experiences. Most of what is remembered is because memories are recorded through memory and it is preserved because we can preserve it, expanding his theoretical argument about the memory of the senses, the cultural heritage of an ethnic past can be conceptualized as a concrete recollection of sensory experiences (Chronis, 2006). Episodic memories, which involve individuals' long-term retention of accurate memories of individual experiences, are the type of long-term memory that is thought to be the most interesting to examine in relation to tourist experiences (Bech-Larsen, 2007), Lived

experiences gain meaning as we think about them and give them memory (Agapito, Valle, Mendes, 2014). By introducing a theory of behavior guidance, (Vallagher and Wegner, 1985; as cited in Larsen and Nielsen 1999) suggest that it is a common human trait to always prefer an abstract representation of a concrete representation of a behavior (for example, a choice task) (Larsen and Nielsen 1999) Thus, it is expected that both the stimuli data and the retrospective experience after visiting the bazaar will create a very rich data. At this stage of the study, it is aimed that the participants/tourists who have completed their sensory walk will reveal the direct sensory experience with the help of SEEP protocol at the end of the Bazaar. Indeed, tourist experiences involve complex psychological processes with a special focus on memory (Larsen, 2007). Despite the existence of various definitions in the literature, tourist experiences can be considered as subjective and individual evaluations of events related to touristic activities that result in certain results and include the expectation and recall stages in addition to the activity in the destination (Cutler and Carmichael, 2010; Tung and Ritchie, 2011). Larsen (2007) confirms that tourist experiences are strong enough to enter long-term memory of past, individual, travel-related events. Considering the planning and design of environments where positive and memorable tourist experiences are more likely to arise, the concept of positive memorable experiences has been discussed and empirically studied (Tung and Ritchie 2011). Therefore, efforts to facilitate the emergence of touristic experiences, which are described as positive recall and recall after the event arises (Kim, Ritchie, McCormick, 2010), are undertaken by destination management design or event design organizations in order to be more competitive (Agapito, Valle, Mendes, 2014). The tourism industry has stated that it must not only improve, but also redesign and reform the next new normal situation. Donthu and Gustafsson (2020) pointed that it is clear that there is currently a lack of research on how crises can change the industry, how the industry can adapt to the process with new techniques, and how research can be carried out in later norms (Donthu and Gustafsson, 2020). Thus, it can be ensured that sensory experiences can be possible and sustainable even under pandemic conditions, without departing from our cultural, ethnic roots and sensory experiences. The COVID-19 pandemic, which is still continuing to affect the world and causing people to experience environments through new sensory-perceptual qualities, as well as sociological and psychological changes, studies in sensory experiences are valuable in terms of becoming an important base for future interdisciplinary studies, new design studies, and proposals regarding touristic environments. When the intensity of smell is decreased and social distancing sets people apart, the prevalent experience of the traditional bazaar may be diminished. In order to understand and improve these criteria, further studies in touristic, cultural bazaar atmospheres and sensory experience are necessary. In this context, experiences in the COVID-19 pandemic situation and retrospective experiences before COVID-19 can be collected from various populations around the world in different touristic contents. Different sample groups can provide a further understanding of the sensory experience effects of COVID-19 and reveal the temporal dynamics of sensory experiences. Interdisciplinary and multicultural research that focuses on various aspects of the bazaar experience might provide a base for designing new environments and spaces that provide heightened sensory experiences for tourists. As new layers of information on the COVID-19 pandemic are revealed each day, it has become even more

obvious that this is a new and significant area that will continue to grow, necessitating interdisciplinary approaches providing more comprehensive understanding.

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Design and Cultural Heritage: New Senses and Sensibilities of Archaeological Sites

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Abstract. The paper is a reflection on the relationship between design and cultural heritage in the specific cases of the archaeological sites. Far from entering into problems of museography, the paper tries to find out the new senses and sensibilities located at the intersection of the lines that link together ruins, public spaces, technologies and design, seeking to understand if there's a way to re-discover a value for the ruins through an interpretative perspective based on integration, interaction and narrativity. Starting from reading the contemporary conditions of the archaeological areas in their relationship with public space and the role of the digital technologies, the article analyses the new forms of dialogue with the past that substitute the traditional concepts of transformation and rehabilitation, following the idea of *expandability* applied to the relationship between design and physical-social context. Making reference to some design experiences in archaeological areas, the paper finally attempts to trace a new plausible sensibility in the processes of urban renewal and cultural heritage enhancement.

Keywords: Cultural heritage · Contextual design · Design for territories

1 Introduction

The issues relating the relationship between design and archaeological heritage are framed in the encounter between the topics of design for cultural heritage and design for urban public space, whose intersection is a polarity that goes towards a renewed necessity of outlining innovative approaches and strategies in the contemporary design actions, following the new disciplinary paradigms and according to the transformation of the cultural senses and social sensibilities (Fig. 1). In this ambit of application for design as a discipline, the contemporary cultural sense (mainly referred to the keyword *design*) can be seen as a new interpretation of the places which are not any more mere physical entities but *areas of actions* for active and participatory social groups and societies; on the other hand, the transformation of social sensibilities (mainly referred to the keyword *heritage*) lies in the mark of a new general environmental sensibility in which our spaces and our lives are intended not in contrast one to each other but as parts of the socio-cultural context, where the urban objects build new relationships with the public spaces and with people's behavior (Lelli, Fabbri & Scodeller, 2021).

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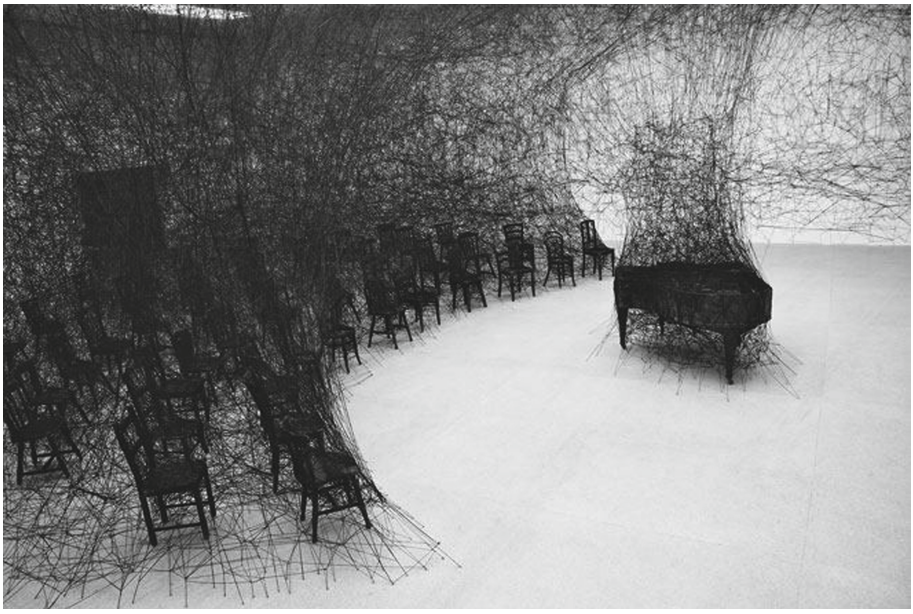

Fig. 1. Chiharu Shiota, In silence. Exhibition at the Kunsthaus Centre d'art Pasquart, Biel, Switzerland. Image courtesy of Suhni Mang.

From an epistemological point of view, as highlighted by Elena Lupo, a transition has occurred from designing *for* cultural heritage to designing *with* cultural heritage, which means a new active role of the cultural heritage involved into a new kind of participatory process based on co-design and co-creation as well as on new interactive forms of relationship between the physical dimension of things and the analogical ones (Lupo, 2021).

2 Archaeological Sites and Public Space

Generally closed inside a sacred space in opposition with the profane space of the city (Aymonino & Mosco, 2006), the historical-archaeological sites constitute a peculiar problem within the mark of the cultural heritage, due to their specificity of being non-functional systems with atmospheric and symbolic value (Baudrillard, 1996); But they are also systems of things, places and unmaterial elements and, on the other hand, sensible places with a deep relationship with the urban context, not only when well-known monuments but also (and more importantly) when small episodes of ancient times (Bagnato, 2017).

In addition, these sites are made of historical traces which are the core of the cultural heritage constituting the primary *bricks* in the construction of the social memory and identity of a specific context. If we consider them as single elements or special episodes, we get only a contemplative awareness of what they used to be in the past and which is their value as historical documents. But if we consider the deep dynamic relationships that

link these elements together, we can revive them in our time, rediscover the narrativity of the places marked by their presence, rebuild the dialogue between history, people and environment (Fagnoni, 2018).

Then, in their relationship with the public space, the archaeological sites, intended as complex systems of fragments, transform the sense of the contemporary urban elements which become fragments themselves: this means that it's not possible to separate the ruins from their own place of disposal and that their presence create a complex cultural context in a unique landscape. This relationship between elements (ancient, historical or contemporary) and places produces a sense for the space, independently from its function and from its role in the urban structure, which transforms the space itself into a *system of places.*

In such a context, it's legitimate to ask why design should be important in this process of sense-making of the relationship between archaeological sites and public space and, on the other hand, why it's not enough to implement actions of mere conservation and/or simple protection. The answer lies in the fact that a public space with historical traces is a complex system of signs with different natures that cyclically overlap in time one to each other and consequently constitutes a never fixed morphological configuration with an always changing dialogue with the socio-cultural context.

Forms, elements, materials, colors, etc., despite their physical condition, don't constitute a stable historical result rather than a system of dynamic elements *actors* of a process based on continuous actions of identification and social acceptance. Therefore, design takes on the role of facilitating this process with its narrative power and with its capacity to link together the physical aspect of a context with the social and cultural ones.

3 Technology vs Design

As regards the role of technology, considering the intersection between the dichotomies reality/virtuality and memory/knowledge, we can today outline how the impact of the new information and digital technologies in the field of archaeological sites' fruition is passing from a condition of additional elements to that of a new reflection on the forms of accessibility and interaction with the urban historical areas, in which the paradigms linked to their relationships with users and with public space have undergone a radical change (Paris, 2004).

Furthermore, in the opposite direction, as quickly as the information technologies impose new instruments and rules, the social visions and perceptions on history and on the past tend to change creating new cultural and social interpretations. And not only that: as the relationship between people and archaeological places changes its traditional sense and sensibility, it becomes increasingly common to see advanced technological devices very able to offer virtual reconstructions, pathways and easy and quick knowledge recalls (Fig. 2).

The reasons for this situation can be outlined if we consider the relationship between the child and the mirror studied by Jean Piaget: as Maldonado reminds us, for the child the mirror is originally a virtual machine able to produce a passive image, but when the child reaches a later stage of knowledge, he starts using the mirror in an active way, so

Fig. 2. Advertising poster of *Roma Virtuale* virtual guided tour (2021).

to create his own interpretation of the image. In the same way, the relationship between man and history is virtual when he doesn't use it except in a contemplative way, while is active and cultural when he uses it through his own interpretation: In the first case he only asks for help from technological devices, in the second case he strongly needs the contribution of design (Maldonado, 1992).

Therefore, if we accept the possibility to have an ethical dimension in the world of the digital technologies, from the first forms of ICT and arriving at the virtual reconstructions and augmented realities, we can more and more consider them as *materials* for design, able to facilitate the users' interaction with urban public spaces and archaeological traces, activating processes of knowledge (Trocchianesi, 2014).

In particular, the main potentialities seem to be the possibility of using integrated systems of information, new open tools and collaborative methods of communication less institutional and more and more *from the bottom.* This renewed trust in the technological devices depends on the fact that the digital culture, in general, has encouraged new dynamic forms of interaction and communication where new languages make possible innovative *active vision* of heritage able to produce new senses and sensibilities, not adding digital elements to heritage but rather creating a culture of integration between them (Irace, 2013).

In this mark, the relationship between design and archaeological heritage becomes affected at least by three categories of problems: first, the ethical role of design and its impact on the physical and social dimension of the space; second, the role of design in

the definition of quality standards for the contemporary public space characterized by the presence of archaeological sites; third, the characteristics of the new digital technologies, materials, forms and design systems used to improve the social interaction with the archaeological sites.

Thus, the challenge is now to understand if there's any possibility for the discipline of design, differently from architecture and urban planning, to socially and culturally improve these places correctly using technology, connection systems and interaction devices, stimulating at the same time peoples' active participation and respecting the historical memory of their context. An approach in which design is an active and dynamic subject in processes of construction or re-construction of forgotten cultural dimensions and in which technology is a way to improve the knowledge of the ancient times following the always changing vision of the past that people may have in the different historical times and going along with the interpretation of the ruins which depend on the specific cultural influences of a social community.

In the final analysis, therefore, activation and actualization are considered fundamental strategies in those processes in which innovation of cultural heritage, better than transformation, becomes the main objective: in this perspective, the interventions can pass through the insertions of new objects, artifacts or services, new uses or functions, new technological devices or new digital possibilities through which the value of the historical places can dialogue actively with the contemporary physical and social context, reaching a double objective. On one hand, improving relational connections between heritage, places and people and, on the other hand, enabling innovative ways of use of cultural heritage by individuals and society (Lupo, Giunta & Trocchianesi, 2011).

4 Design and Archaeological Sites

By observing the most recent interventions in the historical-archaeological contexts it's possible to detect a new approach (understood in the broadest sense of a system of different interpretative declensions) that no longer belongs to the idea of *transformation* and *rehabilitation* but, rather, it is configured as an expression of a new form of dialogue with the physical and social context whose new key to reading resides in the concepts of *expandability*. This concept, expression of the already detected character of the emerging design as a multiverse discipline intended as a way of thinking and doing (Manzini, 2006), can be articulated in three dimensions: social, disciplinary, formal.

In the social dimension, what is *expanded* are the systems of relationship between people, at different levels of specialism and use: let's think, for example, of the integration between different categories of users in archaeological areas (from tourists and occasional visitors even researchers, students and academics), a totally new condition with respect to the clear separation of areas that in the past defined historical contexts (area for tourists, area for archaeologists, area for restorers, etc.); or we may think of the physical distinction of the spaces that followed the different forms of use of the space itself (areas for exhibition, areas for documentation and information, areas for conservation and restoration, etc.), which is now completely disappearing.

Second, there is the disciplinary expandability. In fact, if in the past decades the disciplinary debate on the historical-archaeological areas focused mainly on the disciplinary relationship between architects, restorers and archaeologists, now other disciplines appear, including industrial design, computer science and digital communication, which are now able to *expand* dialogic perspectives by giving an active role to user participation; a dialogue that thus becomes more open, collaborative, interactive, both horizontally and vertically.

Finally, expandability acquires a formal dimension, and this means two things: on the one hand, the historical urban contexts, dense and compact, need to expand their spatial dimension to connect to other contexts (that is, small Roman findings regarding a system of deposits at a regional level, or medieval ruins with respect to other sites that have similar settlement or constructive typologies, etc.); On the other hand, the present time needs now more than ever to establish connections with the past (history, memory, etc.) and with the future (new generations, the transmission of heritage to new users, etc.), although this goes through more virtual forms when not *liquid* or ephemeral (Baumann, 2000).

In Italy the experiences in which is possible to find a contribution by the design as a discipline can be found in big archaeological areas or in important public archaeological museums. Between these, and considering the most recent initiatives, the National Archaeological Museum of Valle Camonica (Cividate Camuno, Brescia, Italy), which exposes prehistoric and roman findings coming from the surroundings, dialogues with the archaeological ruins, with the territory and with the cultural context using multimedia systems and devices which follow contemporary design criteria. The design principles are based on a narrative and didactic purpose through a museographic system "expanded" by a chromatic grammar and an infographic system.

As a second example, In Pozzuoli (Naples, Italy) the archaeological area of the Macellum has been re-interpreted through a new multi-level lighting design system (project by Cannata & Partners) which works with different scenarios that offer dynamic and always changing scenographies according to the economic, cultural and social characteristics of the specific occasion of fruition. The design solutions try to create unusual narrations using metaphors and innovative communication systems so to link together functional, aesthetical, social and emotional aspects (Fig. 3).

An interesting experience in the one developed in Reggio Calabria where the Archaeological Museum has been interested by a new system of visual identity and wayfinding which pretends to be a methodological paradigm for all the archaeological areas of the region (but also for the whole national context): the project aims at improving and enhancing the social interaction between ruins and visitors using innovative infographic and communication systems.

In the international context there are many recent examples of design intervention on archaeological sites in which these different interpretations of the concept of expandability coexist in a plausible innovative vision together with a critical behavior toward the technological tools.

Between them, an interesting experience is the Interpretation Center of the Roman *Via Sepolcrale* in the Vila de Madrid Square in Barcelona (Spain) by UDEU Arquitectura in 2009, where the narrative system is spatially and formally expanded and integrated

Fig. 3. Lighting design intervention at the Temple of Serapide, Pozzuoli, Naples (Italy), by Cannata & Partners (2018). Image courtesy of Cannata&partners.

with the historical route and with the contemporary square in the old town of the city. The Interpretation Center is located in a residual space which covers both the archaeological level and that of the square's public space with a visual continuity between inside and outside. The content is a small exposition system that evokes the ancient remains' excavation process, made of physical panels and digital solution of storytelling, all of them intended as a unique system with the public space of the square (Fig. 4).

Another example can be found in the valorization of the archaeological area of Niederbronn-Les Bains (France) by RHB Architectes (2011), which works with a system of layers through which the remains are connected not only with the surrounding spaces, but also with the entire historical-archaeological system of the city, working in the connections of elements at different scales. Following this idea of *multi-space*, the informative system is made of historic plans, chronological texts, documents, lighting system solutions and the ruins themselves, located according to the ancient routes and accesses to the area. Also in this case the design experience is expanded to a *human centered approach*, being the way people directly and actively live the space and the ancient ruins the most important objective (Fig. 5).

The relationship between design and archaeology can be seen also as an ephemeral presence of elements in the archaeological areas useful to make possible a physical temporary interaction between people and ruins. It's the case of the experiment developed by PKMN architectures + ISAD in the archaeological site of Paquimé in Chihuahua, Mexico (2011), where small design structures are used as moving points of observation, systems of accessibility for people with reduced mobility, fixed and transportable shading devices, portable container of information about the archaeological site, etc. In this case there is an innovative expansion in the use of the design elements to each of whom is associated a different human action (Fig. 6).

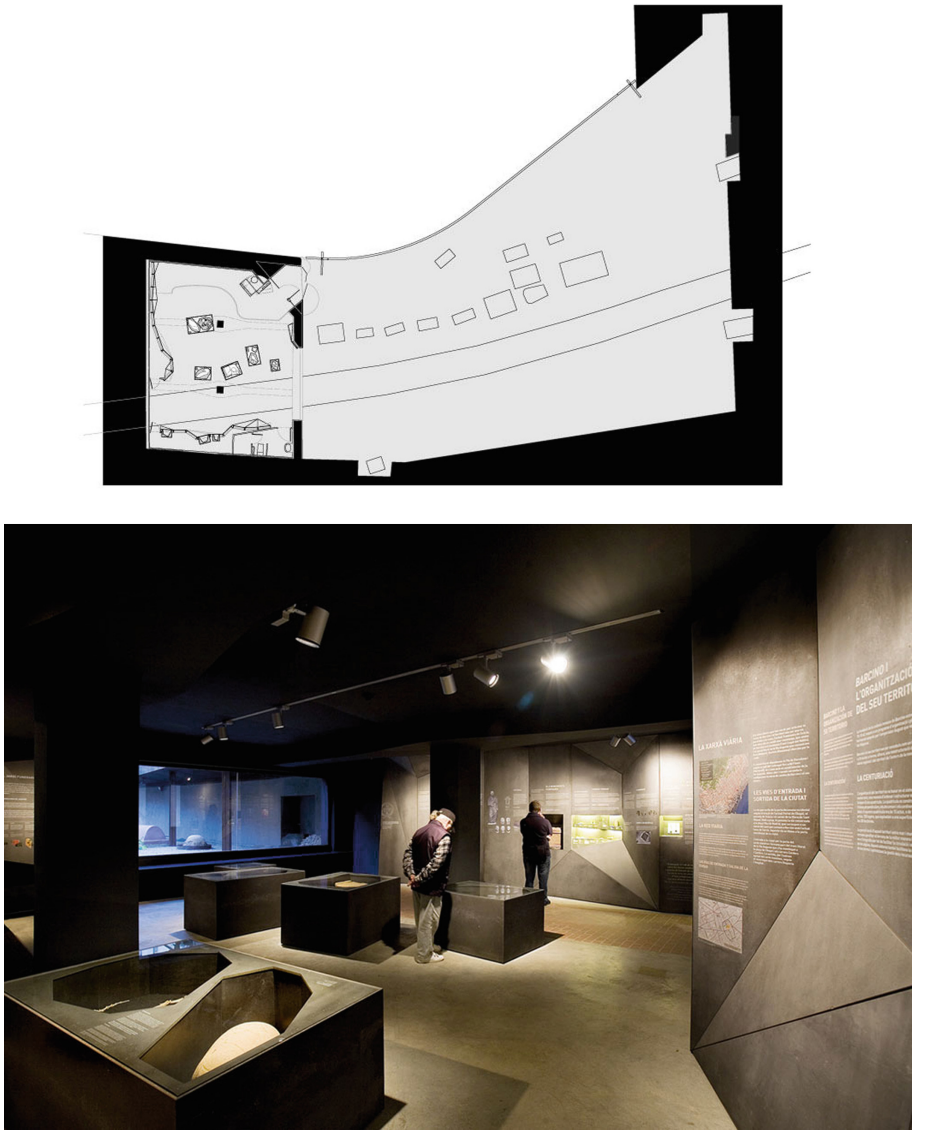

Fig. 4. Interpretation center of the Roman *Via Sepolcrale* in the Vila de Madrid Square, Barcelona (Spain), by udeu arquitectura (2009). Image courtesy of udeu arquitectura.

In a different way, the installation called *Strates* (2012), designed by LNV Architectes & P Fluck in Cugnaux (France), works on a conceptual expandability: the project, intended as a metaphorical interpretation of the archaeological stratification, is a structure made of different horizontal wooden layers (each of them representing a different historical moment) which virtually become *levels of knowledge*, where people can go and

Fig. 5. Valorization of the archaeological area of Niederbronn-Les-Bains (France) by RHB Architectes (2011). Image courtesy of RHB Architectes.

discover the historical surroundings in their relationship with the contemporary public space under different visual perceptions, so to better understand them (Fig. 7).

The observation of these examples, in their heterogeneity, demonstrate how considering the intersection between the line of space/time and the line of reality/virtuality, the expandability as a dynamic condition moves from the center of this intersection in different direction adapting to the social and cultural condition of a specific context. This capacity of adaptability to changes is for the archaeological areas a great opportunity but nonetheless it represents a risk at a time when the solutions and the decisions are taken

Fig. 6. Intervention in the archaeological area of Paquimé (Mexico), by PKMN Arquitectos + ISAD (2011). Image courtesy of PKMN Arquitectos.

into a 'virtual' dimension without any dialogue with the real conditions of the historical contexts (Bagnato & Germanà, 2019).

On the other side, if the productive and economical transformations may determine a slight change in the physical aspects of the urban context, under a social point of view we always have strong impacts not necessarily immediately visible. In this perspective, design can give an important contribution to detect and control these changes, trying to maintain, according to the community needs and requirements, a high level of quality for the public space, in social terms (Bagnato & Martinelli, 2019).

Fig. 7. Installation Strates in Cugnaux (France) by LNV Architectes + P Fluck (2012). Image courtesy of LNV Arquitectos.

5 Conclusions

Linking together the UNESCO's goals for sustainable development and the 2030 cultural indicators with the two aspects of the design value defined by the Montreal Design Declaration (2017): "*Design expresses culture. Designers have a particularly potent role in making, protecting, nourishing, enhancing and celebrating cultural heritage and diversity in the face of globalization*" and "*Design adds value to technology. Through consideration of human perspective and interface, and by focusing on individual interaction first, design bridges technology with human needs*", we can outline some specific ethical aspects of design for cultural heritage which can be seen as parts of a new plausible perspective in the processes of urban renewal.

Considering the complexity of the places marked by the presence of cultural heritage evidences (real semantic territories), the characteristics of integration, interdisciplinarity and integration of the contemporary design approaches translate into models of micro-actions that take the places of the big interventions and/or radical urban transformations: forms of exploitation of cultural heritage through which design, using appropriate physical or digital tools and systems, make possible situations of social and cultural intermediation between people and ruins (Bonini, Bosco, Bulegato & Scodeller, 2019). A narrative power through which people can live the place in its double synchronic and diachronic dimension not substituting what it's already existing (the ruins) with something new (the digital devices) but in a different way, through a participative storytelling approach, better understanding senses and meanings of the historical contents (Bonacini, 2020).

Nevertheless, even if it's not yet possible to draw a general methodology, it is clear however that in the specific case of archaeological contexts design assumes the role of an *observer* (Lupo, 2009) able to link between cultural aspects, technological tools (if there's any) and communication systems with the triple purpose of giving a new value to the ancient ruins, enhancing the knowledge of history, past and tradition and activating user's interaction and participation in the use of public spaces. This is ultimately the

relational and systemic capacity to give not only a meaning but a system of senses and sensibilities to things, innovating human behavior and introducing innovative forms of interaction, according to the intrinsic *relationality* of the commons (Carullo, 2014; Gausa, 2005), through *community objects* with a social responsibility (Koenig, 1983).

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Designing the "Threshold" in Resiliency Cities

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Abstract. The global crisis that we are going through and which may soon degenerate positions several questions about what the urban form will be after the end of the Pandemic, what the new social and human relations will be and, more generally, what life in the cities will be like. This essay will try to explore a research teaching project that involves 30 international students – with different design backgrounds (product, interior, communication and product service system design) – from the Master's Degree elective course, Temporary Urban Solutions (TUS) in the School of Design at Politecnico di Milano, to project possible cultural resiliency solutions enhancing the semi-public spaces of the city. This experimentation between research and didactics, starting from cultural and social investigation, translates into analogical visions and digital practices emphasizing artistic disciplines to give a post-pandemic urban and collective redemption.

The aim of this article is to present different points of view, with a design purpose, and in order to create a collective legacy, in terms of spaces and activities, for the future. The academic research and educational exploration, in the field of Design, highlights this forced urban silence even when the lifecycle of the city will become frenetic again, with a new normality.

Keywords: Resiliency Cities · Post-pandemic Scenarios · Spatial proximity

1 Introduction

Cultural Resiliency Experiments is the claim of an elective course for master's degree called Temporary Urban Solutions (TUS) at the School of Design of Politecnico di Milano, in which about 30 students connected online from all over the world took part.

During the scheduling of teaching activities for this course, before its start, we unexpectedly found ourselves in the midst of a real global emergency due to the explosion of a pandemic that generated a mechanism of adaptation, in the academic and university sphere, to redesign a teaching method – already consolidated in past years – investigating social and cultural issues in order to experiment new research and educational method in the field of Design for Social Innovation and prototype new temporary urban scenarios during pandemic and catastrophic eras. This experimentation between research and teaching approach, starting from cultural and social investigation, describes into analogical visions and digital practices emphasizing artistic disciplines – cinema, theatre, art, culture, dance, music, literature – to give a post-pandemic urban and collective redemption.

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The next paragraphs will focus on a cultural and social analysis to address the issue, then move on to the transformation of this theme into a brief for a university teaching course that has generated eight different interpretations of artistic disciplines-in terms of space and service-for the resumption of social life after epidemics.

The added value of this teaching and research experience is to valorize the concept of legacy of a space or a temporary activity to keep a past alive, something that has radically changed everyday life, in a not too far future.

2 Pandemic-Cities

Covid-19 tragically reminded us that it is the strength of the community that is our last defense; and that this must be developed for the protection of all. According to [1] "to consider the whole society as a huge laboratory for socio technical experimentation": this practice is a remarkable example that could be used as a model in the future on a large scale where future designers must be able to manage complex and innovative processes and possess transdisciplinary knowledge and summarize them in their projects. The solution, therefore, is to rethink the city and its future developments from the point of view of the city as a common good which increases an ethic of active and community citizenship and which, at the same time, is able to guarantee its inhabitants the fundamental rights enshrined in the constitution. Rethinking the city also reflects society.

Pandemics have always shaped cities and also, Covid-19 is already doing that. From the Athens Plague in 430 B.C., which brought about profound changes in the city's laws and identity, to the Black Death in the Middle Ages, which transformed the balance of class power in European societies, to the recent wave of Ebola epidemics in South Africa, which highlighted the growing interconnection of today's hyper-globalized cities, public health crises almost never fail to leave their mark on a metropolis. Of course, followed by the Covid-19 pandemic, "the significant relation of health promotion and architectural design is highlighted more than past" [2]. The control on people's social interactions, as a means for contagion prevention, has disturbed ordinary activities. On the other hand, "the mental effects of such isolation have compromised the mental health of the citizens especially in cities" [3]. Therefore, architecture as the context for human's most activities plays an important role to enhance mental and physical health, control disease prevention and provide a safe platform to return the society to normal life. In an epidemic situation people tend to feel safe in controlled places.

Evolutionary biologists refer to "the theory of punctuated equilibrium, in which evolutionary changes are not cumulative and gradual, but rather transpire in specific moments" [4]. Kuhn [5] conceptualizes these changes as paradigm shifts: "these breaking moments are opportunities to embark on radically new and bold projects". It is unclear if the impacts of Covid-19 on public space will be as profound as they are in other aspects of our life. Corbera [6] says "in the realm of public space and design, a key question concerns how long these impacts will be felt, and the degree to which they will be transformational (…) it may take years before we are able to ascertain how the global pandemic has changed the planning and design of public space". In the coming years, state and local governments may not have the money to implement long-term plans and large fixed infrastructure costs. As a post-lockdown on the periphery of the city, we will

have to develop new ways to use the places we share, from public toilets to restaurants, classrooms, corridors, subway cars and sidewalks. Driven by fear, we will develop new social foundations. We don't know how to feel when we move on land that we cannot completely control, it will take a long time before most of us adapt to a new social and private normality. As the world continues to fight the rapid spread of the coronavirus, confining many people to their homes and radically changing the way we work and think about our cities, some wonder which of these adaptations will last beyond the end of the pandemic and what life could be like afterwards. It is clear the transformation that our cities have undergone in the last months: long panoramas of deserted public spaces, it almost seems to be in a film with no sound, no noise, no human presence, no traffic, but above all no pollution. Since the emergence of Covid-19 our lives have taken place in our homes radically changing our habits and places of cultural interest have become utopian. A growing number of initiatives have been launched, both in the institutional field and by associations, theatre companies, museums and private citizens. Museums closed, exhibitions suspended or cancelled, monuments barred, cinemas locked up, productions interrupted, theatre shows postponed: even culture, at least that which refers to physical places, is hostage to the pandemic period. The directors of the major museums have created virtual tours for the *habitué* of culture as a cure to the forced closure of the rooms on the emergency of the pandemic giving the opportunity to travel between the ages through the artifacts, works and places themselves keeping alive the interest by sitting comfortably on their sofas. Even the theater has moved to producing material available on the internet: many companies and many theaters make available videos of their shows on their websites or social networks.

One of the first realities to mobilize to meet the emergency was the Cineteca di Milano, a private archival institution based in Milan that holds over 20,000 films and more than 100,000 photographs from the history of Italian and international cinema, which made access to the Videoteca di Morando free of charge, where more than five hundred film classics, rare films and recently restored films are collected. Among the most interesting initiatives is the daily column *#DesigninPigiama*, by Chiara Alessi. On her twitter profile, the critic and curator has published, regularly during the quarantine, sixty short videos in which she tells the history of Italian Design culture in pills for everybody. All this is going very well. They are all initiatives and activities, absolutely profitable if you look from a social point of view. On the other hand, they consist of adaptive solutions that go very well in the short term, in the long run, however, not all of them would have the same cultural and social impact as before, depriving an audience to approach them in person and not only remotely. The recent pandemic has radically changed many social habits and interfered with the economic situation, generating new needs linked to neighbourhood living, from the availability of goods and services to the very possibility of meeting, together with a widespread crisis in the world of work. Several examples show how living in the city in its proximity, starting from one's own neighbourhood or block, is propaedeutic to reacting to adverse situations. When local communities prepare to participate in collaborative action, it is much easier to design, produce and activate solutions for a better life. There is a level of proactivity that facilitates the creation and multiplication of this model: from small events related to entertainment or solidarity to actions that respond to particular needs and affect public spaces that are often residual,

to transformations of spaces in anticipation of a structural change that takes on the character of temporariness necessary to test their validity, effectiveness, correct use and benefit for people. The point is that these experiences can then become a system. If people are involved in a project, it becomes an infrastructure capable of creating the physical, social, cultural and economic conditions that allow other projects and actions to emerge and flourish, in a constellation of solutions that make city neighbourhoods more resilient. "Cities that are strategic sites in the global economy because they concentrate command functions and high-level producer-service firms oriented to world markets; more generally, cities with high levels of internationalisation in their economy and their broader social structure" [7].

3 Collettivism or Individualism

Resilience has consistently been recognised as the strength of communities and institutions to deal with environmental, economic and social crises constructively and innovatively. Landry [8] not only defines the city as a multifaceted entity but also as a dense system, comprising "entangled meshes of dynamic, interrelated, emergent, self-organising systems" [9] at different organisational, political and technological scales.

Its vitality is proportional to its ability to respond to these stresses through a continuous adaptation and reinterpretation of spaces. In recent decades, public spaces are becoming places for everybody in terms of interactions and social innovation, offering a context where creative communities provide original solutions to the daily problems that the current economic system can no longer provide. This means that new social and economic hierarchies emerge within the reticular, translatable city, which assigns new meanings to its spaces. Urban changes are perceived more strongly at the neighbourhood level. It is a specific location where the population can find a concentration of functions and services at a reasonable walking distance rather than spread to the immense scale of the city [10]. The latest transformation of public, cultural and social areas is dictated by the strong dynamism and smoothness of the city, which has seen a reaction in the emergence of a postmodern theoretical approach with reference to that part of literature which is defined as the critical one. From the new cross-disciplinary directions of reflection on the interaction between individual, place, society and on social and territorial transformations, a renewed centrality emerges with reference to the relationship between the individual and the transformations that nourish the territories, to the relationship between places and social subjects [11], to the geography of everyday life [12]. In this context, the strong link between the individual and space, as well as the interpretation of microeconomic and "social dynamics generate a complex scenario characterised by many phenomena that cannot be easily interpreted" [13]. Thus, "as economic and social geographies change, the transformation also involves the nature of public spaces" [14]. In modern cities, the public spaces reflect our shared values. They are our community heritage, owned, preserved and used by all members of contemporary society.

The coronavirus epidemic and its immediate impacts, such as social distancing, have raised many questions about the role of public space in these times. In spite of this, we have also seen instances of collectivism and urban resilience. In contemporary society, according to Gehl [15] "people seek a space that must be comfortable, welcoming and

liveable (i.e. the square must have support points such as benches and walls of seating in order to be seen as a public space)". Carmona [16] argues that "spaces become more meaningful when users interact with them". Other authors [17] seem to associate public spaces with a strong sense of community with well-being, feelings of safety and security. Therefore, in the cities of the 21st century, "places to meet and connect could become public spaces and the extended use of public space should be seen as a form of societal development" [18].

In other words, the great social transformations of recent decades have contributed to changing the ways in which society has modified spaces, places and forms of living. At the same time, experts have adopted a new approach that has shifted away from those well-known theories that today appear short-sighted and incapable of dealing with existing reality and proposing alternative solutions that are consistent with the needs of individuals: set the concept of space in the declination of collective, open, public space at the centre of a great literary debate.

In Italy, since the beginning of 2020, the first national lockdown has forced people to create a new type of public space. Citizens are taking to their balconies and windows to enjoy music together, sharing songs across buildings and above streets. Also, people have been thanking medical workers by clapping from their balconies, a sport instructor offers his neighbors a free aerobics class, many have been leaving notes and letters for their neighbors to offer help to the elderly, etc. It's a reminder that connection and interaction are integral to our society even in times of crisis. The inside towards the outside becomes a slogan to which all his research aimed at overcoming the limit between private and public space. According with La Pietra [19] "the home that each of us lives in is slowly taking a new shape that is more compatible with our renewed existential dimension, the digital hermit one. […] More than instructions for living in the city now we need to formulate new instructions for living home".

During the TUS course period, one of the exercises that had been suggested to be completed by the end was to create one's own *Quarantine Journal*. An analogical tool used to express thoughts, feelings, change; a sort of journey to be told, with its difficulties and discoveries, in a near future. It was very interesting to see how the students showed their private spaces, how their everyday life was transformed, through new ways of interaction and the interest shown for the topics of the course. It consists of an individual tool, which allows one to maintain an apparent division between private and public, but at the same time an educational tool that connects the change through a sensitive way of thinking (See Fig. 1).

Fig. 1. Detail of Quarantine Journal

4 From Public to Private Spaces

We have learned to listen to the city and its needs through a more active perceptive sphere. From the windows, balconies, stairs, of our private homes we collect sounds and smells that distracted life has never allowed us to hear, and we can afford to enter a fragile and emotional city landscape. Each of us has wondered at least once in this period if the state of isolation was not the right occasion to stop and reflect on the tomorrow that will be at the end of this pandemic. In this situation the balcony is salvation, the only possibility of still feeling, at least in part, in urban space. The void should not be interpreted in the declination of gap and residual space [20] but could be defined as an open or collective space when in that emptiness a place of identity, socialization, meeting and/or leisure is created [21]. Therefore, in this scenario, the spatial reclamation phenomena is to be considered closely related to the concepts of identity and territory where the contemporary citizen, living in a liquid space, tends to adapt to the changes of the surrounding context [22] and the frequent and contemporary processes and practices "of re-appropriation by people (e.g. urban gardens, self-managed green spaces, places of cultural production, public spaces used for collective activities, etc.) act as a sign of vitality and dynamism of cities, as practices of freedom" [23]. Amid this cultural revolution, a renewed need for people to meet emerges, whereby cities increase the quality of life by assigning new values and collective meanings to emptiness. The reality is that to start thinking about new possibilities.

Imagine a collective enjoyment of culture in the spaces available to us in quarantine, starting from an individual experience. The private space comes out of the walls that

contain it. It shows itself outside to interact with the public space. Benjamin [24] supposed that "the home is that spatially localized, temporally defined, significant and autonomous physical frame and conceptual system for the ordering, transformation and interpretation of the physical and abstract aspects of domestic daily life at several simultaneous spatio-temporal scales, normally activated by the connection to a person or community such as a nuclear family".

In this context, however, there is a space that we have revalued the most, such as balconies, windows, and terraces. A revolutionary architectural element that was previously considered a demarcation point of the domestic boundary and that is now the place of the house from where it is still possible, indeed somehow stimulated, the relationship of proximity with the neighbors and a connection between private and public space.

In Oggiano's article [25], he says that the "wireless communication took place through the windows […] and thanks to them we found beauty in the most hidden place of adulthood, but when we were kids, it seemed like the edge of the world: the courtyard". La Pietra [26] anticipated "the balcony has been revalued by many and considered a stage for relations, from which it is still possible to express, perform and communicate". The term *balconanza* describes this emerging activity of relationships between people from balconies and terraces. Starting from these activities, other semi-public spaces of proximity have been involved in an almost progressive way starting from the experience of the individual with his own apartment and progressively spreading in the remaining condominium spaces: courtyards, stairs, elevators, terraces, etc. Margins between open public spaces and buildings contribute to creating urban paths that form the structural part of the city's form. Urban pathways are the best places where inhabitants perceive the physical elements of the city, where citizens have close encounters with buildings, especially when space is perceived while walking. The inner margins "to show the evidence, the traces of what happens in the interiors, where people and activities determine the real functioning of the city" [27]. The threshold interrupts the continuity of the enclosure of the open public space and allows its crossing. "Threshold is something that sets between two situations, and it amounts to an in-transit space and at the same time a space of demarcation and differentiation; it connects two places, two territories, two environments and at the same time distinguishes them" [28] From the Covid-19 pandemic, the concept of living changed: we, individuals in a busy society, had to orient our routines within our domestic walls, seeking new ways of timekeeping. Suddenly the home has become the main character, our world and our nest, the place that hosts and defends. The domestic environment became a multifunctional space where we carried out various activities. This forced confinement increased our awareness of the importance of the private sphere but also highlighted its problems and difficulties. To find contact with the external reality, totally changed in the quarantine period, the elements that gained importance were the thresholds and everything that faced outside: windows, balconies, terraces became the bridge through which to connect with other people. According to La Pietra [29], "the balcony, that living medium which in my works of the 1970s represented a way of breaking down the barrier between the interior and exterior space, has now become one of the most useful domestic spaces for overcoming forced domestic claustrophobia". The result of this intersection is the enhancement of semi-public areas

in the living sphere: they have the power of connection, communication and transition between a private and a public world.

Resilience involves a system of knowledge, opinions and behaviours that characterise the ability to react to the unexpected to create new equilibriums. When focused on social innovation, the solutions that support it are to be found in people. Not so much in individuals, but in the way they group in forms of cohesion, around an idea of community: associations, circles of friends, inhabitants of the same block of flats, of the same neighbourhood. This way of being together today, especially after several months following a pandemic event, finds forms that lead to collaborations to counter the unforeseen to imagine the future together.

5 Cultural Resiliency Experiments

Florida [30] affirms that "the distinctive character of the creative class is that its members engage in work whose function is to create new meaningful forms". In this way, solutions help improve the perception of spaces, especially public areas, which are often temporary, low-cost, and respond to the needs for everyday liveability, slowly changing cities' faces. One concerning this article's strong motivation and intent is to show the first insights into social and cultural experiments: starting from bottom-up activities to promote high teaching and innovation, enhancing the multi-disciplines of Design and its tools by connecting them with new digital approaches and analogical transitions. Also, this article aims to present different points of view, with a design purpose, and to create a collective legacy, in terms of spaces and activities, for the future. The themes presented in the previous parts of the article perfectly introduce the central theme of TUS for the last academic year 2020. How to design a physical dimension during the quarantine for artistic and cultural disciplines – dance, theatre, music, cinema, literature, art – by exploiting the potential of the semi-public spaces of private buildings? What collective long-distance activities can be experienced? After the quarantine period, what is the legacy of these collective social opportunities? Can a new community be created through these experiences with a social distancing agent?

These questions were answered by 30 international students who participated in *Cultural Resiliency Experiments*, the claim of TUS elective course. This course consists of bringing the concept of city, public space, personal relationships, collective and performative activities into a private dimension such as one's own home, developing new artistic and interpretive forms starting from disciplines like dance, art, music, theater, cinema, literature, culture giving value and using-as an urban temporary stage-the semi-public spaces of one's own condominium: balconies, windows, stairs, terraces, courtyards, elevators, neighboring street, etc.

The different disciplines were explained to the students by experts from the Italian artistic and cultural world to present his idea of performance in a delicate period where the crisis of culture is still evident today. Among the experts we find: a music designer, a speaker of italian radio, a leader of a milanese cultural center, a manager of a historical cinema in Milan, a designer from architecture collective of Rome, the director of Triennale di Milano, the director of Fondazione Castiglioni and an italian performer. The course, after a multidisciplinary artistic and cultural presentation with case studies and

analysis of the theme chosen, begins with this personal vision of the experts, and in this way the students, – divided into working groups – chose their theme to be developed in the following weeks, and thus giving a new interpretation of the discipline and how this could be transformed into a collective activity in the quarantine period. This experimentation between research and didactics, starting from the cultural and social investigation, translates into analogical visions and digital practices emphasising artistic disciplines to give a post-pandemic urban and collective redemption. During the scheduling of teaching activities for this course, we unexpectedly found ourselves amid a real global emergency due to the explosion of a pandemic that generated a necessity to adapt, to redesign a teaching method investigating social and cultural issues in order to experiment with new educational approaches in the field of Design for Social Innovation and prototype new temporary urban scenarios during periods of a pandemic.

A new methodological and design process was tested within six weeks, which consisted of rearranging themes and practices already consolidated with the basis of Design for Social Innovation, using new digital and analogue tools for co-design activities and the generation of simulations for the prototyping of the final project. These experiments result from a new possible educational methodology that reflects on these changes and transforms them into possible new scenarios.

Moreover, one of the determining factors of this design research and teaching experience is time. Time understood as now, an agent to design opportunities for social redemption, but also understood as after, introducing the concept of legacy. According to Laura Galluzzo [31] "the legacy (…) can have different characteristics: material, social, or even in terms of the memory of experiences", with regard to spaces, "a legacy can be composed of discarded materials, structures that can be reused, but also by the memory, especially as regards temporary installations, of the experiences that were had in the space and in the enjoyment the project itself". Also, Amendola [32] defines legacy term as "a parallelism between major events and triumphal arches, monumental squares of the city built in the past to celebrate an event or a specific time in the history of the city, built with the intention of lasting, leaving marks, permanent effects on the urban fabric and the collective memory".

The students have ventured into designing new possible temporary urban solutions, in terms of cultural resilience experiments, to connect the neighbors who lived in their own buildings using a semi-public space (balcony, terrace, stairs, elevator, windows, courtyard) and showing new social interpretations of cultural disciplines. The project, which follows a phase of analysis and research, a remote phase of co-design and concept generation, and a double prototyping goal: spatial prototyping and service prototyping, emphasizing the legacy concept of projects. In the following paragraph are presented a selection from the eight results of TUS.

5.1 Lift Me Up. An Ephemeral Community

Lift Me Up uses the power of literature to create an ephemeral community, creating contacts between people that live in the same building. It gives the possibility to discover new books, it allows you to get in touch with the neighbors and to travel even while staying inside a house. This project takes place in spaces never exploited: the elevator and the landings. That is why the elevator of Fangshan District, in Beijing, will transform

itself, making people discover a condominium library, made with their own books ready to be shared. Moreover, cuttings of books on colored strips of paper will fill up the landings, to give a message of joy, hope or warmth. The project combines both analogic and digital tools and the result will be the sum of individual gestures. Taken alone they are only tools, but together they will create a real work of art. The project is made for the neighbors, and thanks to the neighbors. It will help to create a community inside the building, to discover new books, to get close to literature using it as a tool to escape from the external world (See Fig. 2).

Fig. 2. Lift Me Up-Project by Ludovica Donvito, Martina Gorio and Tiantian Qiu

5.2 In-Between. Connecting Stories

In-Between is a digital-analog spatial installation for people living in apartment buildings, its main goal is the creation of a collection of opinions and suggestions about cinema by connecting different individuals and places. It is designed to interact with people of all the ages, it mainly requires an analog approach always remembering that all the people involved are also invited to share their experiences on the facebook group of the project, where they can meet other participants and even discover new cinema contents. In addition, the In-Between is an evolving project which aims to make people and spaces evolving together with it. In conclusion, the *In-Between* project main goal is to build a collection of movie suggestions and reviews. The method used is, at the same time, funny and educational. As designers we let, little by little, participants build this unusual cinema library giving them all the instruments needed and helping them strengthening their existing relations or even meeting new people (See Fig. 3).

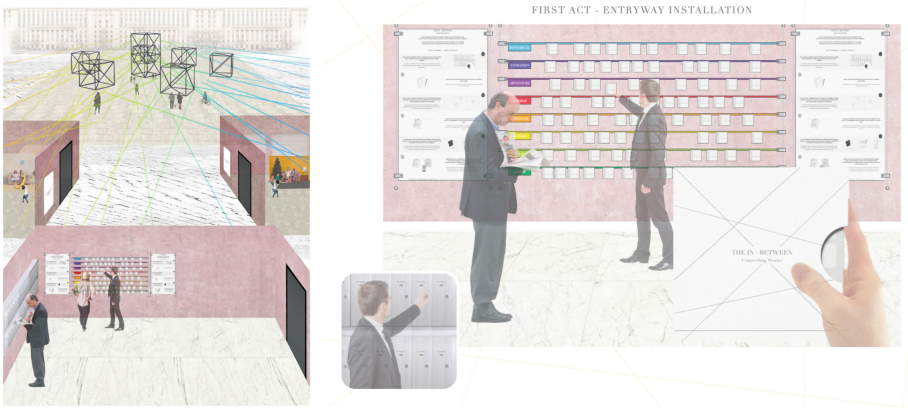

Fig. 3. In-between-Project by Greys Paola Acosta Peña, Mattia Barrile and Erika Grigis

5.3 20 dB. Stop, Listen, Connect

During these difficult times, many people found relief in music, they had more time to listen to their favorite albums, find old memories or just sit and relax to the sounds of empty cities or the nature surrounding them. This project wants to help people realize how important those sounds are and how they can be useful to get through hard times, leaving pleasant memories for the future. 20 dB is a way of imagining a new kind of social interaction for our new normality after the pandemics. 20 dB is an installation to remind people of the importance of sounds in our lives, even the quietest. Given the current situation and the recent measures it had to follow, a new way of enjoying these contents can be a solution both for those who consume multimedia online and those who are not familiar with technology and have a higher risk of being excluded from this revolution that we could see in the future of music as well (See Fig. 4).

5.4 Light Your Mood. A Window into Others’ Movies

By taking the most iconic features of cinema, the contrast between the light of the screen and the dark suggestive atmosphere, the use of colors to convey emotions, *Light your Mood* aims to connect people, isolated in their apartments during the quarantine, and let them relive the magic of cinema from home. The lit window becomes a sort of screen in which people can project their lives and, especially, colored filters allow to express their inner world. Moods are visually conveyed by colors, but more specifically by the association with a movie, a quote and a song from its soundtrack.

Through an app people have the possibility to find out more about their neighbors and empathize with them. Opening the windows, they can also discover new movies to watch in the future. It is a social initiative which wants to connect people, living in apartment buildings, with their neighbors, recreating and letting them relive the magic atmosphere of cinema during the quarantine. Cinema becomes a way to convey moods and emotions in order to feel closer and create bonds (See Fig. 5).

Fig. 4. 20bB-Project by Chiara Predonzan, Chiara Zeni and Andrea Zito

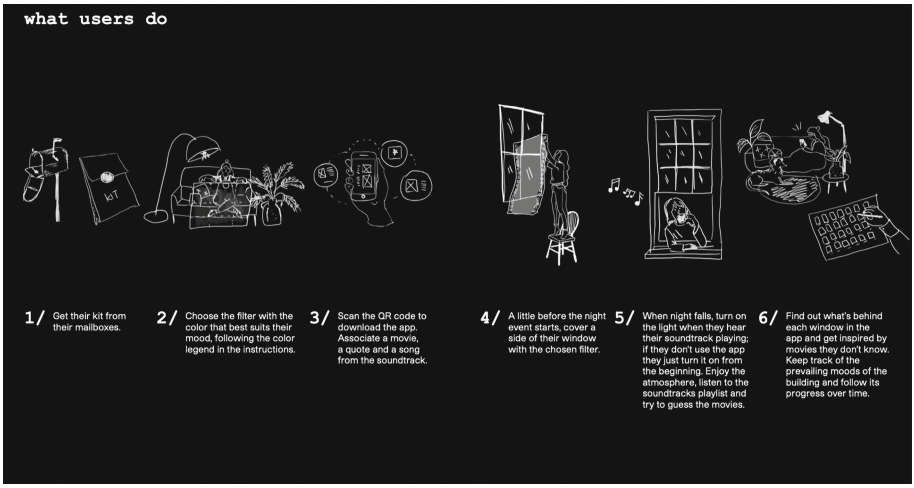

Fig. 5. Light Your Mood - Project by Francesca Bruno, Giulia Fabbi, Irmak Ozkan and Francesca Pavanel

5.5 Stage at Home. Express Yourself

Stage at Home is a project designed more than anything for people who want to stay creatively active during lockdown period and learn more about dance and performance arts, challenging themselves. Even if they are thoughts to be practiced during quarantine period, all of Stage at Home activities can be done anytime, anywhere and anyone. A wide range of kits with instructions have been thought to recreate art performances at home and to learn choreographies from movies and music videos. Activities catalog will be constantly updated, to have a wider choice of titles. Users will have the possibility to

choose what they feel closest to their tastes. The aim of the project is to involve people in learning something new and sharing their results; the most important legacy of *Stage at Home* will be the creation of a community with multiple interactions, accessible anytime by anyone in the world.

By sharing their experiences people can interact with each other and have a digital memory of the experience (See Fig. 6).

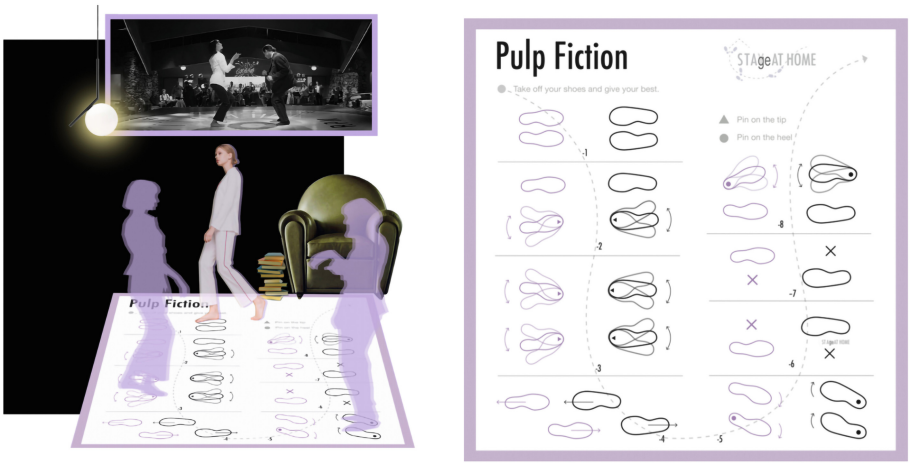

Fig. 6. Stage at Home - Project by Dafne De Marchi, Tianing Hu and Giacomo Zambon

6 Conclusions

In modern cities, the public spaces reflect our shared values. They are our community heritage, owned, preserved and used by all members of contemporary society. The coronavirus epidemic and its immediate impacts, such as social distancing, have raised many questions about the role of public space in these times.

In spite of this, we have also seen instances of collectivism and urban resilience. The ability to resist and be resilient to these transformations, which were certainly anticipated but found us unpredicted, are giving a new meaning to ideas, concepts, or expectations that we thought were clear. In this never-before-seen pandemic scenario, we are all called upon to act, especially those involved in Design, with the intention of envisioning potential solutions from the short-term to a long-term legacy. There are already many research and system experiments to reflect on possible future scenarios, developing solutions that could allow a transition to the new world that could come after the pandemic.

Through the initial research present in the article and a first vision of the new contemporaneity, it is evident the transformation that our cities have been subjected in recent months: long panoramas of deserted public spaces, it almost seems to be in a film without sound, without noise, without human presence, without traffic, but above all without

pollution. A void that wants to come alive with positivity and new certainties. As we have already seen, many initiatives have been planned, by the envious and simple citizens and by the big associations and institutions. In fact, national isolation has forced people to create a new type of public space, starting from their own homes. Carrying the private dimension into a public perspective, to give birth to new relationships, new interactions, to share moments of social inclusion and give a touch of positivity and lightness to everyday life: through music, culture, digital and the return to analogical stories, etc. For this reason, the idea of developing a new sensitivity in the students, opening the possibilities towards the impossible: we taught them to listen to their city, their home and themselves, emphasizing the various needs through a more active perceptive sphere.

Through this article, focusing the attention on the different points of view related to the topic with historical, scientific and literary insights and with the opinion of experts in specific disciplines, we want to express the possibility to start a process of design and interpretative approach to create potential small-scale solutions for a new positive city. This article is interested in resilience, on a small scale, from interdisciplinary research to the single collective teaching experiments. According to the literature, resilience has primarily to do with the maintenance and improvement of the quality of life of individuals, which can be achieved thanks to the creation of desirable contextual conditions. Fassi and Sedini [33] said that "narratives, participation, and co-design are suitable approaches for creating and facilitating visible connections, which in a small scale can help resilience. […] Designing for resilience means to interpret resilience in a more positive way in hard times". However, according to Manzini [34], resilience has to be understood as "a deeper expression of the human character and, at the same time, as ground for a possible reconciliation between human beings and nature, between human beings and the irreducible complexity of our world".

Cultural Resiliency Experiments is one of the many possible projects between research and education, as a case study, which investigated the issue, by adapting to the cultural and social transition we are experiencing. The choice to involve students in a sensitive design for the not easy period, has been a challenge to promote cultural solutions and social involvement, also because they are the future designers of our cities and it is right to start from the bottom to reach high expectations for a not far future. We present the first experiments, carried out in an academic sphere, but certainly easy to replicate and generate for new social challenges. There are already many research and system experiments to reflect on possible future scenarios, developing solutions that could allow a transition to the new world that could come after the pandemic.

It is just a starting point for possible future scenarios, not only a descriptive vision but a reasonable action for our present: in terms of the spaces, we live and everyday use, relationships with others, intercultural connections, and how to give importance to the factor of time. Surprisingly, changing from a fragile present to a mutable future thanks to the creation of new cultural and innovative systems.

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Design from Within. A Study for Endemic and Endogenous Design Processes

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Abstract. "Designing From Within" stands for a specific area of interest and a related new design approach characterized by endogenous and endemic processes. Starting from a culture studies theoretical framework, in which anthropology intertwine with artifacts' social life, in this paper, we will investigate the possibility to think of designed objects as a direct and pure representation of humans' activities (=endogenous), and/or rooted in specific geographical and cultural contexts (=endemic). Moreover, we will analyze how adjacent subjects, such as material studies and circular design could play a fundamental role in explaining how endemic and endogenous design is defined and what are its principles and methods. Finally, we will illustrate and reflect on a case study based on the use of bioplastics within the viticulture sector providing a ground for reflection on a specific design scenario within which to test our assumptions.

Keywords: Circularity · Bio-materials · Do It Yourself · Design Anarchism · Endemic Design

1 A Problem of Weight, Scale and Time

Looking at design history, specifically within the product and industrial design's realm, it is relatively easy to identify those main principles that, since its dawn, characterized the discipline and later revealed themself as problematic and controversial. At the foundation of industrial design and at the core of the industrial revolution, mass production and one-size-fits-all models, while granting access and democratizing purchasing power, demonstrated on multiple occasions their unsustainability and the danger of their short and long-term consequences. Scale, Weight and Time are the three drivers that will help us highlight those critical points and will serve as guidelines to illustrate how endemic and endogenous approaches could depart from those mistakes and redirect design towards alternative sustainable paths.

The scale factor is definitely one of the elephants in the room that occupies the design's building. "The incredible shrinking man", Arne Hendriks fascinating research on the implications of downsizing the human species to better fit the earth, is a great provocation against the beliefs that scaling up is always preferable and needed. When we think about doing good, helping others and giving back, it is difficult to believe that

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there should be a limit to the good we can do or to the help we can give. However, certainly there is a break-even point beyond which a solution may turn into a problem and we shouldn't forget such vernacular knowledge embodied in sayings as "too much of a good thing" or "enough is more than enough". Industrial design, which often tends to walk the line traced by old noble scientific disciplines like medicine or physics and math, has always chased the myth of the universality and replicability of its solutions. From universal design to design for the other 90%, the idea that one solution may help millions has always been highly attractive and carried deep ethical motivations for designers. Unfortunately, the achievement of such a result is very rare, especially without any problematic side effects. Either we talk about the perennial fight for sustainability or to untangle socio-economic issues, the basic problem of solutions is that they often work, or worked, in a particular context, space, time and, above all, at a specific scale. Biofuel production, for instance, which seems to be ideal at a community-scale, when run by farmers for farmers and by small businesses, becomes controversial at a larger scale. Extremely relevant is the case of the Mississippi Delta that in 2007 resulted in a 47 % decrease in cotton acreage with a concurrent 288 % increase in corn acreage. Because corn uses 80 % more water for irrigation than cotton, and more nitrogen fertilizer, this widespread shift in crop type has implications for water quantity and water quality in the area (Welch et al. 2010). On the same note, if in their infancy, services like Airbnb or uber seemed a great solution for improving the connectivity between people and places, and for creating a more efficient mobility system, they didn't wait long to reveal their criticalities. The decimated supply of housing available to local residents, worker exploitation and, in general, a lack of priorities towards the greater social good, made the scaling up of the initial solutions highly questionable. Chasing universality would mean satisfying every single need around the product we're developing, not only the ones concerning the direct users but also whoever and whatever will suffer the consequences of the designed solution. If we agree with Alan Cooper's "design for everyone is design for no one", or Donald Norman's "no single design is apt to be optimal for everyone", we should talk about sizing rather than scaling. "All over the world our ancestors evolved unique cultural expressions, informed by a sense of place and a deep reciprocity with the unique ecological, geological and climatic conditions of that particular place. The local and regional scale is not only the scale at which we can act most effectively to preserve biological diversity, it is also the scale at which we can preserve cultural diversity and indigenous, local wisdom as expressions of living in long-term connection with the uniqueness of any given locality" (Daniel Christian Wahl, 2016).

Weight is another factor that is strictly connected, both physically and metaphorically, with the legacy of industrial production (Thackara, J. 2006). From the heavy load of resources consumption to the human Anthropocene's footprint, it is self-evident that Mies van der Rohe's less is more or the Japanese Wabi-sabi principle hasn't been fully able to transfer their values from aesthetics to a well-rounded design ethos. Weight can be seen as the quantity of materials we use, the information we must decode for accessing services and products, or simply the weight of the debris left behind the so-called "progress". Whoever has ever approached any Life Cycle Assessment software is very well aware of the many materials, components, processes and cycles we must consider to have a plausible idea of the environmental impact of our products. Almost

20 years ago Michael Braungart and William McDonough wrote the book "cradle to cradle" setting the foundations of what is now called circular economy (Braungart & McDonough 2002). A circular economy is an alternative to the traditional linear economy - make, use and dispose - in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life. Cradle to cradle's call for action is more relevant and urgent than ever and often vernacular practices are capable of providing a great circular lesson. In Thailand for instance, as well as in many other locations in south-east Asia and north-east Africa, is common practice the use of elephants' dung to produce and sell paper products to sustain local elephants' shelters as well as supporting local communities through education and job placement. The very close circle loop that these experiences present are very good examples of how context, materials and human activities can result in self-sustaining and low-impact design initiatives. Navi Radjou, one of the promoters of the idea of frugal solutions, defines western innovation as a "more for more" equation in which we add more complexity, we use more resources and we ask our customers to pay higher prices for new products that are constantly in need to differentiate themselves from their competition. The essence of frugal innovation vice versa, a technological model mostly present in the global south, is doing more with less or, to be precise, doing better with less. Simplification and lightening of products and processes are in fact not pursued only for economical or practical convenience but because they usually serve a holistic greater good. Among Radjou's case studies, significant is the successful case of a Danone yogurt micro-factory in Bangladesh, whose facilities have been scaled down at 10% of the usual size, milk is supplied by a net of micro-farms, and automation has been heavily decreased providing more jobs for the local community (Radjou, N., and Jaideep C. P. 2016). This example proves that weight can be reduced at any scale, from the formal corporate world to the informal arts of reuse and recycle like Cuban's technological disobedience or the Indian's Jugaad approach (Bozzi and Oroza, 2002).

The last critical factor is Time. Nightnight. everyone, by J. Paul Neeley, is a simple program that puts your website to sleep at bedtime, encouraging your website visitor's to go to bed and commit to a healthier lifestyle. This viable option is mainly seen as a poetic provocation and the common reticence in taking it seriously suggests that from Ruskin's prelude to the arts & craft movement to Chaplin's modern times, the struggle to survive the industrialized world hasn't quieted much in a few secular leaps. The preference for "fast" over "slow" at the detriment of quality and safety in products' development often has been, and still is, the preferable design choice. In the late 60's Ford, to tackle the increase of affordable car options coming from international markets, designed and produced the Pinto model with the goal of having a car less than two thousand pounds in weight and costing less than two thousand dollars. Eager to have the automobile ready for the 1971 model year, the automotive company decided to compress the normal drafting-board-to-showroom time of about three-and-a-half years into two. After the car failed multiple crash-tests for "Fatalities Associated with Crash-Induced Fuel Leakage and Fires", Ford had the opportunity to review the design and delay the launch of the Pinto but for a costs/benefits calculation, together with the potential timing disadvantage against its competitor, decided to stick to the initial timeline. Between

1971 and 1978, approximately fifty lawsuits were brought against Ford in connection with rear-end accidents in the Pinto, affirming once more the direct connection between speed and risks within any design process. From the Slow Food movement, that fosters a holistic approach to agriculture and nutrition, to Slow Factories that privilege quality over quantity, the demonstration that alternative ideas of time and a more acceptable design pace is possible (Campana and Cimatti 2013). In Derbyshire-England, one of Gavin Munroe's takes five years to plant, shape and harvest one of his chairs. The product's life cycle in this case is not planned based on how long the object is supposed to last but on how long it will take to grow. The patience and cure behind Gavin's furniture hardly fit any modern business strategy, his chairs and tables hardly match any of the IKEA-driven aesthetic standard and yet the suggestion that products can follow and respect a sort of planetarian's circadian rhythm is a lesson that shouldn't go unheard. Design process and methods are not different from production, remember the Pinto story, and the pace designers are used to research and execute has gotten shorter and shorter. Education also should play a crucial role in resetting time-priorities in young designers. A great example is provided by the environmental exposure class at National Institute of Design in Ahmedabad. Every academic year, the first-year students participate in a week-long travel course during which they are asked to "study" a rural village. The group conduct a detailed ethnographic research of the village and collect visual information in their sketchbooks. The slow-pace observation, without any digital recording devices that could quickly steal vivid but partial representation of the community, forces students to interact with people and provides them the time to know in depth their subject before opting for any design intervention. Finally, expressions like time to market, time for production or planned obsolescence, all link design to a very temporary timeframe while what endemic and endogenous practices aim to is a much longer-term perspective, a next-generation thinking through which vernacular knowledge and sustainable actions doesn't have any time limitation or expiration date.

2 Endemic and Endogenous Design

To facilitate the passage from the design's problematic past to a brighter responsible future and switch to a better and more sustainable scale-weight-time paradigm, we suggest adopting the biological terms endogenous and endemic as principles for just design practices. Endemic generically defines something "native"; in the case of diseases, for instance, is about their persistence in a particular geographical area or human population, while for spices can refer to their unique presence in one region and nowhere else in the world. The term endemic is also in opposition to the term pandemic meaning, in the case of viruses, that the reproductive number is stable at one and not subjected to uncontrollable growth. The term Endogenous, that is generally defined as "from within", describes what is produced or found within living organisms like, for example, hormones, genes or viruses but it can also refer to the specific characteristic of a place as far as topography, climate or geography. The use of a biological framework is motivated by the idea that a sort of Lex Naturalis (Natural Law), intended here in its secular exception, should drive design towards outcomes that create as little friction as possible between natural environment and human activities. Moreover, we argue that a deep observation of

human behaviors in their natural habitat should bring designers to implement processes and outcomes that "almost" naturally fit those specific actors and contexts (Beyer, H., & Holtzblatt, K. 2000). While scientifically the two terms address very specific conditions, the way we use them in this research may often overlap. To better define the boundaries within which a Design from Within exists, will follow the analysis of three examples, set in different locations and cultures, and characterized by different and unique traits.

"Something Fishy", by the Icelandic designer Róshildur Jónsdóttir, is a toy construction set that uses discarded fish bones from the local fishing industry as components. The project can be seen as endogenous as the raw material comes specifically from within a well-framed environmental context, the fish belonging to its biosphere and the fisheries from its anthropogenic activity. In addition, the figures that result from gluing together the various osseous shapes recall Icelandic mythology and resemble aesthetics that are unique to local traditions. Finally, every aspect of this project suggests circularity and stays "within": the designer is local, the raw materials are local, and the recipient of the message are Icelandic kids who can play/engage with the essence of their native land while enriching their identity.

In Addis Ababa – Ethiopia-, the artist Elias Sime and the curator Meskerem Assegued revitalized vernacular architecture crafting all the buildings of the Zoma Museum with wattle and daub. In opposition to the common trend of African cities where imported architecture and urbanism, mostly from China, is creating anonymous and massive concrete settlements, Zoma forces to look at the local heritage and resources as a way towards a more sustainable development. Endemic is the way the project valorizes the construction tradition of Northeast Africa, deeply connected with its climate, terroir and aesthetics in opposition to a global modernity. It is also endogenous because of the material utilized, that comes directly from local soil, and because of the vernacular know-how that is grown and preserved through generations. Moreover, the entire museum is a self-sustaining ecosystem in which rainwater is collected, plants and sediment function as filters and the manure from animals on the museum compound creates biogas to help power the museum.

Finally, Chiara Vigo is a craft woman living in the island of Sardinia – Italy. Chiara weaves a very rare cloth known as sea silk or byssus, which comes from the saliva of a large clam, known in Latin as Pinna Nobilis. The harvest of the byssus is extremely difficult and it takes 300 or 400 dives to gather 200gr of material. The production process involves chant and prayers, the products created are not for sale but given to people in need as best luck and the entire process is surrounded by a mystical aura. Endemic is the local craft tradition and the closed link with the island, its waters and its bio-organisms. Endogenous, however, is something less rational and more spiritual. What comes from within, in this case, is the supposed sacred gift of Chiara and her family who are in charge to keep the tradition alive and the only ones able to make the silk "shine as gold".

In each one of these examples, either the material, the tools, the habits and traditions or the author and/or the user, exist within a specific contextual framework that characterized both input and output of the design process. In the world of design, in the last 10 years, we have observed an increasing number of cases in which the development of new materials is done by the designers themselves, starting from local resources and adopting simple production methods. All these experimentations follow a DIY-Materials

approach, defined as the process of experimenting with alternative raw sources to create new materials through self-production aiming for sustainable solutions that could better fit the scale-weight-time paradigm (Ayala-Garcia 2021). The preference for sources easily available within a short-range distance or because of their localized abundance, have favored material-innovation practices that can be easily identified as endemic and endogenous. DIY ingredients, which are the starting matter of any experimentation and tinkering, are often endemic as they can persist in a particular geographical area and also endogenous because they are subjected to a specific ecosystem (Rognoli et al. 2021). The project To See a World in a Grain of Sand by Atelier NL, for example, focuses on the exploration of local variations in sand composition. The initiative, aiming to highlight the endemicity of materials and the consequent endogeneity of the outcomes, collected 330-millilitre bottles of sand from all over the world through their website aworldofsand.com. When fired at high temperatures, these samples produce glass with colors and textures unique to their specific areas creating a physical mapping of local glass identities. Another interesting material in line with endemic and endogenous thinking is Marwoolus by Marco Guazzini. Marwoolus is a unique composite made of marble, wool and a two-component binder. Both ingredients come from a very specific area in the region of Tuscany, the wool from the textile district of Prato and the marble from Pietrasanta, less than hundred kilometers apart. The local availability of those raw materials, coming from the waste of the marble and textile industry gave birth to an always unique material and to a perfect example of territorial design and research.

The COMPAS group (Comparing and Supporting Endogenous Development) is an international network of organizations, from Asia, Africa, Latin America and Europe, which is working on the relevance and applications of traditional knowledge systems in varied areas. For its members, "endogenous development is development based on people's own resources, strategies and initiatives". With a series of principles and guidelines, laid down extensively in the book Learning Endogenous Development, the organization acknowledges the increasing lack of bio-cultural diversity and the need to look at local people, their values and their access to localized solutions and resources to self-determine their future, in both the material, socio-cultural and spiritual dimension (Compas, 2007). The cultural aspect of endogenous and endemic practices becomes a vital element if we look at the global system's tendency for homogenization and dominant cultures' hegemony. Moreover, and specifically to the design discipline, design itself, in many of its manifestations, represents an exogenous element (of external cause or origin) to the context within which it is asked to operate. Design methods and methodologies, especially within the big design thinking formula stream, are often dropped from above with the erroneous assumption that the universality of the methods, customized with a few tweaks, can override the cultural legacy of the problems. Here, we want to argue for design activities that are not alien but endemic to their framework and use tools that endogenously belong to that same frame. What COMPAS promotes and what endemic and endogenous design practices should aim to, is to revert the order of priorities in the technology-culture dichotomy. The conversation about tools and technology is crucial in this context. Neither endogenous strategies nor the previously mentioned frugal innovations are supposed to necessarily downgrade or de-tech our processes. Paolo Cardini

in his search for hyper-contextual futures, focused on the idea of cultural determinism in opposition to the ruling technological determinism. He argues that society and individuals, with their cultural behaviors and beliefs, must influence any technological development, not the other way around (Cardini 2021). Peter D. Jordan, Director of the Arctic Centre at the University of Groningen, sees technology as a human social tradition, and material culture, which includes all the tools and objects used by people in all spheres of their social life, as the result of long-term traditions that are passed on from generation to generation (Jordan P.D. 2014). When exogenous technologies are introduced into a specific context, the scope is always to change the existing conditions and more performance and better time-cost ratio are usually the drivers that induce the detour from tradition. As long as we're able to maintain the endemicity of the design context and pairing exogenous with endogenous tools and processes, we can increase the chances for the preservation of bio-cultural diversity and foster a "natural fit" of any design intervention.

3 Design Neorealism and Winemaking

The passage from customers to users, the incremental use of participatory practices, co-designing and any design philosophy that tries to merge the gap between design and people, are all symptoms that designers got too far from the Papanekian real world, good products are affordable by a few and the abundance of glittered design events stand in contrast to the lack of design sensibility in the everyday life (Papanek, V. J. 1984; Hoftijzer, Jw. 2009). If we acknowledge that design is intrinsically a human activity and it has always existed since the human species started to use its intellect and hands to solve problems, we should consider any design experience as a natural extension of peoples' life. Our idea of an endemic and endogenous design approach is directed towards regaining proximity to the real, both aesthetically and behaviorally. Neorealist films were generally filmed with non-professional actors, they were mostly shot in rural areas, they typically explore the condition of the working class and their scenes were often representing people performing mundane activities. As a sort of design neorealism, here we wanted to explore if an exogenous design proposal could grow from a preexisting context fostering local endemicity and endogeneity. With the goal of reinstating design processes close to people and into natural cycles, we have decided to look at the context of viticulture and wine production to test our assumptions and reflect on the results of our quest. One of the main reasons why we decided to look at this specific field, and where we set our pilot project, is the conversation that, since a while, has been happening among wine producers about natural and biodynamic productions. In 2001 Luca Gargano wrote the manifesto of the Triple "A" movement, stating that wine should come from as little interventionist winemaking as possible. Among other diktats there is the ban of any chemical substance, the use of only indigenous yeasts, the refusal to correct any wine level like acidity, tanning, sweetness or alcohol neither clarify or filter wine before bottling to respect the local identity of the product. Moreover, the meaning of the triple "A" in itself aligns very well the endemic and endogenous philosophy: the first "A" stands for "agricoltore", Italian word for farmer, as the one who's in direct contact with the vineyard and the only one who can build a human-nature relationship able to

give birth to healthy grapes. The second "A" stands for Artisans, meaning to act with artisanal methods to guarantee the preservation of the quality of grapes and wine without altering their natural cycle. Finally, the last "A" stands for Artists, referring to the artistic sensibility of winemakers whose work is able to reflect the terroir where it is embedded in. For all the above, it seemed a perfect environment where trying to extend the idea of triple "A" could be to other components of the wine production cycle. The research ground has been set in the eastern part of the Liguria region in Northern Italy and specifically around the La Spezia province. The selection of this research context has been suggested by the proximity and accessibility to local resources, the presence of a good number of reachable small producers and, most of all, by the unique geographical characteristic of the place, contained between the sea and the Apennine mountains. The Cinque Terre Natural Park and protected Marine area is part of this territory and it represents one of the most pristine and renowned Mediterranean natural wonders. This is due to mainly historical and geomorphological reasons that have prevented an excessive real estate expansion. The activities practiced by man for centuries, and especially viticulture, have contributed to creating a unique landscape in the world, named since 1997 UNESCO World Heritage Site. Our choice went to a small wine producer whose production respects the triple "A" canons and whose wine is not on the market but distributed informally to a small adjacent community which annually helps during the cultivation and harvest of the grapes. The choice of operating outside a business-driven context allowed us to have a wider access to the farmer's time and better explore the potential for community-based interventions. Moreover, among the goals of the project was the will to speculate on possible alternative socio-economic visions, and consequently departing from strict market constraints granted us the freedom to craft our provocation for a sort of design utopia. The project brief was framed as the attempt to create products useful to the winemaking activities with local resources and embedding the manufacturing processes into the pre-existing farming cycle. Materials, tools and outcomes are the focal point of our investigation and they will be analyzed in depth in the following description of the various design phases.

3.1 Bio-Plastic Harvesting Baskets

The first object we identified as a potential subject for our design intervention was a harvesting basket, the containers in which to collect the bunches of grapes during the harvest. The endemic traits of the region invited for a reflection on the typology of the product. Especially around the Cinque Terre area the harvesting is particularly difficult due to the steep cliffs facing the sea. The terraces created over the years allow the cultivation of grapevines and olive trees but access is still limited and arduous to any vehicle aside from little monorails that connect the top and bottom of the hills. For small producers, baskets are still the main tool for harvesting and often the only way to carry the grapes along narrow paths. The work started after the 2020 harvesting when we collected the left-over of the wine production to be used as ingredients for the creation of the bioplastic for the baskets. After a time spent in the barrels with the juice during the maceration process, grape skins are squeezed one last time to capture all the juice left and then discarded from the production process. Part of those skins are dedicated to the production of distilled products like grappa or used to add flavor to

seasoned cheese. The first step consisted in drying the grape skins with the goal to store them and use them at a later stage. The drying process was relatively quick and took around a couple of weeks. We started then experimenting with various bioplastic recipes with the objective to reduce at minimum the complexity of the process and privilege materials affordable and easy to find, for instance, preferring corn starch in spite of agar although the latter offer better performance in bio-plastic forming. After an extended experimentation made through tries and errors, we nailed down what was the mix that was ideal for our purposes and contextual conditions. We noticed that with 73% water, 10.5% grape skin pomace, 10.5% vegetable gelatin, 3% corn starch and 3% vegetable glycerin we could achieve a product that was stiff enough to carry a good weight but with a certain grade of elasticity to avoid cracking. To form the bio-plastic sheets we decided to utilize some unused stainless steel barrel's lids, ideal material to easily demold the bio-plastic sheets and to limit any bacterial contamination. Once the semi-liquid mix is poured into the mold it took three to four days to dry completely. The curing process presented some criticalities, the bio-plastic was subjected to a substantial shrinkage and a good aeration in both parts of the sheet was necessary to avoid cracking and mold. Once the sheets were dry and ready, we proceeded to create the basket adding some external components as metal rings and ropes. The design solution was based on the attempt to find the easiest solution for creating a carrying container starting from a circular shape. In this case, as well as in the entire process, functionality was favored to aesthetics and the final product projected the value of the process and the nature of the material. During the 2021 harvest we had the opportunity to test our baskets and successfully verify their reliability during a full day of harvest during which each basket was subject to 40 cycles with a load of around 10 kg per cycle (Figs. 1, 2, 3, 4, 5 and 6).

Fig. 1. Grape skins drying process.

Fig. 2. DIY Bioplastic samples

3.2 Grapevine Paper Labels

Grape's leaves are the other material we experimented with. The initial concept was to follow some traditional paper making techniques to create the bottle's labels. As happened for the grape skins, after the harvest 2020 we started collecting and experimenting with the material. The process was simple and made entirely with local resources. We first boiled the leaves, then grinded and finally sifted the pulp with a paper making frame.

Fig. 3. Bioplastic production process.

Fig. 4. Bioplastic sheet drying process

Fig. 5. Bioplastic bags carried during harvesting.

Fig. 6. Bioplastic bags during harvesting

After a few failures, we noticed that we needed more fibers to have a better and more resistant paper's consistency and we decided to add to the mixture some cane leaves that were growing beside the vineyard and some newsprint from old newspapers. The wet mix was then pressed and let dry. For the pressing process we looked for tools already present and available in the farm and we went through a couple of methods. The first one was the repurposing of the press used to squeeze the leftover juice out from the grapes as a paper press; however, during the process, we noticed that was way faster to simply drive the little tractor in use at the farm through the wet-paper, squeezed between two wooden boards. Both methods were successful and were of great value for us to observe how both materials and processes can be bent to adjust the need and practicality of the experimentation. After the paper sheets were fully dried, we proceeded with screen printing and cutting the labels. To print we used a home-made ink made with starch wine and some squid ink, collected from local squids, to darken the tone (Figs. 7, 8, 9, 10, 11 and 12).

Moreover, with a slightly more sophisticated tinkering on the existing tools, augmented for an expanded use, farmers could produce bioplastic objects to sell and support

Fig. 7. Bioplastic and paper-making Lab.

Fig. 8. DIY Paper-making process

Fig. 9. DIY paper-making press.

Fig. 10. DIY paper drying process

Fig. 11. Screen-printing process.

Fig. 12. Grapevine leaves paper labels on bottles

their activities. For example, the mechanical pump used to transfer wine between barrels during the filtering process could be used, after a steam rehydration of the bioplastic sheets, to vacuum form the latter into desired shapes.

4 Final Reflections

From vernacular know-how, through which the farmer augmented their knowledge without major technological leaps, to a sort of individual anarchism that let the farmer/designer taking full ownership of the production process, the project presented positive results suggesting the feasibility of an endemic and endogenous thinking in product design. The experimentation followed a DIY approach for both materials and processes and through a tinkering journey we reached a satisfactory balance between feasibility, complexity and sustainability. However, we acknowledge both some criticalities and opportunities that are worth highlighting for a further development of this topic and overcome its flaws. The first obstacle to consider for a successful outcome is the commitment of the farmers and their will to add a new habit to their pre-existing practices. A quick purchase of out-of-the shelf product can be highly tempting and the initial skepticism towards a new process, and the frustration climbing the steep learning curve, can be mitigated only by the full understanding and trust in the whole endemic and endogenous philosophy, which might appear impractical and inconvenient at first. For instance, while industrial production of bioplastic can count on highly controlled thermal conditions, in a more amatorial context, there's the need for constant adjustments and calibration that are possible just after having grown a certain experience and familiarity with the material. The production of the products created, the baskets and the labels, is feasible if the numbers are within the specific scale range of a few thousands of bottles. Passing that break-even point would require adopting other means of production and detouring from the primary concept of a non-scalable system. On the positive side, there are a few opportunities that haven't been tested during this pilot project that suggest a good future potential. Bioplastic and paper making could be an activity that might involve the entire community already present around the farmers and his vineyard, providing an opportunity for social engagement and entertainment (Smith, C.D. 2014), especially for older adults. Moreover, as already happened in the past for basket weaving or straw structures, the same approach could be applied to other materials found on the farm premises. From olive pomace to animal's manure the opportunities are endless as long as a proper outcome is identified and it serves the circular purpose. All the activities were intentionally inserted in the natural harvesting cycle and planned in a way to have as much integration as possible between the farming pace and the products development. Time revealed to be crucial for both materials and labor. Grape skins and leaves had to go through a drying process before being used and the bioplastic and paper production activities were allocated in a time when the vineyard was resting and the farmer had time to dedicate to these new tasks. The Weight of the full production cycle has been also reduced to the minimum granting a complete circularity; tools and materials have been sourced or repurposed from the local surroundings and the bioplastic objects produced didn't leave any trace after their use decomposing in less than 30 days. Last, the Scale has been maintained detached from macro socio-economic systems focusing on the only purpose to serve the specific context the design effort was directed to. Under multiple perspectives, these endemic and endogenous experiences could look impractical and unrealistic if considered within a modern, consumerist and capitalistic society: they require time that we don't have, they are not producing the profit we aspire to, they require a total commitment both physically and intellectually. However, in spite of

following Thomas Thwaites' Toaster Project footsteps, in which a modern David lost his battle with a capitalistic Goliath trying to create today's consumer goods bypassing industrial production, through this experience we wanted to open a window on alternative ways to see design intended in its anthropological aspect (Thwaites T 2011). The social utopia suggested here is a place where cultures and identities are driving innovation, where natural cycles marks time for product development, and where design is a holistic and accessible entity. It is also important to point out that the focus of this article is limited to the product design realm, its practice, its processes and the way its outcomes interact with society. We are aware that including in the equation a broader spectrum of analysis may change the interpretation of our findings but we preferred, for the sake of aiming to the ideal rather than the possible, to provide a fresh perspective on what design could be. Worth mentioning that this research started in late spring 2020 the pandemic contributes to frame our concept and define the endemic/endogenous approach as a direct consequence of the limitations in global exchanges and supplies.

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A Dimensionless Narrative. From Exhibition Design to the Art of Display

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Abstract. The paper aims to implement a critical reflection on some changes underway on the theme of narrative in design disciplines, an aspect that affects today the design, especially since the field is assigned the task of managing, in their formal and interactive aspects, information and transactional contents. The application field of the paper is focused on the museum, as it has been till now the reference point for a visual narrative in which Art has played a central role.

This issue, the language and narrative that derives from it, in the '80s was an exquisite prerogative of architectural disciplines. Rather today, it extends to design and art, disciplines inevitably called to compare with the rampant and noisy world of images, witness today of an excess of communication and information, but at the same time of a narrative deficiency.

Methodologically, through the analysis of some philosophers of the twentieth century who have repeatedly sought a path of meaning for the complex world of signs, the paper aims to give a place to a certain contemporary phenomenology expressed by some museums' case studies.

In the final part, the paper ends up drawing some conclusive lines over this contemporary scenario, with particular reference to the role of narrative and how it is today radically changing.

Keywords: Narrative · Museography · Exhibition Design

1 Introduction. Design to Narrate

Human architectonic space is at the same time a narrating and to be narrated one. The ways in which this narration has been configured in the past, takes shape in the present, and hopefully will also be concretized in the future, are a subject that constantly questions us about the coding of languages and its immediate impact on design disciplines. Therefore, in its cyclicality (code/language/narration/memory) the narrative process strives to root our existence in what preceded us, almost as a legitimacy of our actions, while the language code acts as a continuous medium between the meaning of things and their cultural significance.

If on the one hand we rely on the certainty of the past, in which the mind rests away from threats and in the certainty of the already-known, on the other hand, human nature has always expressed an equal yearning for discovery and innovation, initially

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presented as variants, then experimented, then theorized and, only at the end of this deductive/inductive process, introduced into the world of real things.

Especially in the field of museography, these aspects of the narrative find a multiple positioning, since such possibilities can be found not only on the three diegetic levels covered by work of art, museum building and exhibition design, but also on their mutual positioning and interaction.

Starting from some of these elements, Andrea Branzi (1984) identifies a specific area of the interior project destined to become areas of a complex reflection that involves space, seen as a sequence of small and liquid ambits (almost quantum, one might say), but also the material surfaces in relation to the sensory perceptual responses of the user. In summary, an area of expansion of interest in design, which on the museographic field coincides with a series of major changes, not to say disruptions, in the museum concept, as consolidated so far, elsewhere defined as the "third museum revolution" (Centineo 2021, 15).

These changes involve both project and theoretical sphere, centers of the thought, of the scientific formulation and their transmissibility. In particular, the different museum conception, in the various periods and contexts, assigns to the three bodies of the museum event (the exhibited work, the museum container and the installation) the tripartition of the diegesis, underlying the narrative - text, pretext and context - in different ways. Let us try to gradually define some of them, starting from the narrative and trying to understand the implications related to the narrative aspects.

2 From Collecting to the Modern Museum: Exhibiting Before Setting up

Rather than defining when collecting is born, a phenomenon at the basis of the birth of the museum and for which is made reference to adequate bibliography, we should ask ourselves why it is born.

The classical world lived in fact immersed in an amniotic dimension, made of few images (demonized by Plato) and even less writing (of which for example Socrates was renounced), where the universe of sound played a fundamental role in oral tradition and teaching (McLuhan 1976). This is confirmed by the refinement of the different tonal scales (or modes) of ancient music. This attitude gave an enormous value to the λόγος, as an ordering principle expressed by the word and perfectly found its coherent correspondence in the myth, the ideal place to which the finding of the ἀρχή should be reported. It is the moment when man lives in what Règis Debray (2010) calls the "logosphere".

The birth of Alexandrian philology, one of the major expressions of Hellenism, separates the text from its interpretation, and the concept of "ancient" from that of "classical", allowing progressively to take over the criterion of the principle of authority, expressed under various forms. The most basic of these principles involved an attribution of value, as greater as older the object of study was. A fundamental syllogism, protracted for almost two millennia of history is born: "ancient" equal "beautiful", equal "precious", equal "ethical".

The Middle Ages poured this intent on the sacred sphere, in a proliferation of relics to be flaunted, of sacred representations to be depicted, starting with Saint Francis' Nativity of Greccio and ending with pageants and itinerant *mansions*. The Renaissance extended these intentions from Christianity to the whole classicism, while the Enlightenment expanded them to science and nature, identifying the dissemination of material and immaterial culture as one of the best tools for mass education. Theatres, academies, libraries and, of course, museums were springing up.

This rationalization is incredibly systemic: if we think about it, they were devices from which the narrative possibilities branched, subdivided into dimensionally quantifiable and expressible coding. So, to the libraries belonged the dissemination of linear, one-dimensional codes, those of writing; to picture galleries, the two-dimensional ones; to academies (especially in the case of plaster cast galleries) the three-dimensional ones; and to theatres, connected to performing arts, the four-dimensional ones. This is the moment in which the definition of the study of the visual arts begins, with the distinction inherent in them, between support, media and device, defined as determinant for the transition from "image" to "picture" (Pinotti & Somaini 2016, p. 137).

They are born, almost together, archaeology, pedagogy, sociology, aesthetics, musicology, modern historiography, which in their intent are presented as guiding intermediary disciplines and sciences, that have the task of explaining other disciplines and sciences, of offering them to the community, in one word: to exhibit them. The birth of disciplines that mediate between the content and the container is a theme within which to place the need to exhibit and involves museums to a large extent.

With particular regard to ethno-anthropological disciplines, disciplines not exempt from some contradictions, sometimes dictated by an original complex of inferiority (fortunately today overcome), Alberto Mario Cirese (1977, 37) says: "i quadri sono fatti per essere appesi alle pareti, e dunque non cambiano di funzione se le pareti non sono più quelle della frequentazione quotidiana, casa o chiesa o palazzo"[1]. The paintings of the eighteenth century indeed, but also of the nineteenth, take as a model the halls of the noble houses for the total wall tiling with works of art. An artistic *horror vacui*, in which, without taking breath, in an excess of signs, like the pages of a huge index or atlas, the world of values and cultures is narrated by pictures. In the perspective of this narrative, the world of artistic images is therefore a context, within which to write this or that textuality of the museum story, that uses the potential of the exhibition as a pretext. Just as it is evident that the effects of the Industrial Revolution are perfectly foretold and quite imminent. Art is shortly entrusted with the role of putting in place a reality increasingly oriented towards a process of objectification and classification, on the basis of the new visuality induced by objects. Aby Warburg, already in the air, will just have to fix all this in his *Bilderatlas Mnemosyne.*

[1] "The paintings are made to be hung on the walls, and therefore do not change function if the walls are no longer those of daily attendance, house or church or palace".

3 The Second Museum Revolution, Between Science and Design Practice

As long as the production of objects relied on an artisanal matrix, the objects were reassuring interlocutors, perfectly assigned to a function carried out thanks to a conscious use, and linked to a culture that had produced them, of which they were perfect analogue image. Each object had a corresponding meaning, a λόγος to which it could be ascribed, and thus it floated in Debray's *logosphere.*

With the Industrial Revolution, we are witnessing the sudden introduction of a large number of objects: already known objects are now reproduced with innovative materials and processes, while traditional materials and techniques are also applied to new products, with unusual productive pace and especially with the introduction of the concept of "series" (and the related ones, "variant" and "model"), determining the birth of the concept of "goods".

It is clear that this large number of objects represents unprecedented signifiers. They are attractive and their rejection would mean a denial of progress and social self-marginalization. The objects reproduce at an increasing rate, but still following the rules of direct proportion, those of the Fordian system, and, while their *réclame* spreads the need among the people, the inauguration of a new figurative seriality is gradually created (Manzini 1990, 67).

Renato De Fusco (2004, 1–2), in one of the many editions of his History of Design, speaks of the invention of movable characters as a seminal act for the industrial design, since they combine the possibility of serial reprocessing of the product (e.g. the first copies of the Bible printed by Martin Luther), with the seriality of the medium and with the procedure that generates it (the movable characters). Two valid crossed motivations that, for example, the sensitivity of Règis Debray (2010) identifies as the end of the logosphere, earlier mentioned, and the beginning of the so-called "graphosphere", a moment that fixes not only the passage from autographism to allographism, but also from the transcendent myth to the ever more immanent story, from prehistory to history.

In fact, in his essays on globalization, McLuhan (1976 and 2011) identifies this crucial passage as the beginning of the dominance of the visual component over all the other forms of communication. Whilst these elements previously were in equilibrium with each other, now the consequent standardization of cultures and alienation of individuals, the automation of scientific research, the homogenization and repetitiveness of thought, are definitely introduced.

Between "the avant-garde spirit and, together with it, the conservative reactionarism that every radical innovation produces" (Kubler 1976, 78), the art, which has always noted the meanings attributed to things by mankind, generously bows to the goods and technology that produces them, through the production and attribution of new meanings. This attribution of meaning takes place in two fundamental ways.

On the one hand, the huge number of objects produced determines a new environmental ecology (if we talk about landscapes), new fashions worn to the characters (if we talk about portraits), new still-lifes (if we talk about domestic scenarios).

On the other hand, art frames reality in a different way: the abandonment of pictorial realism can be interpreted not only as the consequence of the competition against photography, but paradoxically also as the attempt to give it a meaning; and aesthetic

fruition, which now also addresses new objects, renews the concept of time, a parameter now necessary and considerable[2].

The birth of the exhibition, in the modern sense of the term, equates the goods exposed to authentic works of art. Thus, Edoardo Persico and Marcello Nizzoli, in the Parker Store in Milan, 1934, place in precious cases the exhibits, finds of a new veneration that rediscover the beauty no longer only in the ancient. Or Carlo Scarpa, in the Olivetti store in Venice, 1956, whose exhibitors, illuminated by discreet spotlights, enhance the most significant product of "made in Italy" with an exhibition architecture absolutely comparable to a museum design.

In Italy, starting from the great heritage of the exhibition, the conditions for the architectural rebirth of the country after the war could be found (Patricia Falguères, in Duboÿ 2016, 15–16), also from a pedagogical point of view. This was a theme very dear to Giulio Carlo Argan that just from the pages of «Comunità», magazine founded, not coincidentally, by Adriano Olivetti, in 1949 greets the Italian publication of *Art as Experience* by John Dewey[3], not only as the first theoretical construction of art as an ongoing experience, but also as a privileged place of education to forms[4].

The interest for the theme overcomes the old pedagogical problem (how to learn to make art) with a more current one: how art can teach to make. And in fact, by the second half of the nineteenth century, some stylistic and figurative changes, linked to the introduction of new techniques involving the exhibition modes, must be taken into account. It is interesting to note that this path took place in the direction of attaining the figurative magisterium. That is, the more realistically reality is imitated (not only by a technique of representation, but also by a compositional conception), the greater the artist's skill is. But the changes to be taken into account with respect to the exhibition are generally more sudden, and they are caused by great advances in the field of technologies, especially those (like photography) involving the arts.

A first considerable change is a direct consequence of the progressive abandonment of figurative imitative/descriptive type, of the frame (for painting) and of the pedestal (for sculpture). Both, frame and pedestal, constituted the mode of the art of relating with its setting, establishing not only the physical limit between reality and imagined or represented reality, symbolizing the self-sufficient unity of the work of art (Simmel 1989, 529), but also a sort of accompaniment of the figurative representation in the work of art, towards the spatial decoration of the architecture set up around it (Poli and Bernardelli 2016, 17–27). This change in figurative art will have direct implications on the exhibition design, that now must take responsibility for linking the work to its context, giving it continuity or isolating it.

[2] In Italian, the word corresponding to "exhibition design" is "allestimento", etymologically derived from "lesto" (quick, fast). It would literally be like saying "fast set-up". In the definition, the speed parameter does not refer only to the mounting and disassembly modes, in quick reversibility, but must be seen to some extent also in relation to the times of use.

[3] The translation, edited by Corrado Maltese, was published by La Nuova Italia in 1951.

[4] The theme of formal pedagogy is at the center of a famous chapter of *Walter Gropius and the Bauhaus*, by C. G. Argan, published by Einaudi in 1951, while in 1962 Argan himself was among the initiators of ISIA, the oldest design school in Italy.

Three projects are prophetic in this sense: the first, the *Musée à croissance illimitée* by Le Corbusier, formulated in 1931–39 and realized in 1959, which will be said later. The second is the New York Guggenheim Museum by Frank Lloyd Wright, 1943, also based upon the geometric theme of the spiral, and the third one is the *Neue Nationalgalerie* by Mies van der Rohe, 1962–69. In this last case, the focus of the project is the theme of the exhibition itself. The entire museum is in fact conceived as an immense shrine, and its architecture, which seems to be diaphanous and stripped down to the essentials, decrees a new narrative role for the exhibition design.

Given that, for the reasons better expressed below, all the disciplines have to do with the narrative, the interior design specifically occupies a crucial role, strategic and perhaps in part even privileged (Bossi 2008, 9): with its spatial organization, it concretely offers something to the individual. "To offer" in the proper sense of "to provide", "to assign", "to propose", "to exhibit". Given that in Italian the word "esposizione" o "esporre" express in a single word both the concept of "exposition" and the one of "exhibition", it is therefore intuitive that "esposizione" (exposition + exhibition) and "narration" are so much closely related concepts, that the "capacity of exposition" is one of the parameters of evaluation for those who are about to tell something, recognizing encoding characters. But if these encoding characters are recognizable, they obviously subtend a memory; and if they are encoded, they obviously project themselves into a language. Language and memory find their point of contact in the narrative, which in fact derives from the possibility of using a language and, in turn, continuously enrich the memory. Code/language/narration/memory, perfectly reflect the quadrinomic theory/technique/praxis/transmissibility, typical of the Renaissance approach (not historically, but as a matrix of thought) that has so far characterized the Italian school and research. The subject is passionately explored by Raimonda Riccini (2013), that considerably feels the need to reconsider the technique in the light of a neo-humanism, very often, not even so veiled, invoked by her.

This is the frame of the great international experiences, with protagonists as James Stirling, Oswald M. Ungers and Louis Kahn, but also of the great Italian museum tradition, represented first of all by Franco Albini and Carlo Scarpa.

At the center of their work is the reading of space and architecture, in which the interpretive process of space, through the themes of the exhibition, faces with strong and courageous design choices the theme of the relationship between new and old, giving life to a poetic narrative in which the "silence" can play a fundamental role. Thus, the cornerstones of this conception are born: Verona Museo di Castelvecchio, Palermo Palazzo Abatellis, Possagno Gipsoteca Canoviana, Genoa Museo di Palazzo Bianco, Museo di Palazzo Rosso and Tesoro di San Lorenzo.

It is a phase in which the exhibition is a sort of pretext for the museum story, a new frame of textuality expressed by the narrative core of the object, also interfacing with architecture, rediscovered context of the museum story.

This new configuration of narrative assumes a specific centrality in the role that especially in the post-war period takes on interior architecture in specific relation to museography and creates the preconditions for the third museum revolution. In fact, the new phenomenology is perfectly visible in all its potential: if the museum itself is transformed, somewhat programmatically and ideologically, into a gigantic display case,

what can rightly be considered exposed is the exhibition itself, as the prophetic Mies' project demonstrates.

4 The Third Museum Revolution: From Exhibition Design to Art of Display

In recent decades, according to some classifications, the Industrial Revolutions have succeeded quickly[5]. Beyond their numerical ordering, if the second revolution was characterized by the increase of the coefficients of the productive rhythms of the objects, the character of the last revolutions consists in their exponential increase.

Since "things are witnesses that are able to provide information about the past" (Atelier Brückner, quoted in Borsotti 2017, 12), the proliferation of objects and their voices, force us to listen to all these testimonies, too many, sometimes even discordant. All this has been amply foretold by philosophical and sociological thinking, but also by literary visions: things have so many voices (Vitta 2017), which dissolve in myriad of signs in a *Gutenberg Galaxy* (McLuhan 1976), or that are collected in the infinite lemmas of the *Library of Babel* (Borges 2003).

The life of things is regulated by three processes, which George Kubler borrows from Henri Focillon, his teacher, in particular from *Vie des Formes* and *Èloge de la main*, where the French historian speaks of art as an encounter between the formal vocation of man and the formal vocation of matter: They are: invention, repetition and rejection (Kubler 1976, 77).

While our cultural tradition was based on enduring values and in any case carried out selective processes, our present condition accepts a "liquid" condition of extreme and continuous mutability, renouncing any selective act: we photograph everything, document everything, we have continuous access to everything, especially visual, although we do not keep in mind (almost) anything. What is deriving from it is the announced death of aesthetics (Kubler 1976, 83) and memory[6], a death by asphyxiation by "semiotic pollution" (Manzini 1990, 121). Too many objects, too short-lived, on whose existence weigh so many faults: from the virulence with which they induced and amplified the temptation of possession and need (Vitta 2017, 13–28), to the one with which they rebelled against their master, the user, increasingly incapable of acting without the appropriate tool, unable to communicate or even to have social and emotional relations, without an adequate technology acting as a medium.

Not only the "prosthetics" of mankind sometimes allow him to act, but, a much more considerable element, their reproductive autonomy of which many of them enjoy, gives them the autonomous capacity to produce themselves other objects, other prosthetics, to transform matter, to create new environmental conditions and finally to transform

[5] In Italy, Jeremy Rifkin's text, *The Third Industrial Revolution; How Lateral Power is Transforming Energy, the Economy, and the World* was translated by Paolo Canton and published by Arnoldo Mondadori Editore, in 2011. Klaus Schwab's text, *The Fourth Industrial Revolution*, World Economic Forum, 2015, was translated into Italian in 2016, and published by Franco Angeli.

[6] In Greek mythology, Mnemosyne, goddess of memory, was the mother of the Muses, the Arts.

mankind into a new unit, mankind/object, that gives origin to a hybrid. All this, including the ensued anxieties, had been prophetically foretold by so much science fiction cinematography. It is no coincidence that it is precisely the cinema medium that outlines this important scenario, indeed it provides the starting point for introducing the node of the third sphere of communication, identified by Debray as the "videosphere", that is a fusion of the two-dimensional code of the images with the one-dimensional one of the text. Cinema is exemplary in this sense: an image in motion that, by changing, follows a diachronic development.

The following passage, anticipated by Walter Benjamin (1966) with *The Work of Art in the Age of Technical Reproducibility*, is crucial: from an autograph image, an unrepeatable unicuum, fruit of the artistic magisterium, catalyst of the convergence of infinite glances, to an allographic image, the result of an endless repetition in series, whose magisterium is concentrated in the generative process, the cloning one. From autograph to allography and from the latter, finally, to the last passage, unsuspected until a few years ago: the "heterography", that stage that Règis Debray (2010) and Vilém Flusser (1997) do not fail to define as a multitude of images waiting for a completion, or for an epidemic spread, increasingly devoid of a glance willing to look at and understand them.

The semantic result is crucial for the museographic narration: the arrangement tends more and more to become the new frame of the object, which, now re-framed, tends to be similar to the work of art. The consequence is not only the raising of the object to the artistic role, a process already prophesied by Pop Art, but also, on the contrary, the debasement of art to the role of object, process already *in nuce* in the Dada Art.

The point which contemporary museography seems to have reached is literally a crossroads: four roads that meet at one point.

The first one is the path from which we come, and it is a very long road in time, along which we have built our millenary cultural identity and handed it down. It is clear that it makes no sense to go back, but it is also necessary to remind ourselves of all that consistent heritage gathered during this journey.

The second is the path of pure architecture, a road that entrusts architects with the role of rediscovering, through an architectural language, the terms of a new further narrative. Examples such as the Guggenheim in Bilbao by Frank O. Gehry, or the Berlin Jüdische Museum by Daniel Libeskind, are symptomatic of how, in the first case, the contemporary museum can be understood as an empty container, a signifier to be filled with a content of different meaning from time to time; or how, in the second case, the architectural language can adapt to the narration of a specific content.

The third is a path that in recent years has deserved scientific insights and has polarized the interests of specific scientific fields: that of the conversion of buildings, abandoned with the end of industrial revolutions, into museums. The adaptive reuse has recently seen not only the convergence of interests of architects and designers, but has given rise to an interesting semantics in which the tale of human fatigue (manual skills, the working classes, and social injustices) have been transformed into the background essentially for contemporary art, justifying to some extent the inversion of the concept of "art of industry" in "art industry", but also placing, as in the singular case of the Museo

della Centrale di Montemartini in Rome, the two archeology, classical and industrial, in close comparison.

The fourth, finally, is the path of exhibition design, a discipline that in its transience, allows the specific conditions to be embodied in an agile architecture, fast, ephemeral and reversible. It is clear that we are not referring to the exhibition historically intended by the Italian School of Interior, but more generally to the potential of the discipline that, rather than interpreting the complexity of contemporary existing scenarios, opens new ones.

In fact, the apparent neutrality, that from the Modern Movement forward acts as a backdrop to the work of art, is not so neutral. On the contrary, it gives rise to a narrative complexity that is an absolute mirror of the complexity of contemporary scenarios. This is also the meaning of that passage from "black box" to "white cube" emphasized by O'Doherty (1976, 79) and prophesied by Le Corbusier in the *Boîte à miracle*, symptomatically originally designed alongside the *Musée a croissance illimitée*. In fact, the exhibition itself transforms into a linguistic system, defining relationships and actions, that end up triggering reactions in a sort of "assisted partnership" (Borsotti 2017, 47).

The characteristics of the codes of this language are many:

1) a hyperdense narrative code, in continuous motion and furthermore also supported by sound;
2) a code that is presented as "authentic" and "truthful", as produced by technological means and therefore presumably "objective";
3) a code that professes to be democratic, accessible and capable of giving voice to all us, in the meanwhile become publishers of ourselves. Walter Benjamin (1966) was nothing short of prophetic;
4) a code that professes reassuring, as we are protagonists of a space expressly created for us, our own stage adapted to our individual needs;
5) an attractive code, as it instills the belief that we are all its complementers, with a final individual passage that will make it unique, "our" personal code, and that at the same time will provide us with the opportunity to rise to the rank of "writers", "artisans", or even "artists".

This synthetic exploration, therefore, gives a perfect glimpse for rightly speaking of "third museum revolution". The predominance of the image and the acceleration of the temporal variable overwhelm the orderly sequence of the museum, understood as a sequence of encounters between spectator and work of art, one in front of the other. No longer pause or break between one poetic line and another, but an incessant communicative flow that needs "un'attività coordinata ed attuazione di un vero e proprio atto di regia di una narrazione a densità complessa" (Borsotti 2017, 17)[7], an "immersive environment", in which *in absentia phoenomeni* the user attends a representation that takes the place of reality, becoming the possessor of a degree of realism far beyond the "degree one" of reality itself: the augmented reality.

[7] "A coordinated activity and implementation of a real act of directing a complex density narrative".

Think of Studio Azzurro's installations, in which the words "video-environments", or "sensitive environments", or "video-installations", are combined with new interpretations of the words "museum" or "exhibition". In them, the architectural space definitively disappears, and the viewer is invested with a new role, the task of completing the creative process.

This process, which entrusts the completion of sense to the user, brings art to be compared with a complex phenomenology, that surely we will soon be called urgently to reorder with a scientific criterion. First of all because the new communicative code, breaking down the classical conception of art, no longer provides for the user's simple positioning as a spectator, but as a protagonist. Subsequently, because, once the aura of the work of art has been broken down, we can try to give an answer to Baudelaire, when in his poem in prose *Perte d'auréole*, he wondered who will settle the head with the halo fallen from the head of the artist in the mud of the street.

What was first placed on high, to emphasize its ancestrality, such as the vault of the Sistine Chapel, has now descended or fallen down[8], like Baudelaire's halo, providing us with the saving illusion of being elevated. But the question is that in the original intentions, users and work of art should not meet each other, but stand one in front of the other, in a dialectic transaction, therefore inclusive of a narrative.

A celebration of technology, even more than the work of art, which indeed lends its endorsement to legitimize the loss of the imaginary reference (Centineo 2019), concretizing the severe vision of Barthes (2003): the technological image is a "crazy medium", since it blends together sensory inaccuracy with temporal certainty. According to Barthes, all technological images want to be raised to the role of art, in order to mitigate their own madness; on the other they tend to dumb down themselves, becoming "useful" to culture, trivialized in the simple pleasure of illustration, or forced in the vortex of the serial reproduction and completion by a user even more seduced by a deceptive mediality (Bonami 2019).

5 Conclusions: A New Role for Design

Regardless of the increasingly articulate framework that seems to emerge today on the subject of narrative, however, we are still writing another page of this long and complex story. We are doing this and we will do it more and more by other means, by other codes, which are no longer two-dimensional or linear. They're probably dimensionless codes. And according to the philosophers mentioned above, from prehistory to history, we are now in a new revolution: we are entering post-history. But even in linear codes, the written ones, there are dimensional references that should make us reflect on how to find an ethical and normative sense in the continuous excess of explicitness in which we live. Think of the worlds evoked by the fabled narration of Aesop, by the futuristic scenarios of Aldous Huxley, by the alternative settings of Lewis Carroll, by the paradoxes of Luis Borges (among the many, *The Babel Library* and *The Map of the Empire*).

[8] The explicit reference is to the show "Il Giudizio Universale" [*The Last Judgment*], produced by Artainment Worldwide Shows, directed by Marco Balich, Rome 2018, in which, thanks to virtual reality, the viewer is literally immersed in the Michelangelo's frescoes of the Sistine Chapel.

They are multiple, projective worlds. After all, the projection of what we cannot see is sometimes the best or the only way to see it. Physics deals with it, not able to see the atom, but its shadow; psychology, which does not see the human interiority, but its reflection; descriptive geometry, which cannot find the improper point, but works on its representation at the finite scale, which falls, as a wonderful metaphor, on the horizon line.

If previously the attempt at innovation was followed by experimentation, as it has been said above, while the theory framed the productive hypothesis before the production of the object, at this stage, in full development, the inductive method seems to prevail, leading the theories back to the object, rather than referring the object back to a theory. The quadrinomic cycle theory/technique/praxis/transmissibility seems to change, inverting the order of the steps, into praxis/technique/transmissibility/theory. In this considerable change, the technique (in its peculiar declination in "technology"), has now become the medium that intermediates praxis and transmissibility, rather than being the magisterium thanks to which transforming the theory into practices. In this continuous interpretation of phenomenology, for years it has been said that, in spite of everything, art and beauty will save the world from chaos, but today also emerges the opposite need to save art (Han 2019).

We probably need a new geography, a new map that may help us in orienting ourselves in this not always ordered scenario: the *mess-age* is the *mass-age*, according to McLuhan's definition (2011). But at the moment, the map we are tracing, looks like *The Empire Map* described by Jorge Luis Borges (1996), a 1:1 scale drawing in which everything is reported, with no selection, including the map itself in its representation. The difference between Second and Third museum revolution exactly consists in this matter: no longer distinguishing exhibiting and exhibited items each other, are we confusing maybe the world with its representation?

New prophets now announce the beginning of the fifth industrial revolution. It is to be hoped that this new phase, the so-called "human revolution", may contain the ethical principles for a conscious management of this complex phenomenology, may be articulated in a hermeneutical grid, necessary to perpetuate the teaching and the transmissibility of knowledge and that, among the many tasks, may interpret the destiny of a place, the museum, which can still be sacred to the Muses.

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The Fertile Context of Olivetti Machines: From Kinematic Device to Human-Centered Design

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Abstract. At the beginning of the 20th century, the engineer Camillo Olivetti developed a streamlined industrial system for the production of typewriters, based on the model of similar successful trials in America. After some initial difficulties and the stop caused by the war, the project of the engineer from Ivrea resulted in an absolutely typical manufacturing model which combined the serial production culture with the quality of the Italian manufacturing tradition.

Over the years, the Ivrea-based company's range of machines and equipment increased in line with its vocation for experimentation and research in the field of culture and society, man's condition and man's working conditions.

Olivetti products actually reflected peculiar ideologies and concretized their ways and contributions in the field of reality and life, moving from the work environments to social service, architecture and urban planning, until to cultural and editorial initiatives.

This paper intends to analyze the Olivetti case as emblematic for Italian design because it was able to combine the "taste for the machine" with Italian manufacturing culture by recounting how it was used as a case study for the teaching activity aimed at building a methodology of historical approach to design project.

Keywords: Olivetti · human centered design · history of design · age of the machine

1 The "Taste For Machines" at the Dawn of Italian Design

In the context of industrial production, national and international exhibitions between the two world wars became fundamental occasions both for the comparison between the companies and for the orientation of a wider public – not only of experts – who was approaching these new products (Bassi, 2007; Labalestra, 2018).

The "International Exhibition of Serial Production" of the VII Triennale di Milano in 1940 played a decisive role in this field, as one of its three sections was entirely dedicated to the industrial production. The exhibitors were some of the most important companies in the country, such as Fiat, Olivetti, Innocenti, Salmoiraghi, and Ducati (Pica, 1957).

The exhibition was organized by the architect Giuseppe Pagano in collaboration with many other designers and was the first exhibition specifically dedicated to design in Italy. This event was preceded by other exhibitions which encouraged in various ways

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a broader reflection, conducted by Pagano himself, on the national serial production of objects in different manufacturing industries: house tools, interior design, technological objects and cars.

However, the most industrialized sphere of the Italian design remained the one of products with machinery and chassis within many goods industries: "From typewriters and calculating machines to white and brown goods, from work equipment to home tools and leisure equipment" (De Fusco, 1985, p. 278). Manufacturers common aim was hiding the mechanical and electrical components, both for practical safety reasons and for aesthetic reasons.

Pagano and the cultural operators following him aimed at unifying the industry in order to foster a "reduction of the multiplicity of types, the creation of the necessary conditions for serial production, the subdivision of work, the promotion of more perfect and cheaper production systems" (VII Triennale, 1940, p. 126). To this end, a priority role was played by the achievement of the objectives of cost reduction, higher production with a consequent "wider diffusion of well-being" and, finally, a better appearance, facilitated also by improved manufacturing techniques. In particular, they aimed at a solution that not only had a good-looking frame hiding the machinery but that was also the result of a research oriented to a more functional configuration based on anthropometric and ergonomic principles.

This is the reason why "Olivetti typewriters become vivid expressive fascinating elements – with their colours and shapes, prisms and bright glass blocks made in Italy by the Istituto del Boro e del Silicio, very modern glass fabrics by Termolux, optical instruments by Galileo, Salmoiraghi and Koritska – when you catch their beauty to the point that 'the magic of the machine' emerges in the current environment" (Casabella 1937, p. 27). Figure 1

Fig. 1. Typewriter Olivetti model M20 in the Olivetti store, Venice.

2 The Olivetti Case: Considerations on Method and Historical Studies in Design

The case of the Olivetti company and its typewriters lends itself by its emblematic nature to the didactic attempt to experiment with a systematic and historical method of approach. For this reason, it has been selected as the subject of teaching exercises in history courses at the Polytechnic University of Bari. Specifically between the academic years between 2018 and 2021. The experimentation was implemented by the author with students of the three-year degree course in Industrial Design at the dICAR department of the Politecnico di Bari. The research work, conceived as a practical exercise within the theoretical course of "history of design and decorative arts" in the second year, made it possible to associate ex cathedra lectures with a methodological path that allowed for at least three goals.

First, that of profiling the history of the discipline of Italian design by providing the student with the opportunity to learn and handle the methods of historical research in relation to design studies and to perceive them distinctly from those of the disciplines of art history and architecture.

Second, the Olivetti experience enabled the student to address the question of the formative task of the discipline's history by allowing him or her to experience the stages of historical research. From the reconstruction of the generous literature on the subject to archival research – tracing the reservoirs of sources in which plans, drawings, reports, user and maintenance manuals are preserved – to the processing of the second documents – produced through the analysis of the artifact, its survey and its graphic rendering Fig. 2.

The end result, is a sequence of chronoligical essays inspired by the method of De Fusco and his History of Design, in which the Neapolitan historian introduces the historiographical artifice of the "four-leaf clover" (De Fusco 1985, 2012; Dellapiana 2018).

The primary educational objective is precisely to enable the student to become familiar with a method by helping him to disentangle the invariant features of the discipline. To do so, he or she is accompanied on a path that will lead him or her to identify and peruse the "four petals" of a product's ideational process-design, production, sale and consumption-to synthesize a phenomenology and, above all, to define the subject matter.

What may initially appear to be a mechanical process soon turns out, in the hands of the student, to be an effective analytical tool for expanding the terrain of inquiry and making it a fundamental part of one's background.

This is a first approach to attempt a correct placement of the role of the designer, understood as part of a more complex system, in the larger process that begins with the conception of a product and, through a complex process, reaches the market.

This sequence is even more appreciable to the extent that the individual exercises are related to one another. And so it is more immediate to grasp the correspondences between designers, production company and sales strategies together with the formal characteristics of the objects with respect to the taste of the society for which they are designed.

The case of Olivetti, from the production of the first models of mechanical typewriters to that of digital devices, thus allows the extraordinary possibility of leading the scholar

Olivetti Lettera 32

Bloccaggio del carrello 16

Quando si deve trasportare la macchina, è bene bloccare il carrello in posizione centrale, usando l'apposita levetta **16** che è situata sulla destra.

Leva dell'interlinea 6

Serve per portare a capo il carrello e cambiare la linea di scrittura. Ogni volta che si ripone la macchina sotto la copertina gommata o nell'apposita valigetta, la leva deve essere ribaltata indietro, poi spostata verso sinistra e spinta in basso.

Cambio dell'interlinea 8

La distanza fra le righe del dattiloscritto (interlineatura) è regolata dalla levetta **8** secondo quattro diverse posizioni. La posizione 0 (folle) svincola il rullo dal meccanismo d'interlinea, per scrivere fra riga e riga o per ritornare sull'interlineatura precedente.

Frizione del rullo 7

Per svincolare completamente il rullo dal meccanismo d'interlinea, si preme il bottone **7** che comanda il dispositivo di frizione. Si usa la frizione quando si rimette in macchina un foglio già scritto per proseguire la scrittura iniziata.

Marginatori 10

Per marginare a sinistra, si sposti il carrello in modo che il guidacaratteri **13** coincida col punto in cui si desidera iniziare la scrittura. Si spinga il marginatore di sinistra verso destra, fino a che si arresti.

Per marginare a destra, si porti il carrello verso sinistra in modo che il guidacaratteri coincida col punto in cui dovrà terminare la scrittura. Si spinga poi il marginatore di destra verso sinistra, fino a che si arresti.

Liberamargine e capoverso 4

È possibile superare sia a destra che a sinistra i margini fissati premendo il tasto **4**. Lo stesso tasto, premuto mentre si spinge il carrello a capo, permette anche di ottenere il capoverso rientrato (quando cioè si vuole che la scrittura cominci più a destra del normale).

Leva liberacarta 15

Tirata in avanti, disimpegna il foglio dal rullo: serve quindi per sistemare a mano il foglio nella posizione corretta, perfettamente perpendicolare rispetto alla linea di scrittura.

Barra spaziatrice 21

Oltre che a distanziare una parola dall'altra, serve anche a correggere l'eventuale omissione di una lettera in una parola, senza dover cancellare l'intera riga, in quanto consente l'utilizzazione del «mezzo spazio». Se, ad esempio, è stato scritto **la comissione mista...** anziché **la commissione mista...**, per inserire la **m** omessa: 1) cancellare la parola **comissione;** 2) riportare il carrello in corrispondenza della **a** della parola **la;** 3) abbassare una prima volta la barra spaziatrice, riabbassarla e, tenendola abbassata, battere la **c;** 4) alzare la barra, riabbassarla e, tenendola abbassata, battere la **o;** 5) ripetere le stesse operazioni fino a che non sia stata battuta tutta la parola **commissione.**

Uso dell'incolonnatore

Il dispositivo incolonnatore permette di incolonnare parole o numeri, come nel caso di elenchi, prospetti, quadri riassuntivi ecc. Esso è regolato dal tasto dell'incolonnatore **20** e dalla leva degli arresti **3.** Stabiliti i numeri e la posizione delle colonne che si desiderano ottenere, occorre fissare gli arresti in corrispondenza della prima lettera di ogni colonna.

Per impostare gli arresti - Si fa scorrere il carrello fino a far coincidere il guidacaratteri **13** con il punto da cui si desidera iniziare la prima colonna e si spinge verso l'alto la levetta **3.** Si fa quindi scorrere il carrello fino all'inizio della seconda colonna e si imposta nello stesso modo il secondo arresto; e così per tutte le altre colonne.

Per incolonnare - Una volta impostati tutti gli arresti per incolonnare basta premere il tasto **20** tenendolo premuto fino all'arresto del carrello in corrispondenza della prima colonna; e così di seguito per le colonne successive.

Per annullare gli arresti - Si porta il carrello in corrispondenza dell'arresto da annullare e si spinge in basso la levetta **3.** Per annullare tutti gli arresti si porta il carrello a capo e lo si fa scorrere completamente tenendo nello stesso tempo in basso la levetta **3.**

Leva del bicolore 18

Alla posizione alta (disco azzurro) corrisponde l'uso della parte superiore del nastro; alla posizione bassa (disco rosso) quello della parte inferiore; con la posizione bianca si esclude il nastro dalla battuta.

Coperchio mobile 17

La macchina è dotata di un coperchio mobile **17** che si può togliere facilmente ogni volta che sia necessario procedere al cambio del nastro e (mediante il pennello di nailon fornito con gli accessori) alla pulizia dei caratteri o per accedere al dispositivo regolatore del tocco.

Regolatore del tocco 5

Una levetta situata sul fianco sinistro del telaio (sotto il coperchio mobile) permette di regolare la tastiera rendendola più o meno pesante alla mano di chi scrive. La posizione più alta corrisponde al tocco più leggero, la posizone più bassa al più pesante.

Aste reggicarta

Per alzare le due aste reggicarta basta agire con l'indice sul triangolino sporgente alla loro base. Se ne raccomanda l'uso specialmente quando si scriva a più copie.

Cambio del nastro

Tolto il coperchio mobile, si avvolge tutto il nastro su una delle bobine: lo si sfila quindi dal sollevanastro, si sfilano le due molle di fermo delle bobine e infine si sfilano le bobine dai loro perni. Si aggancia il nastro nuovo alla bobina vuota e lo si avvolge fino a coprire la fibbia fissata a circa 15 cm. dalla estremità. Si ricollocano le bobine sui loro perni, curando che la parte rossa sia in basso, e si ripetono inversamente le operazioni precedenti.

Manutenzione

Per una periodica manutenzione generale, o per ogni altra necessità, rivolgersi alle Filiali, Agenzie e Rivendite Olivetti che potranno dare a chiunque un competente consiglio.

Garanzia

Le macchine Olivetti nuove, acquistate presso una Filiale, una Agenzia o un Rivenditore Olivetti, sono garantite al primo acquirente per dodici mesi dalla data d'acquisto. Durante tale periodo, l'acquirente ha diritto alla sostituzione delle parti eventualmente difettose di fabbricazione, con la sola spesa della mano d'opera per la sostituzione.

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Fig. 2. Olivetti Lettera 32 typewriter user manual.

in training by guiding him through The ideational and formative processes, within the dynamics of the complex events that intersect and succeed each other in the production of industrial products. But also to reconstruct the collaborations between principals, designers in the optimization of production lines and, above all, in the evolution of a company in terms of design.

In this way, the student and designer-in-training succeeds in fully developing the specifics of the historical method, which, through the intersection of the results obtained, progressively leads to the philological understanding of industrial design by developing a well-founded critical interpretation interrelated to the more general historical framework.

The research is conducted starting with the assignment of a product from the Olivetti catalog to each of the student groups, which independently organize themselves into pairs starting with a numerosity of about 120 per academic year.

After a methodological and bibliographical introduction held by the lecturer, each group proceeds independently to reconstruct specific literature related to their case study. This makes it possible to reconstruct the state of knowledge in the scientific field.

Through this reconstruction, we also come to identify the reference documents useful for the next steps in addition to the institutions responsible for their preservation.

In this case, in addition to the historical archive organized directly by the company itself "Archivio Storico Olivetti" students were directed to possible public or private institutions where it is possible to retrieve historical materials.[1]

This phase of the research was particularly interesting because it revealed, alongside the museum institutions and traditionally deputed to the preservation of historical records, a multitude of documentary deposits.

A microcosm made up of archives of designers, private collectors, associations of collectors, machine maintainers, shopkeepers and many others.

This reconnaissance in addition to the philological reconstruction of the history of the artifact makes it possible to find original materials in which the technical characteristics and designs of the individual typewriter are recorded.

The last and fundamental step is the direct approach to the object of investigation. The physical finding of the object of study that allows for the evaluation of additional aspects such as its weight, operation as well as aspects related to maintenance and noise.

Finally, the student is asked to carry out a detailed survey of the machine that is essential for its redesign to the appropriate scale.

The final stage of the research work involves the preparation by each group of a comprehensive report summarizing all the stages of the work and a summary sheet on its object in which numerous data are given with respect to technical characteristics, the years during which it was marketed, the selling price and most of the technical and physical characteristics Figs. 3, 4 and 5.

A number of technical drawings of the product are also included in each sheet.

It is precisely from the comparison of these individual cards that, having reached the end of the course, it is possible to compare chronologically, aesthetically and technically the Olivetti catalog specimens. Figure 6

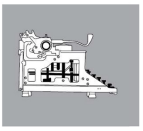
All the mechanical models have recently been the subject of in-depth studies within the design history courses and laboratories of the three-year thesis course in design coordinated by the author. Within this research, a detailed filing of all the mechanical models was carried out, technically redesigning the machines, tracing the original user and maintenance manuals and the available documents digitalized by the Olivetti Historical Archives Association and in many others archives.

These materials, together with those made available by private collectors, and by the models conserved at the Polo Museale Diocesano of Trani, "Museo della Macchina per Scrivere", Fondazione S.E.C.A., made it possible to investigate the evolutionary process of production and the Olivetti project.

This work now makes it possible to reconstruct the narrative of the company's history with greater awareness.

[1] The complexity of the activities conducted by a multinational Industrial Company over the course more than a century can be seen in the intricate documentary network that constitutes the Olivetti archival heritage. https://www.archiviostoricolivetti.it/patrimonio-documentale/archivio-storico/ [maggio 2022].

OLIVETTI PORTATILI ***M40 I SERIE***	* OLIVETTI M40
CARATTERISTICHE : STANDARD MANUALE	ASTIERA : QZERTY CON 45 TASTII
NASTRO : IN TESSTUTO, 13 MM	TATABULATORE : ASSENTE PRESENTE CON 8 TASTI
CARRELLO : CON 90 SPAZI	CARATTERE : PRESENTE
INTERLINEE : 4 POSIZIONI PIÙ LO ZERO	INCOLONNATORE : PRESENTE
PRRODUZIONE : ANNO 1931 - 1948	ROGETTO MECCANICO : GINO LEVI MARTINOLI + CAMILLO OLIVETTI
DIMENSIONI 25 X 39,5 X 35 CM	PESO : 15 KG



DESIGN : CAMILLO OLIVETTI
CARROZZERIA : TELAIO PORTANTE IN GHISA CON FIANCATE SENZA LAMIERINI DI COPERTURA
COLORE : NERO LUCIDO

Fig. 3. Olivetti M40 typewriter summary sheet.

OLIVETTI PORTATILI ***VALENTINE***	* OLIVETTI VALENTINE
CARATTERISTICHE : PORTATILE MANUALE	TASTIERA : 43 TASTI, 86 CARATTERI
NASTRO : /	TABULATORE : /
CARRELLO : /	CARATTERE : /
INTERLINEE : 3 POSIZIONI PIÙ LO ZERO	INCOLONNATORE : PRESENTE
PRODUZIONE : ANNO 1969	PROGETTO MECCANICO : GIUSEPPE BECCIO
DIMENSIONI : 34 X 35 X 11,5 CM	PESO : 3,8 KG

DESIGN : ETTORE SOTTSASS + PERRY A. KING
CARROZZERIA : IN PLASTICA ABS
COLORE : ROSSO, BIANCO, BLU E VERDE

Fig. 4. Olivetti Valentine typewriter summary sheet.

OLIVETTI STANDARD *M*	* OLIVETTI M 80
CARATTERISTICHE : STANDARD MANUALE	TASTIERA : QZERTY CON 45 TASTI
NASTRO : IN TESSUTO, ALTEZZA 13 MM	TABULATORE : /
CARRELLO : 7 CARATTERI DISPONIBILI	CARATTERE : /
INTERLINEE : 4 POSIZIONI PIÙ LO ZERO	INCOLONNATORE : PRESENTE CON 8 TASTI
PRODUZIONE : ANNO 1948	PROGETTO MECCANICO : GIUSEPPE BECCIO
DIMENSIONI : 23 X 38 X 38CM	PESO : 15 KG

DESIGN : MARCELLO NIZZOLI

CARROZZERIA :
METALLICA CON COPERCHIO AMOVIBILE

COLORE :
BEIGE

Fig. 5. Olivetti M80 typewriter summary sheet.

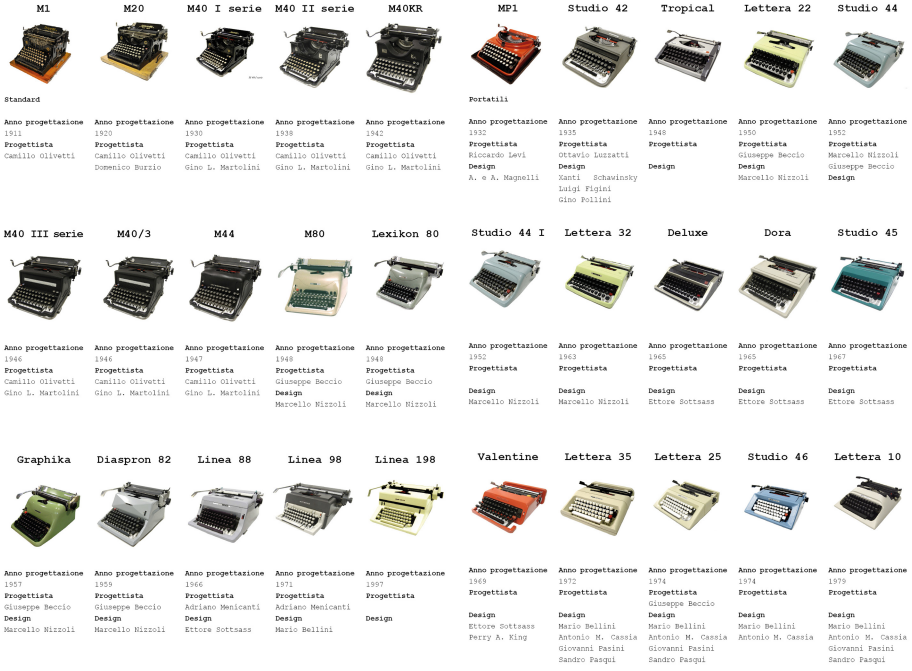


Fig. 6. Reassessment sheet models of Olivetti typewriters produced between 1911 and 1979.

3 From the First Devices to the Industrially Produced Typewriters Until to the "ELECTRonic Galaxy"

Although some experts believe that the first industrial patent intended to "use the machine as an aid during the extended and important writing activity; generally replace the hand that writes the letters with a mechanism including built-in perfect and consistent letters" (Iuvara 1967, p. 28) was by the Italian Giuseppe Ravizza in 1837, the production of a typewriter on an industrial scale started many years later in Italy.

When this happened, the company "E. Raminton & sons of Illinois" had been producing and marketing its models together with its popular precision rifles for some years, at least since 1873.

It was not until 1908 that the engineer Camillo Olivetti founded the company having his same name in the city of Ivrea, in Italy. It took two additional years for him to develop his first prototype; he actually gave up the idea of following the models already on the market and preferred to prepare the project of "a new machine, entirely designed by him, whose details had been designed by him" (p. 73).

The first Olivetti typewriters were introduced only at the Esposizione Universale in Turin in 1911. The catalog given to the visitors stated that the company of the engineer from Piedmont was "the first and single Italian typewriter factory" and that the model "M1", available exclusively in two prototypes, was built according to an original design featuring visible writing, standard keyboard, decimal tab, return key, multiple margins and absolute precision.

The appearance purpose of this machine was extremely clear, both in the lines design and in the technical details and finishes; this was made possible above all thanks to modern electroplating and fire enamelling plants. As you can deduce from the booklet of M1(1), right from the production stage, the prototype is part of a modern project which aims at creating a durable, quality product: "our industrial experience had already persuaded us that products studied in their smallest details, built with highly selected materials and modern systems, cannot fail to gain rapidly the public trust, and the success of the machine we designed and manufactured has confirmed this persuasion".

After the war, which coincided with a period when the company was induced to produce war material, Camillo Olivetti's project was restarted even more intensively with the launch on the market of the new model "M20". The new model featured significant improvements compared to its predecessor, especially in the main kinematic mechanism. In 1930, the first examples of the model "M40" were marketed; this prototype allowed a very sharp writing, featured automatic margins and tabs, a steady tab stop for the paragraph and a 32-keys keyboard requiring a very low pressure on the keys. Together with the lower weight of the machine, these features were the main reasons of the remarkable commercial success of the model.

The following year, the project of the first portable machine "MP1" coincided with a wider range of products provided by the company, which started to offer also office pieces of furniture and calculating machines.

The change occurred simultaneously with the entry into the company of the engineer Adriano Olivetti, Camillo's son, who introduced a series of innovations through research and a very effective management system leading to an almost unexpected period of

commercial expansion. Starting from that moment, Olivetti's story became an even more significant part of Italy industrial, cultural and social history.

Just while Pagano promoted the serial productive culture, the vocation for experimentation and research of the Ivrea company – in the field of culture and society, man's condition and man's working conditions – turned into an innovative way of conceiving and designing the industrial product. Olivetti products actually reflected peculiar ideologies and concretized their ways and contributions in the field of reality and life, moving from the work environments to social service, architecture and urban planning until to cultural and editorial initiatives.

The climate created within the company around Adriano's increasingly decisive role became fundamental to new choices ranging from the furniture sector, with the Synthesis project, to a new project for a semi-standard machine, the "Studio 42".

The latter was designed with the collaboration of a group of experts led by the engineer Ottavio Luzzati, mechanism designer, with the architects Figini and Pollini and the painter Xanti Schawinsky. It was a robust and simultaneously light machine which, unlike the other ones, had an horizontal configuration which made it extremely compact. There already were signs of this change in the design of MP1, a portable device which was not so monumental as the first typewriters but had a flatter and lighter design. However, the new design practice was not evident before the launch of Studio 42 (in 1935), when the close collaboration between designers and planners began from the very first phases of the project; this marked also the beginning of a new working method that would be adopted in the future and lead to the revolutionary Lexicon 80 in 1948, Lettera 22 in 1950, both designed by Marcello Nizzoli, and then to the models by Sottsass in the sixties.

By then, "we are far from the real or supposed rule requiring a mechanism to be covered and protected by a frame whose shape makes the object better looking"; on the contrary, it was clear that "such positive results can be achieved only thanks to remarkable experimental tests, to advanced research […] to the most sophisticated technologies and, in general, to one of the most advanced business policies in the world" (De Fusco, 1985, p. 278).

In the 1950s, Olivetti – which was one of the most popular and internationally appreciated Italian companies for its ability to combine technological innovation and ethical and social issues – introduced its probably most ambitious project: electronical calculators.

In 1950 the company had already signed an agreement with the French "Compagnie des Machines Bull" for marketing a similar product in Italy, but, in the meanwhile, they were "dreaming of electric sheep" in Ivrea (Mori, 2013).

Adriano Olivetti had actually realized that his company had to promptly enter the computer market to make up for the delay compared to the American companies which had already seen the chance of making a profit with these products (Soria, 1979; Parolini, 2015).

In 1955, the "Laboratorio di Ricerche Elettroniche" (LRE) was founded on the outskirts of Pisa. The laboratory was led by Mario Tchou, an Italian-Chinese engineer specialized in nuclear physics, who together with other researchers began working on the design of electronic calculators (De Tullio, 2014).

In 1957 a first prototype is presented, the Elea 9001 or "zero machine", then transferred to Ivrea to automate the management of the warehouse, while the following year is ready the Elea 9002 valve or "1V machine", then transferred to the commercial management in Milan. In 1959 Olivetti presents the Elea 9003 (Elaboratore Elettronico Aritmetico) to the President of the Republic, Giovanni Gronchi (Gazzarri, 2021).

It is the first computer designed and manufactured entirely in Italy and at that time it is perhaps the most advanced technology on the world market. It is based on an avant-garde logical structure, largely conceived by Giorgio Sacerdoti, and has a highly innovative design, due to Ettore Sottsass and awarded the *Compasso d'Oro.*

In the meantime Olivetti had acquired the U.S. company Underwood, a historic competitor manufacturer of typewriters and office equipment, with the aim of exploiting the wide commercial network in the USA and hindering its competitors. However, just because of this important purchase, when Adriano Olivetti (in February 1960) and Mario Tchou – the Head of the Computer Division – died, there was a dramatic slowdown in the project implementation.

In spite of this, Olivetti was the most important industrial group in the office machinery industry in the mid-sixties, boasting 41 companies, 16 industrial plants located throughout the world and about 52,000 employees, more than half of them were employed abroad.

4 Conclusions

The story of Olivetti, from its origins to the years of the transition to electronic equipment seems emblematic in showing that there was a unique context in Italy with a dialectical approach towards the anthropic reality which represented an ideal field of experimentation for the emerging discipline of design throughout the XX century (Ossola, 2014).

Moreover, Olivetti, a pioneer in venture capital in Italy, began to invest with growing interest in operations that were of value not only to the company, but also to the Italian economy as a whole. In 1983, on the occasion of Olivetti's 75th anniversary, a major conference was organized at the "Fondazione Cini" in Venice.

Entrepreneurs, bankers, public and private managers and university professors were invited to take part in the event. For the first time in Italy, this initiative brought to the attention of the general public the issue of financing innovative new companies in a way that had been little known until then. The "Giornata Olivetti Venture Capital" becomes an opportunity to spread the culture of innovation (Piol, 2004).

In this circumstance, the Community imagined by Adriano Olivetti offers the opportunity to address, that of mechanisation, as a problem to be ethically oriented (Nunziante, 2011) to the point of representing the factory as a model of a humanistic and cultural project, but also of the opportunity for co-existence and improvement of the worker's conditions.

One example of this is the story of the creation of the "Consiglio di Gestione Olivetti" (Musso, 2009), an internal committee, a representative organization of the workers provided for by the republican government, which came into being as a result of committees of employees and workers who spontaneously came together in the summer of 1943.

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Material Inter-actions vs Sense Trans-action. Grit Surfaces

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Abstract. This paper examines the topic of the surfaces applied to interiors. It represents a new step in cladding research that broadens the investigation's horizons from soft materials (Pagliarulo & Carullo, 2013, 2018; Pagliarulo, 2017) to rigid materials. This study opportunity is provided by the furniture design research conducted as part of the degree thesis (The paper collects part of the results carried out in the context of the degree thesis entitled: "GE | WAND. Ri | vestimenti di graniglia in terra di Puglia" [GE | WAND. Grit re | Claddings in Apulia]. Relatore: prof. R. Pagliarulo. Studenti: G. Addati, C. Colluto, A. Colonnato, F. Gallone, D. Gentile, M. Losito, A. Marotta, M. Merra, G. Monopoli, M. Morelli, N. Paradiso, G. Pastore, G. Valenza, A.M. Vitucci.), for the Industrial Design degree program at the Polytechnic of Bari, in collaboration with a company (The company involved in the activity of the degree laboratory is the "Attivissimo", active since 1950 in the production of grit, pastina and cementine.) that produces cement paste covering in Apulia. Knowledge of both the traditional grit decoration patterns and of the production techniques formed the basis of a process of minute variations in the relationships between the materials. The cement mixture varies in size, shape, colour, and type of aggregates depending on the variational gradients. By enhancing the composition's register, they also enhance the covering's perceptional sensory qualities. By varying the materiality of the composition, the surface rises from a two-dimensional plane of the composition to become an expressive text. The latter concerns mechanisms of perception and sensation, which intercept the most current design issues of interior coverings.

Keywords: interiors · surfaces · materiality · interaction · sensoriality

1 Surface Prolegomena

The theoretical area of surfaces refers to Semperian principles on the textile origins of architecture, which rekindles interest in the core of that structural tradition that opposed Vitruvian classicism from the second half of the nineteenth century. The myth of the light surface, which defines space and interprets the origins of construction in opposition to the myth of the trilithic structure, is the inspiration for the theoretical direction the contribution intends to support. In Semperian thinking, the intertwining of poles, mats and carpets precedes the use of masonry and has the function of both protecting and delimiting the space. The real essence of the visible space is not lost when flimsy walls

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are transformed into solid walls. Due to Semper's attention to phonetic assonances, he defines the wall as a Wand or a partition and relates it to Ge-wand, which means dress. Gravagnuolo (1992) argues that Semper attributed even more strength to the idea that the oldest weaving techniques were sources of primary aesthetic motifs for architecture (Urmotive). The meaning attributed to the wall remains unchanged even when other substitutes replace the textile surfaces in relation to the technique adopted for each material in specific historical-cultural contexts, such as stucco plastering, wooden boards, and the glazed terracotta. In addition, the imitation of the same textile weaves of carpets is a widespread and long-lasting practice, found in paintings on wood, terracotta, metal, stone, and plaster. Semper describes in his Der Stil how the colors and coatings used in architecture since antiquity have acted as a metaphor for construction and materials on a two-dimensional plane. According to Semper's theoretical reflection, cladding and construction have an intricate relationship. From the early nineteenth century onward, covering the wall structure in order to ennoble or protect it was confronted with instances of the truth of the structures and materials used. (Gravagnuolo, 1992). This problem is all the more evident with the evolution of construction techniques and new materials and opens the scenario towards narrative forms capable of accommodating articulated interpretations, according to which the covering can be a "crime" against the truth of the structure; precious encrustation of the wall structure; a surface that adheres to the frame structure. The complex, articulated and multifaceted debate refers to the theme of decoration[1]. This theme sits at the very edge of modern culture. Many signs point to the fact that the discussion around abstractionism can be traced back to it, which will then become explosive, to the point of being didactic, among the historical avant-gardes. (Pedretti, 1990). The drawing experiences conducted by artists, designers and architects starting from the second half of the nineteenth century have been the study ground for a "research into the structure of form" and not an application of academic conventions" (Fanelli & Fanelli, 1976, p. 2). The maximum expression of this research was found in the pattern design. Study paradigms are the manuals of Walter Crane, Owen Jones, and Eugéne Grasset (Fig. 1). The elements repeated in the plane become representative of the construction of the composition and report the elementary structural values through operations of synthesis and abstraction with the primary elements of the line and the surface, "in a continuous process that sees, among other things, the passage from naturalism to abstraction" (p. 2). Thus, the study of patterns through the representation of structural forms becomes "a means of recovering the internal reasons for the development of contemporary art and design at the roots" (p. 2).

[1] In common parlance, the term decorate is superimposed on that of ornament. Both mean an action that "confers elegance and pleasantness by adding or applying elements that are inherently lacking in practicality and functionality" G. Devoto, G.C. Oli, Dictionary of the Italian language, Le Monnier, Florence 1971. In decorating, the ethical element is privileged. It indicates an attribution of honour, esteem, value, consideration, and dignity. In the decoration, the aesthetic element and the "order" element prevail. Ornate has the same root as ordering, from ordo, with the value of arranging, garnishing, and preparing. The essay refers above all to the ethical dimension included in the concept of decorum.

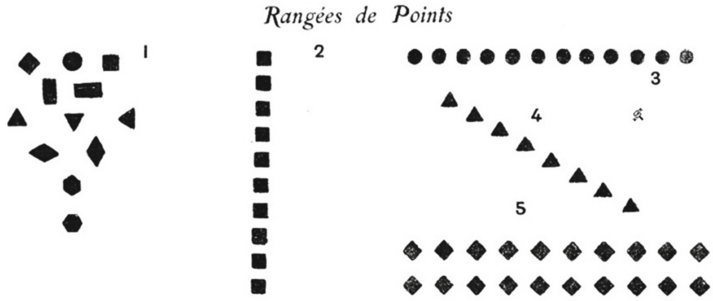

Fig. 1. E. Grasset, Compositional studies on points, from Méthode de composition ornementale, 1905

2 The Surface Between Materiality and Sensoriality

Starting from the Semperian foundations on the principle of cladding, the research tackles the problems inherent in the design of the surface as an envelope that constitutes the limits and gives shape to the architectural space. (De Fusco, 1997). In particular, it examines the aspects of materiality in the composition process and how these aspects can enhance the perceptive sensorial qualities of surfaces. The theoretical path begins with the very definition of surface. The term has a Latin origin and consists of super (above) and facies (face). The surface indicates the exterior of a body or artefact. Due to its epidermal nature, it establishes boundaries between inside and outside, defining and distinguishing the inside and outside spaces. Besides being a physical partition, it is at the same time a place where the visible and the tangible interact with the realm of the mind and the emotions associated with it. In Rancière's words (2007), it is possible to "create forms of sharing the common space (…), configurations of the visible and the imaginable, ways of inhabiting the sensible world" (p. 135). Through its materiality, the surface acquires corporeality and form by defining the boundary between inside and outside. The value of materiality is not determined by the materials of which it is composed, but by the relationships and interactions between its components. The design research on surfaces investigates material interactions through a progression of minute experiments on matter, or rather, of processes/actions, which give the surface itself a differentiation of the states of matter. At the same time, the transformation of material value is the transformation of expressive value, which incorporates, amplifies, and declines new potentialities of surface meaning itself. The surface becomes sensitive, amplifying and enhancing the sensory, tactile and visual qualities. Conversely, the materiality of the surface manifests itself "in its dual sense of haptic mediation and emotional connection" (Bruno, 2016, p. 21).

3 Concrete Surfaces and Polysensoriality

The study on the expressive potential of the surface and the perceptual sensory stresses was developed as part of the interior design degree thesis of the three-year Degree in Industrial Design at the Polytechnic of Bari. The work is being accomplished in collaboration with Attivissimo of Altamura, Italy, an industry leader in producing grit, paste and cement tile coatings. The study and project process begin with an understanding of the iconographic vocabulary (Fig. 2). Some compositional patterns have been acquired and designed, distinguished between geometric and organic shapes. As each pattern gives shape to the tile, the theatre of the composition unfolds from the minimal unity of each pattern.

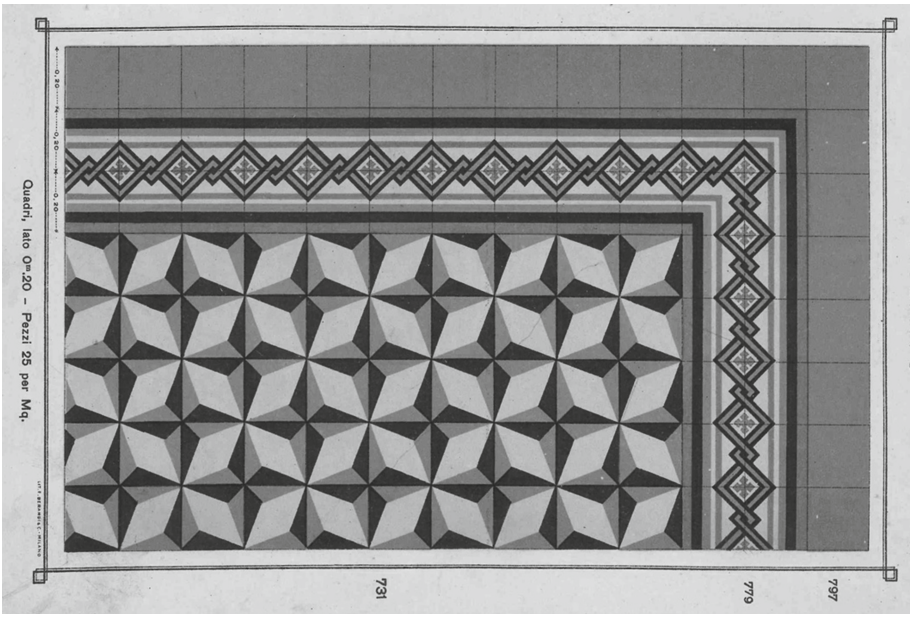

Fig. 2. Grit decorative pattern, from the historical album of Attivissimo

Each tile is the harbinger of a very broad expressive potential, as it generates a variable number of decorative carpets depending on how it is composed (according to the Latin etymology of com-ponĕre), or how it relates to other tiles. Through the actions of multiplication, translation, and rotation, rigid concrete carpets are created, and traditional culture's wisdom values are imparted (Fig. 3). Its cementitious surfaces are characterised by an iconographic vocabulary shaped by about 150 copper and brass moulds handed down since the early 1900s (Fig. 4). The vocabulary of expressive potential is further amplified when the design action passes in a kaleidoscopic manner from the composition of the tiles to the composition of the elements of the cement mixture. The process of making each tile develops according to a so-called "secret" recipe, which the manufacturing company has kept for generations, to guarantee the formal and performance quality of the product.

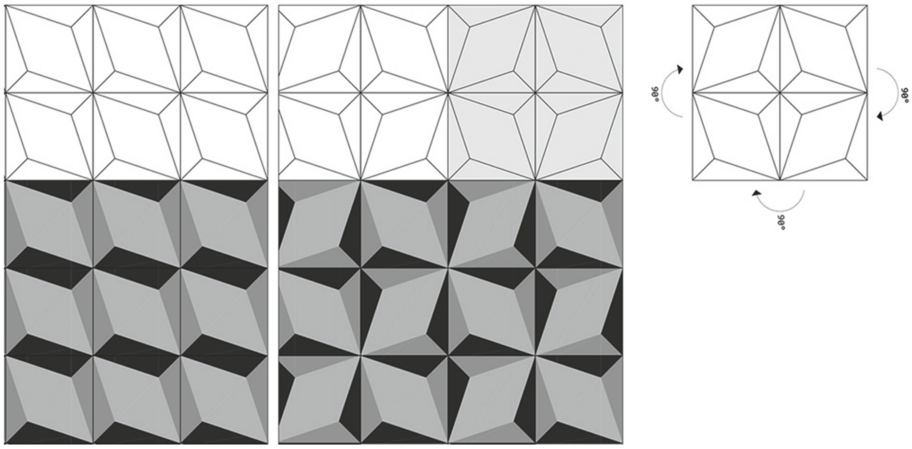

Fig. 3. Structure and form of a geometric pattern

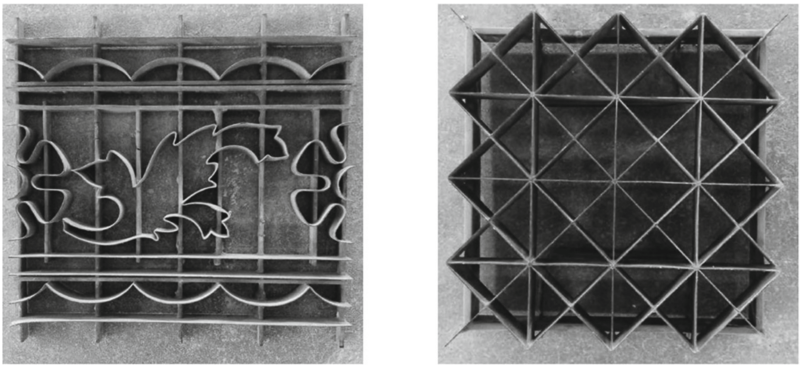

Fig. 4. Brass moulds with floral and geometric design

Cement (high-strength white Portland cement, which has better aesthetic and performance qualities), water, and inorganic oxides make up the mixture[2] (which have optimal resistance characteristics for the coloring of concrete) and inerts[3] (divided into gravel, crushed stone and marble for grit tiles, sand and dust for the "pastina" tiles, dust for cement tiles). The mixture of mortar, granulo-metrically homogeneous, is poured into the tile, distinguishing and declining the colours of the agglomerate in the different sectors of the decorative structure (Fig. 5a). In the same phase, there is also the addition of aggregates, which give material quality about the stone's type, size, shape, and colour. When the decoration is complete, the tile is removed and the cement unit is placed under

[2] The inorganic pigments are divided into: Iron oxides: yellow, orange, red, brown, black; Cobalt oxide: green, blue-green, blue; Titanium dioxide: white; Chromium oxide: green.

[3] The commonly used inert stone and marble are: Arabescato Red, Carrara White, Carbonate rocks, Siena Yellow, Carrara marble, Greek marble, Ebony black, Verona Red, Coral pink.

a press to remove the excess water (Fig. 5b). The tile then goes through a curing process for 28 days in a humid environment in order to promote gradual curing (Fig. 6). The last phase is finishing and concerns only grit and paste, as the cement tile is free of them.

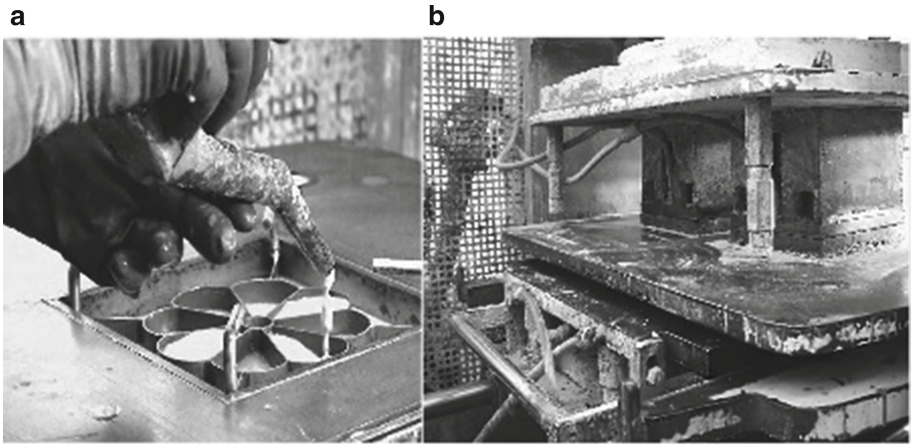

Fig. 5. a. Decorative mould with past. – b. Press machine to remove excess water from the tiles.

Fig. 6. Iron trays for seasoning tiles

The last phase is finishing and concerns only grit and paste, as the cement tile is free of them. Depending on the desired finish, plates with diamond teeth, abrasive brushes, and stone discs can be used to define the smooth, antiqued, satin, and polished surfaces (Fig. 7). A series of abrasive actions gradually results in the mixture becoming corrugated from smooth. After removing the cement, the aggregates previously included in the materiality of the agglomerate reveal their corporeality. In rigid surfaces, the mixture itself defines the formal structure of the surface unit. Construction and form are consubstantial. The material nature of the surface determines the expressive premise of its composition. To put it in the words of Focillon, "form does not act as a higher principle that models a passive mass, since it can be argued that matter imposes its form on form", hence it follows that "matter entails a certain destiny or, if you like, a certain

formal vocation. There is a consistency, a colour, and a grain to them (Fig. 8). Forms, as we said, call, limit, or develop the life of art […]. It is nonetheless useful to immediately point out that this formal vocation is not a blind determinism since those subjects are so well-defined, suggestive, and even so demanding about the art forms they use, and find themselves profoundly modified by them, rebounding." (1972/1943, p. 52–53). In the dialectic between the material used and the technique adopted, the surface's constituent elements are an identity metaphor of traditional culture and fundamental values. From the recovery of the material's destiny to be used in a manner congruent with local knowledge and expertise, new strategies are outlined that are able to modify or reinterpret current innovation paradigms.

Fig. 7. Brushes for finishing actions

Fig. 8. Perceptive sensory scale of stone aggregates

This contribution discusses a specific intervention methodology used in the context of research on surfaces in order to activate an action to enhance the perceptive sensory quality of those surfaces. In a series of minute experiments on each artefact's surface, a differentiation of the states of the given matter is returned so that the material envelope becomes a sensible envelope. The surfaces in the configurations of corporeality convey traces of "touching materiality" towards "stratifications of meanings" and "the sense of feeling spreads from sensations to feelings, from the sensory surface to psychic

sensitivity" (Bruno, 2016, p. 29). Concrete surfaces act on two registers simultaneously: that of the production process and that of iconography, intercepting values of materiality and sensoriality. The variations are made on such distinct tiles: solid colour grit, grit and pastina with traditional decoration, grit and pastina contaminated with other materials (brass and glass) (Fig. 9). A description of each type of intervention follows.

3.1 Material Inter-actions and Trans-actions of Meaning

The first case study demonstrates a progression of variations from the 20 × 20 single layer tile in light grey grit (company colour reference 101G). In this investigation, the perceptual character is explored first through sight, and then through touch. In this regard, the production process begins with selecting the paste components and then with the finishing process. In the project, local stone from Trani is chosen, divided into three grain sizes: fine (2/3 mm), medium (4/5 mm), and large (8/9 mm).

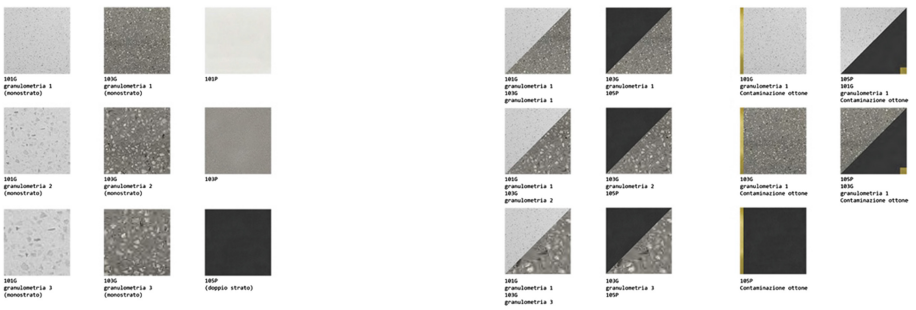

Fig. 9. Abacus of concrete perceptual sensory variants

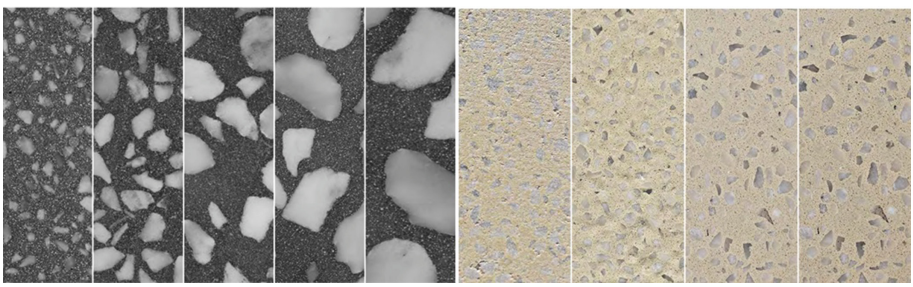

Fig. 10. Scales of visual and tactile perceptive variations

Three particle sizes in three tiles allow you to verify the different ratios between inert and binder with your eyes. Measure shape, type and colour of the stone, in the progression described, from the finest to the largest, differently explain some characteristics of the materiality of the single artefact. In other words, measure/form/type intensify the perception of corporeality. Over time, the stone elements to be refined and punctual become bigger and bigger until they occupy the whole tile. By increasing the grain size of the Trani stone, the white colour interacts with the light and increases the sense of brightness on the surfaces. As a result of being hit by light, the artefact becomes vibrating. If the light changes, the perception of the artefact changes, reaching a chiaroscuro or dark vision-the sense of seeing interacts with the sense of touching when the same surfaces receive the finishing works. Differentiated smoothing actions allow the surfaces to flake in two directions: on the one hand, towards the variation of rough | opaque, on the other towards variations of smooth | shiny. In the first case, the calibration makes the level of individual tiles homogeneous. It is followed by the action of diamond resinoids and abrasive brushes. Three tiles correspond to three different ways of removing the paste. The singularity of the inert materials is gradually exposed as they free their corporeality from the conglomerate in which they are drowned. The surface corrugates progressively and identifies points of material densification by random point constellations. As the ripples of the surface are illuminated, chiaroscuro strokes appear and gradient shadows emphasize the opacity of the artefact. Another triplet of actions describes the sensory scales of liquid/gloss in the second case. Diamond resinoids with 120, 240, 320, 400 600 grains bring the tile's surface to an increasingly smooth appearance free of impurities. From being rough and holding shadow, the surface becomes smooth and shiny and reflects the light. The stone aggregates are levelled out on it, becoming silent traces of Apulian earth sediments. The sensation of roughness finds comfort in smoothness, while opacity gives way to shine. Thus, what was initially intended only as finishing work, now becomes an action heralding value linked to the visual and tactile perception of the artefact's materiality (Fig. 10).

3.2 Decorative Pattern and Trans-action of Meaning

The experiments on the material interactions of the components, aimed at expressing a sensorial perceptual enhancement of the surface, find a new field of investigation when confronted with the register of decoration. In fact, after having created a taxonomy of variation on the grain size and thickness of the tile, we wanted to apply the same methodological approach to a decorated tile. In the first case, grit lending fractions are considered, where one part, of light grey colour and grain size 1, always remains the same, while another part of dark grey colour varies the section of the grains, passing from grain size 1 to 2 to 3. In the second case, fractions of different colours and materials are considered. A half in black paste always equal to itself approaches a half in grey grit, which increases the section of the grains, passing from granulometry 1 to 2 to 3. The Creta tile made according to the taxonomy of variations described enriches its expressive potential by implementing the material interactions of the single element with an extensive vocabulary of compositional patterns (Fig. 11).

According to its position in the configuration of the cement surface, each unitary element gives life to a creative process of the composition: the elements are constantly

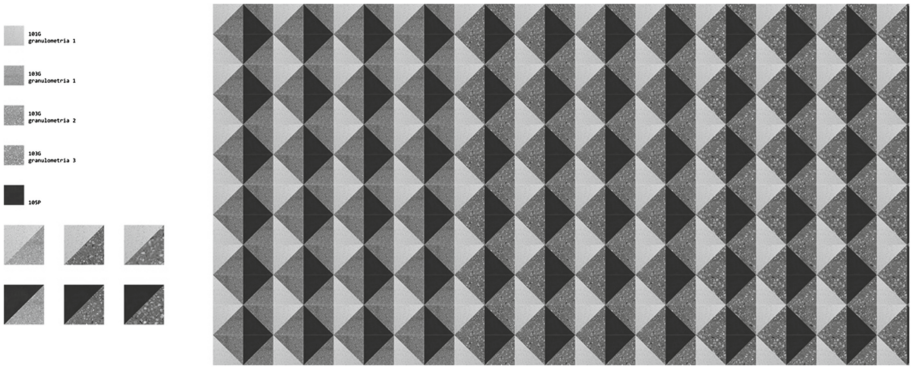

Fig. 11. Sensorial variations on two dimensional pattern

repeating the same, rotating, translating, and multiplying. Thus, the material transmigrations of the single components define perceptive transformations of the surface: the hand touches materiality that is sometimes rough and sometimes smooth and vibrating.

At the same time, the eyes slide over the tales of two-dimensional or three-dimensional drawings (Fig. 12).

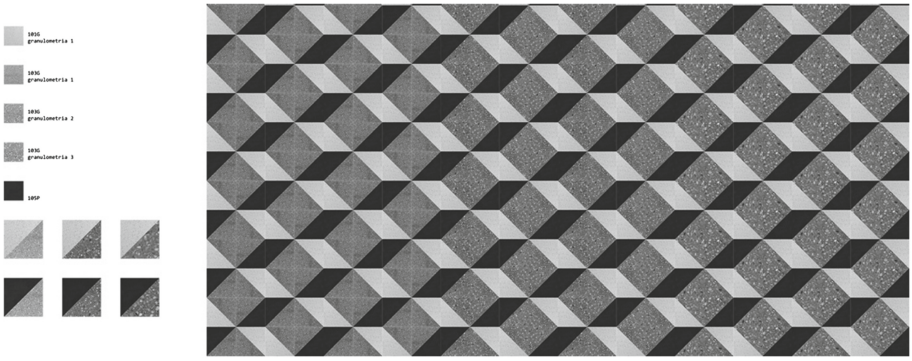

Fig. 12. Sensorial variations on three dimensional pattern

3.3 Contamination of Materials and Inter-action of Meaning

Starting from the experimental research on materiality and perceptive sensorial enhancement, we wanted to subsequently verify the contamination of the recomposed cement with other materials that are distinct to the touch and sight, such as brass, smooth and shiny, and glass, smooth and transparent. The first experimentation (Figs. 13 and 14) was carried out on 20 × 20 tiles in fine grain and pastina grit. The selected colours are white and grey for the grit, while black for the pastina, such as to contrast the chromatic quality of the brass. The metal first appears in the form of a strip (thickness 2 mm, width

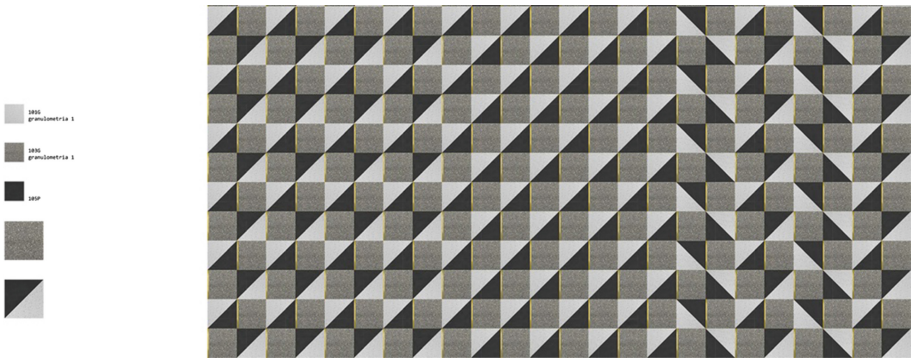

Fig. 13. Compositional variations on two dimensional pattern of concrete and brass

1 cm and length 20 cm), positioned along the edge of the tile. Then it is presented in the form of a chip (thickness 2 mm and side 2 cm) within the decoration of the Creta tile. Shiny lines and points follow one another on opaque concrete backgrounds, like punctuation on the compositional party. The game of opposites finds its representation in osmosis between materiality and sensoriality. The second experimentation with glass plates (Fig. 15) was carried out on a 20 × 20 size pastina tile: the mixture with fine aggregate favours the insertion of the plates. The colour of the pastina, light grey, allows you to emphasise the colour of the glass. The latter, being transparent, take on a colour that varies in relation with the background's colour in which they are placed. The range of glass used is extensive: fractions of strips from white opaline to yellow, light blue, blue, green, and red. In some cases, the contamination is also enriched by the presence of brass fragments to reinforce the colour scheme of the compositional system.

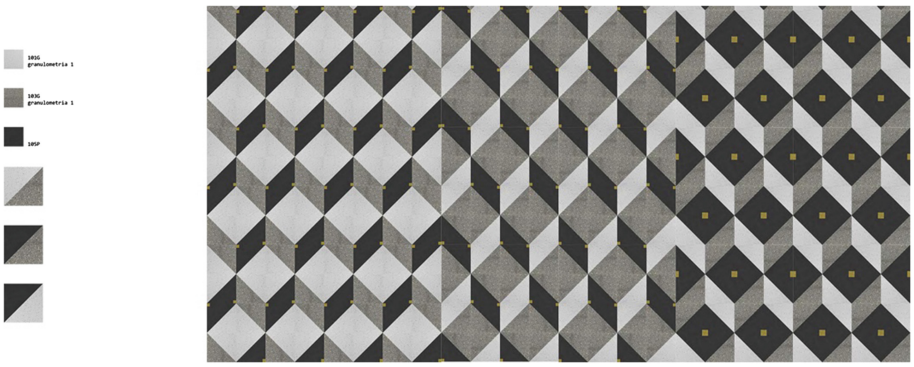

Fig. 14. Compositional variations on three dimensional pattern of concrete and brass

The strips sink luminously into the depth of the opaque mixture, cutting the cement material and remaining as a sharp trace on the surface. The layout is built according to rhythmic sequences of cut and flat plates, which move by translating on the surface,

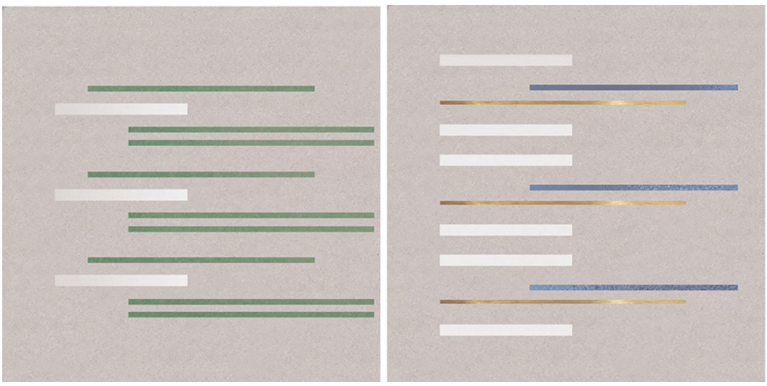

Fig. 15. Brass glass paste compositions

reflecting or absorbing the light in depth. Once again, materiality becomes the bearer of new cognitive experiences linked to the theme of sensorial perception.

4 Conclusions

In relation to both the horizontal and vertical planes of the representation, the evolution of the states of the matter of each tile defines a progression of gradients that can be interpreted as cladding surfaces for interiors. As the image is transformed into a sensory experience, the composition becomes a choral manifestation of solicitations. The act of seeing interacts with the act of touching through a multi-sensory mixture, and it becomes difficult to classify a single sense into which a single function can be poured. "There is a double quality in all perceptions. There is a tactility of sight, and there is a vision of touch or ear. The hand sees, the eye touches. The hand sees but not like sight, and sight sees but not like the hand." (Dal Curto et al., 2010, p. 10). Thus, the surface amplifies its expressive value in the imaginative process of variations on the system of relations between materials. The results of strengthening the physical-material structure thus translate the visual and sign status into an experience that leads to the mechanisms of perception and sensation. By transmigrating meaning, the actions define a new fertile condition of confrontation with the most current issues facing the design of cladding surfaces.

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Design for Culture and Education

Interdisciplinarity and the Essential Tension in the Discipline of Design

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Abstract. The reflection on inter-generational dynamics, and on the role of the inter-trans-actions that can be activated in design, is read in this contribution through an in-depth examination of the notion of discipline as an instrument of inter-generational transmission of knowledge and as a tool for interdisciplinary confrontation. This last aspect came into play in the design debate when it entered the university system in Italy. Since then, the problem of defining disciplinary boundaries and determining its trans-actions with other disciplines – present in the university institutions and competing in the formation of the figure of the designer – has arisen.

The composite nature of the discipline of design, in the Essential Tension between disciplinary convergences and divergences, is not yet adequately supported by easily transferable or exemplary methodological processes. The aim is to provide the context of complexity in which to place the very notion of interdisciplinarity and with it its crucial node, that of lexicons and interdisciplinary communication: "communication is crucial. The varying use of language across disciplines might seem a superficial problem, but it is one that must be solved, or misunderstandings will undermine the foundations of the project" (Mind meld, 2015, p. 290).

Keywords: Essential Tension · Interdisciplinarity · Design education · Innovation and tradition

1 Design and Education in the Italian University Context: The Setting of an Ongoing Debate

While Italian design has gained visibility after World War II through an already vast literature, its structuring as a university discipline dates back to much more recent times. The opening of the first autonomous university courses in design took place in the mid-1990s, within the faculties of architecture, sharing their original reflection on the composite nature of design disciplines. A composite nature that for Riccini is linked to his specificity as a project design discipline. Riccini highlights the "hybrid nature that design shares with other design disciplines, located halfway between formalised knowledge (science, mathematics, etc.) and humanistic knowledge" (Riccini 2013, pp.1–2), or linked to the "composite nature of its own design and cultural space" (Riccini, 2013, p.2).

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The establishment of the history of the path that design has taken so far to form as a university discipline is still in progress, but it already boasts a reference bibliography that focuses mainly on the last five to six years.

Here we cite only a few main references such as those to works by single authors (Pansera, 2015) or collections (Furlanis, 2018), to single in-depth studies (Bulegato 2014; Riccini 2013, Riccini 2009), including more recent debate fueled by this author through monographic issues of the young journal QuAD. This journal set itself the goal of initiating a first mapping of the birth of the different courses of study in design in Italy, from Milan to Palermo, (Bassi 2018; Bulegato & Pastore, 2018; Bulegato, 2019; Della Piana, 2018; Di Roma, 2018; Cristallo & Morone 2018; Lucibello, 2018; Perruccio, 2018; Riccini 2018; Trapani 2018; Trivellin 2019). The aim was to initiate the drafting of a historical-geographical atlas necessary for defining the status of design as a university discipline, investigating places in a convergent way, events and exemplary cases.

From this debate, a number of characteristics of the discipline have emerged, some of which are well known and shared with the faculties of architecture, such as the evidence that the fact that it is pre-eminently a design activity places it in the forefront of the field: 2among the faculties oriented to some form of utility, among those, that is, that in outlining the training projects must come to terms with the implications of practical action on the criteria of teaching" (Riccini, 2013, p. 2).

On the other hand, and greater interest, the access of design to university institutions, compared to its origins in architecture, shows a strong push towards interdisciplinarity:

> to draw on the contribution of formalised and non-formalised knowledge as the necessary competences expand and, at the same time, specialise [...], the increase in complexity on the one hand and the growing social role of the designer today require the contribution of theoretical, technical-scientific and historical disciplines, in continuous dialogue between design as a discipline and the areas of psychology, semiotics, histories, technology, philosophies and science. (Riccini, 2013, p. 3)

This is a true disciplinary constellation that sanctions the abandonment of the artistic or atelier approach inherited from the Bauhaus. The subsequent experience of Ulm sanctioned the entry of new and extraneous disciplines with respect to that artistic structure, to open up to the "connection between design, science and technology, to the ability to glimpse in technical-scientific progress a powerful factor in social dynamics" (Riccini, 2013, p. 3). In other words, it could be said that the interdisciplinary condition already appeared at the time as the framework within which reflections not only on the disciplinary status of design could and should have been initiated, but also on innovation processes. With due national differences, concerning the history of the determination of disciplinary specialisms in the different national contexts, it is evident that the discipline of design is composed of two entities in relation to each other: a convergent thought entirely within the discipline, and one that appears to be already diverging towards the development of complex relationships among fields of knowledge, all to be experienced.

Riccini will insist a few years later, on the lack of "pedagogical epistemologies on a par with the challenges of contemporaneity" (2018, p. 85), highlighting that in particular "in Italy, texts on design education are few and when they exist, they focus

in an introverted way on the tactics and strategies of field training often more attentive to institutional aspects and ministerial constraints than to the density of an incandescent and magmatic matter such as the training project of young designers" (2018, p. 85).

Since 2018, the debate on these issues has become increasingly intense and shared by the scientific community. A debate that is now considered essential, as also witnessed by design historian Vanni Pasca. In 2016 at the conference held in Florence by the Scientific Society of Design SID, together with the University Conference of Design CUID, he was to point out in his paper published in 2018, that "we are facing a process of transformation: the fields of application of design and its definitions are growing, but all this does not correspond to an adequate reflection on the training of designers" (2018, p. 82).

Referring to the thinking of Victor Margolin, he points out that problem-solving approaches are developing, which are often characterised by an engineering approach. He adds that

> even in Italy, in many design courses, there seems to be a growing tendency towards technical training with an operationalist perspective, in the sense that the project is reduced to a list of operations to be carried out to achieve the set objective, and attention to the most advanced techniques (which is an excellent thing) is often developed without critical analysis, while the importance of history becomes increasingly marginal. The risk is that a generation of designers is being trained which lacks historical awareness and reflection on the meaning and responsibility of designing (2018, pp. 80–81).

Pasca stresses in this way that this kind of interdisciplinarity for designers is interpreted as a simple openness to multiple fields of application of techniques and technologies. Thus the discipline of design pursues the development of its composite nature in terms of simple problem solving, and not as a challenge to question itself and its scientific paradigms and action. In this it is not far from what other disciplines are pursuing today in wanting to follow the path of interdisciplinarity.

The French sociologist Johan Heilbron specifies this clearly in a regime of Disciplines. Towards a historical sociology of disciplinary knowledge (2003, pp. 23–42). Heilbron, citing in part the work of Michael Gibbons, Camille Limoges, Helga Nowotny, Simon Schwarztzman, Peter Scott, and Martin Trow, in The New Production of knowledge: The Dynamics of Science and Research in Contemporary Societies (1994), makes this point very clear:

> alongside the disciplinary mode, a new mode of knowledge production has appeared, one which is 'oriented towards and driven by problem-solving. Its theoretical methodological core, while cross-cutting through well-established disciplinary cores, is often locally driven and locally constituted, thus any such core is highly sensitive to further local mutations depending on the context of application' (Gibbons et al. 1994, p. 29). [...] Gibbons and his associates emphasize highly mutable context and use-dependent configurations of knowledge, rejecting the tendency to create new disciplines, as well as what they see as a longing to restore cognitive unity. Transdisciplinarity, as they prefer to call it, is characterized by

> flexibility, multiple sources, and constant flows back and forth between the fundamental and the applied, the theoretical and the practical, the local and the general. Transdisciplinarity is "problem solving capability on the move. (pp. 38–39)

These passages highlight the complexity of references and points of view that a discussion on interdisciplinarity brings into play. Although invoked by many as an aspect that characterises the discipline of design more than others, these brief observations make it clear that the ways and meanings of interdisciplinarity require, at the very least, that we highlight the relationships that come into play.

The following reflections are aimed at identifying those perspectives of possible pedagogical epistemologies that Riccini encouraged, with particular reference to the composite nature of design that has emerged from the latest historical-critical surveys on education. Talking about epistemological perspectives means identifying some general characteristics of the notion of interdisciplinarity, first and foremost its double link with the phenomena of specialisation of knowledge which, at the turn of the 19th and 20th centuries, redetermined the processes of transmission of knowledge, with the opportunities and consequences which we will examine below.

2 Interdisciplinarity, Specialisations, Innovation: In Search of a Theoretical-Critical Tradition in the Debate on Education Advanced by Ludovico Geymonat

Recent surveys carried out by CUID, the Italian Design University Conference, on the educational structure of Italian design courses (Tosi, 2020) show the continuous development, alongside the word design, of specifications for categories of various kinds, partly intended as fields of application, partly borrowed from the lexicons of other disciplines (Fig. 1).

The question that arises is: what does design add or modify or innovate for itself and for those disciplines, or thanks to those disciplines, repositioning them in the comparison and search for lexical differentiation? Or is it a process of seduction that other disciplines exert on a discipline still in a phase of academic development, with the consequence of losing control of its own disciplinary boundaries and language? The question is therefore both one of boundaries and the meaning and modes of innovation in design (Fig. 2).

The debate on disciplinary divisions, inherited from the structures of scientific specialisms that arose at the turn of the 19th and 20th centuries (Geymonat, 1970–1972), produces first of all a symmetrical reflection on the paradigms of innovation that the disciplinary convergence of scientific research first triggers and then accelerates. At the same time, it produces multiple reflections on the risks of this specialist-disciplinary convergence linked to the closure towards different fields of investigation, with particular attention to the problems of lexical technicalities that are their cause, as explained in the editorial in issue 525 of Nature – dedicated to Interdisicplinarity – entitled Mind meld. Interdisciplinary science must break down barriers between fields to build common ground: "communication is crucial. The varying use of language across disciplines might seem a superficial problem, but it is one that must be solved, or misunderstandings will undermine the foundations of the project" (Mind meld, 2015, p. 290).

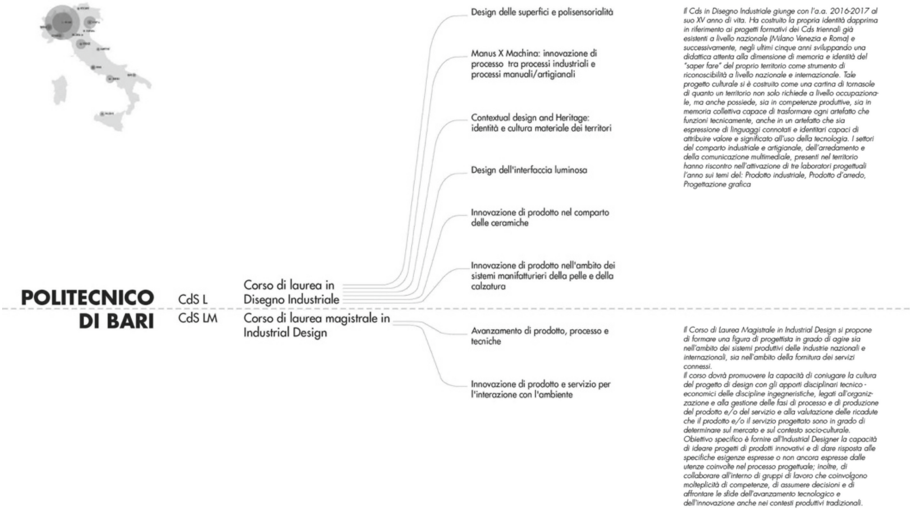

Fig. 1. R. Carullo, D. Scodeller: extracts from the survey conducted by CUID. Graphics editing N. Faccitondo

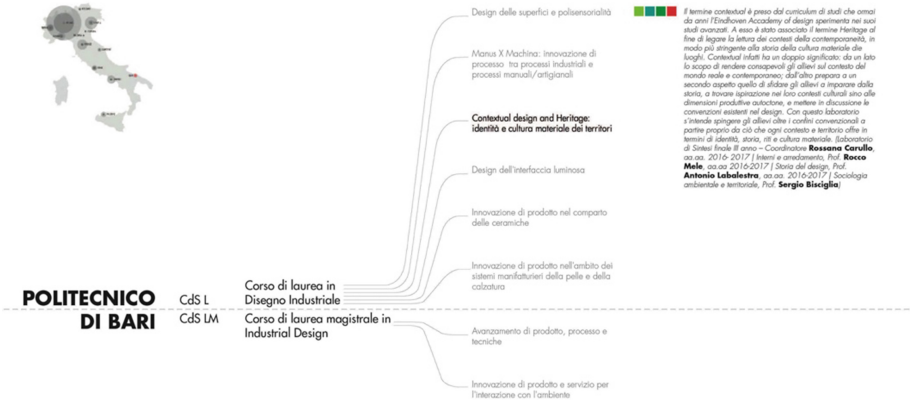

Fig. 2. R. Carullo, D. Scodeller: extracts from the survey conducted by CUID with lexicon specification. Graphics editing N. Faccitondo

Ludovico Geymonat (1970–1972, pp. 535–563) places the beginning of the 19th century lexical specialisation of individual disciplines, which is now exacerbated by the use of English, at the beginning of the 20th century. It is these languages that, according to Geymonat, have determined the disciplinary divisions. The hyper-specialism of technocratic societies has deep roots that pass right through the construction of specific technical-disciplinary languages:

> But in this linguistic technicalisation is also rooted the first and most important aspect of that complex phenomenon of "closure" that has dangerously accompanied, for a long time, the process of specialization Indeed, it was precisely the

> degree of seriousness that this process imprinted on the individual disciplines and the wealth of concrete results that it facilitated, that gave rise to such a dogmatic confidence in the 'specialist scientist' in his type of work, that he did not even allow himself to consider the problem of whether it required any integration or coordination with the work of researchers engaged in other fields of investigation (also due to the actual difficulties of controlling the authentic rigour of the arguments carried out in a language different from his own). (p. 539)

Faced with the awareness of the complexity of the development of the processes of specialisation of the sciences, (Heilbron, 2004, pp. 23–42), Geymonat shows us that the question of interdisciplinarity both formalised knowledge and humanistic knowledge, cannot be treated as a simple practice, but must be fully understood in terms of both its conditions of action, potential and implications with regard to real innovation. Geymonat's critique is directed at the renunciation of responsibility that the specialisation of science has induced in researchers, a renunciation in imagining the development of knowledge within a specific conception of the world with the environmental and civil consequences that we see before us:

> In recent times, scientists themselves have begun to take note of the negative effects of pure specialism. One of the factors that has contributed most to their awareness has undoubtedly been the renewed interest that has arisen in them in methodological problems [...] it is clear that they have favoured the birth of a new mentality, no longer aimed solely at the discovery of some particular result, but at the acquisition of a critical increasing awareness incompatible with the basic dogmatism of the 19th century type of researcher closed within his own speciality. (p. 541)

Such an interest in methodological problems, in other words, favoured the possibility "of using the results achieved by one outside the field in which they had been demonstrated; of scrupulously specifying analogies and differences […]. In this way, scientific research was thrown into an enormously broader field, where any preconceived bias was seriously dangerous" (p. 542), dangerous not only in terms of the development of knowledge, but in general, as already mentioned, for the ethical, environmental and social consequences.

For Geymonat, developing knowledge without questioning the conception of the world that underlies it means proposing models of scientific research that are detached from the social and economic structures of their time, making it impossible to bring the innovative demands of scientific research into reality, and at the same time, to bring the innovative demands that come from practical experience into scientific research: "with the presumed disappearance of this problem [of the conception of the world], the main element of mediation between the economic structure of society and the structure represented by scientific research is missing".

This reasoning is particularly significant for design, if it is true what Riccini said about the Ulm experience, in which the need was felt to open up to the "connection between design, science and technology, to the ability to glimpse in technical-scientific progress a powerful factor in social dynamics" (2013, p. 3). It is a tension that identifies the

relationships between economic, socio-technical and cultural conditions, which concerns precisely the discussion on the future of design education. These are the relationships for which interdisciplinarity is invoked by many. Design as a discipline cannot be separated from the "capacity to dialogue with the revolution of technological and communication systems, […] within a critical dimension of comparison and questioning of the existing conditions, which have long been unsustainable from the socio-economic point of view, of the limitation of resources, of ecological practicability and of the correct conditions for human life" (Bassi, 2018, p. 351). In this direction Bassi also insists, pointing to a path to train a designer from problem solver to sense maker. This presupposes a condition for "the places of scholastic and lifelong training, especially at university, which needs, alongside specialist and scientific-technical training, interdisciplinary knowledge and skills […]". Interdisciplinarity is invoked as an antidote to specialist closure and as a bulwark against problem-solving or operationalist approaches that are in fact incapable of a critical vision of the conception of the world, urged by Geymonat, against all specialist closure.

Finally, Geymonat indicates what it means to undertake interdisciplinary relations: "not in the sense that one science can use the findings of the other [we could say that design can use some finding or technological result], but in the sense that it can – or rather must – take an interest in the way the others are constructed in order to pinpoint what assimilates them and what differentiates them from each other" (1972/1981, p. 543).

It is therefore not interdisciplinarity that is a condition for fostering the development of scientific productivity, or a concept of all-round progress or innovation, linked to a problem-solving and operationist attitude, but the opening up of a field that Geymonat himself defines as 'meta-theoretical', in which the various scientific investigations are no longer concerned with investigating the object of their specificity, but rather with investigating the internal theoretical structures of the discipline in question, and of its development paradigms "in order to be able to determine, as a consequence, the relationships existing between this structure and that of other theories". In other words, it means questioning the identity of one's own disciplinary status, in order to identify the possible pedagogical epistemologies invoked by Riccini.

The consequences of this different approach mean that, for the researcher, "his primitive way of proceeding, accepting the premises and methods of the theory as they had been transmitted to him by previous generations, now appears grossly dogmatic" (Geymonat, p. 543–544). Thus, interdisciplinary confrontation, no longer understood as the simple exchange of a scientific-technical finding between disciplines, becomes a device for anti-dogmatic reflection, for challenging one's own theoretical-disciplinary structure. At the same time, however, it is clear that the methods of theory transmitted by previous generations, i.e. by disciplinary tradition, nevertheless constitute an indispensable precondition for triggering the anti-dogmatic tension of research. We must not be fooled by the many applied results that can be achieved with the new technologies.

The field of reflection that this analysis offers us is that the discipline of design is perhaps too young not to run the risk of conforming to operationalist approaches, or to the theoretical and lexical structures of the many disciplines with which it has intended and intends to dialogue from time to time. This may entail losing sight of that meta-theoretical field which, for Geymonat, constitutes the true anti-dogmatic and

open-minded field of knowledge. It is in this context that the processes of innovation, understood not as the addition of new knowledge to existing knowledge, but as a real epistemological gap that interdisciplinary confrontation can trigger, are set in motion.

3 Thomas Khun'S *Essential Tension* Paradigm: A Reflection on the Concept of Discipline Between Convergent and Divergent Thinking

What emerges is the need for a more in-depth reasoning on the devices that the notion of discipline applies in the processes of questioning itself, in particular in the dialectic between stabilisation and development of its own paradigms. This leads us to reflect on this tension between the convergent features of each discipline, in its tradition of specialised studies, and the divergent features that allow it to deviate in terms of disciplinary innovation:

> I will then express the idea that something like 'convergent thinking' is as essential to scientific advancement as divergent thinking. Since these two modes of thinking are inevitably in conflict, it follows that the ability to sustain a tension that can sometimes become intolerable is one of the first requirements for an exceptional quality of scientific research. (Kuhn, 1959, trad.it 1985/2006, p. 80, tda)

The words of Thomas Kuhn, historian and philosopher of science, are taken from his book: The Essential Tension: Tradition and Innovation in Scientific Research, (Kuhn, 1959, trad.it 1985/2006, pp.79–96) and are reflections that he himself was to use for his perhaps best known text: The structure of Scientific Revolution (Kuhn, 1962, trad. it 1970), in which this point of view is exemplified through the analysis of the historical development of scientific revolutions. The interest in the resumption of Kuhn's thought, recently shared by various scholars of the social sciences (Fabiani, 2006), as we will have the opportunity to examine in depth, lies in having investigated the tension between the identity of disciplinary statutes read in their specialism and tradition, and the ability to modify the paradigms in the radicality underlying new visions or conceptions of the world. The dialectic between tradition and innovation is critical of interdisciplinary problem-solving practices. Kuhn analyses the relationship that each discipline weaves with the history of the transmission of its knowledge within texts, institutions, groups and scientific communities, read in their evolutionary paradigms. According to Kuhn, convergent thinking is such because it "rests firmly on a consensus that is highly acquired through scientific education and reinforced through subsequent activity in the scientific profession" (Kuhn, 1959, trad.it 1985/2006, p. 81, tda). He adds that extended periods of convergent research are necessary in advance to initiate changes in disciplinary traditions, and thus comes to define the relationship between these two poles as Essential Tension.

Within the confines of convergent thinking develops what Kuhn calls normal thinking. This is thinking that is structured by expanding knowledge in a cumulative way within the disciplinary tradition (Kuhn, 1981, trad.it 2006). While within the confines of divergent thinking, revolutionary thinking develops, capable of modifying the existing paradigms shared by the scientific community and the system of relations that used to

define them. Divergent thinking involves "discoveries that can no longer be reconciled with the concepts in use before they were made. In order to make or assimilate a discovery, it is necessary to alter the way one thinks [….]". (Kuhn 1981, trad.it 2006 p.161, tda), in ways that first of all challenge the very structure of disciplinary lexicons. The example Kuhn uses repeatedly concerns the transition from Ptolemaic to Copernican astronomy, a transition in which first the Sun and Moon were planets, while the Earth was not,

> then the Earth becomes a planet, like Mars and Jupiter; the Sun becomes a star; and the Moon becomes a new kind of body, a satellite. Changes of this kind do not constitute mere laws of nature, but also changes in the criteria by which certain terms of these laws were applied to nature [...], you cannot go from the old to the new by simply adding something to what you already knew. Nor is it possible to describe the new in the vocabulary of the old or vice versa. (Kuhn 1981, trad.it 2006, pp. 161–162)

What happens is a change in the meaning of lexicons even though they are already in use: "The distinctive character of revolutionary change in language is that it alters not only the criteria by which terms are related to nature but also, and overwhelmingly, the set of objects or situations to which those terms are related" (Kuhn 1981, trad.it 2006, p. 181). In other words, we arrive at a different conception of the world with difficulties of lexical translatability. As Stefano Gattei points out in a recent collection and reinterpretation of Kuhn's nodes of the philosophy of science:

> since lexicons are functional for the construction of the world of phenomena and for the formulation of scientific problems, and since meanings are linked to lexical structures, all the previous characterisations of incommensurability in terms of problems, meanings and changes of world converge in the notion of change of lexical structure: they are different manifestations of these lexical changes. (Gattei, 2000, p. 337)

The problem of disciplinary lexicons is therefore transversal both to the communication problems posed by interdisciplinarity and to the innovation processes that lead to the undermining of what Kuhn called the disciplinary matrices of each discipline. This often happens, for example, when disciplines tend to specialise, both themselves and their languages, in the course of their development, even though they start from common disciplinary matrices. For Kuhn, the disciplinary matrix is not simply the theory of a discipline, but a system of relations that can be summarised in three main aspects (Fabiani 2006, pp. 9–11): the first is the part of formalisable elements of a discipline. Kuhn defines them as symbolic generalisations (e.g. Newton's second law of dynamics $f = ma$). The second part is the part of elements concerning the beliefs shared by a specific scientific community. The third part concerns the values of a discipline, which can be interpreted differently by the members of a specific scientific community. This last part contains the possibility of activating processes of interpretation. The critical act of interpretation concerns very closely the lexicons of the disciplines themselves, and strengthens the individual value of the activity of individual researchers (Gattei 2000, p. 338). It is at this stage that researchers take the risk of an innovation in the disciplinary

matrix: “The ways of being in the world provided by a lexicon are not candidates for the true and the false: they are evaluated for their ability to achieve a purpose, not to reflect reality” (Gattei, 2000, p. 343). Together with the lexicons in this part, Kuhn also inserts the value of exemplary cases, i.e. examples shared by the scientific community. As Gattei explains:

> their globally normative function derives from the fact that in the articulation of problems and solutions a particular system of empirical concepts is used [...]. Since 1982 Kuhn has called this system a lexicon or lexical structure: this term, borrowed from linguistics, refers to the reciprocal dependence between the different empirical concepts. The concrete solutions to various problems do not simply illustrate a previously fixed lexicon of empirical concepts: certain concepts of the lexicon acquire their particular meaning only with the articulation of exemplary solutions to concrete problems. The lexicon ends up constructing the world of phenomena: the concepts structure a particular region of the world and make it accessible, and all the problems analysed subsequently will necessarily have to refer to it. (pp. 307–308)

The third part of the matrix therefore includes the empirical part in a renewed sense of the relationship between theory and practice. The exemplary cases in fact do not coincide at all with the applicative cases, which are, if anything, problem solving, but allow a movement from theory to practice and a phenomenology of interpretation of reality. It is easy to see how this specification is crucial for a discipline such as design, which has even built specific forms of teaching on the relationship between theory and practice, but also risky disconnections. The concept of the matrix is one of incredible plasticity (Fabiani, 2006, p.12) that allows us to address the meaning that interdisciplinarity can have in this matrix. Kuhn, in fact, in Essential Tension, does not deal with issues related to interdisciplinarity, but, as Fabiani states, the dialectic he identified between processes of stabilisation of disciplines and processes of modification of their disciplinary matrices, allows us to identify their role. According to Fabiani:

> The dimension of inter- and intra-disciplinary competition is certainly what is most lacking in the model proposed by Kuhn: it is nevertheless possible to accept the competitive dimension of scientific activity in the disciplinary matrix, referring to the notion of value that accounts for [...] the dynamics of disciplinary configurations. This dynamic is largely the product of intensely competitive and conflictual activities: the emergence of new disciplines is often the result of the recomposition of territories, some bodies of knowledge are definitively downgraded, others are only maintained in a rather commemorative form. Most transformations in the general configuration of disciplines take place at the frontiers or at the margins of knowledge. They are also inseparable from the transfer of tools or symbolic generalisations, to use Kuhn’s words, leading to new forms of organising work and dividing tasks, but also to changes in language or scientific styles. Particular attention should be paid here to the phenomena of hybridisation. [...] Disciplinary hybridisation is clearly a model of scientific innovation. The intensification of competition, which leads members of one field to invest in another field, becomes

> an explanatory principle for the renewal of scientific practices. (Fabiani, 2006, pp. 15–16)

But this renewal, read against the backdrop of Kuhn's Essential Tension, forcefully brings out the fundamental role of the long timescale of education and thus of disciplinary training:

> only investigations firmly rooted in the contemporary scientific tradition are likely to break with this tradition and give rise to a new one [...], very often the scientist who succeeds in doing so must simultaneously display the characteristics of the traditionalist and the iconoclast. [...] the continual process of clarifying a commonly accepted tradition has produced at least one of those changes in fundamental theory [...]. (Kuhn, 1959/2006, pp. 82–90).

These considerations show that in order to define a researcher as innovative, it is not enough to list personality traits, such as possessing flexibility or open-mindedness, stereotypes that do not identify the Essential Tension necessary for the production of real innovation processes: "we are more fully suited to exploit our potential scientific talent if we recognise the degree to which the fundamental scientist must also be a determined traditionalist or […] a convergent thinker" (Kuhn, 1959/2006 p. 93).

What is the place today where the convergent thinking necessary to nurture an essential tension with the divergence of thought, which is the innovation term to which design constantly aspires, can best be implemented, if not the field of disciplinary education? This question is even more pertinent today, in the face of the multiple impulses according to which "in the sea of thought, everything communicates with everything, each piece of knowledge is in scientific interpenetration with the others. Every object can be known by every discipline, every knowledge can give access to every object" (Coccia, 2016, p. 145).

It is no coincidence that today Kuhn's theories are being reinterpreted from several points of view. Here I would like to mention in particular the survey that came out in 2006 by the École des hautes études en sciences sociales in Paris entitled Qu'est-ce qu'une discipline? (Boutier, Passeron & Revel, 2006) from which Jean-Luis Fabiani's remarks are taken. In his essay A quoi sert la notion de discipline, Fabiani quotes Kuhn extensively and identifies in his Essential Tension the paradigm within which scientific communities cannot do without their relationship with the underlying pedagogical philosophies. Fabien explains that:

> The starting point of the reflection is prompted by an assessment of the relationship between pedagogical organisation and scientific innovation, which is based on a re-reading of Thomas Kuhn's work [....]. We can then propose a general definition of the discipline as a body of knowledge inscribed in texts, paradigmatic examples and forms of instrumentation, which is the object of pedagogical transmission. (p. 2)

This means that reflection on the disciplinarity or inter-discipliarity of design can only pass through knowledge, read through the paradigms of its pedagogical transmission as they have been modified and defined over time. This is why it is necessary to

strongly emphasise the role of the relationship between didactics and research in design, and that of assuming a historical-critical knowledge of the processes of pedagogical transmission, capable of identifying paradigm shifts and their causes. The less pedagogical and disciplinary tradition there is, the more stringent this requirement is. This need is all the stronger the less that pedagogical and disciplinary tradition is at stake, and the stronger are the contemporary pushes towards the seduction of transdisciplinary conditions, as made clear by Heilbron, in his critique of a tension unidirectionally launched into only divergent thoughts: "for such an understanding of current tendencies and debates, nothing may be more useful than an elaborate historical sociology of the production of (disciplinary) knowledge" (2003, p. 39). In this context, Maldonado's apparently autobiographical answer to Hans Hulrich Obrist's question 'you stayed in Ulm for thirteen years, a relatively long time; can you tell us what this experience meant to you? Tomàs Maldonado's answer is:

> Quite a few cultural interests that were previously incipient, barely sketched out, have been consolidated [...], I allude to my theoretical (and practical) involvement with industrial design and communication. On the other hand, it is precisely in this context that my interests in semiotics, in the philosophy of science and technology, and not least in the sociology of communication mature. A decisive role in all this was played by the pedagogical challenge, the need to test myself every day with teaching. (Maldonado 2010, p. 29)

4 Conclusions. *Essential Tension* in Its Implications for Design Education: Interdisciplinarity and Lexicons in the Relationship Between Didactics and Research, Innovation and Tradition

In conclusion we can say that we have outlined, even before the concept of interdisciplinarity, the structure of relationships and implications in which it should be placed. We have not pretended to give any answer, least of all an operationalist one, a point on which Pasca warned us. If anything, we consider the contribution made in critically outlining, with an epistemological slant, its matrix of reference, to use Kuhn's words, to be useful. Certainly in this matrix we can include the relationship that proves to be inseparable between teaching and research. Questioning this relationship also means questioning the Essential Tension of the dialectic between tradition and innovation. Indeed, the appeal launched by Pasca at the suggestion of Victor Margolin (Pasca 2018, p. 81), calls for overcoming problem solving approaches, of an operationalist character, in which the marginalisation of historical-critical investigation is evident. This is a symmetrical appeal to Bassi to transform designers from problem solvers into sense makers.

Kuhn's Essential Tension indicates a new role for the history of science (Gattei 2000, p. 294), a role capable of producing a sort of evolutionary epistemology, in which innovation can show itself in all its incommensurability with respect to the context that preceded it (Gattei 2000, p. 339). Interdisciplinarity or hybridisation is one of the factors that, albeit indirectly, enter into the structure of the disciplinary matrix formalised by Kuhn to manage the implications of his Essential Tension. We have seen how Fabiani reminds us that the intensifica tion of competition "leads members of one field to invest in another

field", and this "becomes an explanatory principle of the renewal of scientific practices" (Fabiani, 2006, p. 16). In turn, the principle of renewal brings with it the modification of the relations of the disciplinary matrix as identified by Kuhn. The first consequence of all is the incommensurability of lexicons following a scientific revolution. The example of the Copernican transition makes this clear. It is no coincidence that lexicons are the crucial node of interdisciplinary confrontation, as the editorial of the monographic issue of Nature dedicated to the contemporary debate on inter-disciplinarity tells us (Mind meld, 2015, p. 290). In those lexicons, finally, lies the whole world of interpretation of exemplary cases, that is, of the minute factual situations of the projects that design deals with, which, within the logic of the disciplinary matrix, can reconstruct the links between theory and practice, design studios, theoretical lessons and technical specialisms:

> the common and widespread university experience testifies to a cultural and operational separation among theoretical-intellectual, technical-instrumental and design studio teaching, as a result, on the one hand, of a methodological 'closure' of those who deal with history-criticism [...] and, on the other hand, of a partial model of self-sufficiency of the project [...]. (Bassi p. 358)

The incommensurability is mainly given by the shift in lexical meanings that each renewal, thus understood, brings with it. It is no coincidence then that yet another design historian recently initiated a study of design lexicons to "make a contribution to defining the individuality of the discipline, which reflects the syncretism of the sectoral activities that compose it" (Dellapiana & Siekiera, 2015, p. 14). Read downstream from Essential Tension, the study on lexicons is now shown to be much more than a contribution to the definition of a discipline's individuality: it is part of its disciplinary matrix. The scholars use the interdisciplinary framework between history and linguistics to analyse an Essential Tension between convergences and divergences in design thinking, linked to changes in its lexicon:

> the result sought here is twofold: to initiate, as is already the case in other disciplines, a study of the linguistic-expressive forms resulting from theoretical changes in the field of design, and to initiate, in a perhaps even more embryonic but promising way, the collection in a Glossary of terms that have become typical of the language of design, highlighting their attestations, recurrences and changes in meaning by means of the tools consolidated in studies of the history of the Italian language. (Dellapiana & Siekiera, 2015, p. 15)

The scholars point out how the absence of academic places for debate, present in Italy for only twenty years, affects precisely the definition of shared lexicons and therefore the structuring of a convergent thought shared by a scientific community:

> this uncertainty in Italy is exacerbated by the absence of academic places of debate and transmission, which, if on the one hand constitutes the strength of the national framework, because it stimulates a process "from below" in continuous and fruitful relationships with companies, independent designers, and the press, on the other hand, does not include clear facilities like those that have already been set up in other European countries, such as in Germany's Hochschule für Gestaltung in Ulm

> or in England's Royal College of Art in London, and the myriad of schools where designers are trained. (Dellapiana & Siekiera, 2015, p. 23)

The study of lexicons represents the possibility of understanding the epistemological ruptures of the changes that have taken place in the evolution of disciplines. It is the premise for an interdisciplinary communication that paradoxically seeks the measure of the immeasurable, the Essential Tension, avoiding highly changeable configurations of knowledge, for which, if anything, one should speak of transdisciplinarity. But, the circle closes here, transdisciplinarity is "problem solving capability on the move" (Heilbron, 2004 pp. 38–39).

This direction of research into design lexicons is now also a field of study at the Design Academy of Eindhoven, which recently opened its Lexicon, (http://www.lexiconofdesignresearch.com/). In the first point of its Manifesto, it clarifies that design is epistemologically speaking a form of knowledge: "Knowledge is an integral part of design. Doing research to gather knowledge – of materials, processes, people, history, aesthetics, and more – supports design activities and contributes to a thriving design culture.

We call this research for design […] Design research = anchoring + capturing + creating knowledge" (http://www.lexiconofdesignresearch.com/manifesto), according to a contemporary Essential Tension.

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http://www.lexiconofdesignresearch.com

http://www.lexiconofdesignresearch.com/manifesto

PhD Research for "Trans-action": The Role of Research Questions

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Abstract. The unique contribution of design in addressing increasingly complex and cross disciplinary challenges, and how design education and research must change to answer to these challenges, is being discussed by the worldwide design community. At the same time, as it shifted from a purely practice discipline to an academic one, design is still taking the first steps in establishing itself among other more mature academic fields. The relative place of design projects within academic research is still not consensually accepted. This paper addresses these two concerns at the critical juncture between design education and research: doctoral education. What we propose is a framework aiming to assist the conversion of a mere interest in a design subject into accurate, theory-driven and post-disciplinary research questions for global 'trans-action'. Through an integrative review, we gather contributions from different authors and academic fields. After reviewing the characteristics of effective research questions, we discuss how different types of research questions combine with each step of the theory building cycle. Then, we adapt an innovation model to help PhD candidates to unveil post-disciplinary research opportunities while incorporating design projects in PhD proposals. Finally, using our own research as example, we show how to synthesize research planning relevant information into a research matrix.

Keywords: Design research · Research questions · Design science · Design education · Post-disciplinarity · PhD in design

1 Introduction

In the scenario of increasingly complex and interdisciplinary problems humanity currently faces, design is either part of the problem or part of the solution. Due to its transformative and active role regarding the ways "we live and we imagine living", design plays a critical role in response to these 'trans-action' challenges. If we want the ecosystems we inhabit, and rely on, to thrive, design research education must urgently adopt a

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"global challenges approach". Because those challenges are not disciplinary in nature, they require responses that are not confined to disciplinary boundaries. Thus, design research needs be post-disciplinary, abandoning siloed ways of thinking and bringing together knowledge from different disciplines (Wilde 2020: 171–173). In these circumstances, the role of PhD programmes, as the starting point of academic research, is in "pushing the interdisciplinary and inter-sectoral boundaries of the field", by "broadening and deepening" existent collaborations while "nurturing new connections" (Voûte et al. 2020: 64). In this paper we examine how that can be effectively done at one of the most important initial stages of the doctorate, which is the formulating of research questions. We also discuss the relevance of accurate questions not only in guiding the forthcoming research but especially in contributing to the theory building in the field of study.

Defining a research question is the essential opening challenge in any investigation not only because it is usually "a pre-requisite for dissertation proposals and funded projects application" but, more importantly, because it is necessary to "give shape and direction" to the study. While "good research questions do not necessarily produce good research", poorly conceived questions "will likely create problems that affect all subsequent stages of a study" (Agee 2009: 431).

This challenge usually starts when students are confronted with the need to convert a personal research interest into a research plan. That process requires creative and critical thinking, while students try to find a balance between a topic that matches their own and their supervisors' interests, keep them motivated and intellectually stimulated throughout the PhD course, and, at the same time, find a scientifically worthy research question for the knowledge advancement in a given field of study (Mendes et al. 2020).

In the specific case of design research, this initial research interest usually comes in the form of a design practice interest, doubt or wish, which is not a research question. As Findeli et al. (2010) puts it, an easy way to grasp the distinction between them is to look at the different kind of answers each of them generates. While "design answers are presented in glossy design magazines with plenty of pictures", "research answers are found in academic journals with as few pictures as possible in the typical grey literature" (Findeli et al. 2010: 295–296). A design question usually arises from students' "dissatisfaction in their professional practice, or from the wish to deepen one aspect that has puzzled them in their professional education" and frequently comes with the desire of designing something. On the contrary, a research question must be deliberately formulated in such a way that its outcome would be valuable knowledge. And while it is obvious that "there are usually many potential research questions hidden in a design question [or intention], candidates don't always have the necessary competence to switch from design questions to research questions (Findeli et al. 2010: 296–297).

The present paper proposes a framework aiming to help doctoral students in the process of converting a design interest into an adequate research question with a focus on finding post disciplinary research opportunities. To that end, a design practice model of innovation introduced by Dorst (2015) was adapted to the academic context of problem definition. But before proceeding to that, characteristics of effective research questions, as generally accepted within the academic milieu, must be settled, including their classification in relation with the theory building cycle.

2 Characteristics of Effective Research Questions

Based on theory from methodologically mature academic disciplines (Agee 2009; Richey and Klein 2009; Doody and Bailey 2016; O'BRien et al. 2019; Mendes et al. 2020), we can affirm that accurate research questions must be relevant enough to contribute to field knowledge advancement and/or practice improvement. They must rely on an adequate literature review aiming to fill a gap in knowledge, contribute with incremental knowledge or a new perspective in relation to the current state of the art. Their answers should interest and benefit a large community of researchers, academics and practitioners. Another important characteristic of accurate research questions is adequate focus balance. Accurate research questions should address a specific study subject and context, without being so specific that they have limited relevance. They must delimit the study boundaries, identify the variables and define the types of data that need to be collected allowing a prevision of the type of observations required and of how will they be collected and analysed, with the instruments to apply and participants to recruit. And, yet, they should leave space for exploration and discovery, instead of being so focused that they provoke 'Tunnel vision' or so constrained they can be answered with yes or no responses. At the same time, appropriate questions need to be answerable, not just by looking for information but through a systematic process of collecting and analysing new information. That implies the researcher has the knowledge, skill, experience and accessible resources needed to conduct and adequately study within an expected timeframe. Researchers must consider potential obstacles and delays such as participants' recruitment, equipment and materials availability, funding and ethical issues among others. Hence, we can characterise effective research questions as being opportune, aligned in time and content with the target audiences' needs and study field state of the art specific, regarding the exact subject and context they address, adequately narrowed, allowing exploration without focus loss, and realistic, requiring available resources and means. Research questions possessing these qualities will provide a framework for conducting the study, giving it relevance, direction, and coherence, thereby helping to keep the researcher focused during the investigation. At the same time, research questions should be devised in such a way that negative results would also be interesting. Studies with positive and negative results "Compose the wall of knowledge" and "it is important not only to show the success", but also to acknowledge what might not be, leaving space in research questions for "the interpretation and significance of negative results" and future hypotheses (Mendes et al. 2020: 21).

3 Research Questions and the Cycle of Theory Building

Recently, Cash (2018) has been expressing his worries about design research weaknesses in comparison with other more mature academic fields and appealing to urgent action for more rigorous scientific, theoretical, and methodological standards. After examining major scientific challenges facing design research, and how similar issues have been addressed in related fields, Cash proposes that theory-driven research, underpinned by a theory building/testing, is at the core of robust scientific knowledge. This cycle (Fig. 1) comprises a set of fundamental steps, involving exploration, theory creation, empirical

scrutiny and refinement, which incrementally shape a body of scientific knowledge. If the cycle breaks down, the build-up of scientific understanding stagnates.

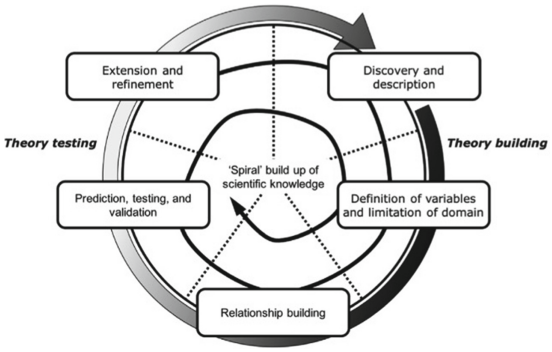

Fig. 1. Theory Building Cycle (Cash 2018)

Each step accommodates research works providing distinct insights that contribute with different types of knowledge about a research topic or phenomenon. "Without an understanding of where within this cycle the research fits it is impossible to define the methods best suited to addressing specific research questions or to integrate insights effectively" (Cash 2018: 90).

Since the type of knowledge generated by a study directly depends on how the research question is expressed, matching a research question with the theory building cycle is mandatory. Firstly, to clarify research's contribution to the current theoretical development and, secondly, to assist research planning namely the selection of the most appropriate research methods. By reviewing literature from other fields where research questions formulation process is more mature, like education and nursing (Agee 2009; Doody and Bailey 2016; Draper 2004) we were able to combine different authors' perspectives, and generalise the relation between theory building cycle steps, the type of generated knowledge and results, research objective verbs and, finally, the typology of research questions, for which we closely followed Dillon's (1984) classification. Our proposal is presented in Table 1, where X and Y represent study subjects and/or variables.

Exploratory research is usually appropriated for the first step of the theory building cycle. It fits with the early stages of examining a given phenomenon, topic or angle. For that reason, it is expected to find very few works previously published about the topic or at least about a specific new angle or perspective. In this case the research will focus on determining the feasibility and the interest in conducting more extensive and deeper studies, indicating research lines worthy of pursuit in the future, unveiling key issues that must be considered and possible adequate research methods to address them. In short, to figure out the "lay of the land" with respect to the topic. Because "exploratory research relates to topics about which very little is known", there are "few guidelines to follow" and research plans are usually qualitative and "less structured". Some of the suitable research methods are literature review, field observation and exploratory interview methods.

Table 1. Matching the Theory Building Cycle steps research question typology – adapted from Dillon (1984)

Theory building cycle step	Generated knowledge type and research outcomes	Research objective verbs	Research question typology
Discovery and description	Exploratory knowledge (1st order) Relevant previous works and results identification Key issues listing	Define Discover Explore	Whether X is? Whether this is X? What X is? What makes X be X? What X means?
Definition of variables and limitations of domain	Descriptive knowledge (2nd order) Pattern identification Variables and/or categories listing Interconnections and boundaries mapping	Describe Observe Seek to understand	What X has? What X does? How X acts? What X can do? How X does it? How X is done?
Relationship building	Explanatory knowledge (3rd order) Establishment of connections and relationships between variables Underpinning mechanisms that explain these connections discovery	Examine Affect Influence Compare Relate Explain Combine	Why or how X has a certain attribute? Whether X and Y are associates? Whether X and Yare alternatives? Whether X is like Y and wherein?
Prediction, test and validation	Evaluative knowledge (4th order) Theoretical models proposition, testing, validation Future outcomes prediction Comparison of empirical studies with theoretical explanations	Test Assess Evaluate Predict	Wherein X and Y differ? Whether X is more/less than Y? Whether X is part/whole of Y? Whether X relates to Y? Whether X and Y co-vary? Whether or how if X than Y, or if Y than X?
Extension and refinement	Ideological/generative/emancipatory knowledge (extra order) Theoretical models expansion and refinement Ideological positioning Social action engagement	Seek for wider and/or alternative viewpoints Push/appeal for change Argue in favor/against an ideological position	Whether to do or think X? What are other attributes of X? How to know X in other ways?

Descriptive research, in its turn, is more "fact-finding" oriented, "focusing on relatively issues of a well-defined entity" and can follow either qualitative or quantitative methods including, for example, case study, content analysis, in-depth interview and thinking aloud methods, amongst others. Explanatory research questions intend to go beyond phenomenon description and "test relationships between elements of the problem". They usually seek to answer "why" questions; trying to identify the causes and effects of whatever phenomenon they are studying" and usually employ quantitative or multi-method studies (Richey and Klein 2009: 43–45). Evaluative research aims to assess the effectiveness of existing methods and paradigms, comparing empirical results with existing theoretical explanations following quantitative, qualitative or preferably

mixed method studies. Finally, we named the type of research fitting the 5th step of the cycle as generative, emancipatory and/or ideological. This would be the type of research that seeks to propose new ideas for the advance of the theory or pushes for change (Doody and Bailey 2016; Cash 2018). A suitable method for this step is, for example, integrative literature review, which consists of reviewing, criticising and synthesising representative literature on a topic "in an integrated way such that new frameworks and perspectives on the topic are generated" (Torraco 2005: 356). Outputs of an integrative review can be expressed in the form of a "research agenda", posing "provocative questions" that give guidance for future research. It can also produce a "taxonomy or other conceptual classification of constructs" or even "alternative models or conceptual frameworks" presenting new ways of thinking about the topic (p. 363).

Of course, none of these steps are isolated entities and their overlap is not uncommon. Many studies have more than one purpose and can fit into more than one cycle's step.

4 Adapting Frame Creation Model to the Academic Research Context

Since a PhD proposal must provide an original contribution to knowledge within its academic field, the initial research question must settle on the boundary between the known and the unknown. It acknowledges what has already been studied but finds a gap or offers a different angle that opens space for further exploration (O'Brien et al. 2019). What we argue is that, as happens in design practice, and in academic research, the novelty of the answer rather depends on the originality of the question. That leads us to examine if and how designers' ability to shift problem situations and create new angles to a problem could be transferred to the academic research domain.

A successful tool employed by experienced designers to look at a problem from a new perspective, almost like a special lens resulting in a new way to deal with it, was presented by Dorst (2015) in his book Frame Innovation: Create new thinking by design, on which the following discussion is based. According to Dorst, frames are not neutral, because they imply the use of concepts with significance and meaning to steer problem exploration and perception in a new direction. So, creating a frame to (re)approach the problem is the result of an intentional action which "rearticulates" the problematic situation "with a new and interesting focus". A frame creates an "image that spans and integrates a broad range of issues under consideration and might draw in even more issues from outside the original problem arena" (p. 64). Seeking novelty and innovation, frames must be inspiring and original at least within the context of the problem under consideration. In his book, Dorst describes a 9-step "Frame Creation Model", based on the idea of thinking around the problematic situation instead of confronting the apparent problem head-on. It assumes that, the richer the context, "the more chance that fruitful avenues can be found to move forward". It starts by intentionally complexifying the problem, deliberately pushing it in numerous directions, which can lead to new and unconventional frames. Additionally, it relies on designers' ability to suspend judgment, temporarily abandon rationality and by "playing around with ideas, tossing up possibilities for frames, in what may look like a childish, playful, hit-or-miss process" (Dorst 2015: 54). Instead of emphasising this creative mindset on the ideation of solutions, as

usually occurs, the Frame Innovation Model prioritises divergent thinking at the problem definition phase. Those two characteristics which mainly rely on creative thinking elements of fluency (generating a great amount of ideas) and flexibility (ordering ideas in different classes) (Tschimmel 2019) are what make the Model especially interesting in the domain of academic research. Firstly, because it provides a structured model that can help PhD students to surpass the difficulties of converting a research interest into an effective research problem. More than that, it brings innovative thinking to this process, stepping away from the usual academic rationalities and augmenting the possibilities of disruptive research.

What we propose next is a 5-step Frame Creation Model adapted to the formulation of research questions (Table 2) as a means to produce novel and hopefully disruptive research questions. To make it easier to use by inexperienced researchers, there was an intentional effort to reduce the number of phases (in comparison with Dorst's original model). Thus, phases that are not necessarily applicable to academic research, like paradoxes, were removed. Additionally, phases that in the academic context require similar approaches, like archaeology and context, were aggregated to create a model with fewer phases, to make it easier to use.

Table 2. The Frame Creation Model adapted to the Research Question Formulation

Context	Exploring key stakeholders involved in the inner circle of the research situation and all the players remotely connected to it, actively or passively. Keeping in mind their influences, behavior, strategies, interests and scenarios where they can be involved.
Field	Expanding and widening the problem space, by considering all the other academic fields, beyond design directly or indirectly connected to the research situation.
Frames	Stating the problem through hypothetical patterns of relationships applying an "*if* the problem situation is approached as if *it* is…then" formula. Forcing at least one frame per academic field considered.
Futures	Envisioning how research might work considering each proposed frame. Avoiding premature closure of problem space, evaluating if each frame has the potential to steer the research in a promising direction. Eliminating frames that require unavailable resources (time, funding, participants, equipment, skills, etc.).
Integration	Assuring that the new frame is well integrated into the broader context of the research situation by formulating adequate research questions, aligned with appropriated paradigms, methodology, methods and techniques.

When confronted with the task of formulating a research question, students usually think they already have a research problem on their hands. As was already discussed at the Introduction, that is rarely the case. More frequently students possess a research interest, or even more probably, a design interest. The Frame Innovation Model challenges the students to start by abandoning their "apparent" research problem, replacing it by a research situation. The research problem will emerge later from all the issues gravitating around the research situation.

To that end, the first step, Context, consists in exhaustively mapping all the players somehow involved in the situation and their divergent perspectives, interests and tensions (Wilde 2020). That must involve, necessarily, exhaustive literature review within academic design journals to establish the current state of the art and where within the theory building cycle knowledge about the topic from the design perspective can be found. But in the intended "global challenges" approach students are strongly encouraged to inform their work by a multiplicity of inputs beyond the discipline itself, including sustainability science, environmental humanities, economics, environmental politics, and governance (Wilde 2020).

The next step, Field, is in the adapted version of the Model and can be taken almost literally. This means that, starting with the players previously identified and the relationships between them, all the potentially involved academic disciplines must be listed. At this point, the initial "apparent" problem has been diluted and probably lost within an over complicated network of connections. Beyond the individuals and entities with varied and maybe opposing interests and values identified at the Context phase, a panoply of related scientific disciplines, each one with its own research interests, perspectives and even privileged paradigms and methodologies are now added to the problem. A post-disciplinary approach "recognizes that in many contexts separation of disciplines is no longer useful or viable". On the contrary, "when disciplinary concerns dominate, relevant issues "may be rendered invisible" (Wilde 2020: 173). That is the moment that the students must deal with the discomfort of apparently being even further away from finding a good research question.

For the next step, Frames, students not only have to manage and deal with this increased ambiguity, and restrain themselves from the urge to finish, but they have to go further and suspend judgment and criticism. It is the moment to play with suppositions. At this step, strange, exaggerated, unrealistic, fanciful, inflated suppositions are welcome. Divergent thinking should be forced through exhaustively asking "what if" and "why not" questions. What if the problem situation "was approached as if it is" anything else. Remote associations, metaphors and analogies can be considered not only within the boundaries of design but special attention should be dedicated to examine frame possibilities within each one of the fields identified at the Context step. Suppositions about how would other sciences be interested in the problem situation, and how would they deal with it, can lead to fruitful new frames. This "affords space to account for different disciplinary perspectives, practices, and values", raising "the possibility of divergent perspectives on the same material". "It better positions researchers to challenge their assumptions and embrace other perspectives" and facilitates "rapid and easy identification of research opportunities" (Wilde 2020: 192).

Still refraining from premature closure, Futures is the time for students to start to look at the frames with a critical eye. At this point, for example, literature review should be enlarged to grasp if and how those other academic fields had already studied the topic and from which perspective and with what results. That would prevent investment in questions that had already been addressed previously by those disciplines. By envisioning in what direction each frame would push research, students can select the more promising ones. By rapidly examining the resources required by each frame, students can quickly discard the unfeasible ones.

Finally, at the Integration process students will formulate some possible research questions arising from the selected frames and integrate those in the broader research context by aligning each question with adequate research paradigms, methodologies, methods and techniques. For this end, we recommend the use of a research matrix, as described in the next section. Rough versions (prototypes) of the research matrix are also useful at the previous Futures stage, when exploring the potential of different Frames.

At the same time, we must recognise that research questions are fluid entities rather than fixed ones. They evolve, and sometimes completely change as the research proceeds, and the investigator develops a better understanding of the subject (Agee 2009). At the end, the final published research questions must look neat and tidy but until then, they can always be developed and refined. "Research questions may morph over time as the investigator interacts with participants and/or literature, develops a better understanding of the problem, and reflects on their own assumptions and interpretations" (O'Brien et al. 2019: Sii). That is in accordance with the design practice concept of problem-solution coevolution, which "involves a constant iteration of analysis, synthesis, and evaluation passing back and forth between (…) the problem space and the solution space (Dorst 2015: 59) – which also makes perfectly sense when thinking of research questions. That fact, however, does not diminish the value of starting any study with an accurate research question. As Agee (2009: 432) puts it, "it is helpful to think of research questions as navigational tools that can help a researcher map possible directions but also to inquire about the unexpected".

5 Research Matrix

To help doctoral students to draw the research plan from the research questions, we strongly encourage the use of a Research Matrix. A design research matrix consists of "a system of rows and columns into which the components of a research project fit", which facilitates the research planning, assuring its internal consistency. It is a tool that "encapsulates the research design, or what the researcher intends to do in the investigation" (Choguill 2005: 615) when designing a research project, including decisions about "research components", such as research purpose, research questions, sampling, data collection and data analysis (Schoonenboom 2018). We agree that research matrix building should be a mandatory piece of any research proposal.

Table 3 proposes a possible research matrix template which includes research question formulation, expected generated knowledge type and the matching theory cycle step, both fitting with classifications provided at Table 3. It also requires the definition of the design research category and research paradigm following the classification presented by the authors of this paper in previous works (Clemente et al. 2017, 2018, 2020). Finally, it asks for the methodological options (quantitative, qualitative, multi-methods) and specific method (such as case study, action research, hypotheses testing, amongst others) and data collecting and analysis tools (interviews, users' tests, etc.). To illustrate how this matrix can be used, the second column is filled in accordance with the research reported in this paper.

As we can see in the matrix, our paper intends to contribute to the 5th step of the theory building cycle, since it intends to produce a generative/emancipatory/ ideological

contribution to theory building. It presents a novel angle from which to think about research question formulation either by aligning it with theory building cycle, through a new taxonomy, or by proposing a framework to formulate research questions according to an adapted version of an innovation problem reframing model. Furthermore, it argues for the relevance of good quality research questions and the potential benefits of adopting the new proposed taxonomy and framework.

Table 3. Research Matrix template proposal

Research questions statement	How to conceive research questions in relation with theory building cycle? How to approach post-disciplianry research question formulation as an innovation problem reframing?
Knowledge type	Generative/emancipatory/ideological
Theory Building step	Step 5
Research objective(s) statement	• Propose a taxonomy of research questions typology linked to the theory building cycle • Propose a framework to approach research question formulation as a innovation problem reframing • Argue in favor of the potential benefits of formulating research questions following the proposed frameworks
Design research category	Research *about* Design (Clemente et al. 2017, 2020)
Research paradigm	Critical paradigm (Clemente et al. 2018, 2020)
Research methodology	Qualitative (Clemente et al. 2017, 2018)
Research methods	Integrative literature review (Torraco 2005)
Data collecting tools	Literature search using academic databases and search engines (Google Scholar, Scopus, etc.)
Data analysis tools	Data categorization Synthesizing tables

For better understanding of "research category" and "research paradigm" lines, we strongly recommend the consultation of our previous works (Clemente et al. 2017, 2018, 2020). According to them, research here presented can only fit into the "about" category, since it does not involve any design project and it fits within the critical paradigm because the emancipatory function of knowledge is embraced.

Finally, the applied research methodology is purely qualitative, and the research method corresponds to integrative literature review, through an iterative processes of previous research findings collection, critical analysis and a synthesis of new knowledge (Torraco 2005).

6 Using the Academic Adapted Frame Innovation Model to Fortify the 'Trans-Action" Role of Design

What we propose in this work is that the above presented academic adapted Frame Innovation Model has the potential to strengthen the 'Trans-action' role of design, by intentionally seeking for opportunities to connect with other research areas.

First, by suggesting an unconventional way to convert a research interest into a research question. Traditionally this process is described in the literature (coming from other academic fields), as a convergent process that narrows down a broad topic of interest into a specific area of study (Doody and Bailey 2016). By transferring the design innovation practice of reframing problems to the academic research domain, what we propose is that the first steps in converting a research interest into a research question must be divergent, exploring several directions in which the problem can be framed. This is a direct application of creative thinking elements of fluency and flexibility that potentially raises the probability of producing original research questions leading to innovative research results. In this sense, one can see the research proposal design as a design project in itself.

Second, by forcing remote associations between the research topic and other academic disciplines beyond design, it contributes by unveiling interdisciplinary connections and post-disciplinary research questions. In 2010, Findelli was already encouraging cross-field research with a design project 'included', and provided some guidance on how to formulate adequate research questions in that context. Vial (2015) also reported an example, crossing design and philosophy academic fields in the context of master dissertations, but in his case, the design project had a more lateral place not being necessarily the means to answer the research question. The main contribution of our proposal is the offering of a structured five phase approach. The fact that this approach is based on an innovation model, results in an iterative thinking process of exploration (divergence) and selection (convergence), to which students with a background in design will immediately relate.

Third, it helps to establish high standards for academic research, by clarifying the differences between a design question and an effective research question. The relative position of design practice research and design academic research, and how practice contributes to theory building have been debated countless times in the last decades. In 2000, Langrish argued that just as "battleships and forks" are not the same thing "just because they are (both) made of steel", PhD research and practice research are also not the same, just because they are both called "research".

As Langrish (2000) puts it, "the PhD is a unique degree in that it is used in all parts of the University system. When it comes to the PhD, design is not free to do what it wants. It has to accept that other people have already set the norms for a PhD. In English Literature, you do not get a PhD for writing a novel. You have to write a thesis and a thesis means 'argument'. A PhD in English adds to knowledge about literature. It is not itself literature (p. 298). A PhD "certifies that the person knows how to do research in an area". At the same time, it also represents an 'advance in knowledge' which is expressed in the format of written argument, or thesis (p. 298–299). This means, that to be recognised as being in accordance with the standards settled by worldwide academic community, a doctoral thesis in design must include, among other obligatory requisites: a clearly

stated research question and a methodology description, indicating the methods applied to answer the question and the assumed underpinning ontological, epistemological and methodological values. The model proposed at Table 3 is intended to help students to develop academic research incorporating a design project, fitting the above-mentioned rigorous standards, by providing a structure to convert a design practice interest into an academic research problem. Using the design project as a means and not an end, the main research output goes beyond the resulting project result. Research produces explicit and communicable knowledge, contributing to theory construction and academic design legitimation. At the same time, by following the taxonomy proposed at Table 1 students can envision the type of knowledge they intend to generate through their research, which will help to select adequate methods and, consequently higher quality research plans.

7 Conclusions

Given the difficulties usually faced by design PhD candidates in converting a research interest into an effective research question, and the related harmful consequences to the academic design field, we summarised the characteristic features of accurate research questions, in relation to relevance, utility, novelty, balanced narrowness and feasibility. Above all, well formulated research questions must necessarily lead to academically valuable production of knowledge. In the very specific case of doctoral design research, where the place of design-projects and resulting products are not yet fully and consensually defined, the ability to formulate effective questions assumes increasing relevance. Poor research questions risk producing academically unacceptable results either because the applied methods do not meet academic standards, or just because the initial question was not oriented to explicit production of knowledge. Revisiting Langrish’s metaphor, one can ask: “Am I certain that the question will lead to battleships, and not to forks?"

A poorly conceived research question can also be a missed opportunity to contribute to design theory building. Addressing this problem, we examined the relation between research questions and the theory building cycle. Because the type of knowledge produced depends on how the question is expressed, matching the research question with the theory building cycle is essential. Directing research questions into gaps in our knowledge contributes to incremental knowledge growth and theory refinement while exploring new directions creates opportunities for disruptive growth. This means that, by asking the “right” questions, one can give shape and direction to the process of theory building. Thinking again about battleships, one could ask: am I asking questions addressing what still needs to be discovered about battleships? Or to take battleships into what they can be in the future? How do those questions I am asking fit into what others have already discovered about battleships? How can others rely on my study to further investigate battleships in the future? Is there a risk that my question is about reinventing the wheel?

Finally, superficially or prematurely closed research questions can be a wasted opportunity to find bridges between design and other important fields and to prove the unique contribution of design when dealing with complex problems. To overcome that, we proposed an adapted version of the Frame Creation Model described by Dorst (2015) with potential benefits to create innovative research opportunities, where design projects can

be used as a means to answer research questions in which other fields have an interest. This means putting design to work together with other academic areas, and, ultimately, to strengthen its position amongst them, with a unique contribution and as an equal.

The proposal relies on Dorst's concept that divergent thinking is not only necessary for finding answers but especially for asking questions. This means that the formulation of innovative research questions must start with a process of intentionally over-complexifying the research situation or students' initial interest. That allows the angle from which the apparent problem can be looked at, to open in multiple directions and brings alternative problem frames into consideration, raising the possibility of finding novel research opportunities. Original research questions, in their turn, possess a higher potential to deliver novel results. But most importantly, by including all the academic fields, other than design, directly or indirectly related to the research situation and forcing each one of them as a possible frame to the problem, opportunities for post-disciplinary research can be fostered.

Going back to the battleship metaphor, one could ask: What other fields are at stake, beyond military and naval construction? In what kind of issues would those fields be interested in? Alternatively: what would happen if we look at battleships as if they are another thing? Like a social isolation scenario? Or a "surviving with limited resources" scenario? What kind of questions would then arise? And who would be interested in them? In another direction: how are battleships related to what is happening currently in the world? What is changing and why?

How far will this help students to frame their research questions, and to what extent will the application of the Research Matrix and the Frame Creation Model adapted to the Research Question Formulation here proposed, support the emergence of original and post-disciplinary research questions, still needs to be verified in the future. Finally, whether those efforts will contribute to fortify design doctoral research, or not, only the future can tell us. But in the spirit of theory building and knowledge growth that we have been advocating until now, we challenge doctoral students and their supervisors to test the model and to share their findings.

In an ever-changing world, with increasingly complex issues to deal with, design is under the obligation to affirm its transformative role, by assuming its position among other fields as an equal with a distinctive contribution, for which academic research, especially doctoral research, provides the prime opportunity. It all depends on the questions that start a doctoral design research project.

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Where They Learn: How Prevalent is the Project in Undergraduate Design Courses?

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Abstract. This paper investigates the idea that undergraduate design courses are predicated on project work framed by a design studio educational setting. To answer the research question, we followed an empirical approach supported by a grounded theory methodology: (1) we gathered 31 publicly available undergraduate design courses programmes and descriptions, (2) we followed the procedures of classic grounded theory to code the data, categorise any clusters that emerged, and finally identified any patterns or insights that emerged from the data. The results of this study support the notion that the design project is still the preferred pedagogical tool for undergraduate design courses; furthermore, the design project is also clearly associated with the design studio educational format. Moreover, the key design education concepts that emerged from our analysis are also evidently interrelated; this finding suggests that an underlying coherent design education theory crosses national boundaries and is familiar to any design course. Finally, the prevalence of learning by doing pedagogy supported by project work within the design studio context suggests that undergraduate design education may not fit distant education formats.

Keywords: Design Education · Design Studio · Project · Design Theory

1 Introduction

After the Covid-19 pandemic, governments worldwide enforced extreme measures to prevent the virus spread; the measures included mandates to move all academic activity to remote settings. This situation was an earthquake in higher-education design courses; design educators struggled to adapt a syllabus that depended on the development of hands-on practical work and the sharing of physical space for decades.

This experience led us to reflect on one of the pillars of design education: the design studio. The most important realities are often the hardest to see and talk about (Wallace, 2009); well-established everyday traditions become engrained and go unnoticed, like water to a fish. So it is with the design studio educational setting. There is a consensus in the literature that at the centre of design education lies the design studio (Cross, 2007); the studio is defined as the physical space where students work alongside their colleagues and under the guidance of a teacher, but it is also a unique educational format and a

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pedagogical idea of how the teaching/learning process of design should unfold (Adams and Siddiqui, 2016). The studio develops both practical skills and theoretical knowledge. While well-established academic disciplines are founded on theory and decades upon decades of research, Design is a newcomer in academia and still holds a close relationship with practice. This means that design pedagogy is interconnected with the intricacies of design practice.

A higher-education design course prepares students to master the skills, tools, and fundamental habits of mind to become proficient design professionals. This type of education (vocational training) depends on one-to-one tutorial teaching, which means teachers and students share the same space in extended classes and learning is based on practical experience. Such educational models are often described as signature pedagogies (Shulman, 2005), the educational formats that "organise[s] the fundamental ways in which future practitioners are educated for their new professions." (p. 52).

In short, the design studio educational format is founded on allowing the time and space for students to learn by doing. This is a suitable educational setting for design, where thinking and doing—theory and practice—go hand in hand. Donald Schön (1987) famously argued that knowledge about designing is better described as knowing-in-action. The author claimed that designing is a form of artistry that develops over time and through professional work. He defined design artistry as the ability for intuitive performance when facing a design problem. Richard Sennett's (2008) concept of craftsmanship was developed along similar lines to Schön's artistry. Craftsmanship depends on a continuing involvement with practice. With practice, complex skills are engrained and readily available to perform; in other words, it becomes spontaneous and implicit in one's actions. Artistry and craftsmanship are consistent with cognitive science studies on deliberate practice (Ericsson and Pool 2016), which is the structured and guided practice to improve one's weaker areas. In design knowledge is developed from experience, which led to a design educational format where students experience project work of increasing difficulty throughout their course.

We gather that the design studio depends on long sessions in a shared physical space to encourage spontaneous conversations between teacher and students; these dialogues or design conversations (Ferreira, 2018a) are crucial to reveal the tacit knowledge that would otherwise remain implicit in the teacher. Design conversations is the term that describes the several instances of one-on-one dialogue between a teacher and a student while working, presenting, or reviewing a design project. A design conversation applies a particular language (Schön, 1983), which is an expression of the design process; it communicates aspects of designing as it unfolds.

Several design researchers recognise that project experience in the design studio is the centre of a student's educational path (Salama, 1995; Green, 2005). Throughout a design course, the design studio is the gravitational pole around which other sub-disciplines gather. While the balance between studio time and lecture-based courses varies between design disciplines, design project experience is generally considered essential to a design student's education (Mcdonnell, 2014). This setting is usual in disciplines such as architecture, product and graphic design, or fashion design (Cennamo and Brandt, 2012; Hokanson and Gibbons, 2014). Noticing this pattern, Lawson (2004)

stated that this type of teaching is a global pattern identifiable across countries and design disciplines:

> "(...) design education looks different from what goes on in universities around the world. You can go into design schools and see a similar pattern repeating time and again. This is true whether the school is in England, The Netherlands, the USA, Australia, Malaysia or Hong Kong. It appears to be a pretty global pattern. It is true whether the school is teaching architecture, product design, interior design or landscape design. (p. 6)"

The design student's pedagogical experience depends on the success of these mundane everyday conversations between teacher and student; which means dialogue (Ferreira, 2018b) forms the backbone of the design studio educational experience. With each teacher-student interaction, the students are expected to progressively build their knowledge and learn how to develop a project by doing it Design education has been based on the practical experience of the design project; an experience shared between teacher and student(s) within the confines of physical space (the studio.) But is this still the case? Answering this question would offer a timely contribution to the discussion about the adoption of distant educational formats for design education (Fleischmann, 2019; Bernardo and Duarte, 2020).

This paper presents an empirical study investigating if the project/design studio is (still) the centre of curricula across design courses. The design studio is widely recognised as a crucial element of design education–even its defining feature–the setting nonetheless lacks consistent empirical studies that support or challenge its underlying principles. In this study, we explored the common intuition that the design studio occupies most of the student's time throughout the course. If this is the case, then this prevalence should be reflected in the program of several undergraduate design courses. Thus, the paper aims to answer one research question:

Is project work in the design studio still the centre of design education?

Based on the results, we will explore contemporary challenges to the design studio in the discussion section. It is crucial to reflect if the studio format should change, and if so, in what way? This discussion should be led by the community of educators and researchers that have the pedagogical know-how of what it takes to nurture a future designer; otherwise, any changes to the design educational setting will be imposed by external actors who may not have the necessary know-how to understand the particularities of design education.

2 Methods

We adopted an empirical approach to answer our research question: "Is project work in the design studio still the centre of design education?" This research strategy was designed to generate insights that are founded in data. The plan was to gather publicly available descriptions of undergraduate design courses (bachelor's degrees) and to analyse their content to detect (or not) the prevalence of project-type classes and the design studio pedagogical format.

The specific method we chose was Grounded Theory (GT); the method suits our goals because GT does not differentiate between data; in GT, any type of data deemed relevant to clarify the problem can be gathered and analysed. Furthermore, while GT enables a focussed qualitative analysis of the object of study, it is also a versatile research method that encourages the discovery of new insights. In other words, GT is an effective method for in-depth qualitative analysis of a research problem while allowing unexpected and unpredictable research results to emerge.

A distinctive feature of the GT research method is its pragmatic approach to data-gathering. Whereas similar empirical methods (such as ethnography or content analysis) would usually define criteria to gather information a priori, with GT, the researcher does not begin with pre-established ideas of what data to collect or how to categorise it. In other words, relevant insights emerge during the data-gathering and analysis process; the research is guided by a general goal or a specific research interest, but not by predetermined ideas of the answers. Strauss and Corbin put it succinctly when they argue that, in GT, the researcher "(…) does not begin a project with a preconceived theory in mind (unless their purpose is to elaborate and extend existing theory). Rather, the researcher begins with an area of study and allows the theory to emerge from the data." (Strauss and Corbin, 1998, p. 12).

The openness to explore a research problem without a priori analytical frameworks and the receptive approach to any data type makes GT suitable for this study. Notice that there is no consistent format for course descriptions; publicly available university course descriptions vary in the type of information, the length, they may or may not include detailed information about each course unit, and so on. Furthermore, our sample is global, so the terminology will not be consistent across countries. For instance, depending on the type of course and the country where it is based, the course unit generically designated as 'design studio' or 'project' may have a different name. Since the study is not focused on the fine distinctions between project courses, we noted the terminological differences but categorised similar (in content) 'project' or 'studio' courses under the same label. Of course, this aspect could have been mitigated if we selected a few courses for in-depth analysis. This would allow us time to contact each course coordinator for extra information and an interview. However, for this study, a broad overview of design education is sufficient to address the research question.

The procedure was to delve into publicly available course descriptions from top universities that offer bachelor's degrees in design and gather relevant textual descriptions to access the type of educational format adopted by each course. The rationale for the procedure was that if indeed design courses are still based on project work within a design studio, then this should be reflected in the course's qualitative descriptions as well as in the quantitative aspects of the course's curricular units. In other words, we should detect the prevalence of project and studio across a 3-year program and their corresponding weight in contact hours and academic credits.

Finally, this study is exploratory; it can serve as a springboard for a future in-depth research project. It is often the case with GT that initial exploratory studies can produce relevant results. As the investigation unfolds, unexpected insights emerge because GT encourages abductive patterns of reasoning (Bryant, 2017) that are naturally conducive to disclosing theoretical connections.

2.1 Sample

The sample was based on the current network of international relationships of the Universidade Europeia and Universidade de Lisboa. It was impossible to investigate all the courses we intended because some did not provide enough information about their courses on their websites. After an initial survey of the courses, we ended up with the thirty-one courses listed below (Table 1).

Table 1. List of undergraduate courses in design

Course designation	University	Country
Programme in Design	Aalto University	Finland
Graphic Design Bachelor's	ALUO Univerza v Ljubljani	Slovenia
Bachelor's in design	Aveiro University	Portugal
Industrial Design Bachelor programme	Designskolen Kolding	Denmark
Bachelor's in visual communication	ECAL Ecole cantonale d'art de Lausanne	Switzerland
Bachelor's in design	EINA Centre Universitari de Disseny i Art de Barcelona	Spain
Undergraduate Degree in Design	ELISAVA	Spain
Industrial Design	ENSCI–Les Ateliers, the École nationale supérieure de création industrielle	France
Product Design	ESAD – Escola Superior de Artes e Design	Portugal
Bachelor Industrial Design	Faculty of Engineering, Lund University	Sweden
Graphic Design Bachelor's	Gerrit Rietveld Academie	The Netherlands
Bachelor's in visual communication	HEAD Geneve, Haute École spécialisée de Suisse occidentale	Switzerland
Bachelor's in design	Indian Institute of Technology, School of Design	India
Bachelor's in design	Loughborough University	United Kingdom
Design for Industry Degree	Northumbria University	United Kingdom
Bachelor in Product Design	Nottingham Trent University	United Kingdom
Integrated Design BFA	Parsons School of Design	United States of America
Industrial Product Design	POLIMI Politecnico Milano	Italy

(*continued*)

Table 1. (*continued*)

Course designation	University	Country
Visual Communication Design	Purdue University	United States of America
Furniture Design Bachelor's	Rhode Island School of Design	United States of America
Bachelor's in Graphic Design	Royal Academy of Art, The Hague	The Netherlands
Bachelor's in design	Royal Melbourne Institute of Technology	Australia
Bachelor's in communication design	The Glasgow School of Art	United Kingdom
Industrial Design	TU Delft faculty of Industrial Design Engineering	The Netherlands
Bachelor's in industrial design	TUe Technical University Eindhoven	The Netherlands
Bachelor's in industrial design	FHNW University of Applied Sciences and Arts	Switzerland
Bachelor's in design	University of Lisbon, School of Architecture	Portugal
Communication Design	University of Lisbon, School of Fine Arts	Portugal
Product Design	University of Lisbon, School of Fine Arts	Portugal
Product and Industrial Design	University of the Arts, Central Saint Martins	United Kingdom
Bachelor of Design Innovation	Victoria University Wellington	New Zealand

The sample includes thirteen courses in industrial or product design, eight in visual communication or graphic design, and nine in general design. There are fifteen different countries across four continents represented. The source material was accessed on the courses' websites during September 2021.

2.2 Procedure

Data analysis followed a classic or *Glaserian* grounded theory procedure (Glaser and Strauss, 2006). Accordingly, the procedure's stages were:

1. **Coding**: we applied open and descriptive coding (labels) to the textual data.
   As expected with open coding, the initial rounds tend to generate dozens of codes, like a fishing boat casting a wide net into an ocean of data. While working through

the resulting codes is time-consuming, the procedure pays because the richness of descriptive labels allows for robust categories and patterns to emerge.
2. **Categorising**: the second round of analysis was conducted to identify any clusters, patterns, or insights. In this stage, the codes identified in stage 1 are grouped to form meaningful categories that explain the object of study. The analysis, therefore, moves from a *descriptive* to an *explanatory* level.
3. **Conceptualising**: the emerging patterns were then compared with our previous findings to establish theoretical connections.

Finally, while analysing, coding, and categorising the data, we constantly triangulated with existing research (from the literature review) on design education.

3 Results

3.1 The Key Concepts of Analysis

What picture emerges from an empirical dive into the program of study of these undergraduate design courses? To answer the question, we will first present the resulting categories that illustrate the clusters of meaning we derived from the text. Then, we will provide a short definition and summarise the content that informed each category.

The analysis resulted in categories closely associated with the design project and design studio; from the dozens of codes that emerged from the study, the most prevalent ideas aggregated around the categories summarised below. It is important to note that this analysis was not based on a straightforward count of instances of keywords followed by clustering as would be the case with, for example, a word cloud software that gathers the frequency of words within a text. On the contrary, our analysis was qualitative, which means identifying a keyword is not sufficient; instead, we proceeded by identifying the meaning of the word as it appears within a text, what context surrounds it, and crucially how is it related to other aspects of our problem of study.

For instance, the design studio is a central idea within our theoretical framework, but in our analysis, we did not merely count how often it came up in the texts. This would give us a wrong view because the term studio can mean (at least) two things in this context: on the one hand, it means the physical space where students gather to work; on the other hand, it means a pedagogical idea of how the educational process should unfold; additionally, the studio can also be a part of a particular course unit's name. The distinction between these uses of the term *studio* is key to interpreting the role of the design studio in a course (Table 2).

The ideas summarised in the table above are interconnected. The key concepts we identified are often alluded to in close relationships. We expected to find ideas such as *studio*, *project*, or *creativity*. However, the extent to which the concepts were related suggests that there may be an underlying theory of design education that is common across international courses. In other words, we could identify the same fundamental ideas repeated across multiple courses. Moreover, these ideas seem to be connected, indicating (perhaps) the workings of an implicit underlying theory. This hypothesis should be investigated further, and we will refer to it again in the discussion section.

Table 2. Design education pedagogical territory

Category	Definition adopted for this study
Design Studio	The physical space where students gather and a pedagogical idea of how the design educational process should unfold
Design Project	A specific and often unique plan that implies the achievement of a solution within a defined period. The project is a tool used in design education to simulate professional practice and train students by way of a sequence of increasingly complex design challenges
Autonomy	Refers to the self-government and independence of students during their educational path
Learning by Doing	An educational paradigm based on a hands-on approach to learning where students must interact with their environment to adapt and learn. The idea is closely associated with constructivism
Professional Design	The universe of professional practice; these include the skills, techniques, tools, and habits of mind of professionals, but also any direct relationship with professional designers
Modelling	Modelling is the activity of creating both mental and concrete visual representations of a design
Practical Skills	Any applicable knowledge related to specific useful competencies
Facilities	The physical settings where students can practice designing or develop related skills
Creativity	The human capacity to create something new and valuable. In design, the creative process leads to the creation of artefacts whether intangible or tangible

3.2 Analysis

We were surprised to find numerous references to the importance of student autonomy in the course descriptions. Of course, it is expected that a higher-education student develops an individual point of view, critical and sceptical awareness, critical thinking, etc., and these attributes are mentioned, for instance, in the Bologna agreement recommendations; however, we did not expect that *student autonomy* to emerge consistently.

In the analysis, what we found particularly interesting was the focus on the student's autonomy to develop their design process and way of working. Independence was often referred not as a generic cluster of qualities but as a specific skill for students to develop as designers, for instance:

> *[S]tudents are given the freedom to define themselves as designers, each finding their own ways of working and direction when exploring problems, developing solutions, and forming opportunities (…) students are encouraged to find their own identities, ways of working and professional niche as designers.* (Aalto)

The description above describes how students should develop their ways of working as designers; also, notice how these positive attributes are associated with future professional practice. There is an insistence that design students develop their responsibility, particularly in finding their way of working and this idea is tied into a sense of these attributes being necessary for the professional world of design:

> *On completion of the course, students can demonstrate the level of autonomy they have achieved at the point where they are ready to begin their professional careers.* (ENSCI)

On the other hand, autonomy is also mentioned in the more common sense of allowing students pedagogical freedom to pursue their educational paths:

> *Our teaching methods aim to stimulate an active learning stance while students are challenged to take responsibility for their learning process and development*. (TU Delft)

Notice above the ideas of active learning and responsibility. Autonomy is also applied in the sense of the students being able to develop their own identities as designers:

> *Drawing from a rich tradition, they are encouraged to experiment and work with a wide range of emerging materials and technologies, developing individual voices through the process of making* (RISD)

Student autonomy seems to be interconnected with all other vital ideas associated with design education; below, we find an example of how student independence is associated with creativity (emphasis ours):

> *The Design BA is both highly creative and intellectually stimulating, encouraging students to experiment with independent design judgement and creative risk taking* (Loughborough)

As was mentioned, autonomy is described as a desirable attribute a designer should have. Design courses assume that professional design requires autonomous, independent, and creative thinkers:

> *Responding to real-world demands, this unique course allows students to explore design ideas and concepts in depth, developing the critical, analytical, conceptual, and practical skills necessary for professional-level contemporary design practice.* (Loughborough)

The course descriptions we investigated often highlight connections to the professional design world, whether it means incorporating industrial partners within the semester, hiring professional designers as teaching staff, or offering professional internships.

> *Throughout your study on the course, we will run several competition projects and live briefs with our industrial partners* (Northumbria)

The industrial design major is a professional program with intensive course work to prepare students for professional design positions (Purdue University)

While developing the skills and knowledge that industry currently demands (…) Interact with professional designers and potential employers through internships and guest lectures (Victoria University Wellington)

The course programmes describe an educational setting within a continuum with the professional world; in fact, the end goal of a design course (or at least one of its aims) is to prepare students to enter the profession. It is no wonder that the educational approach is often described as the typical learning by doing pedagogical paradigm:

In 3 years, you will be qualified to work as a designer on a wide variety of projects (Designskolen Kolding)

Students learn how to design by continuously doing design. (TU Delft)

Interestingly, the emphasis on learning by doing is linked (again) with the idea of student autonomy:

You will acquire and develop knowledge of correct techniques and practices so that you are able to select and apply appropriate skills (Northumbria)

Of course, the design project is the central concept around which all others gravitate. Design projects are the format that allows learning design by doing to occur; it is the pedagogical tool that fosters the conditions for the students' creativity to develop. In an interesting observation, we notice that the design project is associated with professional practice, which emerges again as a central feature of the design educational experience:

Work on project briefs from real industry clients (Nottingham Trent)

The skills and projects acquired throughout the curriculum serve to produce a portfolio of the highest professional standards (Écal)

However, the design project is also a defining feature of design *education*, and as such, it holds a solid pedagogical nature and is, indeed, described as such, for instance:

For the first two years, you will work on one design project per semester. These projects are based on real-world scenarios and challenge students to integrate knowledge developed during the other parallel running courses (TU Delft)

The Main Studies Course centres, above all, an in-depth project work in the context of the freely selectable focus projects (…) In the Main Studies Course you are primarily involved in project work. (FHNW)

The curriculum design of each year is structured into Courses, which are project based (…) explore ideas and creative thinking through a series of project based learning activities (Glasgow School of Art)

The other fundamental idea that connects these threads is the design studio setting. The design studio establishes the conditions for the open exploration necessary for autonomy and creativity to flourish; it also allows the design project to unfold with

enough time and depth to trigger the development of the complex cognitive skills that will make the difference in the professional world.

> *Students work closely with teacher teams, who facilitate a thriving mode for learning in the classroom, including constructive feedback, critique, comments, and open discussions during courses.* (Aalto)

The studio encourages a collaborative and open-minded mindset. Project work within the studio is constantly in flux, and students receive feedback from multiple sources (such as peers, teachers, or external jury members):

> *Learning and teaching approaches (…) reflective and critical discussion to provide feedback about work in progress. This may take place one-to-one with staff or involve a group. (…) The presentation of work in progress or completed work. This may take place on a one-to-one basis with staff or involve a group. External parties may be present if relevant to the project*. (Glasgow School of Art)
>
> *Collaboration is key in all four programmes. You will be working with other design students on big and small projects, most often with a specific topic in mind* (Designskolen Kolding)

As mentioned before, the design studio is a pedagogical idea of how the teaching/learning process should unfold and also a physical space with particular characteristics. The studio is often described as a space for the students to appropriate as their own:

> *With its studios and central Campus, ideal conditions for combining craft curiosity, the acquisition of technical skills, and the necessary digital know-how. In addition, all students have their own 24/7 workspace in one of the spacious studios*. (FHNW)

Incidentally, the studio (as physical space) is connected to other facilities (such as workshops and labs) that seem to complement it by offering specific technological capabilities:

> *In addition to working in the wood shop and other dedicated studio spaces on campus* (RISD)
>
> *Inspiring spaces | Work with our industry-standard facilities and studios, including a dedicated model-making studio, 3D printing space, design and test laboratories, electronics workshops and CAD design suites.* (Nottingham Trent)

These facilities support the learning by doing educational format. Learning by doing is also supported by *modelling*, which means the creation of mental and concrete visual representations of a design during project work; modelling tools and skills contribute to a hands-on approach to learning:

> *Ideation and prototyping skills. Graduates generate strong ideas, can bring them into life and materialise their solutions (…) students have access to world-class facilities, including brand new studios and workshops for physical (printing, metal, wood, etc.) and digital (3D printing, electronics, web, etc.)* (Aalto)

You'll get to create prototypes that make your designs tangible, enabling user-testing and communication with stakeholders. (TU Delft)

Develop a fundamental understanding of design practice activities, particularly the relationship between sketching, modelling and CAD (Loughborough)

It is also interesting to note that the pedagogical experience in the workshops and labs mirrors the master-apprentice dynamic established by the design studio setting:

The studio and workshop supervisors and masters are experts in their fields, ready to support students when needed (Aalto)

This analysis presents an overview of the emerging theoretical territory that resulted from this study. While the resulting categories may not be surprising or particularly new, the connected relationship between these pedagogical ideas is intriguing. The following section will explore what this might mean for design education scholarship.

4 Discussion and Conclusions

The results suggest that project pedagogy and the design studio format remain central features of higher-education undergraduate design courses. Moreover, a grounded theory investigation into the written descriptions of bachelor's degrees reveals the ubiquitous presence of these solid educational ideas within the heart of these academic programmes. Also, project pedagogy and the design studio appear to be correlated if not intrinsically linked; in other words, one does not exist without the other.

Further to that point, all the key concepts that emerged from our analysis seem to be heavily interconnected. This finding suggests that design education may be established on firmer theoretical ground than expected for a relative newcomer to academia. This raises interesting questions regarding the specificity of design education or its signature pedagogy. Other disciplines may share similar learning-by-doing approaches to teaching and even a project-based pedagogy. However, coupling the design project and design studio and the subsequent interconnection of the fundamental concepts of autonomy, creativity, facilities, modelling, practical skills, and professional design establishes a unique pedagogical territory. An important implication of this finding is that if a coherent set of interrelated ideas supports design education, then it follows that any change to one of its elements will have consequences for the others.

What does this mean for the future of design education? Calls for adopting distant learning formats are increasing, but what would be the consequence of remote teaching for bachelor's degrees founded on learning by doing pedagogies supported by project work within a design studio educational format? The idea that this setting can be replicated online is naïve at best and uninformed at worst.

Therefore, this study lends empirical backing to the notion that project-based courses are supported by a design studio pedagogical framework. While data analysis is still ongoing (we plan to gather more course program descriptions and expand the study sample), the results suggest that the design studio remains the main course unit within an undergraduate design course. This is unsurprising. Change arrives slowly in academia, which is not necessarily bad. However, changes should be carefully implemented and

well-reasoned, instead of rushed to meet current societal demands. The Covid-19 pandemic hit the world unexpectedly, and its impact is yet to be fully understood. As stated in the introduction, calls for increased offers of remote classes and recent projects explicitly aimed at radically altering what a design course looks like (e.g. Spitz et al., 2021). Should be met with healthy scepticism.

The study offers an empirical backing to the idea that the design project developed in a design studio is a unique aspect of design education; indeed, it is its signature pedagogy. This study presents up-to-date data on this issue. As such, it represents a relevant contribution to the field and could be the basis for further reflection on design education.

Concerning the concepts that emerged as central to design education, student autonomy was an unexpected finding. As shown in the results section, design courses often describe providing the student with the freedom and autonomy to make choices and foster their independence. This idea is closely connected to future professional paths, but crucially, autonomy seems to be related to how learning unfolds. In other words, emphasis is placed on allowing the students to guide their pedagogical experience. This is suitable for project work in a studio setting where the learning is based on a free and open-ended dialogue with teacher and peers. The implication of finding student autonomy to be a central feature of design education is that undergraduate design courses may be equipped to prepare students for the complex and changing world of the second decade of the twenty-first century.

Finally, we found a close association of design education with the world of professional design, which makes sense given the close connection between design education and design practice. Notice how the preferred format of education mirrors what we find in the real world in terms of studio dynamics, projects, and even the types of physical spaces where designing occurs. Therefore, most design courses aim to be a gateway to the profession. This fact appears positive and well-intended, but design educators should be cautious of adapting their courses too closely to the reality of professional work. An undergraduate course should offer the time and opportunity for students to conduct speculative and exploratory activities that are hard to do in professional practice.

Limitations

The study focussed on the research question, "Is project work in the design studio still the centre of design education?" so our analysis was guided by it. This means that other terms that were not closely related to the project or the design studio (for instance, *innovation* and *sustainability*, for example) were left out of this paper. We wanted to present a concise analysis of the research question. A fuller analysis of all the key terms would be outside the scope of this paper. Also, we are aware that there are important distinctions between different design courses, but again, that comparison would also fall outside the aims of this paper. Finally, our sample could have been extended, and we plan to expand the study in the future with more examples.

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Apprenticeship-Type Learning in the Local: Insights from a Cooperative Weaving Practice for Design Education

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Abstract. A growing area in design research concerns learning from local practices and diversifying design's knowledge space. By understanding and documenting how women in a village in Turkey learn the craft of weaving, this paper reformulates the relationship between the design field and the local context as learning from the local and aims to contributes to the design education field. During the summers of 2017, 2018, and 2019, fieldwork using the participant observation method was conducted in the village. The detailed account of the learning process in this local weaving practice allows us to define this learning as "apprenticeship type learning in the local." The practice consists of a process in which the forms of learning and teaching are inseparably interwoven with socio-spatial elements. It draws together flexible learning processes where the teaching moments blur and students learn in action in a dialogical exchange through observing and making. During these interactions, the importance of considering the cooperative and social aspects of the learning arises: not only technical knowledge, but also social values and beliefs are transferred in an interdependent process.

Keywords: Local knowledge · Weaving · Learning from local · Design education · Experiential learning

1 Introduction: Design and the Local Context

Design's growing interest in local contexts began in the early 1970s (Willis and Elbana 2016; Clarke 2016; Fry 2015). Generally, this interest was associated with the period's development policies and reflections on the discipline of design, as well as Papanek's book, Design for the Real World (1971). The policies included Western aid to "underdeveloped regions", which aimed to improve welfare by promoting modern economic structures and increasing production and consumption. The funding enabled designers to encounter different localities and conduct various projects. The development projects were guided primarily by the idea that design can produce solutions by determining the needs of "underdeveloped" societies within the scope of development assistance (Clarke 2015; Papanek 1971). In response, Papanek claimed that design should be about "collective social conscience and cross-cultural sensitivity" (Clarke 2015: 44) rather than

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mass consumption. He criticized commercial design and aimed to "design for the weak" (Koskinen and Hush 2016: 65).

From the 1990s to the present, the relationship between design and society has become much more diverse. Design has rapidly spread beyond mass production-oriented disciplines into new areas, prompting conversations between designers and local contexts. According to Manzini (2015), designers have become agents of change: they are no longer just the creators of products, but also of systems and discourses. Design processes and methods have also been transforming. Designers have facilitated the adoption of participatory and collaborative design methods. With the expansion of design's areas of interest, the definition of design has expanded as well. Design researchers look for different modes of making things, producing objects, and engaging with materials. Concepts such as lay design (Campell 2017), diffuse design (Manzini 2015), and vernacular design (Kalman and Jacobs 1990), which describe everyday and local design practices, have all, along with expert design, become part of design culture.

Learning from local practices and diversifying design's knowledge space with different ways of knowing is a growing field in design research. Many designers have taken a collaborative approach to research and product development by using methods such as participatory and social design. These methods enable new relations between design with local contexts. Recent studies have repositioned the designer as a learner. This repositioning creates spaces for difference in which participants and subjects of the context define the scope, make decisions, and contribute their experiences (Onafuwa 2018; Merritt and Stolterman 2012; Smith et al. 2020). Many emphasize the importance of local and indigenous knowledges. Sheehan's (2011) framework of respectful design and Tunstall's (2013) concept of culture-centred innovation suggest that design gains a deeper understanding and develops more diverse perspectives when it learns from and pays attention to indigenous knowledge. Some exemplary works examine a local practice (Reitan 2006) or concept (Akama and Light 2020) to contribute to or transform the design knowledge space. Others examine how local knowledge can participate equally in the design process (Reitsma et al. 2019; Wang 2020).

Reitan (2006) examines the traditional clothes made by women in an Alaskan village called Kaktovik. Claiming that people who have not attended design school can also design, Reitan examines the making of clothes as a design process, and their patterns and models as design objects. She states that the official design discipline can learn many things from such local practices, which she calls vernacular design. Reitsma et al. (2019), following the respectful design framework, call for a space that is neither Western nor non-Western, but a hybrid field in which design knowledge and indigenous knowledge coexist equally. To constitute such a "third space", design tools should be completely open to anything the community brings to the table. To achieve such openness, designers should constantly look critically at their process (Reitsma et al. 2019). Wang et al. propose "in situ making and evaluation" (2020: 14) to reach deep local knowledge and to use it to sustain the design process.

This paper aims to reformulate the relationship between the design field and the local context as learning from the local. It achieves this aim, first, by understanding and documenting how women in a village in Turkey (Fig. 1) learn to weave and, second, by investigating ways to translate the obtained knowledge into the design field to generate

insights for design education. Differences and variations observed and recognized in the local context can be used to create new design knowledge. For this purpose, first, we elaborate on the nature and the features of local knowledge and consider what can be learned from local knowledge and local production. Then, we will discuss the research methods and research setting, addressing issues like power balance and representation that could arise when working in the local field. The process of learning to weave in the Village is investigated in detail through participatory observation. The village women come together to weave rugs and bags on the village streets as a part of a tradition of dowry preparation. From building the production tool (a loom) to distributing the end products (woven fabrics), the process is cooperative. The social and material aspects of weaving support socialization, requiring women to cooperate and to make decisions together as a community. By exploring the social and material dimensions of learning to weave, we seek insights for design education.

Fig. 1. A weaving scene from the village. Photographed by Gizem Öz

2 Features of Local Knowledge

Local knowledge corresponds to the beliefs and tendencies that have emerged from a community's ongoing social practices throughout its history. Local knowledge is embedded in the here and now, in practice, space, time, and people. This knowledge is born, produced, changed, and remains in its own context (Geertz 1983). Local knowledge is context-specific, specialized according to social, geographical, and temporal conditions, and emerges from social practices in daily life. It is neither systematic nor institutionalized. Local knowledge, with its location-specific structure, can differ from global norms and have its own logic (Canagarajah 2002; Cleveland and Soleri 2003). This type of knowledge is referred to with many terms including local, indigenous, folk, vernacular,

native, or traditional. We choose to use the term local knowledge because it is more general and best suited to our case.

Local knowledge may refer many different contexts, not only the rural context. It may refer to knowledge that people develop with their own understanding of daily life, outside officially established information, policies and procedures (Canagarajah 2002). It may also be knowledge that is not institutionalized or legitimized within a discipline, or knowledge that circulates in smaller groups outside of familiar paradigms. In a professional context, local knowledge can correspond to the information developed by workers or craftspeople who perform a job without the recognition or approval of authorities (Burgess 2007). In the fields of architecture and design, the knowledge that emerges from the making practices developed by a group over the years can also be called local knowledge (Kalman and Jacobs 1990). The term can describe the knowledge possessed by the inhabitants of a rural area, a village, or a particular group or region within a city. Local knowledge is sometimes synonymous with situated knowledge, and sometimes describing what is outside the global relations. Although these definitions come from different fields, they have certain common features: being specific to its context, being specialized according to social, geographic and temporal conditions, and emerging from social practices in daily life, instead of being systematic and institutionalized.

Urry (2002) emphasizes the spatial dimension of the formation of local knowledge. He defines locality as "the formation of certain social relations in a geographically restricted area" (Urry 2002:63). According to Urry (2002), to understand local relations, it is necessary to consider the relationship between the society and the place, different perceptions of locality, social relations, and how those relations change over time. Space, he argues, should be treated neither as an independent, immutable entity or container in which events take place, nor as any other object. He says that in the distribution and positioning of objects, it is necessary to consider different spatial relations such as "distance, continuity, unity" (Urry 2002:65). Likewise, when considering social organization, the space is not just the area where the organization takes place. Rather, both the effect of spatial characteristics on the organization and the effect of the organization on the space should be taken into consideration: a researcher should try to understand the social and spatial relations that make up the locality. For the field of interest to this article, Urry's (2002) emphasis on geographical togetherness is very important. Both the limited geographical area of the village context and the activity of weaving in the street prompt the formation of different social relations. For this reason, the spatial relationships Urry (2002) mentions will also be examined while detailing the process of learning to weave.

This article examines local knowledge through a local production practice. Druc asks: "What makes a production local?" (2013:485) The features of local production he lists include frequently encountering the same production method in a community, spatial restriction, being seen only in a given area, the use of geographically local raw materials, and being embedded in the social context in which production takes place (Druc 2013). In the Village, weaving is observed to take place in a certain geographical area, frequently encountered in the area, and to create sociality. The yarn, which is the raw material of the production, is supplied from outside the region: local production uses non-local materials. The most important factor that makes the weaving practice local is

its embedding in a social context, its dependence on the values and beliefs of the society, and its production of locality and sociality.

Based on the preceding discussion and field observations, in this paper, local knowledge is defined as knowledge that belongs to a group, that emerged from the specific practices and values of that group, knowledge that the group feels ownership over, that is learned through daily experiences, that is site-specific, and that reproduces sociality. The weaving practice is identified as a local production because it is unique to its own context and creates unique relations. New design knowledge can be created by making use of differences and variations seen and recognized in the local context. Therefore, this research aims to contribute to the field of design education by documenting the local knowledge that emerges from observing the learning of practice of weaving.

3 Research Setting and Research Methods

A modern understanding of research legitimates the knowledge that needs to be recognized within multiple ways of knowing and create hierarchies over others (Smith 2008; Santos 2018). For local, oppressed, and disadvantaged populations, this mode of operation is vital. Since we work in a local context, we take care to avoid such issues when approaching field relations and establishing research methods. Santos (2018) suggests that non-extractive methods can help researchers remain open to alternative interpretations and differences, and self-critical of their own preconceptions and biases. Most modern science practices working in the local context consider local knowledge as raw material to be used in the production of scientific knowledge. This knowledge extraction brings with it decontextualization and abstraction. According to Santos (2018), a researcher who wants to employ non-extractive methods should work like a craftsperson. Knowledge of crafts is not methodologically based on instructions and procedural practices. Rather, it is flexible, and adjustable to fit the context. Therefore, thinking like a craftsperson gives the researcher an "epistemological imagination" (Santos 2018:126). She/He must use methods just as a craftsperson uses her/his tools: creatively, not mechanically. It is necessary to "become a methodologist of its own context" (Santos 2018:7), to avoid rigid descriptions, and to use one's imagination. Despite minor differences, each craftsperson has her own method of production, and Santos (2018) argues that a researcher should develop creative approaches according to the nature of the work at hand.

In the spirit of self-tailored approach, this study used the participant observation method and emphasized self-reflexivity. The distinction between participating in and observing the field is blurred by participant observation. Highlighting that observation can never be completely objective since it instantly makes the researcher a part of the field results in intersubjective relationships and dialogical knowledge (Yazıcı 2019). Because the researcher's experiences in the field impact the knowledge production, participant observation also includes examining the researcher's involvement to the field (Nahya and Harmanşah 2018). Cultivating a self-reflexive attitude, researchers can access an immediate flow of inner dialogue in the field. This attitude involves the researchers making decisions about their next move based on the relations that arises during the observation of informants, their practices, and the research. This exchange creates field methods that

are unique and responsive to the field context. It also resonates with the call to disengage from dominant models and strategies in design research (Akama et al. 2019), moving instead towards more locally situated and contextually responsive methods. In addition, responsiveness aids in the development of the "epistemological imagination" (Santos 2018: 126). In that imagination, local ways of knowing can enrich the design landscape via intersubjective relations in the field, without being abstracted and appropriated.

Many elements influenced my field experience, including loneliness, fear, financial constraints, and societal gender norms. Some answers were not fully honest due to participants' fear of exclusion, some questions could not be asked or answered. We emphasized personal qualities that potentially prevented hierarchies and resonated with the informants, like being a student or choosing clothes, while keeping in the background other qualities like professional identity or conflicting opinions. We also met the expectations of the field and positioned ourselves according to similarities and differences (see Öz and Timur 2022).

The researcher's intuition and insights play an important role in the analysis of ethnographic study on daily life (Atkinson 2013). Furthermore, weaving is also based on intangible knowledge that is learnt and passed down via observation and experience (Sennett 2012). It was required to spend time at the looms to grasp the complexities of this technique and the social interactions it creates. Documentation tools such as field notes, audio recordings, photography, and video were used to assist participant observation.

I (first author) visited the field in the summers of 2017, 2018 and 2019. During these visits, I spent time with different people at different looms and used the participant observation method. Şenay Abla, whom I know through a colleague, provided me a way into the field. After our first encounter in 2017, I occasionally called her to maintain our relationship and asked for her approval before visiting the village. During each of my visits, she greeted me at her home, took me to the looms and introduced me to other women. After spending time in the village, getting to know the people and learning their names, I started to establish my own relationships with them. When I met someone new, I told them about Şenay Abla and the other women whom I had met. To start conversations at each new loom, I asked the same questions, like the names of the tools, even though I knew the answers. My daily needs were met with the hospitality of these women. During my visits, I stayed at a friend's family home an hour away and used public transport.

It is said that weaving has always been a part of the village. In the past, when animal husbandry was practiced in the village, yarn made from goat hair was hung on trees and various fabrics were woven. Saddlebags, rugs, jackets and bedspreads were made. As the villagers started to use ready-made yarn, the variety of clothing products increased with that yarn's qualities. However, there is significantly less variety in the assortment today, as only bags and rugs (Fig. 2) are woven. Moreover, the primary motivation for weaving is no longer material need, caused by the difficulty and cost of obtaining ready-made products. Instead, weaving practices are motivated by the need to recognize a common social belief: the importance attributed to marriage and preparing a dowry.

Each step of weaving has unique challenges. Jobs such as setting up the loom, unwinding and weaving can only be performed with the collective physical and mental effort of many people. Weaving is usually done by five to six women recruited from at least two or three households. In addition to the physical work, women also collaborate

Fig. 2. Some examples of weaved fabric for bags and rugs. Photographed by Gizem Öz

on a variety of other decisions, such as selecting the colour pattern, purchasing yarn, and deciding who would weave and when. In other words, weaving involves working together, making collective decisions and organizing at many levels. In addition, not just the weavers, but all the villagers are involved in the process in different roles at different times. At first glance, the process seems completely random and spontaneous. However, this apparent uncertainty is underwritten by implicit agreements and shared motivations. Although it contains many joint decisions and moments of cooperation, the weaving process has no definite rules or order. As a result, the organization of weaving in the Village is flexible and sometimes undetectable, even by its members. It has no noticeable limits, and it takes place in a unique way. However, every decision is backed by shared factors. In this article, we try to pinpoint the key features the process by which weaving is learned. We will then seek to translate these features into design: the differences, similarities, and relationships will be uncovered and intertwined to determine what this kind of learning process can contribute to practices in design education.

4 Learning to Weave: Apprenticeship-Type Learning in the Local

In the Village, women learn to weave over the course of their daily lives. Girls start to learn weaving by watching their mothers and neighbours on the street and, little by little, by helping them. As they get older, they become more specialized by watching and practicing. Since weaving is generally done for dowry purposes, young women help their mothers while their dowry is being made. Once they have children, they weave their children's dowry as well as their own household items as the main weaver. This form of learning has no specific start or end time, no clearly identifiable teacher-student relationship, and no examinations or certifications. Due to its size, the loom is built in the street, and it becomes a social centre which hosts conversation, gossip, banter, and visits, in addition to weaving. For this reason, learning to weave also shapes a view of life and learners gain a basis for values and beliefs common with their society. Weaving intertwines with life as the learner grows up and accumulates daily experiences.

To explain the process of learning to weave in the Village, we will focus on the theory of a community of practice (Wenger et al. 2010). Lave and Wenger (2008) consider learning to be a situated activity, which simply means that it is experienced in everyday life. This definition is broad: Lave and Wenger (2008) explain that there are, in fact, no

non-situated activities. This theory is based on the thought that learning takes place by doing things together in a community (Reitan 2006). When people spend time together, they share their thoughts, experiences, and advice, they help to solve each other's problems, and they build tacit knowledge among themselves. Both personal relationships and a common understanding of the subject are formed. Therefore, Wenger et al. (2010:4) define a community of practice as "a group of people who share problems, passions, concerns about a topic and deepen their knowledge about the topic by interacting with each other." Authors also emphasize that learning takes place not only in institutions designed for that purpose, but also in all areas of daily life, intertwined with daily practices (Reitan 2006).

In this context, Jordan's (1989) study of Mexican Yucatan women's midwifery and Reitan's (2006) studies in Alaska, in which Inuit women learned to sew local clothes, are instructive. Jordan (1989) researched Mayan midwives in the Yucatan. For years, official health institutions had tried to teach women interested in midwifery about modern medicine. But this training was offered as oral transfer in a classroom environment, following the "Western model". The efforts were unsuccessful. Jordan (1989) explains that these midwives' learning takes the form of an apprenticeship based on imitation and repetition. Thus, purely verbal transmission fails (Jordan 1989). The apprenticeship model is not always the same. For example, it may not always be informal, it may have a curriculum, learners may obtain a certificate at the end, or it may be fragmented, institutionalized, or focused on a specific extended period of life (Lave and Wenger 2008).

Many studies investigate the intersection of craft and design. Not all craft-design work takes place in contexts which count as local, by our definition. Local practices have a social character: they affect and are affected by the practices, beliefs and daily habits of the society in which they exist. Practices may or may not have material gain as a goal, but they always have a goal of fulfilling and reproducing shared social conventions. Local knowledge is also learned socially. In daily life, while living in a particular society, local knowledge is learned spontaneously, without the unique purpose of learning. Therefore, education is not institutionalized.

Craft production can be independent of social beliefs and thoughts. The same craft can be practiced in different geographical locales by people with different social habits. In general, crafts have a purpose of financial gain, although it is not their only purpose. Learning takes place in master-apprentice relationships in workshops. Although these relationships are a part of one's daily life, they are different from other personal relationships. Learning crafts has a purpose and goal. It can be institutional, but it doesn't have to be. The most important point of divergence between craft and local knowledge is the sociability of local knowledge and its intertwining with the social norms and beliefs of the community in which it occurs.

There are also aspects in common between craft and local knowledge. Both include implicit transfers of knowledge. Both involve watching an expert at work, spending a long time with them, learning by doing, constantly repeating. Tacit knowledge, according to Polanyi, is personal information that has been completely absorbed to the point of becoming "ineffable" (1958: 88). This type of knowledge can only be obtained by making because it cannot be represented in words (Kaya 2011; Rust 2004; Altay and Öz

2019). Learning a skill that involve tacit knowledge necessitates the individual repeatedly following a sequence of processes, resulting in the development of her own approach (Sennett 2008). Craftspeople think with their hands and communicate their knowledge through tangible experiences. Because tacit knowledge is not always accessible through words and instructions, tangible performances are required to communicate (Nimkulrat 2012). The methods that the craftspeople demonstrate at their workshops (mothers demonstrate on the street) guide the apprentice (girls) in learning the craft (weaving) through practice (Sennett 2008). Crafts involve tacit sets of information that can only be imparted via material experience.

The unique feature of the sewing practices in Alaska studied by Reitan (2006), of weaving in the Village, and of midwifery in the Yucatan is that they can all be described as apprenticeships that take place within a local community and forming unique social relations around the practice. Therefore, this study calls the approach to learning weaving apprenticeship-type learning in the local. Primarily through examining the intersections of these studies, we pinpoint several identifying features of learning to weave in the Village.

The first feature of apprenticeship-type learning in the local is that it occurs while living daily life and is not an individual process (Jordan 1989; Reitan 2006). Rather, girls learn to weave as they grow up, playing, watching, and helping while their mothers and relatives weave in the street. There is no distinction here between everyday life and the learning of skills. Local learning has no definite beginning and end. It is quite integrated with daily life, not separated from it by clear, definitive lines.

Second, because the knowledge and learning of weaving are situated, the learned knowledge is not displayed outside of its context (Reitan 2006). Western-style education is characterized by going to a special location for education, engaging in educational activities separate from daily activities, and scheduled to occur at specific times and places. None of these are part of apprenticeship-type learning in the local (Jordan 1989). For example, most of the youth in the Village now go to nearby cities to access a quality high school education. In these environments outside their communities, they show no relations with weaving production. In addition, when young women of university age were asked how they will use the products their mothers were weaving for their dowry, they stated that the products would be used in their homes in the village. The weavings were deemed unsuitable for their city homes. Weaving and woven products are established in and belong wholly to the village context.

The third feature is that knowledge acquired through apprenticeship-type learning in the local is embedded in bodily performance (Jordan 1989). The apprenticeship model enables gaining physical skills. Even if the subject is not talked about, the practice of doing is known. Mastering the skill is also mastering bodily behaviour. Speaking and oral expression have little place in the apprenticeship model (Jordan 1989). The same is true of learning to weave. As mentioned, the art of weaving is learned by observing, imitating movements while helping the mother. As any craft, weaving knowledge is highly personalized and implicit.

Fourth, in apprenticeship-type learning in the local, the work being done is the driving force behind learning and overlaps with the desired result (Jordan 1989). The work is not aimed at putting learned knowledge into practice at some point in the future. Rather, the

knowledge is applied while learning and learned while applying. Skill acquisition takes place step by step, as the learner progresses from easy jobs to difficult jobs. In the Village, young girls generally help with threading and bobbin winding. Some help with weaving, but they stay on the loom for a shorter time. Young girls were not observed to participate in very complex processes like unwinding the rope and working the comb. Mothers do the weaving, and the elderly help with more complex processes. In other words, learning is spread over the course of an entire life and progresses through repetition. As a result, there is no expectation for students' success beyond having done the weaving and preparing the dowry.

A related feature is the lack of formal standards and assessment. In this kind of learning, competence is demonstrated by doing the job right, rather than standards, tests, certificates, or rites of passage (Jordan 1989; Reitan 2006). Learners take responsibility for setting up their own looms as they need once they come to the relevant stage of their life.

In apprenticeship-type learning process in the local, the relationship between teaching and learning is unclear. There are no special teaching moments. The loom is not set up specifically to teach someone to weave, and there is often no active teacher intervention in the learning process (Jordan 1989). For example, a mother teaches just by doing her job, weaving rugs and bags for her daughter's dowry. Her daughter also learns from the situation by observing and helping, as an apprentice would, but she is not there specifically to learn to weave. She is there to help, to spend time together, and to socialize. This is the feature that Lave and Wanger (2008) find most interesting about their case from the Yucatan, and which occurs also in the weaving: the realization of learning without identifiable organization or teaching moments (Lave & Wenger 2008).

Finally, in the Village, local knowledge is learned, produced, and transferred by participating in daily life and socializing. This type of learning also has social consequences. People form relationships. Learning to weave amounts to transferring, in addition to technical knowledge, knowledge about the values of the community, how one might participate in those values. The process brings individuals into the community and creates sociality (Fig. 3).

To sum up, the weaving practice represents apprenticeship type learning in the local. Local knowledge is learned, produced and transmitted by learners' participation in daily life and socializing. There are no specific learning-teaching moments. Roles and participation in the weaving process are flexible. Verbal transfer of information is useless because it cannot transmit tacit knowledge. Instead, learning occurs through observation, making, and repetition. As a result, there is no goal other than weaving and producing products. Weaving is done for the nominal purpose of producing dowry products. But, at the same time, due to the intergenerational relations built around the loom, the production enables not only the transfer of technical knowledge, but also the sharing and learning of social values.

5 Discussion

Apprenticeship-type learning in the local is a perspective on learning different from the learning available in educational institutions. Considering design practice and learning

Fig. 3. A weaving scene where young girls and their mothers by the loom. Photographed by Gizem Öz

in a setting other than traditional educational institutions can get fresh insights (Reitan 2006). If we were to translate the lessons learned from apprenticeship type learning in the local, we might find similarities and differences between that learning process and academic design. Those similarities and difference could benefit designing novel educational processes for design education. In the village, the process of learning to weave has unique features. Learning through apprenticeship brings together implicit knowledge and craft studies. Local learning brings cooperation, learning through community and through social values.

Tacit knowledge is crucial in tackling ill-defined problems. Industrial design education is anchored in tacit knowledge as it is an "important domain of problem-solving" (Tatlısu and Kaya 2017: 1418). Thus, to acquire and develop this knowledge by incorporating craft methods into design education, direct experiences with real materials and production are considered an important source of innovation (Gore 2004; Kermik 2012; Altay and Öz 2019). Experiential learning, in which the novice learns under a master through real experiences, is considered an important part of design education (Gore 2004; Tatlısu and Kaya 2017). The weaving practices of the Village add making and experiencing to observing. Growing up, the girls in the village watch their mothers, other relatives and neighbours weave. Over time, they begin to help with small and simple tasks, but as time progresses, they undertake more complex tasks. Finally, by participating in weaving for the dowry, they both do the work and pass on the social beliefs of the village by providing "full participation" (Lave and Wenger 2008). Coppen et al. (2014) and Rogoff (2014) describe "learning by observing and pitching in" as a common feature of education in local, vernacular, and indigenous settings.

The loom on the street is also an area for socializing, where women from different age groups come together and have the chance to observe different abilities. Girls observe both their peers and older women playing the role of teachers. Many researchers investigate and stress the importance of learning through peer observation, "students learning

from and with each other in formal and informal ways" (Boud et al. 2016: 56), especially in design education. Weaving also stresses observing and being together with people of a wide range of skill levels. This suggests interesting questions on how interactions between students from different years can enable cooperation. Such practices contrast with the standard curriculum system which separates students by years.

Unlike the workshop-based craft practices with which the design field is generally related, weaving is uniquely local and creates a socialization and information centre around it. This social dimension enables the learning and sharing not only of weaving, but also of the social values on which weaving depends. The passing on of the values also helps the practice to continue. The cooperative and social aspects of the learning process could be connected to design education. Ensuring togetherness through the act of making and co-producing promotes self-motivation and responsibility towards peers. It also builds a shared culture around education.

Accordingly, women in the Village are motivated to participate in weaving and learning to fulfil a social convention shared by the community. When the process of learning to weave is considered as an activity of sharing and producing common values through cooperative object production, it emphasizes that co-creation can play a role in the construction of a moral approach and ethical awareness that students will acquire during the problem-framing processes. As Gray (2018) suggests, student's moral articulation during a problem-framing stage is a fertile area for research. Co-creation can take on functions such as recognizing the context, recognizing constraints and aligning with peers in the educational environment.

The fact that weaving takes place on the street also makes the participation in weaving flexible and plural. The process involves not only weavers, but also their neighbours, relatives and passers-by, sometimes just by greeting, sometimes by chatting, and sometimes by participating in weaving. This reminds us of the importance of spatiality in creating a cooperative education process. It highlights the importance of a setting that can involve different participants spontaneously and in different ways. The flexibility of the learning process and roles bring cross-pollination and socialization.

6 Conclusion

Each context or locality is unique. Each setting has its own motivations and ways of cooperating. This research aims to diversify the ecology of design field knowledge with the local knowledge of the weaving practice. As Santos (2018) says, knowledge and ways of knowing are endless and each one is incomplete. Design, too, requires diverse methods and insights derived from local knowledge and practices. There is a need for knowledge ecologies in which different ways of knowing can work together. In this paper, we first investigated design's relationship with the local context in terms of methods and approaches which would enable learning from the local. Next, based on an understanding of local knowledge, we dove into the field setting and the research methods that that setting demanded. After giving a detailed account of how learning occurs in the weaving, we tried to establish a possible relation between the local knowledge developed through this field research and design education try to be built in a non-exhaustive fashion. We tried to grasp the dynamics of an informal learning process that takes place in a local

community, and we discussed what the features of this informal learning can add to a formal education environment like a university design education and its interpretation.

In the village, the organization of weaving and community have been shaped to include learners in many socialization activities. These activities always involve helping and working together. Since participation in these activities takes place in cooperation through shared social values, learners are willing to participate and be part of the community. While we all have been discovering the potential of online technologies and new ways of interacting in post-pandemic education, the weaving represents a process in which learning and teaching are inseparably interwoven with socio-spatial aspects. It directs us towards designing flexible learning processes in which the teaching moments blur and students learn by doing, in a dialogical exchange of observing and making together. During such interactions, the importance of the cooperative and social aspects of learning does not arise only where the transfer of technical knowledge occurs. It arises also when the unique culture of education accumulates in an environment that enables students to learn from each other through an interdependent process.

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Managing Design: Responsibilities, Conduct and Rights

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Abstract. The Design practice has influence not only on society, but also on the environment, economy and culture as well, being it formulates innovative solutions for specific problems. Even so, this science is not fully recognized by its true value and potential – neither in the public sector, nor in the private sector. Furthermore, Design Management is also a component that has an essential role in the proper performance of the projects and teams. Nevertheless, Portugal has no Order for the protection and organization of the professionals; the Responsibility, Conduct and Law as a rule are not present in the course teaching plans; and, sometimes, the legislation does not acknowledge the designers' needs. Design was considered a discipline and began to have courses around 1975, making approximately 45 years of existence in Portugal (Gomes 2003). The area is an interdisciplinary practice and is present in several projects and companies. It is a comprehensive discipline, from Graphics with the perception of a brand, to Product Design with the conception of consumer pieces. The various branches of study within the Design hat have a great influence not only on society, but also on the planet, as it is present in everything (Papanek 1984). Furthermore, the number of trained designers and companies is growing in the country, according to data from the General Directorate of Education and Science Statistics (DGEEC). Even so, to date, there are no regulations or guidelines for the conduct of the area and, consequently, its professionals do not have protection or guidelines when exercising.

As for the general objectives of the study, this article seeks to deepen and contribute to the investigation in the area of the responsibility of Design and the analysis of the laws, rights and conduct of the designer in the activity of the profession. In terms of specific objectives, in addition to a literature review, three data collecting moments were executed in order to understand the perception and experience of the students, professors and professionals about the topic in question. In regard to the Methodology, first an Online Questionnaire was conducted (129 participants) to collect general quantitative data, then a qualitative research with Individual Interviews (12 people interviewed) and lastly, another quantitative research with a Survey (19 answers) so that participants could validate all the data collected and potential solutions generated throughout the study. With this data, it will be possible to interpret existing problems, find out what changes need to be implemented and how to move forward with raising awareness of the issues. Therefore, it is intended to investigate the role of the Design manager during the responsible creative process, contribute to the recognition and importance of the responsibilities and rights of Design in Portugal and, finally, understand

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that the area is an important strategic tool and should plan means of support and organization for its professionals.

While Design is a problem-solving activity, Design Management not only participates in the activity but also coordinates the Design process (Borja de Mozota 2003). As can be seen, Design has a great impact both on the economy, the public sector, and on business; Added to this, Best (2006) states that Design Management is another extremely important element to incorporate. Within an organization, Design Management is present in brand communication, products and services. Outside the organization, Design Management has the ability to respond to incremental pressure on organizations from the government and attitudes towards local management and global resources. With this, the essential question arises, if Design manages to have this influence on the lives of citizens and impact on society, it will be necessary to create changes in the dissemination and awareness of the area, updating the legislation, new plans or teaching methodologies and it will be necessary to investigate the organization of professionals? The world is constantly changing, social, historical and technological. Design has to keep up with these changes, it cannot ignore the sociocultural environment that surrounds it. (Monteiro 2004, p.27). Jet Gispen (2017), a researcher who developed toolkits on Ethics in Design for designers, says that Design has a great influence on the way people behave and live their lives. There is rarely a reflection on what a good solution entails, hence Gispen (2017) believes it is necessary for designers to understand the impact of their work and how they will incorporate it.

In essence, the investigation has the objective to comprehend how designers should act in terms of social, professional, ethical and environmental responsibility, which legislations do they have at their disposal to protect themselves, which conducts exist to regulate the field and what changes are necessary to make in these settings. It is expected that with this study it's possible to aid the advancement of the conceptualization of the necessary structures to support the Design' professionals, so that their contribution has a greater reach and has more recognition by the society.

Keywords: Responsability · Law · Professional Conduct · Design · Design Management

1 Introduction

This article's research focus is on rights such as European and Portuguese legislation, and designers' social, professional, ethical and environmental responsibilities. These elements gave rise to the research question: How should the Portuguese designer act and what are their rights and protections as a professional during the creative process?

In perspective, the same design that participates in global overconsumption, also has the ability to help the world (Berman 2013, p.2). Design is a process and a methodology that integrates multidisciplinary teams, aggregating creativity and technology as a way to develop products and services with specific users in mind. It's a broad discipline, from Graphic Design, to Product Design, to Interior Design, to Design Management. But, in Portugal, Design was only considered a discipline and began to have courses around 1975, making approximately 45 years of existence (Gomes 2003).

The various branches of study within the Design hat have a great influence not only on society, but also on the planet, as it is present in everything (Papanek 1984). Considered both a noun, as a result, and as a verb, this being an activity. The area arises from the need to conceive creative solutions to concrete problems, with a certain goal (Gomes 2003). In this way, it is a problem-solving activity, but also a problem-finding activity to discover the user's need.

As for the general objectives of the study, this article seeks to deepen and contribute to the investigation in the area of Design responsibility and the analysis of the laws, rights and conduct of the designer in the activity of the profession. In terms of specific objectives, in addition to in-depth investigation of the state of the art, national surveys, individual interviews with teachers, researchers and design professionals have been planned, in order to quantify and structure the perception of the theme in the eyes of the community and a survey that can validate the data collected. With this data, it will be possible to interpret the existing problems, find out what changes need to be implemented and how to move forward with raising awareness of the issues. Therefore, it is intended to investigate the role of the Design manager during the responsible creative process, contribute to the recognition and importance of the responsibilities and rights of Design in Portugal and, finally, understand that the area is an important strategic tool and should plan means of support and organization for its professionals.

1.1 The Importance of Design

The word "design" comes from the Latin designare, which means to define or draw. The analysis of the etymology of the word shows that it is composed of intention and design (Borja de Mozota 2003). Considered both a noun, as a result, and as a verb, this being an activity. The area arises from the need to conceive creative solutions to concrete problems, with a specific purpose (Gomes 2003). In a nutshell, Design is a process and a methodology that integrates into multidisciplinary teams, adding creativity and technology as a way to develop products and services with certain users in mind. Designers are professionals in the field, who combine "art and technique, in a critical, innovative and creative approach." (Ferreira 2009, p.33), where they follow a design method that can address various aspects (such as cost and efficiency) that ultimately respond to the user's needs.

Therefore, since the beginning with the adoption of the English word, Design is often mistakenly recognized as "drawing" in Portugal, being important to educate in this sense. Design is still reduced to just aesthetic form and style, forgetting part of the ability to integrate functionality, social and emotional aspects, and even the value it adds during the development process of a product or service. Design is more often considered an object than an action, but it is clear that Design refers to both processes and results (Findelli (2001) as cited in Gancho 2015). The author adds that the process - for example a creative thinking process - can involve physical models or be abstract (visualization) and a result that can be tangible (resulting in a product) or intangible with a concept.

Design creates most of the elements that we see, that we use, and the experiences that products and services provide us. David Berman (2013) believes that Design has much more power than it appears, as it is a powerful mechanism combined with creativity that has the ability to improve the world. In his book, the author alerts to the important role of

Design in the persuasion of the public, meeting their needs. He considers that there are manipulations that designers are able to identify and use other methodologies to have a positive impact on society (Berman 2013).

Dormer (1995) states that Design has a function that relates to the outside world – whether in social or environmental aspects – where its function will have an impact on people and the environment, from where they will acquire and later consume (Dormer, 1995 as cited in Regadas 2012). For this reason, Design is a central factor in the innovative humanization of technologies and a crucial cultural and economic factor (Borja de Mozota 2003).

Design methodologies can be used as a powerful strategic tool to differentiate from other competitors, yet it is "neglected by companies" (Kotler and Alexander Rath 1984). Ferreira (2009) states that Design should be valued and few companies understand the advantages that come from integrating a designer in the coordination and management of multidisciplinary teams. For example, in the article McKinsey Quarterly (2020) it is mentioned that there are companies that are great at using Design, manage to grow profits and bring twice as many stakeholders compared to the others. To understand why companies don't make the same choices, they interviewed 200 senior designers, interviewed 100 top executives, and analyzed 1,700 McKinsey Design Index respondents. They concluded that 90% of companies are not reaching their full potential. There is a lack of clarity in the role of a lead designer and a lack of confidence in the potential they bring to the company. They conclude by saying that change starts at the top, including senior designer leadership, and that CEOs often don't understand that designers can have a big impact on companies. Therefore, companies are not using the skills of designer leaders that bring great value to companies.

In Europe, Design policies "are fragmented" and each country promotes the discipline in different ways (Ferreira 2009, p.26). Still, the European Union (EU) created some programs that help some audiovisual and media sectors, for example the program Worth. Lynda Relph-Knight writes in the Design For Europe1, an EU program, states that Design not only benefits companies, but can also benefit the public sector – as the area can deal with cost reduction, use of resources more effectively and aim for certain results. Design's role is definitely associated with innovation and creativity, responsible for the economic sustainability of the most developed nations, as attested by the strategic development programs promoted by the Commission of the European Union in the last decade.

2 Design Management

With Design becoming more comprehensive, there is a greater need for designers to create specific skills for each role needed in a team project. Consequently, by expanding the Design teams and the functions of the area within an organization, there is an opportunity to create a discipline that is responsible for managing these same resources for the success of the group. Branco (2001) defines the discipline Design Management, or Design Management, as an informed process of allocation of Design resources to achieve the goals of an organization, where management will be enhanced in order to ensure the optimized solution (Branco, 2001 as cited in Sousa 2012). Therefore, the discipline is concerned with the positioning of design within the organization, seeking

to identify disciplines that are relevant in the course of projects so that Design can be used effectively (Borja de Mozota 2003).

Choosing the right designer for each role is crucial for the project's success, considering that the Design manager develops the ability to organize a team and choose the right designer for each task (Farr 1966 as cited in Borja de Mozota 2003). Gorb (2001) argues that design management in the business environment is not limited to managing a design process or through the education of managers, but rather to the "correct implementation, by line managers, of the design resources available to the organization in the execution of its corporate objectives" (Gorb 1990, p.2 as cited in Sousa 2012, p.72). The author states that there has to be a balance between manager and designer in the effective use of design.

We can see that Design Management "consists in the introduction of Design as a formal activity program within the organization, demonstrating the importance of design in the company's long-term goals and in the coordination and incorporation of Design resources at all levels of activity in the company in order to respond to these objectives." (Montaña et al. 2007 as cited in Gancho 2015, p.76). In the dissertation by Sousa (2012), he summarizes that Farr (1966), Gorb (2001), Cooper (2011), Mozota (2003), Best (2010) and Branco (2001) conclude that when implementing Design in any context, this it must always be followed up with the management area - there must be a clear association between the two disciplines so that a good dialogue can be developed. Afterwards, they show that it is important to legitimize the area of design management as a central activity in organizations so that it is incorporated at various organizational levels (operational, tactical and strategic). Finally, recognize design management as a core component that integrates various disciplines to enable mutual learning.

3 Design in Portugal

In sum, although it has a great influence, the Design practice in Portugal is not yet as developed as other countries, or even other areas like Architecture (with the Portuguese Architecture Order since 1998)2 and Law (with the Portuguese Lawyer Order since 1926)3. Portugal has no Order for Designer's protection and organization of the professionals; the Responsibility, Conduct and Law as a rule are not present in the course teaching plans; and, sometimes, the legislation does not acknowledge the designers' needs. Even so, to date, there are no regulations or guidelines for the conduct of the area and, consequently, its professionals do not have protection or guidelines when exercising.

Furthermore, the number of trained designers and companies is growing in the country, according to data from the General Directorate of Education and Science Statistics (DGEEC). In Portugal there are ninety four courses taken since 1995 until 2018 (Table 1) and six thousand citizens and companies registered and thirty seven thousand hundred (Table 2). Even so, to date, there are no regulations or guidelines for the conduct of the area and, consequently, its professionals do not have protection or guidelines when exercising.

Notably, Design in Portugal is mostly promoted as an artistic activity and not as a tool to support management, communication and engineering. There is still no economic development plan where Design has an essential role (Ferreira 2009). Because of this,

Table 1. Line Graph of the Number of Design Courses Completed in Portugal (left)

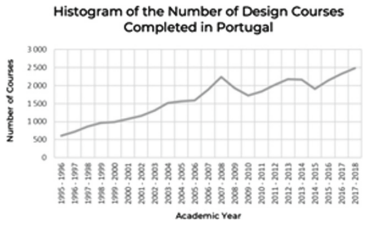
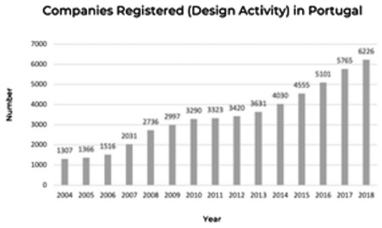


Table 2. Companies (Total of Individual Companies and Companies) Registered with Design Activity in Portugal (right)



the area of Design and its associations lack financial support by the government. Some of the reasons to explain this phenomenon is that there are few Portuguese designers that are recognized and followed nationally (Gomes 2003).

In terms of education Gomes (2003) refers that its necessary to "develop work at the level of organic explanation and appreciation of the idea of Design in private companies, public companies, municipalities, state departments, in the creation of jobs (…) and in the creation of adequate legislation which, at an early stage, adequately protect the various intervening entities." (Gomes 2003, p.27). There are three acting levels to fill in this gap, the training of designers, then the provision of information and awareness in society, and finally, the pressure on power. There is a failure on the part of the Government to promote and create jobs for young designers in Portugal – which would consequently help the economy (Gomes 2003).

It is up to the Government to sensitize the population and recognize Design as an area with professionals who can move the country forward. There continues to be a lack of confidence in the designers' work and methods, fueled by the lack of knowledge of the discipline in the business context (Branco et al. 2003 as cited in Sousa 2012).

In conclusion, this delay in Portugal has historical and social implications, which end up influencing culture and the business environment. According to the Portuguese Association of Designers (APD), the national economy and Portuguese society are experiencing a phase of development where it is imperative to eliminate any obstacles that are obstructing their integration into public or private organizations in Portugal. As can be seen from the data analyzed before, it reveals that there are more than six thousand registered citizens with activity in the area of Design and more than thirty seven thousand students attending courses in the area between 1995 and 2018. Still, few changes have been verified over more than 20 years.

4 Responsibilities in Design

The world is in constant change, socially, historically and technologically. Design has to keep up with these changes, it can not ignore the sociocultural environment that surrounds them (Monteiro 2004). It has a great influence in the way people behave and live their lives, it's necessary that designers comprehend the impact of their work (Gispen 2017).

The term "Designer's Responsibility" pertains to the various aspects that the professional must take into account before, during and in the implementation of the Design project, with the objective of creating products and services that have positive impact and results. The aspects that will be analyzed in this paper will be Social and Professional Responsibility, Professional Ethical Responsibility and Environmental Responsibility.

4.1 Social and Professional Responsibilities

Furthermore, Berman (2013) believes that Design has much more power than it appears, as it is a powerful mechanism combined with creativity that has the ability to improve the world (Berman 2013). Likewise, it has the ability to informar and publicize (McCoy 2003); consequently it's capable of disseminating social, environmental and political advertising (Heller and Vienne 2003). Hence, with this influence there's a need to have some guidelines or regulations the professionals should follow. An example of an oath of responsibility in Design is that of Berman (2013), with The Do Good Pledge, four principles that designers and other professionals must apply in their work. First the ethics, designers must have their own oaths, join associations and follow the rules of conduct, taking into account the social responsibility that the profession needs. Then the principles of the designer as a professional, where each designer must be guided by what they know is correct, finding a solution that answers everyone. The third, effort, where it asks professionals to use 10% of their time to help "repair the world", developing more sustainable solutions. Finally, Berman (2013) encourages designers to act now.

The designer's moral obligations are for everyone, for himself, for the client, for the user and in particular for society (Heller and Vienne 2003). It is important that professionals have notions about social, economic, political and cultural issues as a way to convey messages that are valuable to society. "The designer must be aware that communication Design is a powerful channel (…), the way in which they use this power is their responsibility, before being the responsibility of the client who hired them." (Monteiro 2004, p.30) any project developed by the designers that contains social or political messages, makes it imperative that the professional is aware of the message and to the impact it can have. For example, propaganda, it's a key component in psychological warfare in various historical moments, where they manipulate the opponent to behave differently, to do what they want, seeing only their perspective and nothing else. There is a fine line between persuasion and information, as persuasion is masked as information in both advertising and corporate branding (Heller and Vienne 2003).

Stuart Ewen (2003), analyzes the role of Design in the glorification of corporate power where he states that designers see their work as a "sales device" having no connection to the initial idea that Design has social implications (Heller and Vienne 2003). The idea that Design is a "transmitter of values" has disappeared in favor of what it sells to corporations. It became a corporate profession with a lack of systemic thinking about the impact this area has socially. It is used to visually represent business interests. The author feels that Design has become a toxic form of communication, it is now an instrument in the glorification of corporate power. With that, Ewen (2003) asks for a reflection on our functions and their implications for the future (Heller and Vienne 2003).

Another striking element in Design was the First Things First Manifesto, published by Ken Garland in 1963 and revised in 2000, declaring the importance of Design to

respond to social needs. A manifesto that defends the social concern in Graphic Design, against consumerism and the advertising industry (Monteiro 2004). Rick Poynor (2003), in Emigre 51 magazine, says that the author clearly was not trying to change the "underlying political and economic system" (Heller and Vienne 2003, p.125). The author explains that this manifesto was released at a time when Design was being accepted and getting stronger at a global level. In the nineties, Design began to be used in commercial and marketing areas, everything was "over-advertised" and "over-designed", which led consumers to "over-buying" (Heller and Vienne 2003, p. 95). In this way, graphic designers were automatically linked to advertising, creating a paradigm regarding political and ethical issues.

Another theme related to professional responsibility it's plagiarism. Gunnar Swanson (2003) compares plagiarism to a form of theft, for the author, this matter is an ethical issue, as it is part of the universe of professional conduct. When questioning why plagiarism is wrong, we need to know why it is a violation of professional ethics. The notion of plagiarism being theft, centers on the fact that there is an association between our work as a "property" and that we have possession of a certain product. When a designer appropriates a certain form or idea from another designer, it is considered plagiarism (Heller and Vienne 2003). Swanson (2003) believes that Design is not just a final product, but a process, which makes the whole notion of plagiarism in Design much more complex. In addition, Design is usually a collective process, many elements can participate either in improvements or contributions. The author refers to a quote by James Souttar, where the designer compares Design to cooking, as plagiarism would be someone buying a plate of food at a restaurant, taking it home and serving guests like the chef who cooked it (Heller and Vienne 2003).

4.2 Professional Ethical Responsibilities

One of the areas of philosophy, Ethics reflects on the fundamentals and principles that govern the constitution of norms, proposing goals and ideals to be carried out with a view to human improvement. On the professional side, there is Deontology (from the greek deontos/duty + logos) which designates the moral theory of duty; it also refers to the set of duties of a professional group. Consequently, Codes of Ethics are norms that govern a certain group of professionals. Professional Deontology consists of a set of principles and rules of conduct that establish "correction of intentions and actions, in relation to rights and duties, between a profession and society." (Ferreira 2009, p.29). So it's every designer's guide to how they deal with customers, the structure of projects, how they develop the Design process and the final value of a product. Codes of Ethics are a set of principles of conduct within an organization that help guide decisions and behavior.

Mário Moura (2009) states that currently "Designers tend to see their work as alien to morality – ethically neutral. They just need to do the best job possible, regardless (…) of the consequences their work may have." (as cited in Ferreira 2009, p.89). Ferreira (2009) states that the absence of ethical responsibility during professional activity undermines the recognition of Design. In the Master's thesis of Dr. Denise Ferreira (2009), the surveys carried out show that in their sample of 212 respondents that 83% do not exercise their activity according to a Code of Ethics. Therefore, it will be important to apply

Deontological Codes as a way to structure the area and guide professionals throughout the exercise of the profession.

In history there is no record of a profession that meets the needs of users that does not have a code of conduct - also states that the education of the topic of Professional Ethics cannot be just about teaching knowledge and deontological norms, but rather the discussion and analysis of practice (Brandão 2005). In the documentary Ethics for Design4, James William, says there is something designers can do: become aware that there is a problem. Designers have to be aware of the impact they have and must find ways to quantify it, only in this way can we talk about the problem and hold people responsible for doing it wrong. William concludes that there is a vague sense that something is wrong and it is the responsibility of designers and companies not only to measure the value they are having, but also the value they are giving to people - including the damage that Design can cause. He says that many see ethics as a "brake to innovation", but the researcher sees it as "a steering wheel, or even an accelerator.". The French designer Antoine Fenoglio, on the other hand, asks for a dialogue, because in the end, the designer's role is exactly that, and says that it is what works.

4.3 Environmental Responsibilities

Sustainability is an approach in Design that focuses on those environmental, social and financial factors that have implications for projects (Shedroff 2009). The author mentions that Design has been practiced with a focus on appearance, but Design was never simply the aspect, being also function, performance, usability and sustainability. Sustainability focuses on efficient and effective solutions for the good of society and the environment. He also says that companies that are more successful pay more attention to their impact, manage to increase profit margins and distinguish themselves from other companies. Demystifies the myth that sustainable solutions cost more, explaining that at first it may cost more, but if the focus is on energy savings and material efficiency, in the end it will cost the company less money and solve systemic problems.

Therefore, Shedroff (2009) mentions that designers are part of the problem and part of the solution, as many designs have already created major complications - even though they had the best intentions -, ending up with results that made a situation worse. Many are complacent with engineering and marketing colleagues who intend to develop products of low quality, poor usability and short longevity. Even so, he says that any sustainable solution continues to have a negative impact, as we will be producing.

Following environmental changes and the way companies choose to act, Papanek (1984) shows that it is extremely important that designers are aware of what they create and what is the intention of their choices. He says that designers have an ethical responsibility within society during the development of a product, considering whether we should respond to the customer/company, or whether we should do what is best for society and the environment. Companies and designers examining the product creation cycle will be able to find new opportunities for innovation, reducing the impact on the environment (Brown 2009).

4.4 Education of Responsibilities

All the elements mentioned about Responsibility in the profession point to the education of young designers as the essential point in the formation of conscientious designers. Papanek (1995) reinforces the importance of learning the profession's ethical dilemmas during professional education. Professors should be the first to mention that the Design area is a responsibility and a privilege: "Design students need to understand that they are part of the system in which design objects are produced, used and disposed; that is, the negative consequences of such objects also affect themselves." (Haug 2017, p.7). McCoy (2003) is an advocate for producing a generation of activist-conscious and concerned young designers to inspire other citizens to be active, informed, and concerned participants. "Too often our graduates and their work emerge from a charming mannequin, with no voices, just ventriloquists for the client's message. Let us give designers a voice so that they can fully participate and contribute to the world around them." (Heller and Vienne 2003, p.8).

In conclusion, in the words of Tim Brown (2009), the designer as an individual, even though he may have a certain intention, cannot predict the use of his work, cannot ignore the system, he should also take into account other negative ways in which it can be applied. (Brown 2009). For Joana Monteiro (2004) says that it is the professional's responsibility to do a good job and "spread the essential values in defense of the society they are part of, assuming that the designer is an individual with social conscience, who defends human rights, with ecological concerns and in favor of freedom." (Monteiro 2004, p.35). Therefore, all designers are responsible for the work they publish. Even so, Mike Monteiro (Monteiro 2017) states that when a designer is hired by a company, he is also being hired to assess the impact of the work developed - including eliminating any negative impact identified during the creative process. He adds that the way a designer works influences the rest of the design community - including free work, plagiarism, etc. The designer must work with the community in mind.

5 Rights in Design

In this subchapter, it'll highlight the main findings of documents related to the legislation that protect designers in their career path. In the portuguese legislation, the Constitution of the Portuguese Republic and the Labor Code for all professionals. Then, for the Design Legislation, the regulations for the Intellectual Property and Copyright in the European Union.

In the country's legislation, it was found basic protections against discrimation on the basis of sex, race, religion and politcal ideology. Also, fair compensation, or minimum wage, on the work produced and the time for rest (weekly rest and the right to vacation). Lastly, limitation of the duration of the labor.

Then in terms of Design Legislation, it should be noted that Intellectual Property regulations mention only formal characteristics and appearance of objects. In terms of Copyright laws, Ferreira (2009) mentions that the INPI and the IGAC advise designers to carry out the two registrations (Copyright and Industrial Property) in their projects, but this ends up harming professionals due to the cost that each registration entails. The designer will often have to register several rights as their creation may require more

than one type of registration, harming professionals due to the cost that each registration entails (Ferreira 2015).

For Joana Monteiro, the designer has the right and duty to refuse to work on certain projects and organizations, if we do not agree with the ideologies. It claims that these matters are "a matter of personal integrity and conscience, but also of being responsible to others." (Monteiro 2004, p.31). Still, as Papanek mentioned, many designers find themselves under pressure for financial reasons to accept certain projects that may conflict with their ideologies. There is no official code of conduct, each designer will have to follow their common sense when faced with dubious situations.

5.1 Design Activity in Portugal

As mentioned above, the area of Design in Portugal is still poorly understood, and therefore the profession, legislation and role of the designer follow the same path. The designer's intervention within organizations ends up being smothered by others such as architects, image consultants or artists – ending up being misinterpreted by many (Gomes 2003). Only in 2007 the Designer's profession was recognized in the IRS Code (Code 74100 Division M - Consulting, Scientific, Technical and Similar Activities) and in 2010 had the inclusion in the Portuguese Classification of Professions.

In the interview with Prof. Dr. Nuno Sá Leal, he states that Design is not clearly mentioned in any document of Portuguese legislation. The same happened in the interview with Dr. Denise Ferreira: "(…) the law does not correspond at all, or barely, to what the profession of designer is.". For this reason, it is essential that in Portugal there is an update of legislation. The design profession in Portugal has no regulation, as Antero Ferreira explains, since anyone can call themselves a designer even without any training or qualification, which makes the area very complicated for recent graduates.

Although Design is an activity with higher education in the country, it is not recognized with a professional status "due to the lack of information on standards of conduct among professionals, the lack of control over the status and a certain marginalization in the exercise of the profession." (Ferreira 2009, p. 27). The activity in Portugal is not regulated by written rules or practices accepted by all, adding that the various stakeholders seek to clarify the practices individually. The most urgent measures are the need to define a legal identity, specific levels of training to obtain a diploma, design certification criteria and a code of conduct in the professional circle (Gomes 2003).

Therefore, the delay in recognizing Design in Portugal has historical and social implications, which end up influencing culture and the business environment. According to the Portuguese Association of Designers, the national economy and Portuguese society are experiencing a phase of development where it is imperative to eliminate any obstacles that are obstructing their integration into public or private organizations in Portugal. As can be seen from the data analyzed in the first Chapter of the Introduction to the document in question, they reveal that there are more than 6 thousand registered citizens with activity in the area of Design and more than 37 thousand students attending courses in the area between 1995 and 2018. Few changes have been verified over more than 20 years.

5.2 Conduct of Professional Practice in Design

As design professionals, creatives deal with various stakeholders and for this reason there are certain Responsibilities and Rights that the professional must have. It was considered advantageous to analyze four codes of conduct, where it was possible to compile the various points by which design professionals (and members of each organization) should follow during practice. Based on the ico-D Code of Conduct, an AIGA publication in the Standards of Professional Practice, the ADP Code of Professional Conduct and the ICSID Code of Professional Ethics (now the WHO). After analyzing these codes, it was possible to carry out the following analysis of the interactions between the designer and the profession, designer, clients, society and environment.

First, all the documents analyzed had principles of integrity and respect by colleagues, clients, audience and the society. In terms of the Design in their profession, they should promote the dignity and integrity of the profession and advocate for good practices (quality, payment). In terms of other design professionals they should look for opportunities supporting open and fair competition and not denigrate a colleague's work or reputation for their own benefit.

Then, the principles that the designer should have in mind when dealing with clients include acting with the client's interests in mind, within the limits of a responsible professional and to not work on two projects for companies that have competition if there is any type of conflict of interest. During the work process, the designer must not disclose information without the client's consent.

In terms of the Code of Conduct for society, the designer should avoid accepting projects that could result in potential harm to the public. They must also consider the environmental, economic, social and cultural implications of their work and therefore must minimize the impacts. For the environment the professional must not be involved in Design practice where the project is imprudent for the health or safety of the community and when possible should choose products and services that minimize environmental impact.

5.3 Methodology

We have conducted a traditional literature review focusing on the main themes of this article: Design Responsibilities and Design Rights. Three data collecting moments were executed in order to understand the perception and experience of the students, professors and professionals about the topic in question. In regard to the Methodology, first an Online Questionnaire was conducted (129 participants) to collect general quantitative data, then a qualitative research with Individual Interviews (12 people interviewed) and lastly, another quantitative research with a Survey (19 answers) so that participants could validate all the data collected and potential solutions generated throughout the study (Fig. 1).

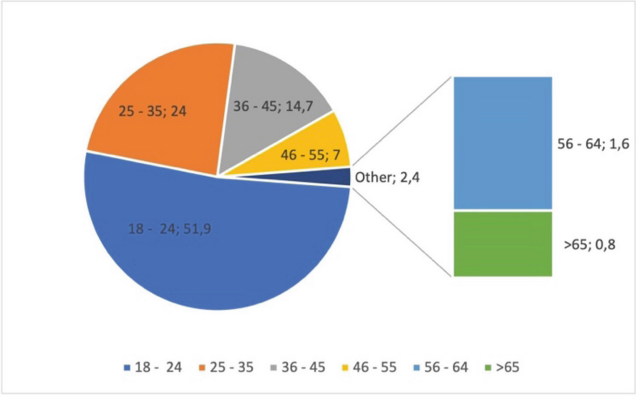
We gathered in an online questionnaire quantitative data which allowed us to collect information about the origin of the design problems at hand. We surveyed 136 designers, students, design professors and design professionals. We had a total of 129 valid responses, between the ages of 18 and 65 or more (Table 3). The age group of 18 and 24 were 51.9% of responses, followed by 24% between 25 and 35, from 36 to 45 with

Fig. 1. Methodology Scheme

14.7%, between 46 and 55 were 7%, two responses (1.6%) from 56 to 64 and only one answer (0.8%) from a respondent over 65 years of age. Regarding gender, 88 responses were female and 41 male. In terms of district of residence, Lisbon was the district with the most responses with 101, followed by Setúbal with 7, Leiria with 11, Braga with 3, Santarém with 2 and then Aveiro, Coimbra, Évora, Castelo Branco, Faro with one answer each. The questionnaire was divided into three parts: Students, Teachers and Professionals, as they have different experiences and perspectives on the current situation. 77 responses were obtained from students (undergraduate, masters, doctorate and others), followed by 36 responses from professionals and 16 responses from professors. Each will respond both in terms of Responsibilities and Rights.

We also did qualitative research with 12 interviews with participants being between 21 and 52 years old, 7 female and 5 male. Half are students, 3 are teachers and the remaining 3 are professionals. Most reside in Lisbon and belong to the areas of Graphic Design, Product Design and Design Management. In terms of degree of studies, 4 have a PhD, 4 are from the 2nd year of the Masters, 3 are from the 3rd year of the Licentiate Degree and 1 are from the 1st year of the Masters. In relation to years of experience, most with less than 10 years, others with more than 20.

Table. 3. Online Questionnaire Demographics

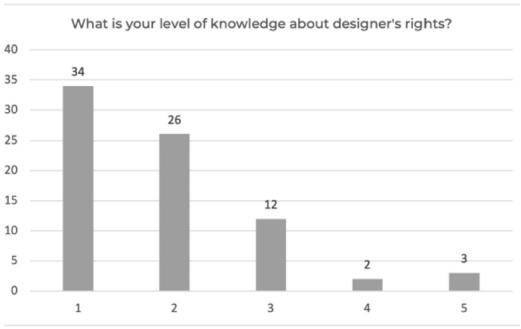


Between these moments, we had closed interviews with professors, professionals and students. In order to validate the previous results a survey was done as a way to solidify the conclusion. Thus, it was possible, in a third moment, to ask the questionnaire and interview participants to validate it with graphics and information. The questions were answered with a Likert Scale, from 0 to 5, with 0 being "Strongly Disagree" and 5 "Strongly Agree". 20 responses were received, of which 19 are valid. The survey consists of five questions, which will validate, help to conclude and understand the data collected during the investigation.

6 Conclusions

As noted, the area of Design and Design management are still not recognized for their true functions – or for lack of dissemination of information on the subject in Portugal. As for Design Education, it was discovered that students do not have the necessary tools to make them feel safe during their professional career (Table 4). Furthermore, teachers who have a medium-high level do not have the chance to teach the information that students need. Most also mention that they consider that the implementation of new methodologies (e.g. workshops) would be beneficial in higher education courses to fill gaps. Therefore, it can be concluded that the themes need to be more present in the study plans of educational organizations. As for teaching, it is not responding to knowledge gaps about the Responsibilities/Rights of designers during and after the courses.

Table 4. Student Question, Section 6 of the Questionnaire

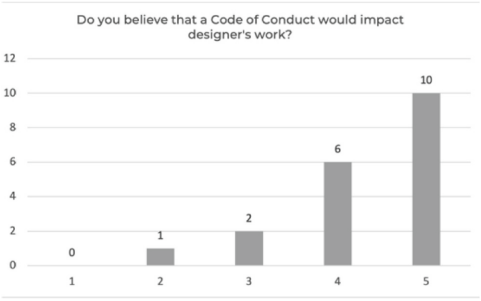


As for professionals, when asked about the legal part of protecting their work (intellectual property) and their protection as a professional (worker's rights) they say that they do not feel prepared and that they are more likely to hire someone to help them.

Regarding legislation and rights, they state that it is imperative to update the laws to include designers clearly. As for the Order of Designers, most agree and feel safer and more protected with the regulation of the community (Table 5). In terms of Responsibility and Conduct, it is necessary to reinforce how much Design can be used in a questionable and partial way. In relation to Rights, there are gaps in the legislation, placing designers

in an unrecognized position. There is no profession that meets the needs of users that does not have a code of conduct or order, as it is vital for the identity and organization of the group (Brandão 2005).

Table 5. Question 4, Survey



In Portugal, it is necessary that the Government sensitize the population, recognize Design as a specific area in the middle so that more jobs are created and invest in the training of young designers (Gomes 2003).

There is an opportunity and demand to choose an organization or order that is the official representation of the Portuguese government (93% of respondents in the questionnaire and 89% in the Survey). Furthermore, 96% in the questionnaire and 84% in the survey consider that the implementation of a code of conduct would help to structure the Design area. For this reason, if an official representation is formulated, it will be able to implement a code of conduct for official regulation, represent the various existing nuclei with a united front with the same objective, help new professionals and also represent Portuguese Design inside and outside the parents. Thus, it is concluded that there is a need to manage the Design area so that the profession can thrive, growing at a controlled pace and in order to be able to support designers during their academic and professional path.

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Multi-disciplinary, Inter-disciplinary, Anti-disciplinary. Transition Knowledges in Design Education

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Abstract. The environmental issues are recently proving to be the center and the connecting element of all the states of crisis, only apparently diversified (energy, political, migration); after the lucid forward-looking analysis of Maldonado in the 70s, the vision proposed in 2019 by the exhibition *Broken Nature* opens new spaces to the "design hope" activated by design, emphasizing the broad responsibility that the designer must take on contemporary challenges. The complex scenarios of the "transition" (environmental, cultural, productive) are also based on the ability of disciplinary encroachment and on the most radical forms of "anti-disciplinary" innovation, which in some cases opens to design forms of interaction with the most advanced scientific disciplines. The study proposes to explore some approaches and visions that go beyond the interdisciplinarity, already widely practiced in the research and teaching of design, feeding theoretical reflections, methodological oriented to the construction of new ways of connection between knowledge. Even in the most advanced levels of the designer's training, some didactic experiences in the national and international field are proposed as distinctly interdisciplinary and intercultural paths, fields of didactic-experimentation, scientific related to territorial/global contexts models of complexity and interconnection.

Keywords: Anti-disciplinary · Design Education · Design Culture · Complexity · Transition

"Il design è un ingrediente fondamentale della vita e della società, anche perché aiuta le persone ad affrontare il cambiamento. Questo è il momento perfetto per dimostrare la sua importanza" (Antonelli 2020, p.10)[1].

1 Introduction: From Applied Rationality to Multiplied Rationality

In 1970 Tomás Maldonado in a small and very dense volume, *La Speranza progettuale*, denounced such a state of alarming degradation of the environment, to require a deep

[1] "Design is a fundamental ingredient of human life and society, also because it helps people to face changements. This is the perfect time to prove its importance" (Author's translation).

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critical reflection on the task of the designer and in particular of the discipline of design. He develops an incisive analysis of the relationship between design and innovation, between critical consciousness and design consciousness, between design and revolution.

"Come crediamo di avere dimostrato il deterioramento del nostro ambiente è giunto ad un grado tale, che qualsiasi nuovo rinvio, anche minimale, finirebbe con il compromettere sostanzialmente la nostra sopravvivenza" (Maldonado 1970 p. 141)[2].

The text proposes today all the visionary ability of anticipation of the great theorist and founder of the teaching of design in the Italian university: environmental issues have effectively proved the centre and the connecting element of all states of crisis, only apparently diversified (climate, political, migratory, health, etc.). Whereas today - given the complexity of digital communication and connection systems, the emergence of social conversation networks, the interconnection of scientific, technological and design research processes - the concept of "applied rationality" in which the author places his perspective of design hope, can perhaps be expanded into that of "multiplied rationality".

Within the disciplines of the project in fact, experimentation based on forms of collective intelligence (social design, participatory design) and connective intelligence (design thinking, open design, co-design) is intensified, intertwining contributions of different epistemological visions, scientific and didactic disciplinary fields, social actors and territorial policies.

Above all, these general considerations want to give account of the urgency to redesign again the perspective of a new "design hope"; in fact, design, which was born historically as a project of the industrial product, even if with articulated implications (artistic, social, ethical and political), is now facing with the need for a further paradigm shift, which can demonstrate - or not – the above mentioned quality (Antonelli 2020, p.10), as a "fundamental ingredient of human life and society" in the "transition to sustainability"[3].

2 Everyday Life and Proximity

Maldonado ends affirming that: "comunque stiano le cose il progettista dovrà agire, dovrà abbandonare definitivamente la «sala d'attesa» in cui lo si è costretto a restare fin ora. E dovrà agire anche se il quesito rimarrà sempre aperto, cioè senza sapere se alla fine l'autonomia non si dimostrerà sempre un'illusione" (Maldonado 1970 p. 141)[4].

[2] "As we believe we have shown the deterioration of our environment has come to such a degree, that any new postponement, even minimal, would end up substantially compromising our survival" (Author's translation).

[3] The most significant publication of the EEA-European Environment Agency, SOER 2020, announces, despite the improvements of recent decades, a worrying environmental future for Europe. The globalised and systemic nature of future environmental challenges implies that, in order to achieve the EU's long-term sustainability objectives, substantial changes will need to be made to fundamental social systems, in particular food systems, energy, mobility and the built environment (EEA, 2020).

[4] "Whatever the situation, the designer will have to act, will have to abandon definitively the «waiting room» in which he has been forced to stay till now. And it will have to act, even if the question will always remain open, that is, without knowing whether in the end autonomy will not always prove an illusion" (Author's translation).

Gathering today the indication of its great theorist, design will perhaps also add to its increasingly complex and dynamic map of knowledge, practices and methods, a kind of "creative activism", which nourishes the ability to respond to the state of permanent emergency in which we live. It is up to design, preparing and strategically connecting the various possible disciplinary contributions, but also developing new forms of collective intelligence: virtuous synergies put in place by territorial actors, by communities of practice and especially by the users. It is therefore a matter of developing an equally timely capacity for cultural and social elaboration, to be immediately poured into reality, with or without the mediation of institutions, companies, academic structures; indeed, activating "from below" connections, actions and ideas, starting from the rediscovery of the richness of the dimensions of proximity and everyday life.

The attention to the transformations of the ways of life in the daily life, is one of the ways of research and design processing inherent to "design driven" innovation:

"Saper vedere consente di individuare le esigenze tacite e inespresse delle persone, spesso tramutabili in opportunità per l'innovazione. È una capacità connaturata al design, talvolta una dimensione inconsapevole generata dalla e nella quotidianità ed è particolarmente rilevante, nel modello italiano, in quegli ambiti - casa, lavoro, divertimento - esperiti nella quotidianità da ogni progettista" (Treccani 2021)[5].

From another front of research and reflection, the anthropologist Michel de Certeau, in his fundamental text, *The invention of everyday life*, notes that the "technical path to follow consists in bringing scientific practices and languages back to their place of origin, everyday life, everyday life", indicating the overcoming of that line of demarcation traceable to modernity that affirms the superiority of the "powers of techniques on social practices. It separates the procedures of a specific knowledge from the natural languages on which the common signifying activity is based" (de Certeau 2012, p.10). Today this limit, deeply rooted in the industrial culture - therefore in the culture of design - begins to be questioned by the spread of collaborative design methods and practices, that feed on the social practices and specific forms of innovation they develop (Trapani 2018, p. 154).

On the other hand, travel restrictions imposed during lockdown periods due to the COVID pandemic have shown the importance of "proximity": according to Ezio Manzini (Manzini 2021, p,3), it is a "generative" concept that allows to connect the issues of services to citizens, of caring for people, of the regeneration of urban spaces, "pushing us to reflect on a future of cities that does not develop on a central-suburban axis, but with a plurality of centers, each one with its specificities". It is the same direction of the "15 min city", launched by the Mayor of Paris, Anne Hildago: it promotes the idea that every citizen in a short perimeter and in the time frame of 15 min, may have access to six fundamental functions: living, working, supplying, caring, learning, enjoying (Tricarico and De Vidovich 2021).

[5] "Knowing how to see allows us to identify the tacit and unexpressed needs of people, often transformed into opportunities for innovation. It is a skill inherent in design, sometimes an unconscious dimension generated by and in everyday life and is particularly relevant, in the Italian model, in those areas - home, work, fun - experienced in everyday life by every designer" (Author's translation). https://www.treccani.it/enciclopedia/design-strategico_%28XXI-Secolo%29/, last accessed 2021/12/01.

3 Interdisciplinarity for the Complexity

After the experience of the pandemic, the words of Paola Antonelli[6], above quoted in the epigraph, indicate with a particular strenght the challenge that design and the entire culture of the project must take on, without any possibility of compromise, mediation and referrals. The level of severity of environmental problems and the need to activate multiple strategies of "repair" of the environment, were effectively represented in the exhibition *Broken Nature. Design Takes on Survival*, curated by Paola Antonelli with Ala Tannir at 2019 Triennale di Milano. The event has profoundly transformed the current perception of the mission and design dimension, expanding its vision, the field of knowledge, sensibilities, the ability to build connections and forms of participation. Antonelli also emphasized the limit constituted in the evolutionary line of the discipline by the concept of "user centered design"[7]. It is no more enough interacting and co-designing with consumers, according to the methods of "design thinking", while it is necessary to be aware of the duty to act for a radical change, in the extraordinary complexity of interrelations of all the elements of the biosphere. Design takes on a particular responsibility, because:

"I suoi metodi dovrebbero essere rivolti non solo a correggere il corso autodistruttivo dell'umanità, ma anche a reintegrare il nostro rapporto con l'ambiente e con tutte le specie, compresi gli altri esseri umani, […] lo sforzo combinato di squadre interdisciplinari e internazionali; di aziende, industrie e governi; e della base della cittadinanza. In ogni caso il design sarà un elemento connettivo fondamentale" (Antonelli and Tannir 2019, p. 38)[8].

This vision opens the perspective of new connections between disciplines. It now outlines an evolutionary scenario in the research and teaching of design that differs sharply from the recognized historical vocation of design to interdisciplinarity: new lines of research that also follow the path of a more radical trans-disciplinarity, based

[6] Paola Antonelli, Senior Curator, Department of Architecture and Design, and Director, Research and Development of MoMA, where she started working in 1994, after studying architecture at the Politecnico di Milano, was awarded an AIGA medal in 2015 for "expanding the influence of design in everyday life by sharing fresh and incisive observations and curated provocative exhibitions at MoMA". She was ranked as one of the hundred most powerful people in the art world by *Art Review* and *Surface Magazine*. He has curated several architecture and design exhibitions in Italy, France and Japan.

[7] The most well-known application of design with strategic problem-solving implications for companies is Design Thinking, in which the expressed needs of consumers are met through a user-centered approach. The innovation process is totally focused on consumers, who play an active role, participating in the co-creation of value. Design Thinking offers a package of analysis tools, in which observation, experimentation and the search for empathy with the customer are enhanced. However, the innovation produced is market-pull, because everything depends on what is required by consumers, while the scope of latent needs that radically change the meaning of products and services remains unexplored.

[8] "Design methods should be aimed not only at correcting the self-destructive course of humanity, but also at reintegrating our relationship with the environment and with all species, including other human beings, […] the combined effort of interdisciplinary and international teams; of companies, industries and governments; and the basis of citizenship. In any case, design will be a fundamental connective element" (Author's translation).

on adherence to the issues of complexity, with an epistemological approach that seems indispensable to trigger the radical processes of transition and repair of the environment[9].

While the scientific disciplines and design practices, organized in the system of knowledge are transformed into "fluid" fields of knowledge, increasingly interrelated and multidimensional (Manzini 2006, p.12), which circumvent the traditional academic partitions, also in the designer's operational skills.

"il momento attuale chiede sempre più di superare il concetto di "professionalità ristretta" limitata a competenze di routine operative in favore di una professionalità allargata" che sappia interpretare e guidare i profondi mutamenti in atto" (Riccini 2016, p.356)[10].

Design, by its nature dedicated to interdisciplinarity and inclusiveness[11], therefore faces a decisive moment, in which the theoretical-critical and methodological choices will not only have repercussions within the academic debate and its didactic structure, but they will lead to the redefinition of one's own knowledge and field of action, equipped with a real technical-scientific and socio-cultural relevance; while currently it is more diffused an idea of design as "such an open, flexible, all-encompassing field" such, to lend itself to incursions, deformations, instrumentalizations by other disciplines that have other purposes, beyond design and design thinking.

4 Specialization vs. Wide Field

It is in relation to this complex and problematic scenario that we should ask: how to continue to deepen and develop the historicized and specific themes of design and at the same time - in the perspective of a necessary decisive reversal of trend - laying the foundations for a new approach to design and knowledge processing, able to face the scale and complexity of the issue? How can we avoid favoring in design research and teaching, the adherence to the well-established fields of academic disciplines or, in any case, to the dominant scientific paradigms, which often direct - and even unconsciously force - the research activity on already defined paths[12]?

[9] There are many approaches to the theory of complexity: in Italy, they have been covered under several disciplinary perspectives, since the 80s. According to E. Morin, considered the greatest theorist of the subject, modern culture would be derived from mechanistic science a dichotomous and reductionist conception; complexity is an antidote to atomization and separation, to a progress out of context. In fact, the theory of complex systems is based on the idea that in an isolated system the disorder irreversibly increases, the entropy that would lead it to death. Instead, it is the continuous exchanges of an open system that define life and its balance. Ecology also takes account of the exchange between open systems and the environment. Complexity is the challenge we face. (Morin 2017).

[10] "The current moment increasingly demands to overcome the concept of «narrow professionalism», limited to routine operational skills, in favor of an «enlarged professionalism» that can interpret and guide the profound changes underway" (Author's translation).

[11] Bruce Mau in his manifesto-project *Massive Change*, states: "moving from product design to transition economies, from graphic design to information economies, design is reconfigured as an interdisciplinary, distributed, plural and collaborative activity" (Mau 2004, p.16).

[12] "A paradigm can both clarify and blind, reveal and conceal. In its bosom the central problem of the game of truth and error is nestled" (Morin, 2001, p. 26).

"The history of science, however, is not only that of the constitution and proliferation of disciplines, but also that of the breaking of interdisciplinary barriers, of the encroachments of a problem deriving from one discipline to another, of the circulation of concepts, of the constitution of hybrid disciplines that will eventually become autonomous. Finally, it is also the history of the formation of complexes in which the different disciplines aggregate and agglutinate. In other words, if the history of science is that of disciplinarity, another linked and inseparable history is that of inter-poly-trans-disciplinarity" (Morin 2000, p.111).

The French philosopher Edgar Morin, sociologist and father of the "complex thought", has long indicated the need for a new "knowledge of knowledge", which educates to the "thought of complexity" and multiplicity; a "pertinent knowledge" as it falls into a real context and aimed at the recomposition of a global vision, especially in the issues affecting humanity and Planet Earth. Morin's thought and vision can also guide a first answer to the questions posed.

"Contrary to popular opinion, the development of general mental aptitudes allows a better development of particular or specialized skills. The more powerful is the general intelligence, the greater is its ability to treat specific problems" (Morin 2001, p. 39).

Just the most theoretical of complexity therefore indicates the most effective way to deal with seemingly defined and circumscribed problems. The specific problems that design faces as a discipline of the project - where innovation is elaborated and spread, and transformations are produced in socio-cultural contexts - require on the one hand depth skills and a very specialized approach, on the other hand the framing in a "broad field", which facilitates dialogue with "the bearer of other themes and problems" (Manzini 2006, p.12), and other knowledge and skills. However, the effectiveness and relevance of design is always commensurate with the action of its most "expert" competence, able to use "cultural and practical tools that can integrate and promote the design skills of non-experts"; in particular, in the processes of social innovation, where forms of co-design emerge, that can also have articulated and sometimes contradictory aspects (Selloni 2015).

5 An Anti-disciplinary Discipline

Among the disciplines of the project, design is considered the least formalized area scientifically, because it is based essentially on experimental practices and because it constantly "records" and often anticipates the changes of a complex and evolving reality, to be interpreted. This particularity of its proposal - apparently - without a fully codified scientific statute has however made it a discipline, "ductile, resilient, opportunist" (Legnante 2016, p.17), able to accept the changes, adapt and respond in original and innovative terms to opportunities and critical issues. But from another point of view, design is instead to be considered as a discipline completely placed in the field of science, as "falsifiable", in the sense of Karl Popper: its results are always open, refutable, destined

to be overcome by changing global conditions and contextual situations, knowledge, technologies and needs[13].

In other respects, we can also consider design a discipline with a marked anti-disciplinary nature. The semantic complexity of the term "anti-disciplinary" refers to the increasingly emerging issue of the relationship between design and science, which has found an extraordinary field of experimentation in the research of the MIT Media Lab in Boston[14]. Joichi Ito, former director of the prestigious research institution, says about the relationship between design and science that the two areas are sufficiently independent from each other, so that today we can work on both in terms of a fusion radically innovative and regenerative of new objectives and scientific perspectives, completely unimaginable within fields of knowledge traditionally connected and interacting:

"Design and science are opposed one another on the circle, and the output of one is not the input of the other as is often the case of engineering and design or science and engineering. I believe that by making a "lens" and a fusion of design and science, we can fundamentally advance both. […] Interdisciplinary work is when people from different disciplines work together. But the anti-disciplinary is something very different; it's about working in spaces that simply don't fit into any existing academic discipline, a specific field of study with its own particular words, frameworks, and methods. […] Perhaps we can design something that is both rigorous enough, engaging enough, and antidisciplinary enough not only to survive, but to thrive." (Ito 2016).

The anti-disciplinary, beyond the proposed definition, therefore alludes to a "white space" that for the designer today is not only the prospect of a new complex and fascinating work area, but is also the conceptual key of the relationship between science and design, which today has also a particular philosophical relevance, starting from an increasingly smaller distance between nature and the artificial, between material and immaterial, in a continuous process of integration and even "fusion". Synthetic biology, which is about our ability to change natural processes, or artificial intelligence, which develops in relation to the study of cognitive processes, faces enormously complex problems, that continually cross the boundaries between natural and artificial and consequently also the boundaries of existing disciplines. We therefore discover that we must depend on nature to cross the complexity and uncertainty that characterizes our present environmental and cultural condition.

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[13] In the *Logic of Scientific Discovery* (1934/1958), K. Popper states that a theory is scientific if it formulates predictions that can be falsified by experience. The continuous application of this method is for Popper an expression of the never definitive character of scientific knowledge, but at the same time a guarantee of the growth of knowledge and of its undefined approach to truth.

[14] Founded in 1985, the MIT Media Lab is one of the world's leading research and academic organizations. Unconstrained by traditional disciplines, Media Lab designers, engineers, artists, and scientists strive to create technologies and experiences that enable people to understand and transform their lives, communities, and environments. Faculty, students, and researchers work together on hundreds of projects across disciplines as diverse as social robotics, physical and cognitive prostheses, new models and tools for learning, community bioengineering, and models for sustainable cities. Art, science, design, and technology, play off each other in an environment designed for collaboration and inspiration.

6 Teaching Design for the Real World

The need to build open and unconventional methodological frameworks for design is evident in the most advanced research activities, where contributions from different disciplines can more freely aggregate, and where specific international programmes mostly call for innovative and interdisciplinary approaches. But in their teaching articulation, also the structures dedicated to the training of the designer begin to welcome complex themes and open and adaptive learning processes, with the aim of building professional profiles with skills and visions oriented to the quality of life, able to articulate the project as a process of knowledge and participation in the transformation in progress.

Historically, the schools for the training of designers have set themselves, *founding* or *refounding* objectives, precisely through the experimentation of new connections between the practical knowledge and the dynamics of innovation driven by the evolution of the techno-scientific disciplines[15]. In rereading the stories and geographies of design teaching, it emerges that the multidisciplinary dimension has been the ground on which to base the experimentation and formalization of teaching methodologies for the project; but also, to connect the needs of production with social issues and cultural productions, laying the foundations of the "design culture" as defined by Ezio Manzini:

"However, design is not only the sum of its methodologies and tools. Neither is the role of design experts reducible merely to this equation. Before being a technique, design is a capacity for critical analysis and reflection, with which design experts produce knowledge, visions, and quality criteria that can be made concrete in feasible proposals. And this understanding holds true at all levels: from the single local solution to the evolution of the entire socio-technical system. Therefore, whoever steps forward as a design expert must also be—and be acknowledged as—a carrier of this specific culture: the design culture. Design culture encompasses the knowledge, values, visions, and quality criteria that emerge from the tangle of conversations occurring during design activities (the ones that are open to interaction with a variety of actors and cultures) and the conversations that take place in various design arenas" (Manzini 2016, p.54).

In design-centered teaching, different disciplines and approaches to innovation meet in an articulated manner. Design, humanistic, techno-scientific, interpretation, representation, management, etc., generally coexist in an essentially "peaceful" condition of complementarity: this is the "juxtaposition of knowledge" that characterizes the multidisciplinary approach practiced in the various levels and directions of design teaching.

We must also consider how the academic institutions are strongly organized, in the staff and in the educational and scientific structures, around the disciplinary areas and groups. A complex and rigid bureaucracy therefore hinders the fluidity of the lines of research and didactic experimentation, interdisciplinary aggregations, trans-disciplinary and even more anti-disciplinary experimentations. It follows that in academic institutions "incremental innovation" is mainly produced, leaving little room for those forms of "radical innovation" that should be implemented today (Penati 2001, p.47).

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[15] Cfr. *Tre scuole: Bauhaus, Vchutemas, Ulm*, Casabella n.435/1978, (Dir.T. Maldonado), Electa, Milano.

The design schools also propose a strong identity connected to their academic tradition and to the productive and cultural characteristics of their reference context; this also implies the need for a clear codification of the training and job opportunities that are offered to young designers, while it is risky and difficult to develop in teaching those reversals and distortions of the "points of view", that today can produce the desired radical change of perspective in planning the future.

The proposal of more driven forms of interaction between knowledge, interests above all the most advanced levels of design teaching, where students are already equipped with a specific basic training and a developed autonomy and critical capacity. The emerging project themes that in many cases are the subject of specialization courses or PhD programs, tend increasingly to stimulate new learning processes that embrace the complexity of reality and aim to develop forms of systemic and radical innovation. We therefore want to conclude with the analysis of some training paths, in the national and international context, that propose themselves as fields of didactic-scientific self-designing experimentation, trying to deal with multidimensional issues and practice a holistic approach. In particular, some proposals for advanced teaching combine the most up-to-date technical-scientific skills with the attention to local realities at different scales. The complex dimension in which we live and act, as designers and as people, can offer concrete and dynamic models of inspiration. In addition to the more consolidated forms of action-research in the productive and socio-cultural contexts of proximity, today some schools propose the exploration of wider and even global territorial scenarios. They intercept the innovative dynamics, virtuous or not, connecting the flows of production and information, the characters and expressions of communities, the complex environmental variables, geo-political mutations.

A general overview on master's training (Master Degree) in Italian universities highlights the constant prevalence of specialized courses that trace, albeit with different emphases, the historical bipartition of design in product and visual communication, alongside courses related to specific local vocations or codified professional activities. Other courses aim to explore the complex processes of innovation, focused mainly on the techno-scientific fields and the transformations of production processes (advanced design); while other higher education courses are modeled on a methodology and vision of the project as a process of virtuous transformation, starting from the production systems of a geographical, economic and cultural context, to extend to social practices (Systemic design).

If we move into the European context, proposals emerge for training paths that tend even more to expand the intersection of design with other disciplinary fields "to facilitate a deeper understanding of today's complex society, but above all to propose transformations through design" (Design Academy Eindhoven 2021).

The Master Degree GEO-DESIGN of the Design Academy Eindhoven is presented as a "platform" to explore the social, economic, territorial and geopolitical components with which design today is confronted; The school's critical focus on industrial production as responsible for the current environmental and social instability involves the intention to base the training on an understanding of reality, its multiple dimensions and global issues: design must cross, interpret and regenerate the most diverse knowledge "from

material stories to cultural visions of the world, from humanism to ecology, from plant and animal rights to artificial intelligence, from the core of the Earth to Space".

While in Italy a second level university course is proposed as an interpreter of inter-disciplinary and planetary issues: Planet Live Design offers an unprecedented educational path in the current academic system, with the ambition of "prepare designers specialized in the design of new, conscious and intelligent ways of existence on the planet" through a multidisciplinary, multicultural and multinational educational offer (University of Campania 2021).

Other design schools of great international prestige offer a multidisciplinary and transnational program: the Global Innovation Design (GID) offers a double Master, from the Royal College of Art (RCA) and the Imperial College London (ICL)[16]. In fact, the course is jointly managed by the two institutions and in addition each student spends two semesters abroad at highly qualified and "global" inspired universities; the student's experience thus develops not only through "a rich mix of perspectives on design, engineering, business and culture" but also towards an intercultural perspective that strengthens the ability to combine different points of view and therefore to feed the multiplicity of "conversations" that flow into the design culture.

In conclusion, it can be said that the consolidated foresight attitude of design can now move into the ability to anticipate and experience significant connections of the scientific fields, of experiences, of visions aimed at the care and survival of the "real world".

And it is desirable that design can renew and revive its consolidated character of "relational discipline", experimenting with new ways of "fusion" with other knowledge and collaboration with all the actors of the environmental, technological and cultural transition, at the heart of international politics and the hopes of future generations.

Consolidating in design training the methodologies that facilitate the understanding and comparison with the complex problems of reality, means substantially soliciting the ability to cross the domains of disciplines, directing the curiosity and design intelligence of younger people towards forms of relevant knowledge and - potentially - radical innovation; teaching design through truly proactive connections also means activating and amplifying it in productive and social contexts furthest from academic elaborations, the creative skills and awareness of young design professionals in responding to the challenges that emerge from an increasingly dense reality of pressing issues.

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Design for Health and Wellbeing

A Product Design Approach to Promote: Psychological Detachment in Remote Work from Home

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Abstract. This research seeks to respond to a current problem, which has to do with the impact of remote work, from home, on the mental health of "knowledge workers" in particular. One of the greatest struggles people report having is being able to disconnect from work, a state known in the field of psychology as Psychological Detachment.

In this context, the main objective of this work was to create a product capable of helping people in the process of disconnecting from work at home. To this end, we established an interdisciplinary research where the contribution of psychology stood out. After conducting a literature review, which culminated in the definition of a theoretical framework, we carried out user research, starting with surveys to find out about users who are being affected and concluding this stage with an Ideation workshop where users were encouraged to design solutions to help them disconnect from work. This collaborative and iterative process resulted in a number of ideas emerging alongside the theoretical framework, culminating in the proposal of three product concepts specifically aimed at helping people disconnect. These were subsequently evaluated by users and, according to their perceptions, gathered using User Experience Questionnaire. One of the concepts was chosen for refinement. Due to constraints imposed by the COVID-19 pandemic it was not possible to produce a prototype of this concept for evaluation with users, which limits this study. Obtained results and their implications are discussed.

Keywords: Product design · well-being · work-life balance · work from home · psychological detachment

1 Introduction

The ability to stop thinking about work or to achieve a state of mental disengagement during off hours is known as psychological detachment (Sonnentag 2012). Previous studies have found that psychological detachment from work during off-hours is beneficial for wellbeing (Sonnentag & Fritz 2014). Well-being is a broad concept that comprises both favorable short-term affective states (e.g., enthusiasm, relaxation) and more long-term aspects of psychological health (e.g., life satisfaction, absence of burnout) (Sonnentag 2012, p. 115).

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By contrast, failure to successfully achieve psychological detachment from work has been associated with several health-related problems, such as sleep disturbance, dysphoria and cardiovascular disease. Switching-off from work is therefore an important mean to prevent work-related long-term health problems (Cropley & Millward 2009).

The pandemic of COVID-19 in the last two years has dramatically affected societies and the economy, contributing to accelerate the ongoing transformation in the way we work, namely boosting remote working from home. However, remote working from home has been associated with an increase in the reported cases of incapacity to disconnect from work, which has become a current major concern in terms of health and wellbeing, as shown on the report of the State of Remote Work 2021 (Buffer).

Despite the existence of many studies focused on understanding how this "spillover" of work into people's lives or the inability to "psychological detach" from work has a direct negative impact on health and well-being, few studies have addressed this issue from a design perspective.

Previous studies suggest that psychological detachment is negatively affected by the lack or blurring of boundaries between the two domains (i.e., work and leisure), accentuated by the scarcity of physical differentiations (Sonnentag, Kuttler & Fritz 2010). In the case of remote work from home, the workplace no longer necessarily has a space (Physical) distinct from home, which reinforces the importance of understanding the complex relation of work-home interactions.

2 Problem Statement

This study focused on the following problem: How can product design help achieve the process of psychological detachment from work at home.

From the latest State of Remote Work report, carried out by Buffer (2021), for the last three consecutive years of this survey the biggest struggle with working remotely has been "Not being able to unplug". On Teleworking and Occupational Health, of the Covid-19 Barometer of NOVA National School of Public Health, the results show that 54% (n = 581) of the respondents are satisfied with their situation of teleworking. However, only 37% (n = 400) are satisfied with the balance between telework and personal life. In fact, 59% (n = 661) consider that "they work more hours than usual" and 42% (n = 453) considers that it is not possible to "disconnect work" to be able to rest. However, approximately 70% of respondents consider that they have full autonomy and flexibility so they can decide how and when the job is done. Studies carried out by Eurofound (2021) show that people who work regularly at home are more than twice as likely to exceed the maximum limit of 48 h a week, compared to those who work in office buildings. Almost 30% of people who work from home say they work during their free time every day or several times a week, compared to less than 5% of those who work in an office environment.

From the psychology field, this issue is framed on the spatial and technological boundary arrangements between work and home, and people's ability to create and maintain boundaries between their work and non-work roles (Ashforth 2000). Thus, we attempt to understand the phenomenon in order to collect actionable strategies aiming to translate them into a physical product with the intent of easing the role transitions and providing marks or signs that could help identify the need for unplugging.

Every stage of the development of this research has been carried out in order to answer the following questions:

- To frame the problem and define the scope:
  RQ1: What are the fundamental struggles or difficulties that people working from home are having?
- To navigate the literature and find key references and build the framework:
  RQ2: What are the most common strategies implemented by users for achieving psychological detachment, and maintaining the work-home boundaries?
- Our main concern while conducting user research:
  RQ3: What patterns, in daily routines of remote workers working from home, can be seen as an opportunity for implementing a design solution that could help to disconnect from work?

3 Relevance

There's an evident increased interest on the subject of employees' mental health, in all scale companies, mostly because it is directly impacting productivity and worker relationships, compromising companies interests. As referred in Deloitte's Mental health and employers report (2020), this can be grasped from the use of terms such as presenteeism, "where people work when they are not at their most productive", and the newer trend of leaveism "where employees feel they must work outside of their normal working hours". This challenges the preconceptions and cultural forms that "overworking" is acceptable and is related to success.

The relevance of this study thus lies on the one hand in the intention to promote the individual capacity of each person to make better decisions regarding their health and well-being and, on the other hand, to assume the mediating role of artefacts, as agents capable of enabling human behaviour and, thus, transforming society.

4 Design of the Study/Research

The following diagram (see Fig. 1) visually illustrates how this study was organised, its main stages and the interconnections between moments.

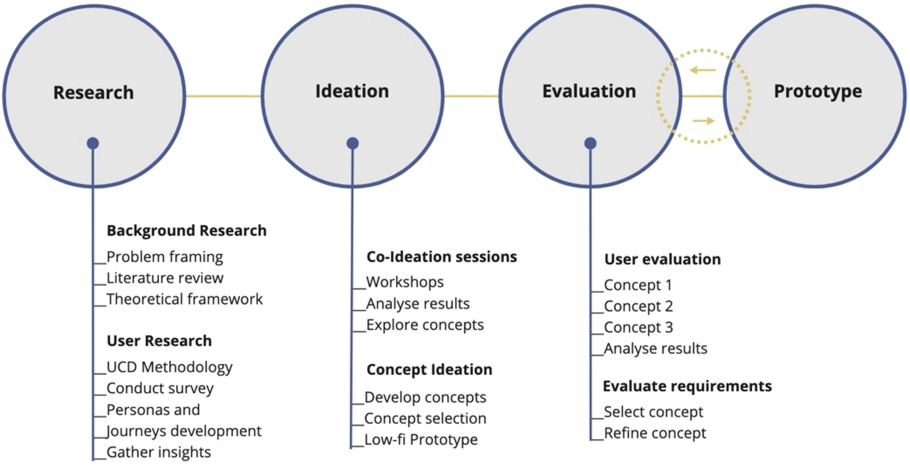

Fig. 1. Study diagram

5 Literature Review

Well-being is a keyword in the WHO definition of health; "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity". Multiple studies across different disciplines have shown how work conditions directly impact individuals' well-being. "Stressful work situations are associated with poor individual well-being and increase health risks, particularly high workload" (Sonnentag & Bayer 2005, p. 393). In the current context of extensive use of remote work practices, the term of working from home is often seen as a "double-edged sword" as this practice can increase the chances of conflicts between the domains. Clark (2000) defines this balance as "satisfaction and good functioning at work and at home with a minimum of role conflict". Most of the work in this area makes a simplistic distinction between home-life and work-life and does not differentiate between different classifications of responsibilities within each sphere.

In the search for balance, where the meaning of "home" and "work" concepts start blurring and juxtaposing, depending on the level of "integration" or "segmentation" that each person has in their dynamics (Nippert-Eng 1996), the fundamental difference between the space where we live and the space where we work are matters of significance and meaning. Both have potentially the possibility to foster a wide range of activities and, in relation to how they are structured, are filled with cues that lead on how to use and navigate them although most spaces are created with a primary purpose and this purpose determines their design and sensory characteristics (Proshansky 1983). Each place gives people the structure to perform certain type of activities and acts as the platform to manage different types of roles, depending on the activity that is taking place, in a way this physical transition help manage the role transition between them, "Whatever the role of an individual (e.g. wife, father, son, doctor, or banker), there are appropriate physical settings that not only help to define this role but indeed determine by virtue of

how well they measure up as supporting physical systems, how competently he or she can be expected to play the role." (Proshansky 1983).

The ease of transitions between this two domains, seems to be a fundamental factor for developing a balanced relationship within the daily activities and the different roles that those activities entail, "the nature of role transitions - That is, the psychological (and, where relevant, physical) movement between roles, including disengaging from one role (Role exit) and engagement in another (Role entry)" (Ashforth, Kreiner & Fugate 2000). In the subject of transitions, two main themes arise, both within the psychology field, that not only gives us the tools for understanding the phenomenon but have extensive research and user studies to comprehend the underlying mechanism of role transitions; boundaries management and recovery process, specifically - Psychological detachment.

The relevant concepts for approaching this subject and consequently developing a theoretical frame are indicated in Fig. 2.

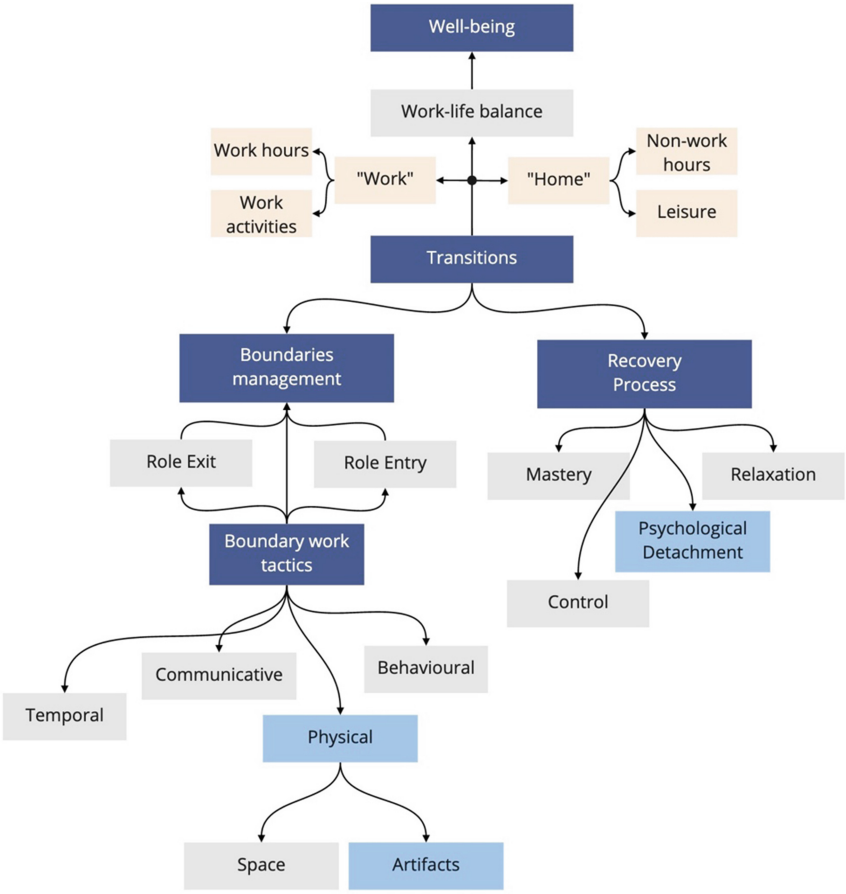

Fig. 2. Revised concepts and their relationship.

5.1 Psychological Detachment

The term Psychological Detachment was introduced by Etzion, Eden, and Lapidot (1998) describing "the individual's sense of being away from the work situation". For example, when a person is detached from work, will not engage in work activities such as answering phone calls or responding emails, and in the psychological aspects it involves stop ruminating about work problems or opportunities. "The term psychological detachment is used to emphasize the psychological component of disengaging from work during off-job time as opposed to being simply physically absent from the workplace. Psychological detachment implies a distraction from job-related thoughts. For psychological detachment to occur, it is not sufficient for one to change location by leaving the working place; one must also take a break from thinking about work-related issues." (Sonnentag & Bayer 2005, p. 395). Psychological detachment plays a fundamental role in recovery processes that refers to the process of reducing or eliminating physical and psychological strain symptoms that have been caused by job demands and stressful events at work (Craig & Cooper 1992).

Individuals differ in the degree to which they detach from work during off-hours. It is probable that a heavy workload and high time pressure increase people's general level of arousal, such that people find it difficult to unwind when leaving their workplace at the end of the workday and instead stay cognitively busy with work-related matters (Sonnentag 2012). In addition, the combination of a heavy workload and high time pressure implies that tasks remain unfinished when employees leave the workplace, which might increase their tendency to continue thinking about work related issues.

5.2 Managing Physical Artifacts

"Artifacts are visually salient, typically tangible markers that serve as cues about a culture, a domain, or an identity" (Elsbach 2004). In her original study on boundary work, Nippert-Eng (1996) found that individuals use physical artifacts (often subconsciously) as ways to negotiate the work-home border. The power of the artifacts as cues or signals is shown in this example: "Even my two-year-old knows when I put on a collar that I'm going to a meeting". Specific examples were found, of many types of artifacts being used instrumentally, which was consistent with previous observational work on artifact use (Nippert-Eng 1996).

As conceptualized by Nippert-Eng (1996), one of boundary theory's key components is the management of the physical borders between work and home. The author notes that "work" and "home" represent two physical domains around which lie borders of various strengths. Weak physical boundaries are easily passed through, while strong physical boundaries can require significant effort to cross. Such boundaries might be a wall, commute, or a door, although these boundaries can be manipulated (Kreiner, Hollensbe, & Sheep 2009).

Some strategies led to the exploration of concepts based on the provision of marks or signs that could help identify the need for unplugging. Figure 3 maps the worked strategies.

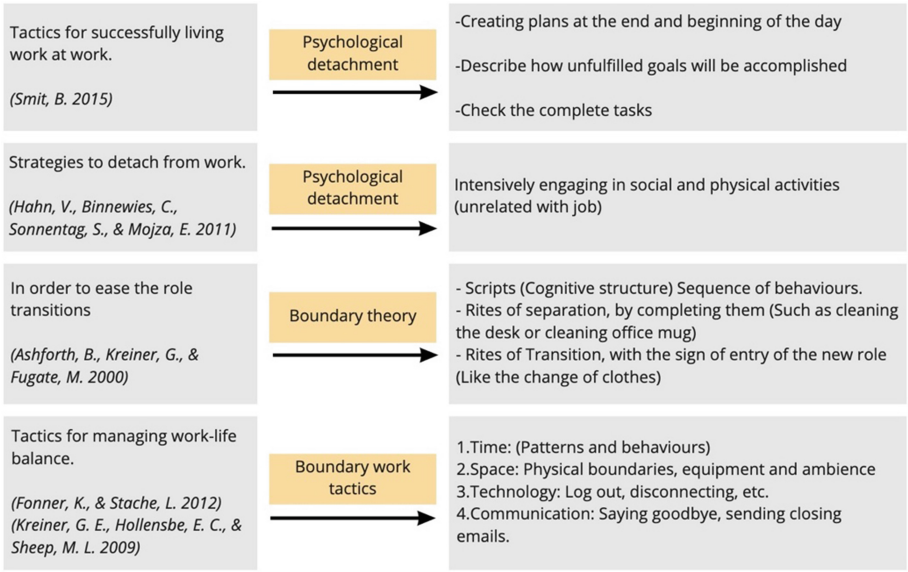

Fig. 3. Summary of strategies

6 Method

The general approach was framed by the ViP (Vision in Product Design) method (Hekkert & Dijk 2011). ViP is a method which advocates that the designer should come up with a vision of the relationship between the user and the product, and then use that vision as the basis for your design. This means examining the underlying ideas of the project in detail before arriving at a proposal, i.e., clarify exactly what we want people to understand, experience or do. The ViP design approach is grounded in three basic principles: 1) It is future oriented; 2) Its interaction centered; 3) Its context driven.

Under this umbrella and after a systematic literature review, we conducted a series of participative methods/techniques intended to generate concepts of artifacts that could boost psychological detachment from work. In general, the study comprised five main phases: 1) Research; 2) Ideation; 3) Evaluation; 4) Prototype and 5) Results and conclusions.

The phase 1 – Research - comprised two main steps: Background research (Problem framing, Literature review, Theoretical framework) and User research (Survey, Personas, User journeys).

The phase 2 – Ideation - comprised co-ideation sessions (Workshop, Explore concepts) and concept ideation (Concepts development, concepts selection, low-fi prototypes).

The phase 3 – Evaluation - comprised User evaluation (Compare concepts), Evaluation against requirements (Select concept and refine).

7 Results and Discussion

User research - Questionnaire

An online questionnaire was applied to understand which strategies were more popular to disconnect from work at the end of the day. The data was collected from a total of 59 people, 56% (N = 33) female and 44% (N = 26) male, 45% (N = 26) in the age ranges of 31–36 and 29% (N = 17) of 25–30, 26% (N = 16) of them living in Portugal, 20% (N = 12) Argentina and other percentages of people in Brazil, Spain, Uk, Germany, and Finland. 90% (N = 53) working from home full time (+40 h per week) and 75% (N = 44) only since the pandemic started in 2020. We asked participants to identify their routines or activities that help them take their mind off work after finishing working and to explain what it was. The responses were analyzed and subsequently grouped into categories (see Fig. 4).

Results show that exercising is the most common strategy used for disconnecting from work at the end of the day with 34% (N = 20), including going for walks, stretching, training, and playing sports. This popularity can be associated with being a highly engaging activity that requires attention and a specific set of conditions that provides transition rituals between activities. 32% (N = 19) of the respondents said they did not have any routine or activity (None). The meaning of this result is somewhat unclear, since this could either refer to not having a routine because they do different activities every day or not having recognized a strategy that helps them to disconnect.

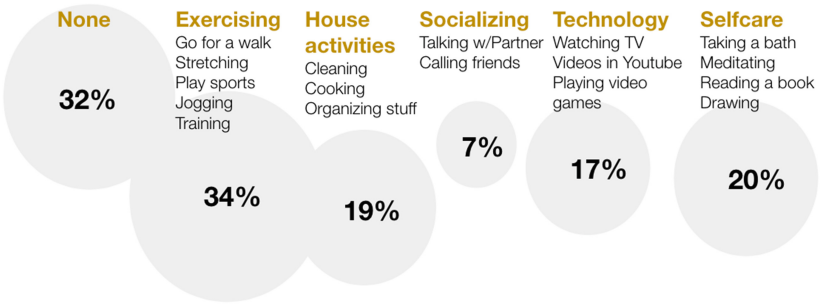

Fig. 4. Strategies categories.

The open-ended questions referring to how the respondents usually start and end the work routine at home is meant to recognize patterns, and routines that help us identify the most common signifiers or transition marks between roles. The categories used in order to classify the answers is based on the Boundary work tactics (Kreiner, Hollensbe, & Sheep 2009) as shown in Fig. 5 and Fig. 6 referring to the beginning and the end of the work routine, accordingly. The results revealed that the beginning of the work routine is closely related with the use of technology (open the computer and apps and log in) 93% (N = 55) and is also relevant to the communicative category (Talk to colleagues, open chats, send mails and messages).

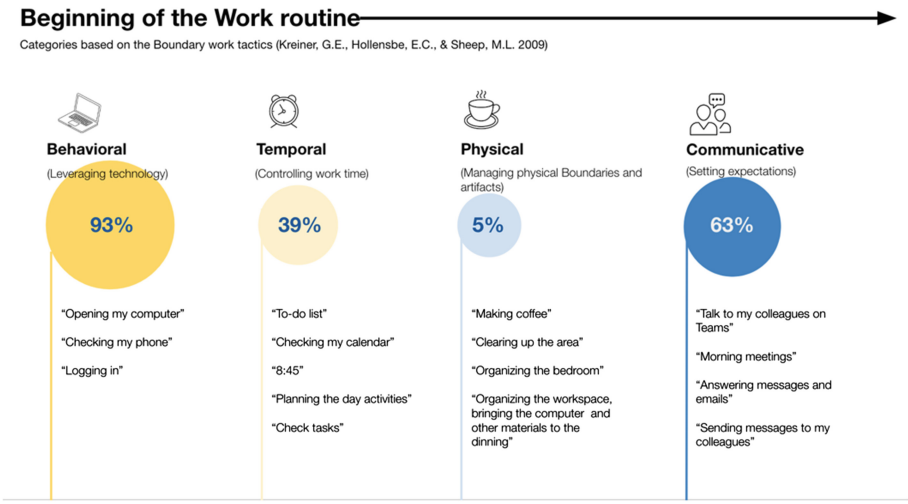

Fig. 5. The beginning of the work routine.

The end of the routine is also related to technology 54% (N = 32) nonetheless in this case is almost as equally important as the relevance of Time (Task and schedule) 34% (N = 20) and Space (Organizing, cleaning and making changes) 36% (N = 21) tactics categories. See Fig. 6.

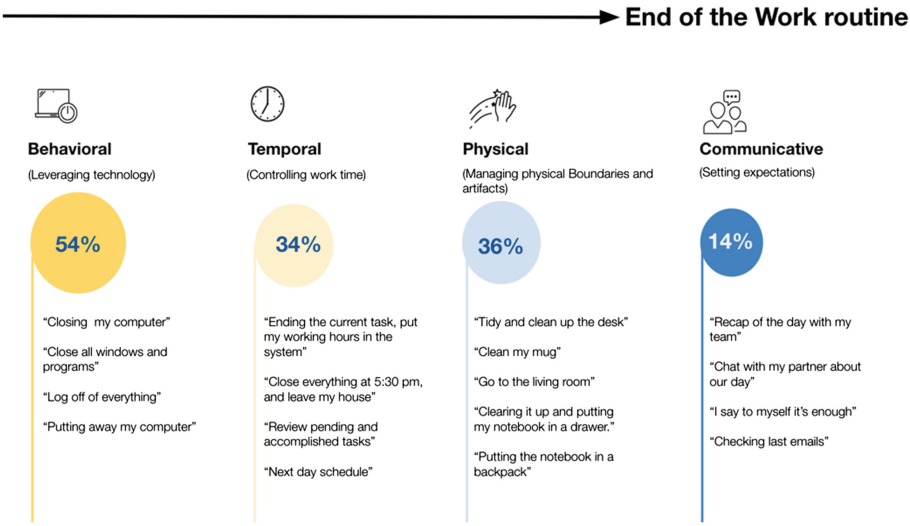

Fig. 6. The end of the work routine.

8 Ideation - Workshop

9 participants were invited to take part in the conducted online workshop, they were among the previous questionnaire respondents, and left their emails to be contacted for a possible next stage of the study. They were selected according to the level of Psychological detachment that was indicated by the participants in the question #19 of the previously conducted questionnaire; "Would you consider that you have difficulties keeping your mind off work in your free time?" responding within the scale of 1 - 5, being 1 (Strongly disagree) and 5 (Strongly agree). All the participants were grouped in three groups according to the number selected on the scale; (5) Group 1: Low detachment, (3) Group 2: Medium detachment, (1) Group 3: High detachment.

In order to gather insights and develop ideas on products that could help increase the level of PD based on close personal experience about the subject according to their own strategies, three online sessions of co-creation were held in a collaborative platform called Miro, each session took part with the three different levels of PD identified. The categories suggested, as a starting point, to develop ideas for solutions on "How can we help Ana to achieve her goals?" are based on the categories of "Boundary work tactics" created by Kreiner, Hollensbe, and Sheep (2009). Ana was the developed persona that portraits the characteristics and struggles of the Low PD and was presented in the workshop as the person who we are "helping out" and developing ideas for, creating empathy and the perspective of an outsider. And Ana's goals were related to improving her work life balance, time management, and the ability to disconnect after work at home.

The three different workshops with the three groups resulted in three boards filled with ideas for helping "Ana", with her problem of keeping her mind of work. Each participant explained the ideas presented on the board, they were assigned to five red dots to "vote" for their own or other participants' ideas that they liked the most in order to narrow down the list.

It was interesting to see how the ideas that each participant gave for helping Ana, were inspired by their own strategies and needs, and according to their level of detachment was notorious the level of detail for these strategies. For example, the group with the high level of detachment had very practical and straightforward solutions, mostly because they found effective ways to achieve PD, such as; "Ana wants a list of things that she accomplished that day, so that she can see that she has done a lots of things and feel that she has done stuff instead of feeling she is missing something" or "Ana wants to be part of a sports group, so that she can have a motivation to go out and work out". On the contrary, the group with low levels of PD provided solutions mostly focused on their own very specific needs, other than concrete strategies, for example; "Ana would like to have technique and app that allows proper disconnections (like pomodoro) but focused on also well-being, so she can feel more productive without affecting her mind" or "Ana would like to have a defined space for working comfortable and not disrupting with noise any meeting (for her or her partner), so that she can work better".

After learning about routines and peoples experience of what causes poor psychological detachment when working from home and how do they manage it, we were able to identify two main components; Physical component: On something tangible such as time that can be measure and productivity that can be evaluated in different ways

according to completing task or achieving goals, and the second component has to do with the psychological side; acting thought the fear of losing the job, or having negative emotions of performing poorly or to simply not feel productive enough.

After breaking the continuous working without boundaries, that leads to overwork and prevents or creates difficulty to achieve Psychological Detachment of people working from home, we wondered what's behind overwork? And after the workshop sessions we were able to identify, from the interpretation of the participants' comments, the following aspects:

- The guilt factor, to demonstrate that you are a great worker.
- The sense of not being productive enough
- Or simply because they have too many things done for tomorrow's deadline. (Matter of organizing time and manage expectations).

9 Ideation - Concepts Development

The concept development step began by collecting the three main ideas/metaphors resulting from the workshop, identified as a starting point; a game, a totem, and a visual mark. Each of them include one or more elements of metaphors and used them as a trigger for brainstorming possible artifacts according the what, why and how questions and adding the "Something on the wall" and "Something on the desk" as a strategy to simplify the options on artifacts that would take part of the limited space of work within the home and that would have a direct visual and physical relationship with the user while its performing working activities.

The three initial concepts were then developed in more detail, and evolved as three design provocations, synthesizing all the previous stages of research, to receive feedback and evaluate from there.

The illustrations (Figs. 7, 8 and 9) were developed to express the meaningful characteristic of each concept, including the actions taking place and the expected user reaction, placed on the assumed context of the place of work at home.

Concept 1 - Desk Scale

As a metaphor for the balance scale (see Fig. 7), it represents work/life balance. It makes the imbalance of work at home visible and physical, interfering and directly affecting work conditions when the balance goals set by the user are not achieved.

How does it work? This desk/standing desk has the standard hydraulic system to adjust the height with an added mode that inclines the surface, which can be turned on and off when convenient.

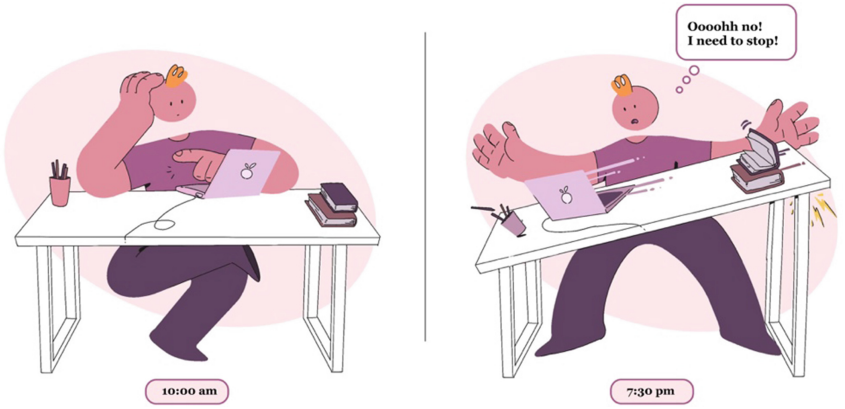

Fig. 7. Desk scale concept illustration.

The mechanism will be linked to applications such as calendar or task managers, where it recognises the number of hours of work without interruption and begins to progressively incline the desk surface creating unfavourable conditions to continue working, until the user compensates it with personal activities to achieve balance and consequently a straight working surface.

Concept 2 - Bird Factor

As a reference of the cuckoo clock (see Fig. 8), the bird represents the user's personal life, which is being neglected by their work life, and shows how it's condition worsens during the working day without attending to their personal and health needs. It makes visible the long-term consequences of having an unbalanced work life and how it will negatively affect physical and mental health.

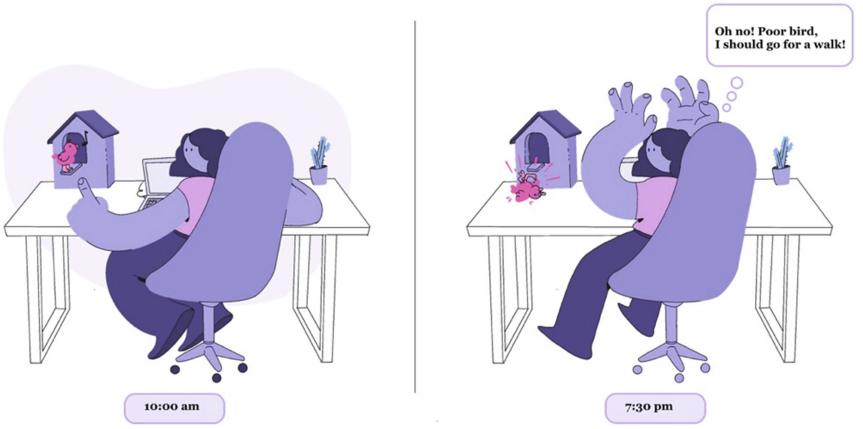

Fig. 8. Bird factor concept illustration

How does it work? It will be linked to applications such as calendar or task managers, where it recognises the number of working hours without interruption, the bird's exit intervals can be configured according to the activities of the day, or scheduled times, but if the user does not perform his/her personal goals the bird will begin to appear each time in worse conditions throughout the day. From a fresh appearance and with a clear sound at the beginning of the day, to progressively deteriorate until reaching the maximum deterioration in its appearance with sound interference.

Concept 3 - Time Reels

With flexible working hours, setting limits and expectations is more important than time itself. The idea is that the user has a clear vision of the "stages of each day" expressed through a clock without numbers, that indicates the day progression with colours and a certain number of marks, that will trigger the projection of videos or the so called "Reels" (that are related to the marks or personal goals set by the user as motivational tool). See Fig. 9.

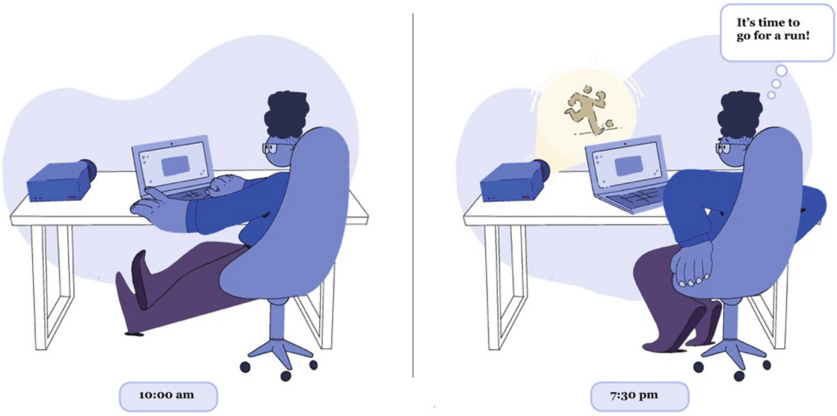

Fig. 9. Time Reels concept illustration.

How does it work? It will be linked to an application such as calendar or task manager and will ask the user to indicate the number of hours that he/she plans to work and to set the marks or personal goals of the day; Indicating for example stretching at mid-morning and running at the end of the day, and when the clock gets to mid-morning a Reel of someone stretching will be projected on the wall and at the end of the day a Reel of a person running will be projected on the wall. This artifact will act as a reminder and motivation, projecting the user's goals and making them tangible and visual. This will help the user to achieve their personal goals, influencing and promoting positive and healthy habits into their work routine.

10 Evaluation with Potential Users

The online survey was conducted using Google forms, and it was based on the short version of the User Experience questionnaire (UEQ). We received 42 responses to the concepts evaluation survey, nonetheless the demographic data of the respondents was not collected.

As a summary of the results obtained, the bird factor has the highest values in the sample, being the highest in 6 parameters (4 of Pragmatic Quality) and not having the lowest value in any variable. The Desk scale has the lowest values in 6 of the 8 parameters, and the most important attribute to highlight is that it was considered a disruptive idea. At the end of the evaluation carried out, the respondents were asked to choose which of the concepts they preferred, and the results had very little margin of difference; it was a pattern that was maintained throughout the whole collection of the 42 responses. The bird scale and desk scale obtained the same percentage of 34,1% de votes (N = 14) and the rest were for the Time reels with 31.7% (N = 13) and 50% (N = 21) responded 4 (In a scale from 1 to 5) that they be very much willing to use it if it existed.

The chosen concept to develop in further stages; The Bird factor. It was also the concept marked with the two components previously mentioned, Physical (Visually) and Psychological (Emotionally), directly focusing on the sentiment of guilt and responsibility that appears to be present in most cases as the reason for overwork and disabling Psychological Detachment, although in this case referring to the guilt and responsibility as consequences of their own personal life neglect.

11 Concept Iteration

The proposed product evolved based on the feedback received in the evaluation, and it focuses on providing an End ritual (Transition) to the user, that would act as personal activities reminders throughout the day, that according the recommendations provided by the experts that were reviewed in this thesis are highly effective on achieving psychological detachment at the end of the working day, such as taking several breaks during the day and providing a sense of closure, applying the different boundary management strategies (Communicative, temporal, technological) While monitoring water intake, meals and stretching as general recommendations for maintaining healthy habits, and any other “Personal” reminder dedicated to physical and psychological health of users while working. See Fig. 10.

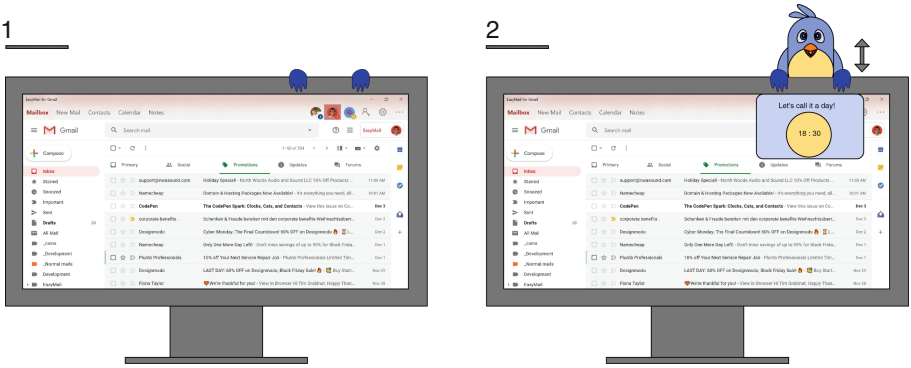

Fig. 10. Bird clock, appearance for the end signal.

The main future of the product will be the End signal of the End ritual, that would be configured by the user every week, according to their needs in order to develop habits of transitioning between roles and explore the most effective strategies. Customization will be the key, as every person would find effective different strategies according to their preferences. Ultimately this will be an informative tool of self-knowledge and self-care, it would provide reports of habits according to its use and act as a personal activities manager.

Being part digital to facilitate the functions that in some ways are in the same work environment as the user (The computer) pop up messages will be more effective in terms of attention, and physical part to materialize or externalize these alerts and reminders, keeping the character of the bird because it provides a friendly and much more relatable character capable of evoking empathy.

How does it work? The user will fill at the beginning of the day, week or month according to the desired settings of the reminders. Throughout the working day and according to the reminders set by the user, a push notification will appear in the top right corner of the computer and the bird will pop up, according to the set reminders, for example; every 40 min to remind the break of 10 min. In case that the user is busy and unable to perform the activity that is being reminded, for example in the middle of a meeting every push notification will have two options to select, one will be "Yes, let's do it!" and the chronometer will start to count the set time or "Not now!" and the message and bird will disappear. Every 3 consecutive "Not now!" the bird will start appearing affected and deteriorated, until the next 3 following reminders are performed correctly and the bird will appear "Normal" again.

And at the end of the day, the set time for example at 18:30 hs it will appear the bird going up and down (Fig. 10), and if the user is ready to stop working she/he will click on the yellow button and then will pop up the option(s) that were selected or added by each user in order to create their own END ritual. The user will have to push down the bird manually when it is done working as finalization to the end ritual.

12 Conclusions

This research resulted in a series of ideas that emerged along with the theoretical framework that led to the proposal of the first three product concepts specifically intended to help people disconnect, to create boundaries between work and personal life. These concepts were developed using design methods, mentioned in the literature review, focused on creating desired interaction, thinking about future situations and how to establish beneficial habits for users, using resources such as metaphors and known elements that are transferred to another domain. These were subsequently evaluated by users, and according to their perception, one of the concepts was chosen for further development and iteration.

The latest concept of the Bird factor outlined in the realization chapter, embodies all the stages of this research and it is presented as the beginning of a conversation that needs to be continued about a product that could be centered in healthy practices while working from home, that highlights the importance of mental and physical health, that prioritize user's personal desires and goals, during and after work and above all a product that aim to maintain the work-life boundaries that now more than ever are showing their importance in preserving the home dynamics.

The future stage of this work will be to test this initial concept with users after resolving its details, in this case with prototypes, not only to evaluate the user appreciation of the product as was done previously with the three initial concepts stage, but to obtain concrete results on its effectiveness, and to measure in what level it contributes to achieving psychological detachment.

The biggest challenge in relation to the subject of this research is that it addresses behaviors and habits, which can only be considered through sustained study and observation over a certain period of time. Only with the continuous repetition of these "rituals" could we observe their real effects in daily practices, specifically if they could influence on improving the work routines at home.

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From Play to Game. Smart Toys for Inclusive Physio-Cognitive Therapy

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Abstract. The research presented is placed in the field of design for health and well-being and focuses on the role of play in supporting educational inclusive practices aimed at children with autism spectrum disorders (ASD). More specifically, the paper proposes some outcomes of the interdisciplinary research "*Pro-Ability/Sens-Ability*", carried out by the authors, that led to the development of a play interface (physical and virtual) that implements music therapy for the enhancement of the motor skills of children with ASD.

The paper presents:

- the state of the art considered relevant to the evaluation of the positive influence, in clinical and therapeutic practice, of play dynamics guided and supported by music therapy;
- some relevant study cases related to the project game consoles developed in the specific scientific area of interest of the present paper;
- the user research: quantitative user research regarding autistic users (supported by care givers); qualitative user research regarding the interview of experts (music therapist, pediatric neuro-psychomotor nurse);
- the mockup of a play console that integrates the virtual and physical interface.

Keywords: human centered design · medical design · inclusive design · interaction design · smart toys

1 Introduction

This paper shows some of the outcomes of the ongoing research *Pro – Ability/Sens – Ability* focused on the Design for wellness and for medical devices, carried out at the Polytechnic University of Bari in the areas of product design and interaction design, with the collaboration of the Italian nonprofit Association "Con.Te.Sto" based in Trani and the Presidio of Rehabilitation "A. Quarto di Palo and Monsignor G. Di Donna" based in Andria. Particularly have been involved in study the therapist and psychologist to define the quantitative and qualitative inquires during the user research phases.

The *Pro – Ability/Sens – Ability* approach, focuses on a new area of the interest of the design discipline based on the convergence and comparison of the theory and the praxis, ranging from the product and interaction design with a human centered and inclusive approach.

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In particular, the paper focuses on those areas of the medical design that investigates the interaction between physical sensory experience and cognitive rehabilitation particularly connected with autism spectrum disorders (ASD) in children in pre-school and primary-school age, through the play. Different cultural environments give different meaning and possible classification to the world play. Particularly, following the IPA declaration (International Play Association) by Theresa Casey, have to be highlighted the effects of lack of time and space for play and the serious and life-long negative effects on children's bodies and minds (http://www.ipaworld.org). For this reason, this research will focus on the positive role of play associated to the recreational pleasure and enjoyment (Garvey 1990, p. 4), addressing an inclusive context and approach to the therapy routines for ASD children, in order to enhance fine motor skills while having fun.

The clinical practice concerning the rehabilitation of pre-school and school-age children affected by ASD identifies therapies based on the dynamics of play (Hillman 2018) as a valid support for emotional and social growth and for the acquisition of skills related to proprioception and fine motor manipulation (Provost, Heimeri et al. 2007).

As this research lays on such a scientific domain (from neuroscience to psychology, from informatics to ergonomics and cognitive ergonomics) the design approach used for this work is mainly based on an expert mindset (Sanders 2008). From a methodological point of view, in fact, the research tries to combine the human centered approach with the design + emotion one. However, the particular topic cannot be separated from the necessary comparison with the area of social sciences. In this respect, the research required the involvement not only of the main users (children with ASD, parents, doctors and therapists) but also the involvement of social welfare associations in order to compare the topic with the challenges of social inclusion (Tosi et al. 2020).

The human centered approach of the research relates as much to the interdisciplinarity of the research as to the involvement of users in the context of the research development.

The inclusive approach of the research is expressed in the development strategy of the play-educational devices that, while focusing on the theme of the child's fine-motor development, enhance, first, the recreational-educational dynamic of the game, essential for emotional and cultural growth as well as for the acquisition of skills and abilities of social relations (Visalberghi 1988).

This study has been carried on during the pandemic period, when the crisis has exacerbated the distress of families and individuals with autism spectrum disorders also in relation to the reduced availability of medical care. For this reason, the methodological structure has been adapted, the structure of the qualitative survey, for example, has been carried out through remote platform.

At this stage of the research, the design hypothesis has been validated by the phycologist and the therapist.

Starting from this premise, the design process has been guided by some of the protocols coming from the clinical approach: mostly, for the definition of the user, we considered such therapy practices that maximize the parental role and the sensorial stimulation through both physical and digital interfaces in the play experience. In fact, starting from a scientific state of the art in the psycho-neurological field (actually, divided on the appropriateness of the use of gaming in children (Murray et al. 2021) affected

by autism spectrum disorders) this study focuses on the "physical" and "cognitive" experiential dynamics that systemizes the tactile, auditory and visual sensory experience with the dynamics of the virtual interaction.

The aim of this study, in fact, is:

- to develop a design led approach based on persuasive gaming theory (Huizinga 1939; Caillois 1958) for the support of cognitive-sensorial impairment of children;
- to design a mockup play, based on scientific literature evidence and user research, to support the rehabilitation of children with autism spectrum disorders through an interactive analogical - digital gaming systems.

An action-research approach has been used in order to develop the project hypothesis, involving a multidisciplinary group of psychologists, psychotherapists (experts in the treatment of autistic spectrum disorders), technologists and computer engineers, parents and children (Bianquin 2017).

2 Logical Problem: The Role of Play in the Growth of Children with Disabilities

Autism spectrum disorders are a lifelong condition (ISS 2011). Therapeutic interventions, especially at an early stage (Stern 2015), can help children to acquire essential life skills and, consequently, to live a more serene everyday life.

Therapies foster the development of skills related to social interaction and allow the child to gain access to new learning experiences. The benefits and therapeutic powers of play cannot be overlooked when discussing therapy for children. These special play therapies are mainly used in children between three and twelve years of age and treat cognitive, behavioral, emotional and other social disorders (Mcmahon 1992).

According to contemporary Infant Research studies (Lavelli 2007) facilitating the development of game skills means intervening as early as possible for the activation of perceptual-motor, praxis and communication skills in autistic children.

The play helps the birth of intersubjectivity, imitation and language and is based on the construction of meaningful interaction proposals, which are based on reciprocity and on the development of motor-praxis and socio-communicative skills (Gison et al. 2012; Vincenti 2015).

Increasing Ict application, from the other hands, since in the 60s started to shift the sensorial human activities in a new light, assuming the sensorial experience could be entrusted to the interaction with a computer. "These new models of sense turned sensual operations and feelings into data that had to be brought into information flows and had to produce feedback loops to improve teaching and research; it also made classrooms into research laboratories and workshops where new ways of being in the world and languages to talk about experience were configured" (Dussel 2020).

Design education strongly contributed in to define that Montessory's education model based on physical experiences during the preschooler age. Bruno Munari (Campagnaro 2019), in its Tactics Lab for kids, defined a new sensorium that has been greater important

for the educational research and for the social and psychological sciences, in which tactile and visual experiences were translated as information records and as data processing.

With reference to the field of DSA, the world of tools supporting therapies for the treatment of these disorders is today constantly evolving, both from a therapeutic point of view, for the updating of the techniques adopted, and from a technological point of view, for the design and production of the artefacts and devices used (Rivera et al. 2016). In order to explore the potential of gaming in children and young people, it was therefore necessary to analyse and distinguish the therapies and methodologies most used and known for the treatment of autism spectrum disorders.

3 State of the Art

3.1 Treatments

Educational treatments for children with autism consist of activities programmed by experts, the main aim of which is to improve specific skills or abilities of the child, in particular communication, social and behavioural skills.

The Guidelines 21 for the treatment of autism spectrum disorders in children and adolescents (2011), drawn up by the ISS, were the starting point for understanding the breadth of existing therapeutic actions and for drawing up a general descriptive framework on the subject. This study takes up and supplements the first and fundamental study of 2007 by the Scottish National Guideline Network (SIGN, 2017), from which, however, it departs on several points, in particular in limiting the recommendations to only those therapies that can scientifically demonstrate their effectiveness.

The guidelines divide interventions into two areas, distinguished from each other by the use or non-use of drugs. For the purposes of this research, only non-pharmacological treatments were considered and analysed. These are presented divided into five classes:

- Parent-mediated interventions
- Communication interventions
- Educational programmes
- Structured behavioural and psychological interventions
- Biomedical and nutritional interventions.

The distinction of these classes was made on the basis of the critical evaluation of the studies attributable to these treatments, with reference also to the quality and quantity of the scientific evidence demonstrating the efficacy of the interventions, so that the therapies presented in the different classes are not mutually opposed but, on the contrary, are very often superimposable. Similarly, the classificatory nature adopted in this research was aimed at providing a scheme, useful for easier understanding, and not at defining limits and "watertight compartments".

The class of interventions with the largest number of studies and trials, and consequently demonstrating the greatest attention of specialists, is that of structured behavioural and psychological interventions, which predominantly adopts applied behavioural analysis (ABA).

A specific in-depth study on cognitive-behavioural, psycho-educational and music therapy made it possible to highlight criticalities and compatibility between the different areas of intervention.

One play-based therapy is DIR - Developmental, Individual Differences, Relationship-Based - (also referred to as Floortime), in which parents and children play together at ground level and are guided by the instructions of the psychologist who manages the complexity of interactions according to the child's individual abilities (Guiot et al. 2011). Similarly, Lego Therapy, devised by LeGoff, is a programme based on Lego bricks that involves an hour-long play activity in which autistic children play together under the supervision of an adult who helps them solve problems, including social ones. Among the many forms of therapy dedicated to autistic children and young people, music therapy has been shown to increase motivation to engage in treatment, which is therefore more enjoyable (Trevarthen 1999; Wille 2016; Sharda 2018).

In recent years, 'task-oriented' modes of intervention are finding particular success. One of these therapies is occupational therapy, which consists of identifying the activities in which the child has most difficulty, and then devising strategies to help the child overcome these problems and implement useful movements in daily life. This approach is particularly useful in autistic individuals, as these patients often present delays in the acquisition of the first stages of motor development and clumsiness in fine motor skills and coordination. These motor anomalies could be linked to repercussions on the cognitive level, thus explaining the great difficulty, on the part of persons with autism, in reading and interpreting the movements of others in accordance with a purpose.

3.2 Relevant Cases Study

The following section illustrates some of the most significant examples found in the state of the art about therapeutic toys for children with autism spectrum disorders.

The parameters used for the comparison classification were:

- fun or recreation: it refers to the ability of play to entertain children and provide them with quality play experiences;
- utility: it refers to the therapeutic or educational value of play;
- emotional factors: it refers to the ability of the game to create positive emotions or make people understand moods;
- aesthetics: it refers to the overall evaluation of product design, looking at features such as shapes, colors, and general appearance;
- technology: the smart and computing components of the device are evaluated, as well as the ease of understanding and use of these technologies.

Build a Robot. Build a Robot is a wooden toy produced by Plantoys consisting of dismountable and modular pieces. The toy was designed specifically to meet the needs of children with Autistic Spectrum Disorder, although it is intended for children of all ages. The primary function of the robot addresses the need for emotion identification, a useful tool for these children with difficulties recognizing moods from facial expressions. The toy includes four interchangeable geometric heads representing the emotions of

happiness, sadness, anger and surprise. Assembling the different pieces encourages the development of motor and sensory skills in the child (Fig. 1).

Fig. 1. Build-a-robot (source: https://www.plantoys.com/products/build-a-robot)

Pooki. Pooki is a toy designed by Tina Dinh, of Monash University, for all children, but especially for autistic children. Its ambiguous and undefined shape invites children to manipulate it at will, customizing the toy with some additional elements configured as flippers, available in different material, tactile and colour textures. The design considered all ergonomic and user-friendliness requirements, as well as safety (Fig. 2).

Fig. 2. Pooki (source: https://designawards.core77.com/Strategy-Research/48324/Pooki-A-Toy-for-All-Children)

Electronic Play Mat. Designed by Jin Yijing of the Beijing Institute of Technology, this product develops a special type of treatment for autism that involves parental participation. This play mat consists of several hexagonal units and each unit is an interactive

electronic element connected to sensors, LED light sources and acoustic devices. By moving around on the mat, children activate lights and sounds, which motivate them to participate more, improving their perception of space and balance. The modules, assembled through magnets, can define different configurations and thus different play experiences (Fig. 3).

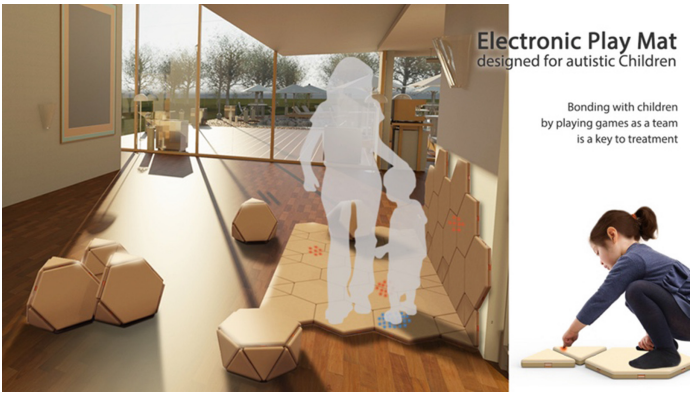

Fig. 3. Concept of Electronic Play Mat, ways of use (source: https://www.jamesdysonaward.org/2018/project/electronic-play-mat-for-autistic-children)

Yibu. Yibu is a concept product designed by Frog and is a kit consisting of five wooden toys connected to a digital application. Each physical element has a real-time environmental data sensing technology connected to a character that interacts accordingly in the digital game. As children play, they learn about the world and its physical data, such as temperature, sound, light, direction and rotation, influencing the actions of the character who faces environmental challenges on screen (Fig. 4).

Fig. 4. Yibu, the five elements in wood (source: https://www.frog.co/work/yibu-transforming-screen-time-for-kids-with-sensor-technology-and-real-time-data)

4 Research Objective

General objective of the Pro - Ability research is to foster the design approach to product and interaction towards an inclusive and positive experience for impaired people. As the research presented focuses on ASD children, it is primarily concerned with the development of a play kit for cognitive and tactile fine-motor rehabilitation.

The research starts from the definition of the state of the art in reference to the existing gaming artefact, both material and digital, particulary addressed to the rehabilitation of the fine motor and hand-eye coordination problems experienced by autistic children.

A further focus was on the issues of sociability, waiting and respecting shifts with reference to the habits of these users.

The needs analysis of autistic children will address the design process, focusing on:

- the enhancement of the fine-motor ability and hand-eye coordination;
- the development of the interpersonal collaboration, for the social objectives;
- learning to respect the rules, be patient and wait your turn;
- inclusive rehabilitation activities based on play.

5 Methods

The extreme sensitivity of users required an approach as close as possible to their needs and requirements to design customized solutions.

The method adopted is therefore in the tradition of person-centered studies, in which 'needs' are the focus of research and design action, and it is based on human interaction and experience; in particular, in the ASD disorder, this approach focuses on human experience in relation to motor and cognitive disability.

The complexity of the research field also required a multidisciplinary approach, which involved a team of researchers from different disciplinary areas: medical area (clinical and rehabilitation), human sciences area (psychology, pedagogy and sociology), project area (design, computer science, mechanics). This approach is identifiable in Human Centre Design, and it has been taken both in the established procedures of 'user research' and in the involvement of users at every stage of the process.

A desk phase, characterized by the study of the state of the art and the analysis of the evidence emerging from the scientific literature, was followed by a field phase, specifically user research conducted in the field, involving associations, schools, operators, professionals and families, which allowed for the observation and listening to children, either directly or mediated.

5.1 User Research - Questionnaires

A questionnaire was administered to children with autism spectrum disorders under the age of 12, filled out through the necessary mediation of a parent. The questionnaire was disseminated both at specialist centers and online, published on various groups via social platforms.

The questionnaire, consisting of 34 questions divided into required multiple-choice questions, optional open-ended questions, questions with more than one option and questions with the selection of a value on a linear scale, was drawn up under the supervision of specialists in the therapeutic area.

Also, in relation to the most common type of therapy for these users, the questionnaire focused on manual skills and types of motor difficulties on the one hand, and musical preferences and experiences on the other.

The quantitative analysis yielded a total of 64 responses and provided valuable information about the difficulties and problems participants experience in their daily lives, which is useful for understanding preferences and habits.

The therapies most frequently used by these children are ABA therapy (82.8%), psychomotor therapy (51.6%) and music therapy (21.9%). Most of the users presented motor problems (79.5%), divided into fine-motor, coordination, and balance difficulties (Fig. 5).

Regarding manual skills, the participants stated that they were not very precise in their manual movements (50.8%) and had difficulties in manipulating small objects (30.8%) (Fig. 6).

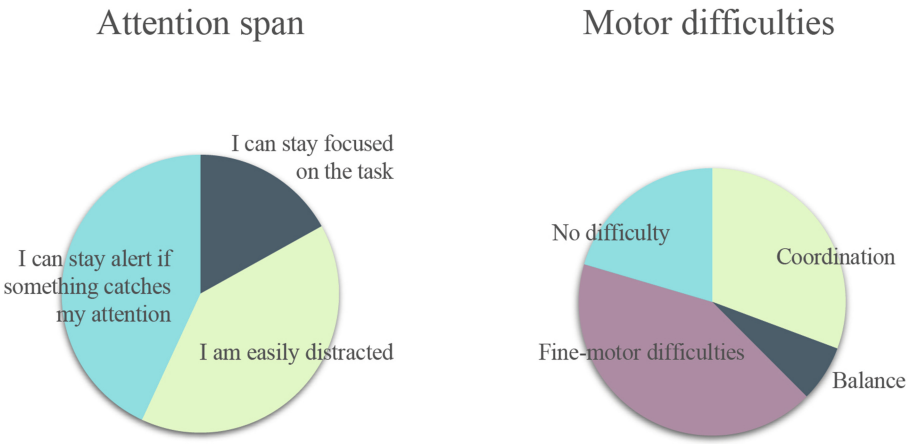

Fig. 5. Graphs of the survey results concerning the question on attention span and the type of motor difficulty encountered by users.

As regards musical preferences and experiences, it was found that 41.5% of the respondents like all kinds of music, 35.4% prefer lively and rhythmic melodies, while 23.1% prefer them slow and calm. The musical instruments favored by these children are the piano (46.2%), the drums (44.6%), and the guitar (30.8%). In addition, many users entered the name of their favorite musical instrument, including xylophone, drum, violin, and maracas. A large percentage of users had tried playing an instrument and were enthusiastic about the experience (70.8%), compared to only 4.6% who found it negative.

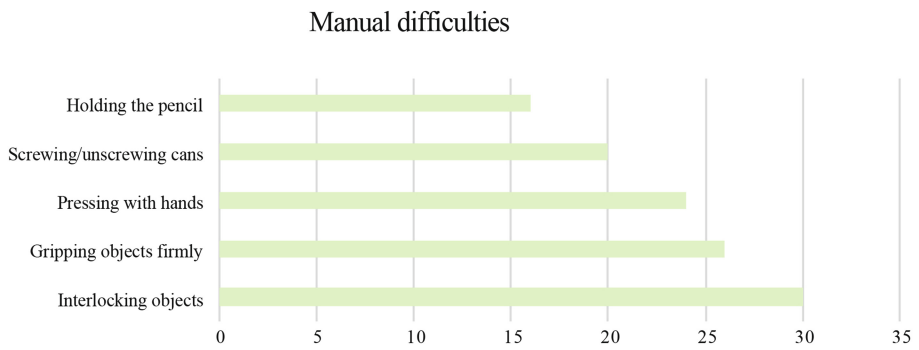

Fig. 6. Graphs of the survey results concerning the manual difficulty encountered by users.

5.2 User Research - Interviews

The qualitative analysis consisted of a number of semi-structured interviews with specialist therapists working with ASD users and was useful to investigate the scope of the study in more depth and to validate the design hypotheses.

In particular, the discussion with a music therapist highlighted the effectiveness of therapy associated with music in many respects. On the one hand, it influences the improvement of the motor skills of young patients - particularly in those with motor difficulties and stereotyped movements - by allowing them to experiment with different types of manipulation, converging a random movement into a voluntary movement, linked to the action of playing. On the other hand, music therapy can be a valuable aid in managing waiting time and understanding the duration of a task: it is essential, in fact, that each task is marked by a start and an end sound, which can regulate the time interval to be dedicated to each task. A further fundamental aspect that emerged from the interview concerns the validity of the use of sound as positive reinforcement, and as a motivator for the execution of a given action: obtaining sound feedback following a movement, in fact, represents a powerful stimulus capable of creating interest and soliciting the children's attention.

The interview with the pediatric nurse, who is also a behavioral therapist and neuropsychomotor therapist, gave us a close insight into the most frequent fine-motor problems of users with ASD and the methods used by psychomotor therapy to help autistic patients improve their motor skills: all activities are carried out as a game and, often, physical toys typical of the developmental age are also used to implement certain movements. His opinion of technology was not positive, mainly due to the extreme complexity of the currently existing software programs aimed at cognitive development and therefore not very suitable for autistic children. However, the child's obvious natural attraction to technology is symptomatic of how useful technology can be in therapy and provide positive reinforcement by convincing the child to actively participate in the assigned task.

6 Design Research

As a first design outcome, the Pro-Ability research presented provide a first mockup set of toys addressed to the fine-motor skills enhancement. The needs analysis has been defined both from the state of the art literature and from the user research. Greater importance has been given to the dialogue with territorial non-profit associations. The objectives identified by the user research were:

- to help in the development of fine-motor skills and hand-eye coordination;
- to educate in the presence of others and interpersonal cooperation;
- train waiting and respect for turns;
- making therapeutic activities fun and relaxing.

To this purpose, a set of five 3D printed smart toys, connected via Bluetooth to a tablet application, was designed to start producing a first ecosystem for physical and cognitive rehabilitation. The proposed play set implements the Music Therapy approach and assumes as its objective the support of young users in the exercise of their motor skills, through the focused manipulation of the designed devices. The final configuration of the prototype realised considered the ergonomics of the individual object in relation to the different types of manipulation, according to orthopaedic surgeon Kapandji's prehension scheme (Kapandji 1982).

The final result consists of an application connected to a set of five smart toys (Figs. 7 and 8). The adjective 'smart' in reference to the toys implies the presence of technological components hidden within the play tools, which allow them to be paired with devices such as tablets or smartphones, via Bluetooth chips. This makes it possible to combine children's particular predisposition and curiosity towards technology with a material and physical experience. The playful activity exploits the interface proposed on the tablet screen to sensorially communicate with sight and hearing the haptic action performed with the physical toys, which become game controllers.

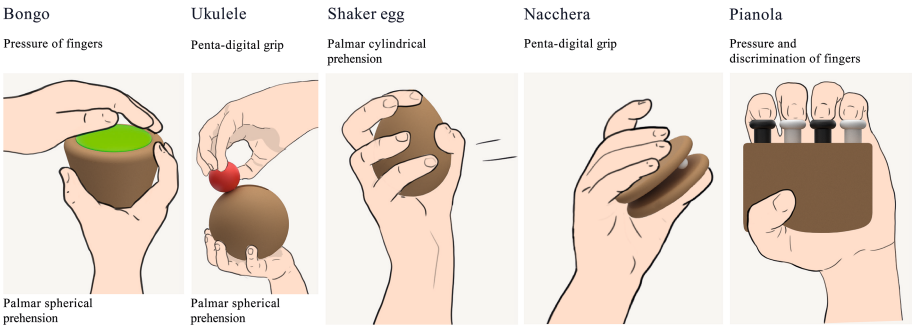

Fig. 7. Prehension: reaching, hitting, shaking, squeaking, pulling toy (Piaget task for enhancing prehension. Concept by Noemi Attanasio).

Fig. 8. Prototypes. Smart toys 3D printed (by Noemi Attanasio).

Each of the five designed toys presents a different shape, and provides different manipulations of use, corresponding to the musical instrument played, aimed at the indirect sound response, obtained on the digital device.

The application interface provides intuitive and user-friendly graphics (Fig. 9).

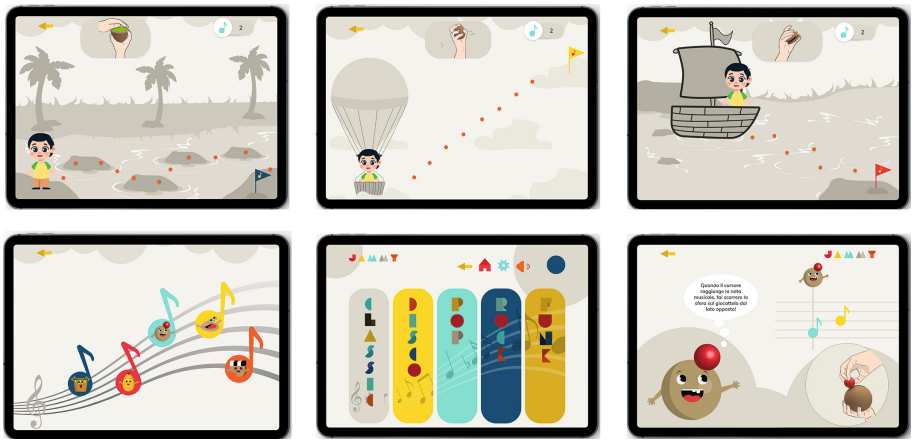

Fig. 9. Interactive digital application with physical smart toys. Graphic user interfaces (by Noemi Attanasio).

7 Conclusions

The presented research combines the culture of design in the areas of product and interaction with the medical field, specializing in motor and cognitive therapy. The hypothesis of working on a set of therapeutic and playful toys affirms the need for an inclusive approach to disability.

Quantitative and qualitative surveys have outlined the specific needs and difficulties of autistic users. In particular, the study refers to motor and related cognitive skills. The advancement of research has then outlined the possibility of promoting, through play, social interaction and inclusion, opening up the configuration of new cultural meanings for the field of study.

Acknowledgments. The theoretical research is part of the Pro-Ability and Sens-Ability research framework developed by the Design_Kind Lab at the Polytechnic University of Bari.

The mockup toys and video game presented in this paper were developed by Noemi Attanasio and are part of the final project of her bachelor's thesis titled "Favole musico-motorie. Design di un gioco per bambini con disturbi dello spettro autistico", at the School of Design of the Polytechnic University of Bari (thesis advisors Prof.ssa Annalisa Di Roma and Alessandra Scarcelli).

The state of the art of treatments and the user research were developed with the Italian nonprofit Association "Con.Te.Sto" based in Trani and the Presidio of Rehabilitation "A. Quarto di Palo and Monsignor G. Di Donna" based in Andria. The dissemination of the questionnaires, which led to a high number of responses from users, was supported by the online Associations "Autismo: ricerche e condivisioni", "Associazione nazionale genitori di soggetti autistici, ANGSA Lecce", "Ricerca e terapia nello Spettro autistico (e delle sue politiche)", "ABC Centro ABA", "Autismo ANGSA".

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Kinetic Calendar for Emotional vs Physical Stress Tracking in Women

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Abstract. This work aims to address the need of creating visualization tools for better self-awareness of not visible daily life conditions, such as stress and emotional peaks, to facilitate the detection of patterns that could be related to some physical symptoms. It is focused on women because of the constant hormonal changes and the close relation of these with stress responses; and the fact that women are more likely to present psychosomatic disorders.

Women who reported been affected with this condition, remembered not being able to relate the emotional cause of the symptom until after the diagnose. That would usually trigger a vicious cycle of stress and frustration that would worsen symptom.

In the literature review it was found that psychosomatic disorders affect women in a 2:1 ratio compared to male pairs, due to biological, socio-economic, and cultural differences. It was also found that emotional self-awareness might decrease somatic related symptoms and that heart rate variability might be a valuable tool in the target tracking of users' physical conditions in a near future. This kind of tools might not only serve as visual feedback but also it can help the physicians to detect patterns or relations for some common mental-related affections.

Keywords: User-centred design · Emotional Design · Stress · Gender Equality · Women's Health

1 Introduction

1.1 Importance of Self-awareness

This paper presents the design research aimed at developing an integrative model to increase the self-awareness of emotional status in women. The human centred design (HCD) was considered for the methodology, since this approach is now being applied also inside the health and wellbeing field, taking in consideration that physical and emotional health are affected by several interrelated factors (Bazzano 2017).

If we set ourselves inside the post-industrial era, we will find that the importance of the object is as valuable as the experience it gives us, or the feedback we receive from it. If the objects that surround us are in some way a reflection of our personality, and

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therefore of our past experiences, what this work intends is to work as a mirror. Not to judge the physical features, but to capture in some way the emotional journey of the user over a period of time; to work as a visual diary where the user can get some insight of her daily sensations and make a relation of how this might turn in to unperceived state of stress or discomfort, and that could in a long term affect their physical state.

This work is inspired by the need to remember that we are affected at many levels by things we cannot see: from microscopical reactions to thoughts and feelings, society needs to pay more attention to what happens inside of us more than around us, and historically, it has been the role of design to bring them to somewhat visible. Starting from fact that all humans have feelings regardless of if they are positive or negative; and the necessity of expressing them even if that might result uncomfortable under some circumstances.

In the late years popular culture surrounds us with more external stimuli than ever before. Everyday life challenges give us access to unlimited sources of information from all around the world. We get to see what our friends and idols are eating, wearing, where they are going; we have immediate access to stores, museums, TV channels, football team's staff, etc. Giving us constant examples as how life should be and therefore attracting our attention to the social dimension of the world and triggering a constant need for approval even if it means forgetting our deepest feelings.

Upon that, the competition and the current social standards prize popularity, productivity, and aesthetic, leaving knowledge and spirituality out of the priorities of our everyday lives. However, running away from the fact that coherent expression of emotions is a human need is what is getting many people in a stress-depression spiral, causing that at some point these emotions are expressed through physical symptoms. The path to emotional wellness may involve awareness of thoughts and feelings.

Using a positive attitude and recognizing the own signature strengths, seeking support, and expressing emotions in a suitable manor, setting priorities, accepting mistakes, and learning from them.

Psychosomatic Disturbances. Those who experience discomfort, pain, or physical symptoms for long periods or even chronically, may feel great confusion and worrisome when visiting medical services after being told that no apparent organic cause is found for their problem. Some people could even adopt a disqualifying attitude by mentioning that perhaps these ailments are due to psychological causes, making the patient believe that he is emotionally weak or that he is crazy, however, psychosomatic disorders show how emotions and stress really affect the organs of the body, through chain reactions that alter the chemical balance of the body.

The reason for the focusing this research on women is that some studies stipulate that the females are more prone to emotional affectations derived from stress, including the major prevalence of psychosomatic associated symptoms. The term psychosomatic refers to real physical symptoms "that arise from or are influenced by the mind and emotions rather than a specific organic cause in the body" such as an injury or infection (American Psychology Association). One of the possible explanations could be the hormonal changes that take place, not only monthly but during each stage of the woman's life according to their age and reproductive system's condition.

Technology gives us possibility now the of measuring physiological data in real time and at somewhat affordable prices. Thanks to wearables and tracking devices; as well as human-centred design approach to better grasp some of the user's perceptions, we have now the opportunity to compare the physical stress versus the emotional stress. We should remember that physical stress could be any change in the environment that puts cells or organs under pressure, such as dehydration, menstruation, training, pollution, etcetera. On the other hand, mental stress originates in the cognitive processes of the subject, even without being aware of it. Thoughts and emotions are sometimes translated to bodily sensations (Nummenmaa 2014) and can also turn into an almost palpable sensation of stress while other daily stimuli can fail to be noticed by the individual, but at the end of the day, all of these mental and physical processes, can have an important impact on mental health. Some examples in this wide spectrum of experiences can vary from traffic, relationships, economy, to the social environment or the predisposition to depression or anxiety amongst other conditions.

A common misconception is that psychosomatic conditions are "imaginary" when these physical symptoms of conditions are real and require treatment. Thus, a qualitative analysis took place by interviewing women at reproductive age with long term physical disturbances without apparent medical causes. From that point, an objective parameter that could reflect stress was considered: Heart Rate Variability (HRV) was selected as measure that could give a range of valuable data about physical stress (Campos 2021) and it could be enriched with the subjective perception of emotional stress of the user and registered according to each day in a calendar, to better understand the possible relationship between emotional peaks, mental or physical stress, and hormonal phases.

Although design has always been a tool to visually communicate intangible information about sensations and emotions, thanks to technology and teamwork between several disciplines applied around the user's everyday objects, today we are able to show the variations of such information more and more quickly, so both the field of health care, are a perfect canvas for proposals aimed at physical and emotional well-being.

For the concerns of this thesis work, we will also consider the concept of Integrative Medicine in western culture, which is grounded in in the definition of health. The World Health Organization (WHO) defines health as "a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity" (World Health Organization 2021). Therefore, it "seeks to understand the patient's unique set of circumstances and to address the full range of physical, emotional, social, spiritual and environmental influences that affect health" (Weisfeld 2009). Being emotionally healthy means being aware of your emotions and how they affect you and others: "being attentive to your thoughts, and feelings, and behaviours whether they're positive or negative. It implies the ability to accept our feelings rather than deny them. Being emotionally healthy means that you take a positive attitude about your ability to acknowledge your emotions. You feel that you can make choices and decisions based on a synthesis of your feelings, thoughts, and behaviours, rather than behaving in an immediate and reactive way to your emotions" (Jones 2014).

The biopsychosocial model is not only a medical care approach widely accepted in recent years, but the scientific confirmation of a holistic philosophy that searches

for evidence-based medical data that includes several explanations to confirm the relationship between physical and mental aspects, with a circular causality nature, instead of visualizing body, mind, and the emotions as separate entities. Therefore, it is now more than ever that user centred design can be nurtured by the spectrum of therapeutic approaches for participating in new product or system proposals, in an interdisciplinary work, hand in hand, not only with users, but also with healthcare professionals to achieve optimal health and healing.

This approach for holistic and integrating techniques towards well-being is therefore, a model of health care that combines both conventional and unconventional therapies that serve the whole person and focus on prevention and whole health. Women are the highest utilizers of health care and Integrative Medicine for a variety of reasons. Integrative Medicine represents a more "female energy" in the field of medicine, which is needed even more today as health care moves toward value-based care and out of high-cost and high-harm care. Integrative Medicine can be incorporated into medical practice and into health workers' lives for wellness (Phillips, Cockrell, & Parada 2018).

1.2 Body and Mind

Our bodies consist of several biological systems that carry out specific functions necessary for everyday living that we will explain very briefly just to keep in mind the intricate self-contained ecosystem that we hold in our bodies. Conscious and unconscious processes take place thanks to the relation between all our organs and our mind that are biologically programmed to search for equilibrium. When external or internal stimulus put any of these systems under pressure, a whole complex reaction of neurologic and endocrinologic systems is unleashed, reflecting either bodily or mental tension to which we refer as stress (Fink 2010). Fig. 1.

According to the context and/or disciplines, there is some confusion about the precise meaning of the term "stress" even if it's widely recognized as a central problem in human life, as underscored by Lazarus: "*For the sociologist, it means disturbances in the social structure. Engineers conceive it as some external force which produces strain in the materials. Physiologists deal with the physical stressors that include a wide range of stimulus conditions that are noxious to the body…In the history of psychological stress research, there has been no clear separation between physical stressor which attack biological tissue systems and psychological stressor which produce effects purely because of their psychological significance*" (Lazarus 2006).

However, stress can have a different meaning for different people under different conditions. The most generic definition of stress is that proposed by Hans Selye: "Stress is the nonspecific response of the body to any demand"; and he also underscored that stress should not and cannot be avoided, since just staying alive creates some demand for life-maintaining energy. It is associated with a great variety of dissimilar problems, such as:

…Surgical trauma, burns, emotional arousal, mental or physical effort, fatigue, pain, fear, the humiliation, frustration, loss of blood, intoxication with drugs or environmental pollutants, or even the kind of unexpected success that requires an individual to reformulate his lifestyle. It is present in the businessman under constant pressure, in the athlete

straining to win a race; in the air traffic controller who bears continuous responsibility for hundreds of lives; in the husband of a sick wife; in a racehorse, its jockey, and the spectator who bets on them.

While all these problems are quite different, individuals respond with different degrees of intensity of patterns of biochemical, functional, and structural changes essentially involved in coping with any type of increased demand upon vital activity and adaptation whether the situation is perceived as pleasant or unpleasant. (Selye 1976). Many times, we fail to realize the extent to which these internalized habitual emotional patterns dominate our internal landscape, diluting and limiting positive emotional experience, and eventually becoming so familiar that stress essentially becomes a defining part of their sense of self-identity. (LeDoux 2015).

Stressful life experience can have significant effects on a variety of physiological systems, including the autonomic nervous system, the hypothalamic-pituitary-adrenal axis, and the immune system. These relationships can be bidirectional; for example, immune cell products can act on the brain, altering mood and cognition, potentially contributing to depression. Although acute physiological alterations may be adaptive in the short term, chronic or repeated provocation can result in damage to health. (Kemeny 2003).

Stress arises not only in direct response to external situations or events, but also, to a large extent, involves the ongoing internal emotional processes and attitudes individuals perpetuate even in the absence of any identifiable extrinsic stimulus (Arnetz & Elkman 2011). Recurring feelings of agitation, worry, and anxiety; anger, judgment, and resentment; discontentment and unhappiness. Insecurity and self-doubt often consume a large part of our emotional energy even when we are engaged in the activities of everyday life.

The mind can be defined as a person's set of intellectual or mental faculties and refers to the group of cognitive psychiatric processes that includes functions like perception, memory, reasoning, etc. According to the Oxford English Dictionary, it "is the element of a person that enables them to be aware of the world and their experiences, to think, and to feel: the faculty of consciousness and thought"; and we hold it responsible for processing feelings and emotions, resulting in attitudes and actions. Mental processes clearly play a role in stress, it is most often unmanaged emotions that provide fuel for their sustenance. It is well recognized that thoughts carrying an "emotional charge" are those that tend to perpetuate in consciousness (Arnetz & Elkman 2011). It is also emotions that activate the physiological changes comprising the acute stress response. This -also known as- "fight or flight" response, refers to a physiological reaction that occurs in the presence of something that is terrifying, either mentally or physically an it's triggered by the release of hormones that prepare your body to either stay and deal with a threat or to run away to safety (Goldstein 2010).

In response to acute stress, the body's sympathetic nervous system is activated due to the sudden release of hormones. The sympathetic nervous systems stimulate the adrenal glands triggering the release of catecholamines, which include adrenaline and noradrenaline. This results in an increase in heart rate, blood pressure, and breathing rate. After the threat is gone, it takes between 20 to 60 min for the body to return to its pre-arousal levels (Gordan, Gwathmey, & Xie 2015). Fig. 2.

McCarty explains that stress research has traditionally been oriented towards studies examining the cognitive processes that influence the perception of stress (a cognitive perspective) or the body's response to stress (a physiological perspective). Surprisingly, however, comparatively little attention has been given to the role of the emotional system in the stress process. From a psychophysiological perspective, he says, emotions are central to the experience of stress; indeed, it is the emotions activated in response to perceiving a stimulus as threatening—feelings such as anxiety, irritation, frustration, lack of control, or hopelessness—that are truly what we are experiencing when we describe ourselves as "stressed." All the above examples of "stressors"—whether minor inconveniences or a major life change—are experienced as "stressful" to the extent that they trigger these emotions.

In the last decades, research in the neurosciences has made it clear that emotional processes operate at a much higher speed than thoughts, frequently bypassing the mind's linear reasoning process entirely (McCarty 2006). And although emotions can be induced by thoughts, they may also arise from unconscious associations triggered by external or internal events. In other words, not all emotions follow thoughts: emotions often occur independently of the cognitive system and can bias the cognitive process and its output or have a physical consequence without any perceived emotional background, that given the relation between bodily systems, can give origin to a chain reaction.

Most of these reactions involve chemical substances produced by the boy, including hormones, which is why it's the study women can be of huge interest; in addition to the higher reported stress and because of the particular hormonal changes that take place in their body. Hormones are important agents of protection and adaptation, but stress and stress hormones, such as the glucocorticoid cortisol, can also alter brain function, including the brain's capacity to learn. Severe and prolonged stress can impair the ability of the brain to function normally for a period of time, but the brain is also capable of remarkable recovery.

Emotions. In psychology and philosophy, emotion typically includes a subjective, conscious experience characterized primarily by psychophysiological expressions, biological re-actions, and mental states. Emotional systems comprise both neural and bodily states that provide immediate means for protection of the individual and that maximize adaptation to survival-salient events (Saarimäki, y otros 2016). Categorical emotion models argue that evolution has shaped a limited set of basic emotions (anger, fear, disgust, happiness, sadness, and surprise) with different neural and physiological substrates to support different survival functions. These basic emotions are also characterized by distinctive feelings and culturally universal expressions (Tracy & Randles 2011).

Humans -and most other animals- appear to be equipped with a set of predictable but complex responses to situations. We call these the basic emotions: anger, fear, surprise, disgust, joy, and sadness, as described in the 1970s by anthropologist Paul Eckman. According to some theories, they are states of feeling that result in physical and psychological changes that influence our behaviour (Schacter, Gilbert, & Wegner 2011) (Scherer 2005) The physiology of emotion is "closely linked to arousal of the nervous system with various states and strengths of arousal relating, apparently, to particular emotions", and it's precisely emotions that activate the autonomic nervous system and hypothalamic-pituitary adrenal axis, leading to changes in the activity and function of

the body's systems and organs. Thus, many of the deleterious effects of stress on the brain and body are in fact physiological repercussions of negative emotions. It is also the emotions activated in response to perceiving a stimulus as threatening—feelings such as anxiety, irritation, frustration, lack of control, or hopelessness— that are truly what we are experiencing when we describe ourselves as "stressed." From a psychophysiological perspective, emotions are central to the experience of stress.

1.3 Women's Health

Even if women represent the 49.58% of the world's population (UN World Population Prospects 2019), women are still not proportionally included in clinical research in numbers that reflect the prevalence and impact of disease in women. This means that clinical practices (including treatment guidelines and medication dosages) are derived largely from the male physiological perspective. Even at the very early stages of scientific discovery, a gender lens is not considered as there remains a strong bias in research studies to use male animals to study treatments for disease (Johnson 2017).

Psychosomatic pathology has a greater frequency in females (Hange, y otros 2013), and different risk factors have been described in medical literature. Among them there is an association of sexual hormones with body symptom expressions, a higher perception of emotional distress in women, and mood swings related to endocrine patterns and the normalization of physical symptoms as expressions of emotional distress or even with long term somatization. These changes can be reflected along many stages that can or cannot be present during the life of a female, as well as other physical changes can appear during menstrual cycles. (Table 1).

Table 1. Hormonal Changes during a women's lifetime

Stage	Years	Experiences + hormones
Puberty	9–21 years old	Irregularity with the menstrual cycle. It takes time for the body to build up enough of a hormonal concentration that you can ovulate and menstruate regularly, as well as develop secondary sex characteristics
Adult Menstrual Years	21–35 years old	In this maturation period, the physiological changes unique to women are menstruation-related disorders and uterine or ovarian diseases. An increase in the lifetime frequency of menstruation due to recent changes in women's lifestyle. Contraception, changes in habits and substance regular intake play fundamental roles during this stage
Pregnancy/ Post pregnancy	Age varies	Large increases in estrogen and progesterone that produce changes in the amount and function of a number of other hormones and organs. After pregnancy, estrogen and progesterone drop significantly before readjusting causing mood imbalances and further physical changes

(*continued*)

Table 1. (*continued*)

Stage	Years	Experiences + hormones
Perimenopause Phase one	35–45 years old	Lower reproductive disposition. Increased risks depending on lifestyle and genetical factors, such as of breast cancer, high blood pressure, and heart disease
Perimenopause Phase Two	45–55 years old	Follicle stimulating hormone (FSH) levels change until ovulation stops. The body manufactures slightly less, but ideally, a balanced amount of estrogen and progesterone and testosterone
Climacteric Period	55 + years old	Estrogen deficiency, osteoporosis and other psychiatric symptoms may occur more frequently, as vertigo, migraines, and urinary problems

The menstrual cycle is a direct indicator of the overall health, and periods are the body's way of saying that things are working as they should. Having an extremely irregular or heavy period, or losing it altogether, can indicate an existing underlying condition. By tracking various details of the cycle, we will be able to recall things that otherwise would have been forgotten when speaking with a healthcare provider.

Some Facts

- One study of 58 women showed an increase in oxidative stress and cellular aging in those suffering from high levels of stress.
- A 2006 survey conducted by the American Psychological Association found that 51% of women reported stress to influence their lives, versus 43% of men. (American Psychological Association 2006).
- Women's stress tends to manifest itself more often in physical ways as compared to men, with medical conditions that include obesity, depression, hypertension, and anxiety.
- Women are twice as likely to be diagnosed with depression as men, and often that depression traces back to stress as a key root cause.
- The journal Personality and Individual Differences reported that out of 2,816 people tested, women scored much higher than men did on chronic stress tests.
- The National Institute of Mental Health advises that a big part of the higher stress numbers in women is they tend to play multiple roles at work and at home, they are often single mothers, women are more likely to live in poverty than men are, and they are also at risk for domestic violence.
- Women attribute children as a much more significant source of stress than men do. In the modern day, the stress equation for women has become further compounded by the commonly seen working mother, who must juggle a demanding career, kids, house, spouse, and everything else.

In 2001, the U.S. Institute of Medicine declared that 'every cell has a sex' (Pardue et al. 2001). In the past decade, some progress has been made to understand how to analyze sex in tissues and cells. The notion that there are biological differences between the sexes is most evident and comfortable when it is applied to the reproductive system. However, sex differences have been identified or suggested at many levels of biological organization, from biochemical to behavioral. For most of the population, as well as a substantial fraction of scientists, not all known differences are obvious, and not all of those that have been suggested or suspected are easily explainable in biological terms.

The relative roles of the sex chromosome genes and their expression explains X-chromosome-linked disease and is likely to illuminate the reasons for heterogeneous expression of some diseases within and between the sexes (Wizemann & Pardue 2001).

Hormonal changes throughout the menstrual cycle have been suggested to cause changes in mood like irritability and anxiety, but a definitive link between mood and the menstrual cycle is still under study. However, if we could be able to notice recurrent changes in the mood during a cycle, and learning when these changes happen, it could be another piece of information to help understand the rhythm of it. Tracking the many emotions and mental states all people experience, as well as being aware of changes can prepare the user for them and to better manage them.

Whereas emotions are direct responses to external events, mood is a diffuse experience of the balance between one's overall personal resources and one's life challenges. Mood passes and changes: they can last for hours, or sometimes even days, but they are constantly changing and converging into other moods. At the same time, moods are pervasive. They represent the no reflective feeling state that forms the core of our affective being (Russell 2003), and they are a direct indicator of our general subjective well-being (Diener, Fujita & Sandvik 1994).

Design can also influence mood by enabling and stimulating people to engage in a broad range of mood-regulating activities. It is very useful for this project to research some novel mood-regulation strategies and explore how these strategies can inspire design interventions (Desmet, Hekkert, & Hillen 2003).

1.4 Tracking and Health

In the simplest terms, emotion tracking is the ability to measure and gauge the emotional status across a period. Tracking emotions is one of the fastest growing ways to help quantify our mental health. Technology companies have worked over the last few years to create a solution that best helps us to identify and understand our emotions. The sole act of tracking the own sensations and states, our routines and changes has meaning, not only for ourselves but for the sake of medical research and other women will reflection self-steam and self-knowledge (Feldman Barret & Russell 2015).

Sensing physiological patterns is not a new thing; ambulatory medical devices have been under development for years, helping people with various medical complications, to monitor heart rate, blood pressure, and more. Affective wearables overlap with medical wearables in that both may sense physiological signals (Mann 1997). Both may be concerned with sensing signals that indicate stress or anxiety, an application of interest not just for people suffering from anxiety attacks or other medical conditions, but also for healthy people who are interested in staying healthy.

Miniaturization of components has enabled systems that are wearable and nearly invisible, so that individuals can move about and interact freely, supported by their personal information domain. Current efforts that use physiological sensing are focusing on: Gestures, GSR (Galvanic Skin Response), EKG (Electrocardiogram), EMG (Electromyogram), BVP (Blood Volume Pressure), Respiration and temperature, and in the late years smartphones have allow us to get a little familiar with the concept of Heart Rate Variability outside a health facility context.

There are currently no clinical studies using ambulatory auscultation or pulse oximetry for HRV studies, but such are possible. In clinical use since 1970, Holter ECG recorders have evolved by incorporating advances in electronic amplifiers, processors, solid state memory, batteries and wireless communications (Khairuddin & Ku Azir 2017).

1.5 Heart-Rate Variability (HVR)

We've described some highlights of the critical function of input from the body's organs to the brain in contributing to the input patterns that ultimately determine the emotional experience. Although complex patterns of activity originating from many different bodily organs and systems are involved in this process, it has become clear that the heart plays a particularly important role. The heart is the primary and most consistent source of dynamic rhythmic patterns in the body from many different bodily organs and systems are involved in this process, it has become clear that the heart plays a particularly important role. It is the primary and most consistent source of dynamic rhythmic patterns in the body. Thus, with each beat, the heart not only pumps blood, but also continually transmits dynamic patterns of neurological, hormonal, pressure, and electromagnetic in- formation to the brain and throughout the body.

In general, emotional stress including emotions such as anger, frustration, and anxiety, lead to heart rhythm patterns that appear incoherent, disordered, and jagged. In contrast, sustained positive emotions, such as appreciation, care, compassion, and love, generate a smooth, ordered, sine wave-like pattern in the heart's rhythm.

The natural fluctuations in heart rate, known as heart rate variability (HRV) or heart rhythms, which are a product of the dynamic interplay of many of the body's systems. It's been demonstrated that distinct heart rhythm patterns characterize different emotional states. Past studies have also indicated that ECG signal can be affected by various environment parameters such as mental issues and different types of physical activities (Takahashi & Suzuki 2015).

Heart rate variability (HRV) is defined as the physiological variation in the duration of intervals between sinus beats; it's a measurable reflection of the balance between sympathetic and parasympathetic systems, and it has been used as a marker for cardiac status and predicting CV outcomes. Recently, the availability of commercially available heart rate (HR) monitoring systems has had important CV health implications and permits ambulatory CV monitoring on a scale not achievable with traditional cardiac diagnostics (Singh, y otros 2018).

In brain-damaged adults, Lowensohn reposted that HRV decreased and rapidly diminished in line with increases in intracranial pressure (Lowensohn, Weiss, & Hon

1977) A more recent study in 145 trauma patients confirmed that an increase in intracranial pressure, as measured by invasive ICP monitoring, is preceded by a reduction in HRV. Changes in HRV have also been shown to be an early indication of the occurrence of brain death (Conci, DiRienzo, & Castiglioni 2001). However, some studies show that depending on the artifact, the electrocardiogram (ECG) signal can be misrepresented because of interference and baseline wandering, reducing the accuracy of the data, especially in a moving person (Kim, Noh, & Jeong 2015) and some improvements for complex detection, data compression and data de-noising are still needed.

Limitations of HRV Measurement. Although the ability of HRV to provide information on biological systems is promising, there remains a few physiological and technical issues that need to be considered when interpreting HRV clinically. The context of HRV recording is crucial, as numerous factors including age (increased age leads to reduced HRV), gender (higher HRV in females), thought to alter HRV.20 Factors such as posture and movement also need to be considered as it has been shown that HRV is markedly altered between standing and supine positioning (Task Force of the European Society of Cardiology 1996). HRV is also affected by some technical factors such as ECG sampling frequency, length of ECG recording and the presence of artefact or interference (Shaffer & Ginsberg 2017). Despite the potential of HRV measurement, it is still largely a research technique and has not become part of routine monitoring in critical care (Sztajzel 2004).

2 Objectives

- Measure the base level stress of the user's body by using the Heart Rate Variability parameters.
- Offer an easy way to register the number of emotional peaks or symptoms around the day.
- Design a calendar-like product where to relate the previous inputs with the months or hormonal cycle.
- Help the user register this data to make available for further statistical or medical purposes.
- Encourage the user to develop a sense of self-awareness in the unseen part of them, giving importance and acceptance of not only of the physical sensations but also of their emotional reactions.

3 Hypothesis

Detecting how emotionally volatile the user might be in certain situations can be a huge help in improving her mental health. For example, insights from emotion tracking could help a medical professional provide advice and support on how these feelings can be coped with in everyday activities. This emotional data can then be correlated and reported on to help you unpack the instances and circumstances that lead to distressing situations, or likewise, happier moments.

4 Materials and Methods

This is a descriptive, qualitative study, based on semi structured interviews done to a sample of healthy women that have suffered from physical discomfort or symptoms related to somatization, during extended periods, in particular digestive functional symptoms, urinary symptoms, headaches and muscular or joint pain without apparent medical causes. This, in order to understand the possible needs to be addressed and to better frame the design proposal.

The second phase is the theoretical research, in which the Heart Rate Variability was found suitable for the project, since it's a physiological parameter that can be easily measured using available technology already available in smartphone apps (Campos 2019), and it can be a practical and useful way to evaluate somatic stress.

The third stage is developing the design concept that will give didactic feedback to the user, registering the number of emotional peaks or functional symptoms (not caused by a disease), around the day, like; anxiety related with abdominal functional pain, etc. and combining these two inputs into a matrix to be translated into a visual code.

A kinetic calendar is proposed as a suitable way to show the emotional and physical symptoms, registered daily, since it's a visual showcase of the possible transitions and severity of symptoms along the whole hormonal cycle, making it correspond to the menstrual cycle of the user, where each day representative unit, can move into a particular position.

The continuous observation of the monthly figures or patterns that form in the calendar display, encourage the user to develop a sense of self-awareness, encouraging the understanding and acceptance not only of the physical sensations, but also to link them to their emotional reactions.

The data will remain stored inside the app, to help the user register this data for longer periods and to make available for further statistical or medical diagnoses if the woman decides voluntarily to share her information.

As a further stage, a clinical analytical study will be proposed to look for statistical association between hormonal cycle and nervous autonomic response, to describe the correlation between emotions, stress levels and hormonal cycle. This study phase should be done in collaboration with a liaison psychiatrist and/or endocrinology specialists.

5 Discussion

Tracking systems provide a variety of means of monitoring stress and other conditions outside the confines of a medical facility and gathering data as the wearer carries on his or her daily activities. Of course, none of the data collection or analysis implies that a user will choose to change his behavior or lifestyle, but projects in this fields can help a wearer make informed decisions, and can be shared with a physician, if the wearer desires, for help in treating chronic stress related disorders.

Several authors have correlated HRV with inflammatory markers. This suggests that HRV is related to both anti-inflammatory and pro-inflammatory signals with a stronger association being present in patients who are more unwell (Papaioannou, Dragoumanis, Vasiliki, Gargaretas, & Pneumatikos 2009).

HRV analysis offers a unique monitoring modality that provides information regarding variability in complex biological signals. HRV can potentially detect and track the state of the whole physiological system over time and during the development of illness, potentially even before it is clinically apparent. If these challenges are addressed, HRV analysis has the potential to revolutionize critical care monitoring and introduce an era of monitoring based on individualized variability analysis (Johnston, Barret-Jolley, Krige, & Welters 2020).

The health monitoring system has been incorporated slowly in everyday life with enhanced graphics and better user experiences; by using smart phones that display comprehensive information patients are allowed to check some parameters almost anytime and anywhere. This can enable a continuous flow of physiological information by remote monitoring (Ullah, Shah, & Zhang 2016) and lower the cost of public health care by removing the need for health professional to take part in data collection and analysis frequently. In addition, physiological information can be shared through wireless connectivity by a whole team of medical professionals for quicker health recommendations (Satija, Barathram, & Sabarimalai 2017).

IoT can connect medical devices such as ECG, sensors, and other diagnostic and imaging devices. The networks of IoT-based devices are expected to not only improve the detection and prevention of diseases but also reduce medical costs, increase the quality of life as well as enhance the patients' experience of using these devices (Khairuddin & Ku Azir 2017); and by incorporating IoT into existing network configuration, healthcare organizations can modernize the whole healthcare industry using smart resources. However, the integration of existing devices into IoT-based configuration will require backward compatibility and flexibility (Islam, Kwak, Hossain, & Kwak 2015).

6 Conclusions

Tracking apps provide a variety of means of monitoring bodily functions and other conditions outside the confines of a medical facility and gathering data in real time as the wearer carries on his or her daily activities, since "mobile phones and wearable devices have become extensions of an increasingly diffused and smart digital infrastructure" (Ghose 2021). However, this focuses only in the physical input, which is why this proposal adds the emotional and sensorial factors to the collected data, making it possible for the user to observe changes of colors, intensities, and shapes on the display in order to make easier the recognition of possible emotional patterns and the relation they might have to chronic pain or disturbance.

The state of the art in computers and materials, as well as the interest from society in the personalization of their environments (Heidmets 1994), opens an opportunity window for design to continue to explore the emotional field. In this case, the suggestion is to merge these efforts and multidisciplinary input, to propose a sort of "emotional mirror", a display where users can leave tracks and patterns of their monthly journey for a further auto-analysis of their own physical and emotional.

Data collection and analysis must be aligned with ethical privacy policies, and only the users will be able to choose if they want to share this information with health specialists or ask for therapeutical advice for any changes in daily choices or coping behaviors,

but this design proposal can help healthy people or patients to have valuable information for treatment of chronic functional symptoms related to stress.

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A Design-Based Approach to Support Hospital Wards in the Digital Turn. The Development of a Case Study to Support Hospital Ward in Reducing Errors in Therapy; a Problem of Intergenerational and Cultural Gaps

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Abstract. The error in pharmacological therapy is a significant issue in the context of hospital care practices. This contribution does not consider the error as a mere casual event, nor as the result of deviations from defined procedures, but inscribes it within the framework of the activities (and relations between activities) that define care. As a privileged point of view, the analysis circumscribes the communication system, highlighting as a critical point the passage of information between medical and nursing staff. The article takes its cue from a real case study, in which we analysed the networks of information and communication, starting from the medical and nursing documents that accompany the care activities. The interpretation of the processes investigated stems from the design culture, particularly from a human-centred perspective. The first design elaboration follows the analysis phase; in this context, the artefact acts as a transitional prototype, a bridge-object between the established routines and practices of the current reality and their role as a gateway to a digital future.

Keywords: Digitalisation of communication processes · Translation of health information · Errors in healthcare · Data Traceability · Incremental innovation

1 The Healthcare System: Scenarios of Transition

Design, intended as culture and practice, has an increasingly intense interest in issues concerning the world of health and personal care, both in everyday public and domestic life. This interest is manifested on several dimensions: the more traditional and historicized one, that focuses on the design of artefacts and environments for personal care; the codesign of innovative systems, products, and services, in which there is an open dialogue between designers and people with different knowledge and experience - from doctors to nurses, from patients to caregivers; and the strategic one, in which design culture is the bearer of innovation processes in the health sector [1, 2]. The Covid-19 pandemic

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has changed our society, especially in the field of care processes in which patients and medical personnel are involved; it has also stimulated a constructive reflection on the interdependencies between the actors in the care processes. Human wellbeing is a point of contact between medicine and design culture: both participate, act, and design to improve the person's condition - *the central place of human beings in our work* [3].

The contemporary challenge facing the future seems to relate to designing and managing care services to ensure their effectiveness in addressing new issues (such as those brought about by the pandemic) and conditions of a structural nature (such as those associated with an ageing population). Among the critical transitions that the healthcare world faces soon, there is the challenge of outlining strategies to manage the transformations induced by the overbearing entry of new digital technologies, with their impacts on medical practices, methods, and cultures [4]. Such a transition requires cultural, technological, and infrastructural changes that will likely require a cross-generational leap to unfold in terms of an accomplished innovation [5].

In this paper, we focus on analysing a problem related to the everyday experience of patient management in the hospital environment. Starting from a small-scale project that introduces an incremental innovation, we want to highlight the goodness of a systemic, multidisciplinary and codesign approach in bringing out the width and depth of implications and impacts to be addressed in the broader processes marking the transition of hospital facilities to the "digital turn".

There is no single definition of transition processes; they take on different connotations depending on the disciplinary perspective from which they are observed. In this article, we agree to use the term 'transition processes' to refer to the way people respond to change over time, through active forms of personal, relational, situational, social, or environmental adaptation [6]. The reconstruction of identitarian values [7] and the definition of a stress threshold that does not hinder learning processes [8] are essential to ease the acceptance of transition processes. In these processes, different generations pose different issues concerning the impact that may result from the transformation of information and communication processes produced by the digital shift.

2 Errors in the Hospital Context: An Overview

Passive reception or proactive recourse to forms of digitalisation of information and communication processes within hospital wards is investigated here because of the possibility that these very processes may generate errors and adverse events.

In the context of medical care provided in a hospital environment, according to the extensive existing literature, we define an "adverse event" as the damage or discomfort capable of undermining, even seriously, the safety of the patient, due to errors resulting from the various medical services received. The adverse event is part of the comprehensive chapter of clinical risk. It defines situations ranging from states of anxiety caused by diagnostic or laboratory errors or by communications that are not correct or not understood by the patient to more severe effects - including even the patient's death - resulting from infections, allergic reactions to drugs or inappropriate therapies and interventions [9].

The problem has long been the focus of health safety research and policies to prevent the impact of adverse events on patients' health, reputation, and the economies of health

and social systems [10]. According to World Health Organization [11], 10% of patients encounter an adverse event during healthcare treatment. Error can depend on a plurality of causes. The literature offers several approaches aimed at observing the phenomenon from different points of view and purposes:

- approaches that correlate error with specific types of healthcare activities (e.g., diagnostic, surgical, pharmacological, etc.) [12].
- approaches that describe error according to the nature of one's behaviour that caused it (e.g., unintentional, under high-risk or routine conditions, caused by deviations from procedures, due to carelessness, dependent on poor organisation of one's activity or incorrect forms of organisation of the system, etc.) [13].
- approaches that cluster the error based on the ability to understand, comprehend, remember, and perform even complex operations. In other words, the error is related to interpersonal skills, competences, memory functions, and operational skills [14].

The process of recognising, measuring, preventing, and limiting the consequences of an error is known as risk management [15]. In this approach, the typical intervention methods follow the standards usually established by each National Health System [16, 17]. On a territorial scale, these standards are received and modified according to the peculiar activities performed by each entity, such as hospitals. Despite this kind of adjustment and personalization, these standards base their philosophy of intervention on methods and procedures borrowed from industries or organisations (e.g., war-type) dealing with complex technological systems. For such reason, a deterministic imprint prevails, unsuitable for a hospital environment dominated by the aleatory nature connected to the human component rather than the principles of strict functionalism [18, 19]. These risk management protocols are not fully effective because they underestimate the human component, and the characteristics of activities where interpersonal relationships have extraordinary importance and where the "outcome of the process" is the patient and his/her healing rather than a technological or organisational artefact [20].

3 The Research Framework: A Methological Background

A human-centred approach was adopted to understand the human component and real experience in the practices of the care processes and to develop new design opportunities. An initial phase of analysis and understanding of the practices in use in the ward and the relationship and communication dynamics used by the medical and nursing staff was followed by an iterative phase of conception, evaluation, and implementation of the identified project hypotheses.

Although belonging to the case studies research, the methodology proceeded in the reconstruction of events, processes and procedures, interactions, context conditions and relationships, not through direct contact with the dynamics of real life in the ward, nor by collecting direct testimonies from patients. Since this is a COVID-19 ward, the analysis focused on listening and discussing with the operators, retrieving documents, interviewing, and creating scenarios. Thanks to these activities, the micro-dynamics of care were outlined in their complexity and, at the same time, the experiences, difficulties, perspectives and wishes of the different actors involved were grasped.

Gathering the documentation and interviewing the ward staff enabled us to map the daily activities and highlight the nodes where problems lurk, which can lead to errors [21].

In particular, the research has focused on communication processes, noting the elements that can predispose to failures, misunderstandings, omissions, with even fatal outcomes as evidenced by literature data [22]. The dense communicative interweaving between many subjects and many objects plays a significant role in making care activities particularly complex.

Within the ward daily activity, we have identified a critical moment, the "handover" [23]: the precise activity through which nurses and doctors give back events, criticalities, diagnostic interventions of which the results are expected, medicine dispensing that must be carried out outside the ordinary prescriptions, etc., passing "the baton" to the colleagues of the next work-shift. In this context, all the actors and the artefacts - material and immaterial - are present, making it possible to investigate their role in the complex network of care, while identifying unexpressed process difficulties [24]. In the hospital context, the complexity of communication artefacts is evident; we are dealing with

- Documents filled in following official formats and templates (e.g., clinical classification document and incoming medical assessment; clinical diary; single therapy sheet (*Foglio Unico di Terapia* - FUT); nursing care planning document; discharge letter; random error and adverse event report form, etc.).
- Informal notes (e.g., sheets and notes to pass information between nurses at the handover: cases to be monitored, special instructions or interventions to be carried out "as needed"; sheets with patient's notes; lists of the patient's medicines, ordered or reconstructed "from memory"; diagnostic reports brought by the incoming patient).
- Dialogues, descriptions, prescriptions, reports (e.g., written and oral communications; verbal and visual - with different degrees of iconicity -; formal and informal; in presence and at a distance - the latter in object-mediated form and/or mediated by other subjects; transcriptions and translations).
- Signs and codes (e.g., formal and/or agreed code systems between operators; signs; signs and feedback signals, QRcode, Barcode).

This article does not return the multiple layers of meaning that the documentary artefacts, observed and analysed in the research, assume in the care process. They have a notational function; they are prescriptive devices for the activation and organisation of complex activities; they are memory archives and legal instruments. They implicitly incorporate the organisational structures of the institution, with the divisions into roles and the consequent authorities and competencies of who can write, who can read, who can exceed them, and who has the task of making them operational. These elements are not secondary in a project of translation of complex activities into a digital system. Even if we only dwell on the primary functional role granted to them by the system, the following emerge: communication gaps; overlapping of activities sometimes not regulated by an adequate information exchange; criticalities linked to the traceability of tasks, roles, and responsibilities. The documents accompanying the care process do not fully play their role as connectors in the interaction between the different subjects working around the patient.

4 Problems and Expectations of Transition: Intercultural and Intergenerational Gaps

The analysed ward manages communication processes in a hybrid form comprising handwriting on paper and digitalising some data.

Concerning a transition towards the full digitalisation of the information in the practices of care, the interviews with medical and nursing staff outline different perspectives, that the digital natives' interviewees attribute to questions of age. Firstly, young interns and nurses request the start of digital experimentation. They believe that doctors - almost all over 55 years old - are holding back this transition due to their "technological inability". Secondly, the interviews raise exciting issues related to the difficulty in mastering new instrumental knowledge and the impact of digital transformation on the cognitive level.

The primary reflections include:

- a first consideration concerns experience: this has been trained using paper formats. Visual habits, consolidated forms of writing and reading, which have become routine, have favoured the reinforcement of behaviour and thought patterns. Abandoning this system must therefore be accompanied by the necessary periods of adjustment, with soft transitions, precisely to avoid potential errors.
- a second concern, which emerges above all on the part of medical staff, lies in the risk that the switch from paper to the screen may reduce the ability to read *at a glance* the data, which currently take up an entire A3 page. For doctors, these data are highly identifiable. Numerical data and time traces give an immediate picture of the disease, have their own "uniqueness", and refer directly to the patient, as if they were his/her identity card. The spatial positioning of texts and visual signs in the page helps to reinforce visual memory, and therefore the capacity for synthetic reading.
- a third concern arises from the loss of expressiveness that is inherent in handwriting.

Here we grasp issues beyond the contingencies gathered from individual experience because they bring to light questions that have already found a place for reflection in some disciplines. These include the psychology of perception, communication cultures and visual communication design and semiotics for their contributions to visual configuration and signification processes.

Firstly, with Bucchetti [25], we can say that every recipient, when faced with a communicative artefact, is predisposed to understand. In facilitating the act of understanding there are, as is known, communicative devices [25] such as: the visual organisation of information [26]; the hierarchy of content [27], the text-image connections [28]; the guarantee that the data is traced and easily traceable; the simplification of the use of content, including text, through forms of visual translation [29].

The paper formats on which doctors and nurses work are not very effective in guiding the gaze, following the contents according to their relational links; giving a hierarchical order to the information; in making the eye dwell on points of attention.

Visual field mastery seems to be more linked to familiarity with the format of the paper, which derives from previous experience, than to designed perceptual qualities. As an example, the table structure of the FUT in intrusive (Fig. 1): its layout organised in rows and columns, dominates the content, and does not confer a preferential reading order in a vertical or horizontal sense. Once filled in, it doesn't allow identifying its "calendar" structure clearly: data are enclosed in too small cells and entered too close together, creating an indistinct texture.

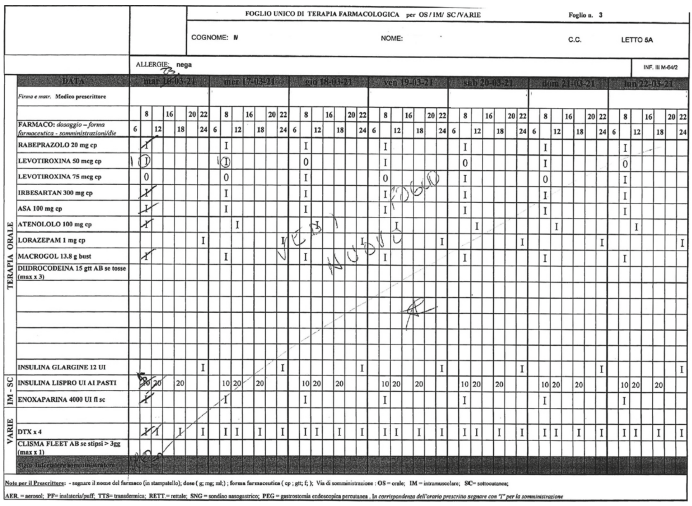
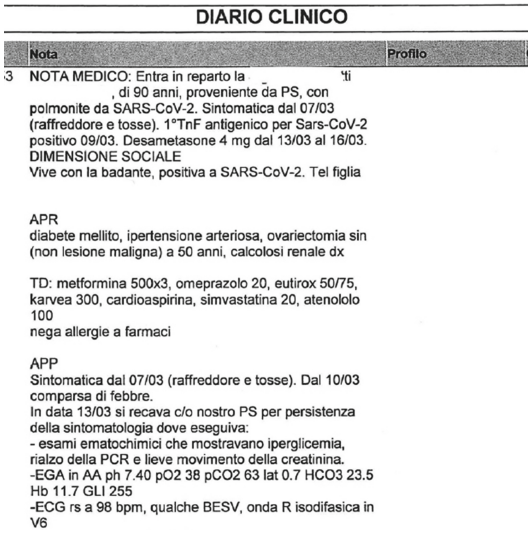


Fig. 1. An example of the *Foglio Unico di Terapia* (FUT) handwritten by the staff within the ward.

Other layouts are entirely undifferentiated and present themselves as a writing space with no real structure, not answering the reader's expectations [30] regarding where to look for specific information. In other words, it is not easy to trace the contents sought (Fig. 2).



DIARIO CLINICO

	Nota	Profilo
3	NOTA MEDICO: Entra in reparto la _ 'ti , di 90 anni, proveniente da PS, con polmonite da SARS-CoV-2. Sintomatica dal 07/03 (raffreddore e tosse). 1°TnF antigenico per Sars-CoV-2 positivo 09/03. Desametasone 4 mg dal 13/03 al 16/03. DIMENSIONE SOCIALE Vive con la badante, positiva a SARS-CoV-2. Tel figlia APR diabete mellito, ipertensione arteriosa, ovariectomia sin (non lesione maligna) a 50 anni, calcolosi renale dx TD: metformina 500x3, omeprazolo 20, eutirox 50/75, karvea 300, cardioaspirina, simvastatina 20, atenololo 100 nega allergie a farmaci APP Sintomatica dal 07/03 (raffreddore e tosse). Dal 10/03 comparsa di febbre. In data 13/03 si recava c/o nostro PS per persistenza della sintomatologia dove eseguiva: - esami ematochimici che mostravano iperglicemia, rialzo della PCR e lieve movimento della creatinina. -EGA in AA ph 7.40 pO2 38 pCO2 63 lat 0.7 HCO3 23.5 Hb 11.7 GLI 255 -ECG rs a 98 bpm, qualche BESV, onda R isodifasica in V6	

Fig. 2. An example of a completed clinical diary, reporting the patient's medical history summary.

Finally, a few considerations on handwriting: this type of writing facilitates the writer's recognition of the contents *at a glance*. It allows him/her to identify details and salient features without proofreading the entire text (Fig. 3).

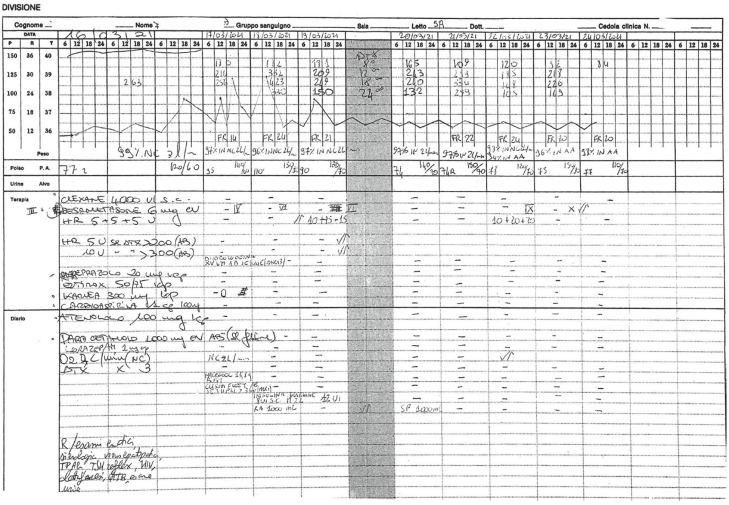


Fig. 3. An example of the Nurse Care Planning, handwritten by the staff within the ward.

All this is compounded by: the inhomogeneity of the handwritten text, its imperfection, discontinuities, the more marked and uncertain traits, elimination marks, etc. Everything that becomes a *distinctive sign* triggers the visual memory, activated more by exceptions, by salient points than by the homogeneity and uniformity of the textual texture [31].

Again, the very act of writing triggers critical cognitive and memory processes [32, 33]. In handwriting, there is a need to pre-set the sequence of thoughts and reflections, give them a logical connection, define their hierarchy, and make sense of them [34]. This intellectual effort facilitates subsequent memory processes, activated by the particular "motor memory" linked to hand movements [35].

On the other hand, the impact of handwriting on error cannot be dismissed as a secondary issue. This is because the doctor's handwriting is not always understandable; sometimes, it must be interpreted and can give rise to misunderstandings.

5 Communication Flow Without a Palimpsest

We focus on some issues relating to the communication organisation in the hospital environment to identify further critical points. Here are the main ones:

The spatial collocation of information: information about the patient and his/her health status is generally spatially located according to the writer's contingencies: Some located in the doctors' room, collected in folders containing the patients' medical records; others belong to the nurses, sometimes they are transitory and serve to note specific tasks of the work shift; others represent the results of examinations or medical consultations written directly and included in the medical record; others hang on the door of the patient's room or directly on the bed and concern parameters, functions or body values that must be monitored daily. Detailed information on the individual patient's treatment can also appear in a note on the medication package or in the drawer of the patient's trolley.

The temporal dimension of information: stable and long-term information coexists with short-duration ones in the treatment process. It is essential to keep track of it to verify the effectiveness of the therapeutic actions implemented. Writing crystallises the process data, which may change in the meantime. The updated data and the trend are significant, just as knowing who entered the information and at what time. The temporal indication of all the events (e.g., when taking the therapy, when measuring specific parameters, etc.) helps relate to any expected effects of the therapy.

The sharing dimension of information: the handover. The work of medical and nursing staff is organised in shifts. Daily examinations, the prescriptions and treatments, and updating the medical records, etc. are mostly carried out in the morning shift by the doctor who follows the patient continuously during their stay. In the following two shifts, the on-call doctors only intervene if the patient's condition is not stable. At each change of shift, there is a handover. The documentation is made available to the next shift, giving an overview of the whole ward and each patient, with particular attention to emergencies. The nurses of every shift write brief notes, on sheets of paper for their use, to remind the main precautions to be taken, sometimes outside the routine programme (Fig. 4).

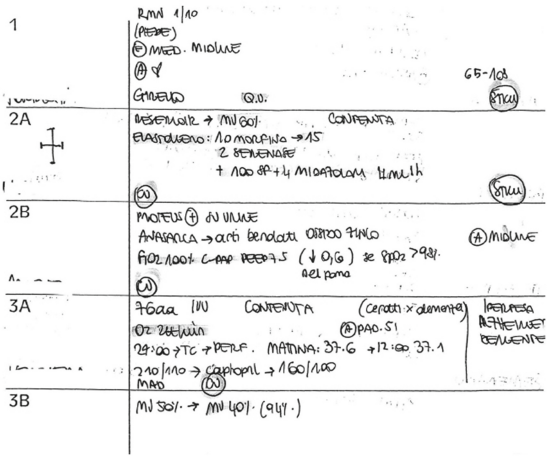


Fig. 4. Handwritten notes taken by the nursing staff, describing the patient's condition and the therapy organization.

We could define this moment as a sort of "baton handover" that, on a visual level, refers to a gesture with its physicality and at the same time recalls the passing of something concrete, material [23].

Precisely at this juncture, all forms of writing, transcription, synthesis, and interpretation come into play, where there may even be a mixture of information deduced and synthesised from primary sources (e.g., the Clinical Record, the Nursing Record, the FUT), and information transferred informally, in terms of advice, suggestion, operative hypothesis etc. [23]. Information, taken out of its context of origin, may generate doubts or contradictions in the following phase.

Process chains: within the process that manages care, several information and communication chains can be highlighted, such as: communication processes linking the ward to the other wards and other hospitals; communication processes relating the doctor in charge to the other doctors on the on-call shifts; communication processes linking the medical staff to the nursing staff, for information on the patients' condition and instructions on diagnostic and treatment interventions; communication processes of the doctor with patients and caregivers; backstage communication processes relating to the complex logistics of medicines and other diagnostic-therapeutic services; communication processes of the nursing staff with the patients (Fig. 5). Each of these levels of communication possesses its specific criticalities which are particularly evident in the intersection between the different layers of communication, due to the lack of a planned connection and more effective tracking of the different information steps.

Process feedback: the operations carried out by the doctor are easily identifiable, whereas it is more complex to trace the procedure - and thus the responsibility - of the nursing staff and to establish who and when carried out a specific operation. To ease the communication process, the ward personnel has started using symbols (e.g., circles, vertical bars, sticks, etc.), attributing them specific shared meanings. These symbols, which are marked on the therapy sheets to indicate the performance of the planned care activities, do not allow the operator to be univocally associated with the activity carried out.

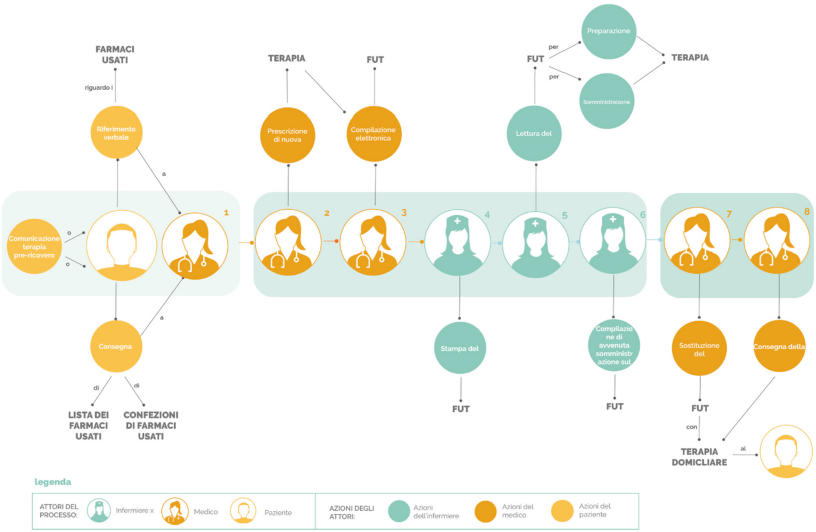


Fig. 5. An outline of the therapy prescription process from the beginning of the hospitalization to the homecare.

All these microdynamics make us notice that every communication artefact, even if it keeps its documental value, cannot make the fruition of the information unitary, which remains fragmented and unconnected. Nor can it effectively deploy the function of "prescriptive apparatus" capable of activating complex procedures and coordinated actions conceived as frames of an organised structure. We consider the communication artefacts, their nature, their joint purposes, the strong need for an integration that follows a plan. For this reason, we adopt the term *flow communication* [36] to indicate forms of communication that do not consist of *"many separate events, functioning separately, usable and plannable as such". In flow communication, "[…] the artefacts are immersed in a network, a spatial and temporal structure within which they take shape"* and need points of connection, a *palimpsest* or a *"general plot that organises the communicative artefacts in space and time"* [36] (translated by the authors). Precisely what seems to be missing in the script of a complex communicative process such as the one concerning care practices.

6 Palimpsests and Translations: The Transition from Paper to Screen

Firstly, the change from paper sheets to digital media represents an opportunity to design the architecture of the contents as a whole - the palimpsest of the communication flow - and to define the segmentation of the contents and the consequent framework of every single page that generates expectations to the information that the operator is looking for.

The format change becomes an opportunity to rethink the overall structure, giving the relationships between contents "on the page and between pages" a space-time logic.

It also makes it possible to define visual hierarchies and logical meanings given to the single frames to guide the reading where the expressiveness of the written sheet is lacking.

Critical elements are found in the possibility of maintaining *the glance* allowed by the paper page, where the punctual data is easily reconnected to the temporal trend of the patient's condition. In this *translation step* [29], all the conceptual and operational tools developed by the communication design are used to ensure transfers between different languages, between other supports, formats, and media; to make the contents more usable; to facilitate access and retrieval by users.

In addition, cognitive psychology and workplace studies [37] suggest paying attention to the familiarity that operators develop in routine practices, in habits of use, in memories and experience. These become relevant in places subject to risk activities such as those carried out in health care places. The digitisation of information processes makes it possible to prepare the feedback necessary to make the actors in the various stages of the process identifiable, tracing their responsibilities at the exact time when the action takes place.

Some information *stitchings* become relevant. For example, the research phase revealed the need to have a visual overview of the whole ward - a sort of mental map helping nursing staff to visualise the rooms and beds of critical patients who need extra attention - and at the same time detailed information on these patients. Similarly, it is necessary to reconnect information about the patient's condition before admission to the ward - motor and cognitive autonomy, therapies in use, drug allergies, etc. - with information about prescriptions and medications - with information about medicines and forms of support that are needed during the stay in the ward. In the necessary *stitching*, attention was paid to the nature of the communication forms: verbal, textual, numerical, figurative (with different levels of iconicity).

In the same document and/or more documents, information expressed in different forms of representation coexists. This depends on the purpose for which they are used. Sometimes precise values expressed in the numerical form are useful, and sometimes it is necessary to check the data trend in diagrammatic form. The scale of the data may also change according to specific diagnostic questions. For this reason, it seemed relevant to create a greater connection between information located in different documents and to design easy accessibility to the simultaneous display of different formats of the same information.

A potential criticality in the transition to digital systems relates to informal communications of which no record often remains. Within a complex system, informal exchange has its natural physiological necessity (e.g., simplifying relationships, speeding up information exchanges, drawing attention to situations, confidentiality, etc.). In most cases, informality is linked to talking and colloquial forms and tools (e.g., mobile phone and smartphone) that allow information to be given and received at a distance. Tracing informal dialogues, ensuring that their naturalness remains and that their memory remains, is a potential challenge of the digital shift.

In the transition from analogue to digital, the importance of expressive connotations makes us notice how an important "communicative residue" can be formed [38] for several reasons: because the textuality between the many actors of the care process is

made of expressed and latent contents; because of the plurality of languages present (e.g., verbal, visual, sensory, gestural); because it is possible to lose the emphasis that is in the spoken word where extensive definitions, accessory impressions prevail (e.g., interjections, intonation, mimicry, or gestures); because the world of care is full of lexical ways and professional slang. The resulting textual weave has a strongly connotative and contextual character.

Other critical issues are cognitive. When reading "on paper", the eye explores the entire surface, favouring the mechanisms of visual memory. In on-screen digital formats, one is forced to scroll between different screens and interfaces. This requires a more significant cognitive effort to govern the content in its entirety. Secondly, the digital format, which works on links, induces fragmented reading where one continually "exits" the page to connect different contents [39]. This mechanism makes it easier to compare data and link information together. The hyperstimulation and the continuous zapping from one content to another make reading superficial, less accurate, not anchored to memory processes, also reducing the level of comprehension of what has been read [40].

There is at least one further issue addressed in the literature. Several studies have found that, with digital reading systems, a habit has formed of associating on-screen reading with the search for quick information, with texts that are not particularly demanding - for example, texts of an informative-disclosing nature - that do not require long periods of reflection. This habit consolidates an expectation, an expectation when we approach a text in digital format. As the literature reports, we tend to attach less importance to this than to printed texts, which we tend to associate with more relevant content.

As previously stated, with Simone [41] it is worth recalling the fact that every time we modify the technical form of the tools, we modify at the same time *"the work our mind does on information, the way it receives and reworks it"* [41], and the *sensory equipment* we use in acts of understanding.

There are forms of knowledge that are more related to learning by seeing (e.g., using a simultaneous intelligence that operates on visual stimuli that are presented in large numbers at the same time and among which it is difficult to establish an order), others to learning by listening, others still to learning by reading, using a particular type of vision that is the *alphabetic vision* [41], that uses a sequential intelligence that operates on the succession of stimuli, hierarchizes information, follows temporal sequences [41]. The transition to the digital format must guarantee that these different forms of "learning" remain active while maintaining the plurality of sensory stimuli connected to the various forms of communication.

In dealing with the transition to the digitisation of the communication process, alongside the expected reduction of those errors, dependent on the dispersion of information data, the potential problems connected to how the information is read in the digital format have also been taken into consideration [42].

7 Transition Prototypes

Supported by multidisciplinary contributions, the case study analysis has made it possible to elaborate an initial design outcome. In this context, it acts as a *transition prototype* [43],

a sort of bridge-object between the customs and consolidated practices of the existing reality and their adaptation to a digital future.

In our case, the prototype does not only represent the object in its early stages of development or becoming; it has a broader social value, to bring into reality a series of ideas, methods and processes, connecting the physical and practical elements to the theorised ones, helping to create a dialogue with the actors involved in the design process [44].

In terms of design practices, this object incorporates the need for multiple forms of translation [29] to facilitate communicative access. In the new artefacts, it is important to maintain some of the characteristics of the forms of consultation and interaction consolidated by experience to guarantee familiarity of use; even more so in working environments with a high risk of error. It is important to maintain the expressive features belonging to the different forms of communication; these are necessary to give the right style and tone to information and texts that have different functions, addressing different actors of the process and obtaining different behaviors and actions reactions from the interlocutor. The activation of multisensory forms of reception able to return also fast and urgent messages, informal communications, is also necessary.

On the level of theoretical reflection, it tries to incorporate attention to cultural pluralism, in response to the needs that emerged strongly from the interviews with the system's actors. To bridge the distance detectable in the needs and requirements expressed by medical personnel concerning nursing staff, we must consider such value. This distance is further underlined by generational differences and by a different propensity to move towards digitalisation of processes to make data, operations, responsibilities traceable.

8 Transition Objects

The project consists of a digital platform whose interfaces and interactions have been designed to facilitate: the continuous access to data; the traceability of responsibilities; the data comparison, to have a constant overview of the patient condition; the scale-up from the individual patient to the whole ward, to provide a continuous monitoring through a visual map; the possibility of recording voice notes, to encourage the expressiveness of communication and to leave a trace of informal forms of communication; the opportunity of viewing the medical and nursing staff work-shifts, to be able to use personal and non-impersonal forms of communication. The project intends to: work on the communicative immediacy and simplicity of the interfaces to facilitate access to the use of digital tools; transfer the information from the printed page to the digital screen, trying to adhere to the users' previous visual experience (e.g., being able to see the patient's entire clinical history *at a glance*); display the status of the requested exams (e.g., booked, to be performed, being performed, reported, etc.) (Fig. 6).

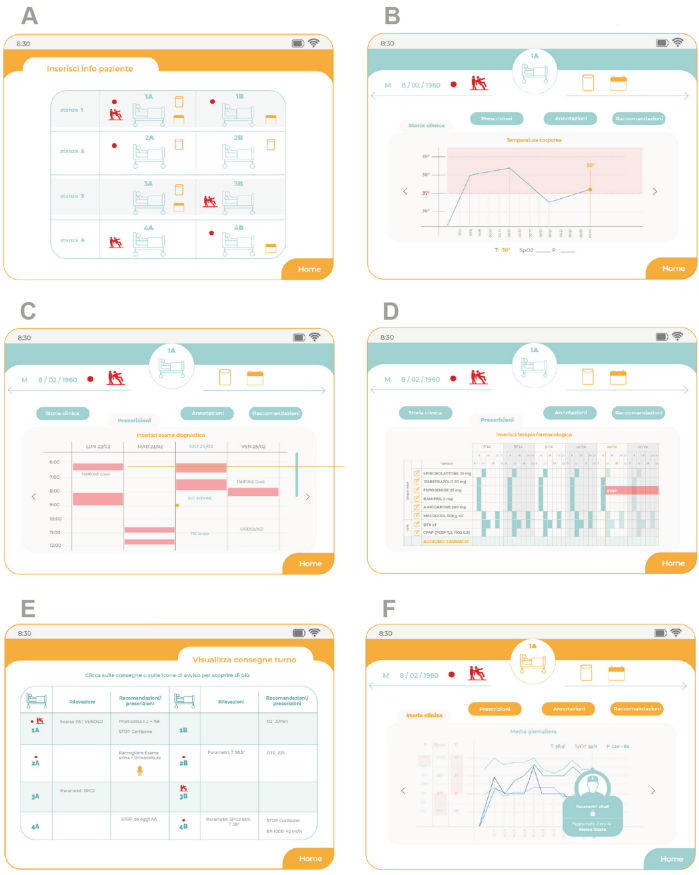


Fig. 6. Some examples of the redesigned system and its interfaces. More specifically, from the top left: A, visualization and identification of patients admitted to the ward; B, entering the patient's vital parameters; C, booking the diagnostic examinations; D, managing the medication therapy; E, visualisation of daily delivery summary; F, visualisation of vital signs history and parameter entry author.

The project is the first step in mapping and transferring the communication system between medical staff into digital format. Further measures will include the integration of the entire information system that accompanies the hospital care process.

In the Research Group's experience, this design case study offered the chance to connect with healthcare staff and raise awareness of the value of design culture and action, in an institutional context often characterised by bureaucracy and hierarchies arising from clinical experience [45, 46]. In a scenario of design opportunities such as the one bequeathed by the Covid pandemic, in which tools, processes, and services related to health can also be rethought, this article intends to propose a reflection on the role and importance of collaborative spaces (and their dialogical nature) in which designers, medical and health personnel, patients, interns and students can work together

to address current and future issues in the field of health and personal care, and co-design innovative solutions.

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Smart Outdoors for Elderly: Insights from Expert Interviews

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Abstract. Assistive technology is a new paradigm in information technology in which people are empowered by a digital environment that is not only aware of their presence, but also sensitive, adaptive, and responsive to their needs, habits, gestures, and passions. Most assistive technology research focuses only on the indoor environment, making use of gadgets that must be installed in the environment or worn especially for the elderly who are more exposed to risks and dangers that prevent them from being active and having a routine of activities outdoors. If the solutions that seek to generate safe environments could be implemented in outdoor scale, the elderly would have greater security to perform outdoor activities, increasing their quality of life and autonomy. The main objective of this paper is to understand the needs of the elderly population in urban areas by the help of experts in architecture. Expert interviews were conducted to understand specifically the problems of the elderly in large cities. The results showed that only experts in architecture are not enough to understand the problems and foreseen possible solutions. However, it is foreseen to include experts from other areas as well as elderly to give insights into what they think about possible solutions to elderly's problems in the Smart City context.

Keywords: Smart Outdoors · Elderly · Expert interviews · Ambient assisted living

1 Introduction

This study is a part of a master's degree research aiming to make an intervention in a public space to enhance the wellbeing of the elderly in outdoor spaces. The main objective of the study is to propose a smart solution for outdoor spaces, specifically a public park in Lisbon.

Studies show that everyday elderly face hazards and barriers that prevent them from being active and performing outdoor activities (Barnsley et al. 2012). The Ambient Assisted Living (AAL) system is a socio-technical system that uses networked artifacts embedded in the environment to lead the flow of life to well-being (Abtoy et al. 2020).

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There are many solutions under AAL (e.g., blood, temperature and fall detection sensors, cameras for monitoring and reporting emergencies in real time). However, most of the AAL solutions are focused on indoor environments, such as smart homes, using information from sensors in the environment and on the person (Rashidi and Mihailidis 2012). Mostly, outdoor assistive technologies are based on wearable devices that the elderly do not feel comfortable wearing (Li et al. 2019). Nevertheless, if unobtrusive solutions can be implemented within an outdoor scale, the elderly can perform more activities without facing risky and undesirable situations. This plays an essential role in increasing the quality of life and it does mean longer independence of the elderly's life (O'Grady et al. 2010).

Research showed that the most frequent risk situations are falls. Indoor falls are generally common in inactive older people, whereas outdoor falls are more common in healthy older people (Duckhan et al. 2013). The frequency of going out is a useful indicator for frailty for physical function and health-related quality of life among the elderly. A potential idea can reduce the burden and cost of giving care to elderly people while maintaining safety and autonomy (Jin et al. 2012). Chippendale (2017) emphasizes that the reason why the elderly seldom use public parks is not explicit. Therefore, it is crucial to understand the needs of the elderly while using outdoor spaces (i.e., public parks) as well as the reason why they are reluctant to use them. The number of times an elderly person performs outdoor activities is a great indicator of frailty for physical function and for the quality of life-related to their health. If outdoor activities are able to improve the quality of life of the elderly, as well as their health, this will result in a reduction in costs and the need for caregivers as the elderly will be more confident and autonomous (Jin et al. 2012).

In this regard, the main research attempts to propose design solutions based on the assisted environment concept on a city scale, assuming that the older population can independently experience and live in collective and public surroundings (particularly, in a public park). Furthermore, the research will focus on how Smart Technologies may assist the elderly in an appropriate manner by adapting the environment to the user rather than the user to the environment.

Studying demographic data on the aging of the Portuguese population revealed a problem that necessitates the adoption/creation of spaces to encourage the older population to leave their homes. Portugal is the second-oldest country in the European Union today, and it is anticipated to become the first by 2050. The goal of this study is to provide comfort and technology to outdoor settings so that the elderly feels comfortable and motivated to participate in outdoor activities without concern. However, it is critical to describe the issues in full before considering potential solutions. Expert interviews are frequently used to gather information about or investigate a certain area of activity. As a result, expert interviews were con-ducted to gain a better understanding of the potential challenges that the senior population may experience in the urban setting. The purpose of the paper is to present the insights/findings of the expert inter-views.

2 Method

Expert interviews can help to shorten time-consuming data collection processes, notably, if the experts are viewed as "crystallization points" for practical insider knowledge and

are interviewed as surrogates for a larger circle of players (Bogner et al. 2009). In this context, the research focused on potential issues that the elderly may encounter in their daily lives in major cities. It was intended to go beyond explicit expert knowledge by stressing the experts' unique perspectives on certain themes including the elderly, technology, and the smart city concept. The expert's role in these interviews was crucial, as it allowed the exploratory phase of the project to be much more efficient and richer in data collection than just using exploratory observation by itself (Young 2018). Expert interviews provide researchers with an effective means of obtaining results quickly and, more importantly, quickly obtaining good results. The fact that the interviewer and the interviewee share a common scientific background or validity system can provide a high level of the expert's motivation to participate in an interview (Meuser and Nagel 1991). The mixed research method, which is both qualitative and part quantitative, was employed for this. On the quantitative side, demo-graphic information about the experts was gathered to create a better profile, which was then used in conjunction with, qualitative data to better understand their opinions and points of view, as well as their back-ground experience.

2.1 Participants

27 experts (14 men and 13 women) from Brazil and Portugal participated in the study whose ages vary between 26 to 67 years old ($M = 36$; $SD = 12.93$). The experts have the same background, architecture. However, not all experts exercise the profession; only 15 (55.5%) continue to work in the area. Five (18.5%) of the participants work in the design area, 2 (7.4%) in urban planning; 3 (11.1%) in the academic field; 2 (7.4%) in landscaping.

2.2 Materials

An unstructured questionnaire with seven questions was performed (Table 1). The questions focused on three specific topics: the elderly, technology, and smart cities. Additional questions were asked during specific periods to reinforce the topic matter of the inquiries. After that, all the responses were formally recorded and transcribed into a document for analysis. Since the expert's native language is Portuguese, the questions were prepared in that language.

2.3 Procedure

The experts were invited through email. The researcher explained the ongoing research as well as how the interview would be handled, either online or in person. Online interviews are executed via WhatsApp, Skype, or Zoom, while face to face interviews adhering to COVID-19's isolation rules. The face-to-face interviews were carried out in a café during regularly planned sessions by the researcher. Both sessions are recorded and manually transcribed to a sheet by the researcher. The results were then compiled in a single online document and reviewed as a whole, with the goal of developing criteria.

Prior to the meetings, the interviewees were given a list of objectives. The goals were to obtain a better understanding of the elderly in the setting of a public area, familiarize

Table 1. Interview Questions

Q1	Fact: The number of elderly people is growing worldwide. Elderly people tend to become less active and more subject to social isolation and loneliness with reduced physical activities and social interactions. Question: In your point of view and based on the knowledge you have; what kind of problems do the elderly have daily in the urban environment?
Q2	What do you understand about the word "technology"?
Q3	When it comes to your projects, what is your relationship with technology? When do you include it?
Q4	How important do you believe technology is when it comes to solving everyday problems for the elderly on an urban life scale? Justify
Q5	Have you heard about Smart City? If so, how would you define it?
Q6	If you answered the previous question in the affirmative, how do you believe that a Smart City can help to solve the problems mentioned by you previously?
Q7	Fact: Adequate spaces for the elderly are an essential element to maintain the well-being of the city population. Next to these spaces, the elderly can socialize, develop physical and leisure activities. Question: Taking into account the existence of several parks in modern cities and the high number of elderly people living in urban centers, how do you believe that urban development can be improved to better meet the needs of the elderly population who currently live in urban centers?

themselves with concepts related to technology and smart cities, and ultimately to see how the ideas may be combined to better tackle the challenges exhibited. The researcher began by asking about the interviewee's background and gathering demographic data to determine if he or she would be willing to participate in the study. Following that, the experts were informed that all material will be recorded on audiotape. The session began only when the expert agreed to be recorded. During each conversation, the researcher also took notes for future analysis. Each session was approximately 25 min long.

3 Results and Discussion

The results were analyzed by finding a pattern of the most mentioned/common topics and keywords which the experts mentioned during the interviews.

In the first question, experts were questioned about which type of problems the elderly face within the urban environment. The frequently addressed topics were, maintenance and mobility, and less focus was given to accessibility, security, transportation, and signs/warnings. Under the maintenance and mobility, experts identified factors that can reduce the ability for circulation of the elderly as holes in the pavements, roots of trees that exceeded the limits of flower beds, loose and irregular stones. They suggested that the layout of spaces requires adaptation, which does not happen in certain public areas (e.g., pavements that were flat and uniform in order to avoid deformation; materials that are more permeable, resistant, and less slippery, even on rainy days; Better conservation of public spaces, choices of trees/plants for landscaping that are appropriate for the location

and that over time will not perish or develop roots that deform the sidewalk). This can create a high-risk situation for the elderly who frequent these spaces for both leisure and bypass. Typically, these same spaces end up being remodeled to meet the needs of the younger populations, seldom taking into account all users. By only targeting a specific population, a deficiency is directed at the older population, therefore, they might find these spaces less attainable which can lead to the point that the elderly does not feel a part of the whole. Regarding transportation, experts mentioned that public transportation must also be improvements, whether in the issue of heights between the street and the bus (the most common means of transport used by the elderly), the frequency with which it passes, and also more respect for drivers and other passengers with the elderly while boarding and disembarking from the vehicles. Also, the problem of the location of bus stops was also mentioned, also the signs informing where they are located when it does not consist of a small shelter.

Even though experts did not specifically mention problems with accessibility, security, and signage, these are important and basic elements for the mobility of the entire population. These topics should be considered due to the role they play for a group of people with physical (e.g., Difficulty in walking, reduced resistance, and muscle function, stiffness of joints, decreased vision and hearing, loss of strength, need for support instruments such as canes and walkers, reduced range of motion and changes in gait and balance) and cognitive limitations (e.g., Forgetting recent facts and gradually increasing with memory loss; Recognition of people, places and situations; Difficulty expressing yourself correctly; Difficulty of quick answers, in this sense reflexes.). When these topics are inadequately designed, placed, or used they can pose greater consequences, such as a lost sense of location, risk of falls, and more serious injuries for the population in consideration. Even though the experts did not mention it, technology could be an alternative to decrease these problems. However, the lack of encouragement and familiarity of the elderly with the technologies (Chen and Chan 2014), could risk the interaction. Moreover, due to shame (Chen and Chang 2013) or lack of training (Pal et al. 2018), the elderly could stay away from avoiding interacting with the environment which entails a vicious cycle of isolation and loneliness.

Experts emphasized that the difficulties faced by the elderly, often end up not being considered. Typically, solutions aim to serve the general population, while non intentionally setting the elderly population aside. Certain solutions generate more discomfort for the elderly (e.g., Gym equipment focused on the needs/difficulties of these users; urban furniture designed ergonomically for the elderly; adoption of signs using symbols and vibrant colors for easy perception). They mentioned that this is often seen when large investments, which seek to bring modern solutions by making use of new materials/technologies, are used. Frequently, ready-made solutions from different countries are used that lack the characteristics of the place and its users, thus not being compatible with the real needs of users. A specific example was given, such as the adoption of urban furniture design from Nordic countries in places like Brazil, where the product was developed for a climatic condition and use and being installed in another place completely contrary to the original context, not fulfilling its function.

The second question was dedicated to technology. The most common words which were used by the experts were advancement, facilitator, innovation, and automation. The

idea of advancing society is given through the intercommunication of different materials, techniques, and systems that together generate improvements in daily activities, thus becoming a facilitator. In other words, the interrelationship between different interfaces generates greater comfort and efficiency for the user in their daily lives, becoming a facilitator, as it creates a more favorable environment for carrying out activities without the need to worry about adjustments/adjustments that are automatically pre-adapted. Technology was also associated with developing innovation by providing greater mastery and technical knowledge. According to them, technology is a technique or method to facilitate the performance of their daily tasks. Due to the fact of the era we live in, the new is mostly related to the most modern, endowed with the most innovative technology. Experts mainly identified individual technological solutions such as electronic devices, cell phones, and computers but not on an urban scale. It was expected to see comments about smart solutions dedicated to the city, though none of them mentioned anything regarding that.

The third question was dedicated to the use of technology in experts' professional life, regardless of them being academic, urban designers, or architects. The most frequent responses faced were technology as a tool as well as automation of interiors. Repeatedly, technology has been cited as a work tool that facilitates the design, printing, and/or presentation of proposals for a client. It was also mentioned as BIM modeling software (e.g., Revit, ArchiCAD), applications at work (e.g., interconnected devices), automation of home systems (e.g., lighting, smart TV, automated curtains). Besides, technology was used as a search tool for new materials and alternatives to present to customers. Furthermore, the latest technology was associated with high value and innovation.

For the fourth question, it was not possible to find a consensus about the importance that technology has in solving problems that the elderly population faces daily in large cities. Most of the answers indicated that it is important and necessary to solve the problems with the help of technology, especially when the problems are related to the ability to move around the city, and also the reintegration of elderly people into the daily life of cities (e.g., many elderly people aren't capable/allowed to drive, or sometimes they are afraid of going out alone, they end up developing a life much more on the scale of the neighbor-hood rather than on the scope of the city as a whole. Based on that, they ended up developing their daily activities along with places where they easily reach with short walks). This type of stimulus brings back the liveliness and the feeling of belonging ends up increasing, giving this portion of the population more autonomy and independence to live their life peacefully (Lord et al. 2011). Technology was mentioned only as an alternative to intercommunicate public transportation with the elderly population.

Among the 7 questions, this question was the most controversial, it was not possible to draw a continuous line of reasoning. Some confirmed that the city should develop with technology, while others said that design would make the elderly feel safer. It can be concluded that in this specific issue, technology would be just an ornament for the city if they were thought of in a more inclusive way.

Question number five, most of the experts heard about the smart city concept and defined it in various manners. We can justify it with the fact that there are many definitions for the smart city concept such as many authors refer, but the first known definition of a smart city emerged in the early 1990s, referring to the use of Information and

Communication Technologies (ICT) and new and modern structures for cities (Albino and Berardi 2015). Since then, the idea of Smart has evolved and never reached a pure and direct definition. There is a lot of research around this concept and also a lot of variations (Alawadhi et al. 2012). Some authors, such as Quijano-Sanchéz et al. (2020), claim that a city cannot be considered intelligent unless it emphasizes the use of technology as one of its most significant advances. As stated by Robertson (1995), one of the precursors to the concept of smart cities, each city is a global phenomenon, both in terms of local and global scope. They have unique characteristics. Therefore, it becomes a challenge to create a unique model that can be replicated everywhere in the world, based on the fact each area has the geographic location, ways of life, habits, and customs specific to each region. Among the experts who have acknowledgement about the concept used followings: the green city, cities that use technology to help citizens' daily lives; neighborhood planning in large cities, monitoring of transport and flows within the city to meet the basic needs of the population, automation using sensors equipped with artificial intelligence, a city that has intercommunicating means, alternatives focused on the well-being of the elderly population. Between all 27 responses, very few managed to emphasize the concept of the smart city as a way to help people live their daily lives. The suggestion of a smart city being related to urban planning, on a neighbor-hood scale or just by public transport, was the most common. Most of them mentioned that smart cities are related to engineering areas but not urban architects/designers. Rarely they refer that technology could adapt and interact with possible solutions.

The sixth question was about how a smart city can solve problems. They mentioned ideas such as automation of traffic lights, in order to better coordinate car traffic, allow more signal time for the elderly population to cross the street, correction of irregularities on the sidewalks, better control of public transport, seeking less waiting time, and less chance of creating fall accidents in case users try to run to board the transport. In summary, they commented on interconnect problems and also highlighted that most of the population aware of the elderly's difficulties and able to help them.

The last question was about how urban development could be improved to solve the needs of the elderly. It was possible to group the responses into 7 subgroups as follows: (i) better use of public space; (ii) improvement in the daily life of the elderly population; (iii) improvement for future generations; (iv) resolution of existing and previously mentioned problems; (v) innovation and adaptation of already known solutions to routine problems; (vi) remote assistance; (vii) generation of activities for the inclusion of this population in the urban network again. Regarding problems that elderly face, they seemed worried, but also without a bigger comprehension of what they really face and how they could solve those situations without being forced to avoid it outside the park.

4 Conclusion and Future Work

The aim of the ongoing research is to propose smart solutions for a public park to improve the well-being of the elderly. It was intended that the concept of Smart City and the Internet of Things would help to achieve the objective of the study. Therefore, interviews with experts were carried out to verify the most common problems that the elderly population is exposed to daily. The objective of the paper is to analyze the

results of the expert interviews. The results showed that mobility problems related to urban conservation were the most appeared responses. The current conditions of the cities in which the experts live (Brazil and Portugal) are not satisfactory regarding good pavement, conservation and signaling in the areas of streets, parks and squares. Public transport issues were also addressed, as well as the lack of empathy of people who work and use public transport. Furthermore, the elderly seems to be limited to an area which they are already familiar and are unable and/or avoid going to more distant areas due to inability to move. If smart solutions can spread in the city instead of limited area, the elderly may feel more secure and go beyond their limits.

Additionally, they embrace the adversities that the environment offers, constantly facing challenges that can lead to serious injuries, as well as psychological trauma that leads to loneliness. Boukhennoufa et al. (2019) states that the most serious problem is the lack of physical activity/movement of the elderly since this causes the weakening of muscles, increasing the risk of falling both at home and on the street. Activities and spaces aimed only at the elderly population was also a topic addressed because it's never an integrated solution, it's always a space only for elderly, segregating them. Making a link with the next issue is the lack of connection with space and belonging where the users don't feel part of the whole. Regarding the relationship between technology and the elderly, the answers were quite diverse and there was no consensus on how technology could help. However, creating unobtrusive smart environment that would take care of elderly without them interfering the process with extra equipment (e.g., wearables, phones).

The experts considered technology only as an automation tool or innovation on the scale of the individual, not as a whole. Technology was never mentioned as something important or as something that could meet the needs of the elderly, helping them to perform activities autonomously, as noted in the literature (El-Basioni et al. 2014). Multiple times, physical and cognitive limitations were addressed as problems, but not ways to improve these situations. However, for the experts it is extremely important to solve current problems and search for an environment capable of meeting all needs, without mentioning technology as a fundamental source to achieve this goal. Most of the experts gave limited examples when it came to technology (e.g., home automation). It may be related to the fact that few of them were able to think of technology as something broad, varied and/or city-wide.

The interviews with experts also expected to elucidate how the concept of Smart Cities could help to solve the existing problems of the elderly, nonetheless none of the experts mentioned it as a way to solve the problems of the elderly. As mentioned by Joore (2007) when elderly people have independence and their own routine, end up generating an increase in the life expectancy, in addition it also brings more vitality and predisposition to any adversities that may face quotidianly. The results showed that experts could not explicitly detail how Smart City could contribute to solving the independency problem. Some alluded to a modern and green city, where there is less pollution or entire neighborhoods are planned to make the most of space. Few experts have linked the smart city to object-applied technology in order to improve users' lives. It is believed that this little connection to the concept is due to the fact that many think that the smart city is directly related to the development of complex systems, and

only covers areas of technology applied to information technology/robotics, which is a common concept (Sharma and Park 2018), although it is a limited point of view of this concept. This study was based on the idea of showing how it's possible to explore the concept of Smart City beyond the field of city technology, but also creating a network that intercommunicates users and objects in order to have better results in everyday life.

In conclusion, the experts stressed that different populations (i.e., active aging and disabled population) could get advantage of the technological solution which are meant for elderly. People will get used to live with the technology and get the benefits of it while being motivated. For instance, they can still do the same activities in outdoors though worry less about their safety and feel more protected due to the outdoor taking care of them in a discreet way.

Elderly needs a purpose to feel that they belong to the community which leads to social inclusion. It's known that social inclusion remains an important element of well-being for people with disabilities (Buntinx and Schalock 2010). Based on that the cities should be planned in a way to include people during their entire life to the urban context. Nowadays this rarely occurs which result in elderly feeling lonely and isolated. Smart cities could help to make them to be included through many different purposes. Specific areas of the city (e.g., public parks) can become experimental fields to attract elderly and reinsert them on the city life.

The results of did not reveal enough insights to help with the ongoing research, hence, it is planned to include more experts in the study besides architecture field. As it was mentioned before smart city does not have only one specific definition, therefore, the experts should not be uniformized. Besides extending the sample more data should be collected from the target users. Naturalistic observations were carried out which aimed to observe the elderly in their daily environments (Satte et al. 2021). Even though, it was possible to understand the various risk and undesirable situations that elderly faces in the context of a city environment, the results were not the central points for the development of technological solutions. It is expected that the interviews with more experts would help to speculate possible solutions.

Moreover, the study was carried out during the Covid-19 pandemic and contact was restricted by issues of safety and health, therefore, continuation of user studies could not take place. However, as a future work, it is foreseen to do interviews with elderly to justify the results of both studies, expert inter-views and naturalistic observation.

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Design as the Mediator of New Social Health Culture. Towards a Co-benefits Model

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Abstract. The COVID-19 pandemic accelerated the need for change, raising questions about the current approach to health. The re-definition of the role of health and well-being towards an interdisciplinary approach is knowledge-driven and technology-enabled and the focus of innovation is shifting from the treatment of disease to prediction and prevention. The new model of the 'co-benefit belt' through design activates a process of systemic improvement and extends beyond the digital, pursuing the logic of interaction.

The role of Design as a mediator is emphasized, lending itself to emergency situations, to the design of protection devices by implementing multifunctional and shared protection dynamics, intervening in rethinking the universe of devices with Human Centered Design approaches, optimizing methods and processes. The case study presented describes the development of the research project funded by the Campania Region, "Smart&Safe". Design for new individual protection devices", among the initiatives to fight against Covid-19. The research proposes an update in the redesign of individual Personal Protective Equipment (PPE), to explore a new dimension of the project that highlights the transition to an Individual and Intelligent Protection System (IIPS), reflecting on the various levels of safety faced during health emergencies.

Keywords: Design for health emergencies · IoT for Self-care Services · Co-benefits belt · Health Ecosystem Model · Individual and Intelligent Protection System (IIPS)

1 Scenario

Research and development in the disciplines of health and well-being tend to increase the quality of life. Currently, the population is ageing, rapid urbanization is occurring, and the impacts of global climate change and the rapid pace of technological development are bringing about major challenges that will affect people's daily lives. Different disciplinary fields collaborate with specialized industries using advanced technologies to collect, monitor and control data on the health of users, practices that are based on a culture that demands greater responsibility and awareness in a larger social area. If

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society tends to be more open and to reinvent itself during periods of need or extraordinary crises, the Coronavirus-19 pandemic crisis has determined a concrete change in the line between what is useful to do in the immediate future to provide a response to the emergency, and what could be done in the medium or long term, and how to do it in a perspective of continuous interaction for extended benefits.

Whenever a human being is faced with new, problematic, unknown and often not easily adjustable conditions in the course of its life, it is forced to "adapt" in order to survive physically and/or psychologically. Adaptation is a change of self, of the structures and means at one's disposal in order to cope with the novel-ties coming from the environment, generating a system of fluid relationships. It is a process that is as complex as it is frequent, but above all it is of fundamental importance for the maintenance of an essential human balance.

Adaptation in everyday life, where problems are always new and evoke equally changeable behaviors and responses; adaptation also means responding to psychosocial conditions that arise due to sudden crises.

Human health and well-being are at the core of the human experience; however, the way people think about health and well-being is constantly evolving.

At present, humans are in the process of an epochal change, accelerated by technological developments and innovation, but also by contingent factors such as the pandemic. Society as a whole is being called upon to re-evaluate its approach to health, questioning the economic and socio-cultural model. An approach driven by knowledge and enabled by research, experimentation and technological innovation. The basic concept focuses on the prevention of the individual spreading to the whole of society, through effective and efficient models that consider sustainability as a reference parameter. Individuals do not operate individually but are supported by a shared ecosystem of objects and people, involving different actors, collaborating between governments, institutions, companies and organizations. The main focus of the idea is the definition of health as a state of complete physical and mental well-being exercised in a social dimension and not simply as the absence of disease. The considerations on the duration of the initiatives to be adopted, in terms of evaluating the reactions on the immediate benefits that can be obtained in order to deal with certain criticalities, and those in the medium or long term that need to be made available, which concern the sudden change in lifestyles, lead us to take a historical perspective on the real change that is currently happening; a combination that sees the opposition between possibilities and limitations, increasingly unbalanced on the second term. Compromises, adaptations, limitations, forecasts, confinements, terms that are born to characterize the actuality, qualify the state of emergency, while capturing the deep sense of the challenge to which we are urged to respond and for which to derive consequent and shareable actions and behaviors. We need concrete measures that not only make it easier to care for the sick, but also strengthen people's ability to use their potential (e.g., by choosing healthy lifestyles) to prevent illness and injury. For many people, 'health' means more than just the ability to function or live disease-free - it also means the ability to be an active member of society and the local community. For many people, the value of health is not measured in economic terms; rather, it is the ability to live a life of well-being. Currently, health is largely seen as a re-source for well-being. Yet it is also a social, physical and psychological resource. We see health as a holistic state

consisting of functional performance, social and experiential well-being. It is clear that simply removing or reducing an unhealthy condition is not enough to improve health. The experience of health goes far be-yond the absence of disease, it refers to health in different areas of life, from the place of residence, to avail-able services and lifestyle choices with a reference that relates the relationship between man and himself, man, objects and materials, man and the environment, man and social circles, and so on. New technologies will reshape the stages of care, bring cost reductions to the public sector; technology in devices, linked to wellbeing will achieve reasonable costs by increasing functional performance for humans. User Experience will measure pleasure in use for the user who enjoy technology if it really becomes part of everyday life. New players will be involved, such as app developers, telemedicine vendors and those providing solutions for healthcare environments and databases.

2 Design as Mediator for Health Emergency

The recent Covid-19 and health crisis offered the opportunity to rethink design role in facing emergency situation. Design has shown more than ever itself as a powerful mean to react to crisis situations and in all cases in which people or the environment are subjected to risk. Design contribution to emergency, with its interdisciplinary approach, is particular evident through the designing of products, services and communication systems to react, monitor, prevent, create awareness, giving a prompt answer in sudden and catastrophic event but also intervening in 'endemic' crisis situations and sometimes being able to detect new types of alarms.

The urgent need for limiting measures therefore leads us to emphasize the role of Design as a mediator, lending itself to emergency situations, to the design of protection devices by implementing multifunctional and shared protection dynamics, intervening in rethinking the universe of devices with Human Centered Design approaches, proposing strategies that translate the knowledge and experience of the most advanced research into products, optimizing methods and processes (Ranzo 2017). The re-definition of the role of health and well-being towards an interdisciplinary approach is knowledge-driven and technology-enabled. The new model of the co-benefit belt through design activates a process of systemic improvement and ex-tends beyond the digital, pursuing the logic of interaction. Innovation across health-related disciplines and technologies has the power to transform lives. Behavioral science and health expressed in quantity, combined with wearable technology and digital will shift the focus from the treatment of disease to prediction and prevention, and thus to the concrete and lived realization of health and well-being. The general perspective would pursue the renewal of the value chain and the construction of human-driven health markets using design strategies, drawing from different fields, in the transformation of the public and private health system, taking an active role as a leader of change together with new partners in building a secure future. Design is a mediator of co-creative dynamics between user, health system and measures for care and recovery. Some of the most promising areas in the preventive health market include devices, digital platforms and apps provided by companies; promoting: self-care in the home with the setting up of the Virtual Medical Record (VMR); and in the broader context, the 'co-benefits belt' model. They encourage and assist people to

engage in health awareness, healthier lifestyle habits, e.g., through constant monitoring of various health parameters or by encouraging exercise in consideration and a connected community.

They also help people to contribute to the improvement of their own and others' health by playing an active role in self-care, providing devices, biomarkers or apps that give personalized information on possible risks to which an individual may be predisposed and outlining the risks involved. Traditional healthcare providers will benefit from the new opportunities provided by the systemic design and engineering of health devices, the platform economy, digitization, computing and the sensor revolution presenting new opportunities to create open systems that prefigure a new type of inclusive healthcare system.

The presence of technology used in the health sector will determine the model of the system itself; open, decentralized, a new role for the health professions.

Technology in healthcare reduces costs by allowing users to take their own health into their own hands - to a certain extent - and support doctors in their daily work. It can also encourage and guide people to make sensible decisions about their own health, spreading a new culture of wellness. The frontier of new types of markets that health is entering needs to build new partnerships and bring health experts into new environments, creating co-benefits and spreading a new value chain. Using the re-sources of individuals and groups is central to achieving the goal of a healthier society in the future. A healthy society maximizes its functional performance. To build healthy societies we need to promote health in everyday life; the body's relationship with the materials we surround and cover ourselves with, exercise, nutrition, low stress levels and pleasant social interactions are all crucial to maintaining a healthy and happy life. Aspects at the heart of Design for Health: from the individual material in contact with the body; to the device that cooperates with the user; to management and education; to networking communities of users. When health promotion through different environments involves new actors, new points of demand emerge, extending the range of possible solutions and spreading a greater understanding of health problems, thus stimulating innovation that helps solve health market challenges. Health, wellbeing and innovations for the realization of a new model that brings economic benefits, consider their export in a global market.

Health and well-being are human and productive goals for society and its actors. The future of health and wellbeing must be human-centered; this means putting people at the center when designing prevention and treatment devices and services. In order to realize this vision at all stages of life, individuals must take responsibility for their own health and wellbeing and engage in a lifelong effort. The future roadmap for health and well-being requires the orchestration of multiple and diverse agents to form a functional ecosystem: today's scientific and technological breakthroughs can chart the way to improve the health and well-being of individuals, communities and society by challenging emergencies and systemic obstacles.

3 Human-Centered Approach Design

The theme of technical and functional clothing design cannot ignore the methodology of Human-Centered Design that refers to the ISO Standard providing guidance and requirements in the interaction between man and machine (computer). Attention is focused on

part 210 of the standard that establishes the guidelines to be followed for a design that focuses on the person with a whole series of requirements (ISO9241). The user experience is based on learning, acquiring, and knowing a given device (Morville 2018), then its abilities and limitations and actual usefulness. The design must consider not only the aspects related to the product and the user's response, but the whole system of activities concerning the organization of the team of developers (UED04).

The honeycomb schema (User Experience Honeycomb) by Peter Morville (Morville 2014), president of Se-mantic Studios, specifies the user experience defined by seven juxtaposed hexagons, each representing:

1. Usefulness: you must not stop at the initial design; you must implement it to make it more useful and innovative in relation to the user to whom it is addressed;
2. Usability: this is an important criterion in user interface design methods (for computer systems) as for all other products, but not sufficient to determine the entire user experience.
3. Desirability: it explicitly concerns the sphere of emotions that the power of the device provokes in the user, conveyed by the aesthetic quality (image) and the reputation of the brand.
4. Findability: it is necessary to design systems and products in which users can find what they are looking for with ease and transparency.
5. Accessibility: design for all is aimed at categories that express special needs (Papanek 1973), i.e., those with disabilities (more than 10% of the population), it is necessary to make technology accessible to all, so that they can use it and use it as a potential vehicle to eliminate existing barriers;
6. Credibility: this represents an important lever to better explicate the design tools that decisively influence credibility on the part of users.
7. Value: the products that are developed must be part of the value chain for those who produce and for the group of users for whom they are intended, increasing customer satisfaction (UED04).

ISO 9241-210 updates in content, criteria, and method the previous ISO 13407:1999, the main points are:

1. Clarify the concept of iteration throughout the design phase;
2. Emphasize, in the design method, the central role of the user that informs the entire design process;
3. Explain and make transparent design activities;
4. Clarify the principles of user-centered design (ISO 9241).

Part 210 of ISO 9241 is concerned with providing a set of rules and requirements consistent with the principles of human-centered design throughout the life cycle of interactive systems. Human-centered design refers to a method of developing interactive systems that aim to produce a computer system that is useful and usable to the user and that covers the user's needs and requirements. The use of a human-centered approach to development benefits everyone who is in close contact with the product, from developers to users. Following the human-centered approach, moreover, the quality of the final

product-service improves considerably through a series of considerations that concern the user-machine or service relationship in terms of productivity; the ease of use that allows a wide use and cost reduction; the accessibility in the social field; the improvement of the user experience and therefore of the skills or capabilities; Increased product knowledge and consequently the efficiency of the organizations that use it; reduced stress and discomfort for those who use it out of necessity; increased reputation and image of the production brand; achievement of sustainability goals centered on the user experience of a community of users.

In addition, the use of appropriate methods of human-centered design of a product or a service reduces the risk of failure in achieving the requirements and performance demanded by companies and clients, vice versa the rejection of the acquisition by users based on the market to which it is addressed. According to ISO 9241-210, good design is based on knowledge of the environment in which the product under development will operate, the functions and performance it will perform, and the target or type of user for whom it is being developed. The project and its process must consider the following elements: for whom it is designed (client); by whom it is used; but also, by those who, directly or indirectly, are affected by its implementation; for UNI a reason for failure of a product or service, of which an inappropriate design approach, depends on neglecting or not taking due account of one or more of these factors. When designing a product-service, it is also necessary to always keep in mind that users do not have the same goals nor the same ways of using devices, nor the same operations, depending on a specific field of action. The most fitting example is related to the user interface, in the case of a young person it could be completely inappropriate on a smartphone if used in a working context; in both cases the personalization of the contents is a key factor, operated in extremely different ways.

Therefore, it is fundamental, during the design of a service or a product, the behavioral analysis of the characteristics of the user (final consumer or client company), without underestimating the functionality it must have and the physical environment of use. These three pieces of information are called the context of use. Another central point of ISO 9241-210 is related to the design of a good product, indispensable is the active involvement of the end user during all phases of creation. Users must be chosen so that they represent a meaningful sample for the use of the product or service, and they provide relevant requirements and feedback to the product that may turn out to be suggestions or proposals to make changes and improvements to the initial design. Development therefore not only puts the user at the center, but even, from the beginning to the end of the process, includes the point of view of those who will use the product.

The information that users formulate about the product will be vital to its success, and because their suggestions facilitate improvements, users will benefit from a product that is tailored to their needs. This process of human-centered development follows the logic of iteration, that is, it is based on the repetition of a whole series of steps until the desired result is achieved. The repetition of all the steps ranging from development to user testing, to the receipt of feedback that follows, to the application of changes once they have been evaluated and the re-submission to users until the result is not achieved, means that step by step, progressively the various uncertainties about the project are

eliminated during development and the result achieved, continuously revisited is ad hoc for users and will meet every request.

4 Human-Centered Approach Design

4.1 Project Objectives

The follow case study collects the results of the research project funded by the Campania Region, "Smart&Safe". Design for new Individual Protection Devices" submitted to the call for the acquisition of re-search and development services for the fight against Covid-19, constituting a substantial study of the is-sues related to health emergency, compared to existing protocols related to individual protection systems. The research proposes an update in the redesign of individual Personal Protective Equipment (PPE), in order to explore a new dimension of the project that highlights the transition to an Intelligent Individual Protection System (IIPS) and therefore plural with the aim of relaunching reflection on the contents related to the various levels of safety to be implemented during health emergencies, thanks to the development of solutions for the use of the devices themselves that determine a relational system of integrated protection. In addition, the reflection goes in the direction of the development of advanced performance of the devices; able to implement an application field based on human experience, it is ready for human-device interaction, implementing a multifunctional and shared protection dynamic. In line with the European states that have emerged to deal with the Coronavirus emergency, the Campania Region has redefined a specific funding framework to immediately identify proposals for innovative scientific and technological solutions to help treat, test, monitor or contribute in any way and in the shortest possible time to counter the serious health emergency caused by the Covid-19 pandemic. These solutions, which include validation and prototype testing, are intended to increase the functionality of existing products and services or create new ones.

The "Research and Development Proposal. Design for new Personal Protective Equipment (PPE)" is articulated in the design and prototyping of several types of PPE gowns, coveralls and T-Shirt with smart and wearable equipment for the safety and security of the operator in the workplace of work (Franceschini 2020). Through a system of control and diagnostics for the prevention and assessment of risk assessment, an "Active Safety System" is set up. The Personal Protective Equipment (PPE) understood in its current meaning, becomes an Intelligent and Individual Protection System (IIPS) defined according to the differentiation of the different layers that make up the final unitary configuration of the system unitary final configuration of the system. The Intelligent Individual Protection System is composed of different layers which, starting from the outermost one, are distinguished in the following parts to each of which is entrusted with a performance and a functionality ensuring: the primary protection (integral suit) the secondary protection (USCA smock); the advanced protection (smart T-Shirt) with wearable add-on in terms of wearable add-on in terms of control and diagnostics of the health worker. PPE is defined as any equipment intended to be worn and held by the worker to protect him or her from one or more risks that may threaten safety or health during work, as well as any complement or accessory intended for this purpose (Article 74 paragraph 1 - Legislative Decree 9 April 2008, n. 81). The first category (simple

design, intended to protect minor offensive actions, e.g.: sun-glasses) and the second relating to all PPE that do not fall into the first and third categories intended for protection at work - enter the 3rd category as follows: "this is PPE of complex design intended to safeguard against the risk of death or serious injury of a permanent nature. To this end, PPE in this category must be appropriate and balanced in relation to the risk; chosen wisely; properly worn and removed; safely disposed of". In the "Technical Document on Protective Measures for Health Protection in the Transport and Out-of-Hospital Management of Patients" Infected or Potentially Infected with Class IV Biological Agents "(December 7, 2015) it is stated that PPE for the management of highly contagious include the following items of clothing: shoe covers or boots; water-resistant coveralls or waterproof gowns; FFP3 - full face masks; goggles; waterproof apron; double pair of gloves. PPE must be worn before encountering suspected infectious or infected patients. Health care workers must be extremely careful when donning and doffing protective gear to avoid self-contamination. In safety principles for PPE donning/doffing there is still no gold standard, to this end, clothing that is easy to put on and take off is suggested, accompanied by a written procedure and accompanied by pictures. Good behavioral rules suggest the following: when putting on PPE, hand hygiene should be performed before putting on new gloves; when removing PPE, care should be taken to avoid any contact with contaminated PPE, do not reuse disposable PPE, decontaminate goggles, non-disposable face shields. International scientific research clearly demonstrates that the removal phase of contaminated PPE often involves self-contamination by operators. An estimate of the degree of contamination during the removal of PPE used for Ebola was carried out by the University School of Medicine of Seoul (South Korea) on operators with work experience (about 3 years). The research has highlighted several critical issues: during the experiment 65 cases of contamination occurred (2.2 incidents/person); the greatest vulnerability occurs with the removal of respirators (79.2%); the removal of shoe covers records 65.5% contamination; while 41.3% in the removal of the hood. The most frequent site of contamination is the neck, foot, and head area when not covered by a full coverall. In addition, the PPE removal phase must be performed with extreme care, since the external parts and especially the front parts of the PPE, are likely to be more contaminated than the rear parts and the top of the head, therefore, it is necessary to avoid touching the front part when undressing and more generally all external parts. To confirm this, in the undressing procedure, the PPE suit should be turned upside down, as should the gloves, and confined in a container for safe disposal. PPE donning times (195–266 s), higher than removal times (154–209 s), influenced by the donning/undressing steps of the coveralls (approximately 50 s), boot/shoe covers (approximately 40 s), and gloves (approximately 30 s).

4.2 From User Experience (UX) to Collaborative User Experience (CUX)

The sphere of User Experience (UX) according to the ISO standard encompasses not the direct user experience of the product itself and as an end but involves a broad sphere of everything about the use of the de-vice. Donald Norman states that the design of products and services pertains to the emotional sphere in "Emotional Design" states that people have three levels of processing while using any object. The first level is called visceral - represents the automatic reaction that is established between the user as soon as an object

appears in his sight. It is a completely automatic level of reaction and the user expresses a judgment in relation to the degree of acceptance that the object provokes (whether they like it or not), the degree of interest (boring or fun). The emotions according to Norman are therefore to the center of the attention of the designer and include: the behavioral level that describes the effective use effective use of a tool and therefore the sensation provoked in the user in feeling pleasure or not from the use of a device in view of the desired result (Norman 2004).

The second level is called reflexive - it has nothing to do with the aspect of effectiveness but rather. The second level is called reflexive - it has nothing to do with the aspect of efficacy, but gathers everything that gives rise to positive memories during the use of a product such as a sense of satisfaction and accomplishment in use. Marc Hassenzhal, Professor of Experience and Interaction at the University of Siegen, has al-ways been interested in the design of user experience, defines aspects not related exclusively to productivity but of pragmatic objectives that concern the user's desire to "do", while the latter of "being", referring to the effectiveness and efficiency of a product or service, and more personal dynamics (Hassenzhal 2010).

The design of a service or a product with a human-centered development, therefore, takes into account to take care and design from the user's point of view not only the product, but also its paper documentation, through which the user learns to use at best what is created, which is composed of an on-line user support, reachable in case of any eventuality; the assistance and maintenance service, which has to take care of helping the user in case of various inefficiencies caused by the product; if necessary, a training phase to guide future users in its use; the design of the container, inside which the finished product will be inserted; all the accessories and related documentation. As described, the product development team following the human-centered design approach is composed of members from different areas of knowledge and scientific fields and are based on the following requirements: the relationship between humans and usability, accessibility, and human-machine interactions; the users or organizations that will use the product; the context of use in which the product or service will operate; sales, marketing, user safety aspects; and support and maintenance engineers; the user interface and other visual aspects; user manuals, training, and user support; user, service, and business management; systems and business analysts; hardware and software systems, programming, manufacturing/manufacturing, and maintenance.

The key concept is that Human-Centered Design is planned and integrated at every stage of its progress, from conception through testing and maintenance the project includes planning for all ergonomic factors by assessing how the usability of the product or service changes based on the number of users, the environment in which it operates, its relationship to other systems, or represents a user safety issue; how the levels of various types of risk can result from poor usability; what influence the type of development environment has. In general, then, it can be said that the intent is to identify appropriate methods to reduce the risks of user interaction with products, services, and systems as much as possible.

In the hypothesis, therefore, of more actors and factors involved, the Collaborative User Experience (CUX) to develop a product or a system of products, follows the footsteps of user-centered design, taking the following steps understanding and defining the context in which the product or service being developed will operate; specifying the requirements of the collaborating users and the reference organization; evaluating the project and the service already existing and operating to implement it from the point of view of the performance of the product and especially the service extended to the community, considering that there will be multiple users (Chapman 2015) or organizations with different needs, and the context of use will vary de-pending on who will use the product, how many will use it and the service system connected.

4.3 Performative-Suit Design. Wearable Monitoring Systems

Performative-Suit Design considers wearable devices as a means of stimulating discussion and debate among designers, industry, and the public about the social, cultural, and ethical implications that exist about the use of emerging technologies. Focused on experimentation, the application of textile (and non-textile) materials and wearable technologies, it relates to areas of human activity that require specialized, performative clothing, a type of functional clothing. Creations that foster new abilities, equipped with sensors that perceive and interact to changing environmental conditions, transforming themselves developments of the human in relation to new technologies and the Internet of Things (IoT), triggers a series of questions about the dimension of the future body (Singleton 2018). Objects evolve, it is assumed that they will develop an internal relational system, in short, they will communicate with each other, interacting to organize activities in autonomy in a relationship of reciprocity and symbiosis. Faced with these challenges, the body and beauty lose their original charge, we look to the future by pushing the limits of the human towards a design of the self against the conventional schemes.

Software to "animate" them guarantees the functioning of a living organism, because they establish a relational dialogue with the contexts of life. The next frontier sees relational objects designed for this purpose since the materials and smart components of which they are composed and from which they are generated; the "informed" matter the so-called STEM Materials, Sustainable Transformative Engineered Multi-functional (Moretti 2019). STEM Materials are considered as possible enablers for solutions that respond to many social and especially global challenges (Moretti et al. 2019). A generation of materials capable of providing heterogeneous responses related to multifunctionality. STEM Materials will incorporate an "Internet of Things" (IoT) concept, where their processing capability will allow systems to interact with the environment and express various functionalities. STEM Materials do not yet exist, but many clues from various theoretical and experimental results suggest that they can be developed because there are living organisms that inspire them. In the prediction of the project "Smart&Safe" the creation of a PPE System with smart and wearable equipment for monitoring the health and social worker in the workplace, is done through a system of control and diagnostics for prevention and risk assessment at work, with the configuration of an "Active Safety System".

The "Smart&Safe" project is divided into the following phases: a path of training and practical and operational innovation on safety; the implementation of an interactive and updatable product-service system that al-lows to monitor physiological parameters and to intervene on risk factors directly on operators, thanks to the possibilities offered by the "active safety" systems; the future forecast foresees the configuration of a product-service system connected to a network for the sharing of medical records. The objective of creating innovative products and services in the field of PPE safety has a significant impact on the behavior of those working in the field. Creating PPE equipped with systems that interact with the user means equipping them with smart and wearable devices that can learn from experience and prevent risks and recognize emergencies. PPEs form a system that contains a smart element: a smart T-Shirt able to scan the physiological parameters of the individual worker. The provision of recording devices, and data retrieval, triggers the corresponding corrective and/or investigative and protective mechanisms. The Individual and Intelligent Protection System (IIPS), which dialogues with the user and the surrounding environment and guides him in safety, is –configured as an element of the Product-Service System that guarantees reliability both for the wearer and for managing safety in the workplace (Morville 2018). The SPII thus conceived is the terminal of the interactive, reliable, and safe Product-Service System, with various degrees of performativity thanks to sensors positioned in contact with the body and with the outside world to monitor personal and environmental data that will be appropriately processed to implement prevention and control measures.

4.4 Smart&Safe: Individual and Intelligent Protection System (IIPS)

The Research and Development proposal "Smart&Safe". Design for new personal protective equipment (PPE) "is divided into the design and prototyping of several types of PPE shirts, overalls and T-Shirts with smart and wearable equipment for safety and protection of the operator in the workplace (Beam 2011). Through control and diagnostic system for risk prevention and assessment, an "Active Safety System" is configured. The PPE understood in the current sense, therefore becomes an Individual and Intelligent Protection System (IIPS) defined based on the differentiation of the different layers that make up the final unitary configuration of the system. it consists of several layers that starting from the outermost one is distinguished in the following parts to each of which is entrusted with performance and functionality ensuring: primary protection (full suit); secondary protection (USCA gown); advanced protection (smart T-Shirt) with wearable add-on equipment in terms of control and diagnostics of the healthcare worker. The IIPS will respond to different needs, identified as follows:

1. PPE USCA shirts. The Local Health Authorities have activated the establishment of the Special Continuity Care Units (USCA) which, in line with the guidelines of the regional government, with mobile units (task forces) and doctors will carry out active surveillance activities through the administration of tampons at home to suspicious patients and to those who have completed the quarantine period and for whom recovery must be certified. To this, USCA operators need, as for health workers in triages, and in the red areas inside hospitals, of PPE consisting of new gowns designed to facilitate dressing/undressing and disposal operations in compliance

with the provisions of the law. The implementation times are to be referred to the very short term (WP1, WP2);

2. PPE full suit for triage and hospital environments. The premises, relating to the 3rd category as it can be seen from Legislative Decree 4.12.1992, n. 475, and the "Technical Document" of (7 December 2015), provide the technical-legislative references for the re-design of PPE made up of new full suits designed to facilitate dressing/undressing and disposal operations. Implementation times are to be referred to in the short term (WP3, WP4);
3. Smart T-Shirt with smart equipment and wearable add-on. The "Active Safety System" is the design of a wearable add-on T-Shirt. The smart T-Shirt integrates a smart device capable of measuring the physiological parameters of the individual healthcare worker during their stay in the ward. The wearable equipment works as a physiological data detection and measurement device. The implementation times refer to the medium term (Figs. 1, 2 and 3).

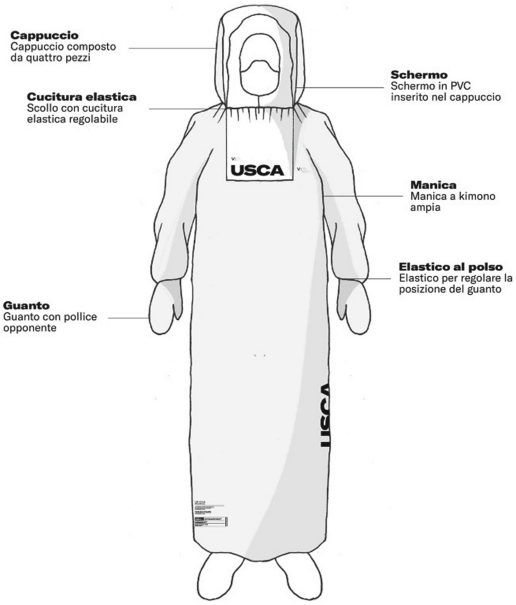

Fig. 1. Technical drawing front and back SCCU gown Personal Protective Equipment for Special Care Continuity Units (SCCU) (Sbordone et al., Smart&Safe Project 2020).

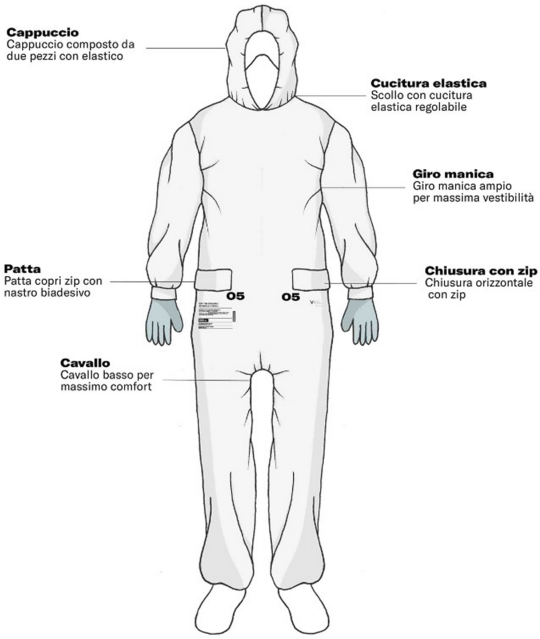

Fig. 2. Technical drawing of PPE full body suit for triage and hospital environments. (Sbordone et al., Smart&Safe Project 2020).

4.5 Textile Design Process

In the design of the Smart T-Shirt, the Work Dress Design methodology was adopted, that is, the design phases relating to the different functional and performative degrees designed in response to the user's needs were developed on the T-Shirt garment. The Work Dress Design methodology consists of three phases of conception and design of the garment, divided as follows: Commodity, Utility and Facility.

The garment was designed starting from the conception that in the first stage of use it must meet the Commodity requirement, the design, therefore, considers the clothing structure in layers or functional zones in consideration of the fit and ease of use (Baurley 2004). The body mapping detected and consequent to the actions of the users (socio-health personnel) in the performance of the work practice, distinguishes the adaptive areas (areas of the body with dense muscle masses), from the collaborative areas (areas of the connecting body) to the exposed areas (areas of the body that are vehicles of contagion).The second stage of design refers to the concept of Utility, that is, to the design that is embodied in typological innovation and the communicative component. The latter incorporates the needs of the utilitarian component and, as a means that is ready to summarize the requirements of ease of use, fit and smart equipment, it assumes the role of a communication tool for users and the community wide of users. The T-Shirt

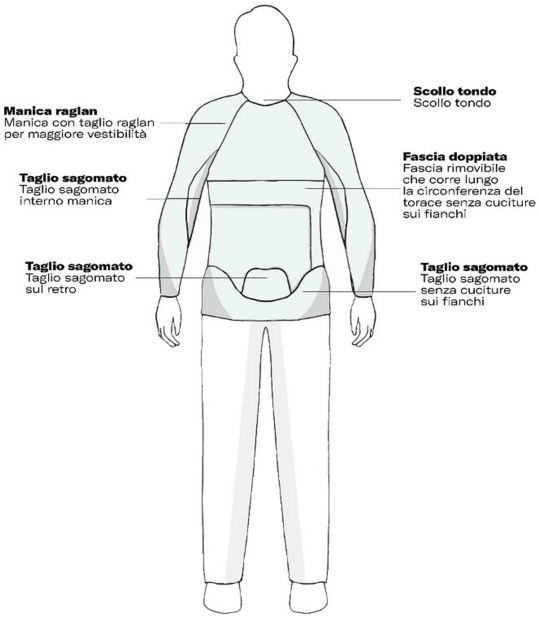

Fig. 3. Technical drawing front of wearable add-on Smart T-Shirt that integrates the Active Safety System (Sbordone et al., Smart&Safe Project 2020).

is designed to accommodate areas that describe its usefulness through a multi-chromatic graphic code that summarizes the different functions and degrees of performance that the T-Shirt is equipped with. The Utility component is reflected in the design of the packaging which, together with the T-Shirt, forms a single means to contain and dispose of, after use it is confined to the same pack in total safety. The third stage of the design is identified with the concept of Facility, in this phase, the body mapping developed in the Commodity stage, as well as orienting the modelling of the T-Shirt, prepares a series of elements for measuring the vital parameters of the socio-healthy operator - rate for monitoring in the work-place. The creation of the Smart T-Shirt and the system that interacts with the user involves a human centered approach for the design of smart and wearable components that can learn from experience and prevent risks, recognizing emergencies. The Smart T-Shirt, in fact, able to scan the physiological parameters, of a single employee has a set of measuring devices and data retrieval. The Facility system that communicates with the user and the surrounding environment and guides him safely, is configured as an element of the smart and wearable that guarantees reliability both for the wearer and in ensuring and managing safety in the workplace. The Smart T-Shirt thus conceived represents the terminal of the interactive, reliable, and safe product-service system, with various degrees of performance thanks to sensors positioned in contact with the body and with the outside, for monitoring personal data and environmental data that will be suitably processed to implement prevention and control measures. In anticipation of the Smart & Safe Project, the creation of a PPE system with smart and wearable equipment for monitoring the socio-health operator in the workplace (Tsao 2020), takes

place through control and diagnostic system for the prevention and assessment of risk at work, with the configuration of an "Active Safety System" of which the typological and textile design of a Smart T-Shirt is part.

The Individual and Intelligent Protection System (IIPS), therefore, through the Smart T-Shirt is equipped with an "alarm fatigue": worn as a base layer in contact with the skin, the Smart T-Shirt detects fatigue and work-related stress affecting engaged social and health workers in the activities of high intensity of care and the medium-low. Activities where high percentages of false alarms are often generated, the management of which adds to the enormous workloads that operators in these departments have to bear.

In terms of design, the adaptive zones correspond to flexible body areas, the collaborative zones correspond to the containing body areas, the exposed zones correspond to the body areas to be protected. The study of the body mapping thus characterized is followed by the research of materials and the typological configuration designed helps to position the different textile and non-textile materials (Langenhove 2007). The design guidelines adopted in the various stages of design are as follows:

1. Aesthetics: everything related to the judgment of the appearance of the shape and its functions must be associated with its level of attractiveness;
2. Comfort: after a short time, users get used to the device and no longer feel they are wearing it, thanks to the fact that it adapts without hindering the user's movements;
3. Ease of use: the user interface must be simple and immediate and must allow improving the usability level of the device;
4. Ergonomics: the physical shape and dimensions of the device must respect the anatomical aspects of the user and adapt;
5. Topicality: technology must follow fashion by studying the context of use in the best possible way to integrate what is happening in the environment for which it is intended;
6. Resistance: the worn device must be resistant to shocks that can unexpectedly and unintentionally occur, to abrasions, to temperature, to humidity, and must be able to withstand water without affecting the durability of the product;
7. Wearability: considers the physical form of the product and its relationship with the user. To be wearable, a product must comply with most of the principles mentioned above, including comfort, availability, and aesthetics (Donciu 2013). Wearability is a key factor for the success of a device, in terms of user satisfaction [HFCD14] (Figs. 4 and 5).

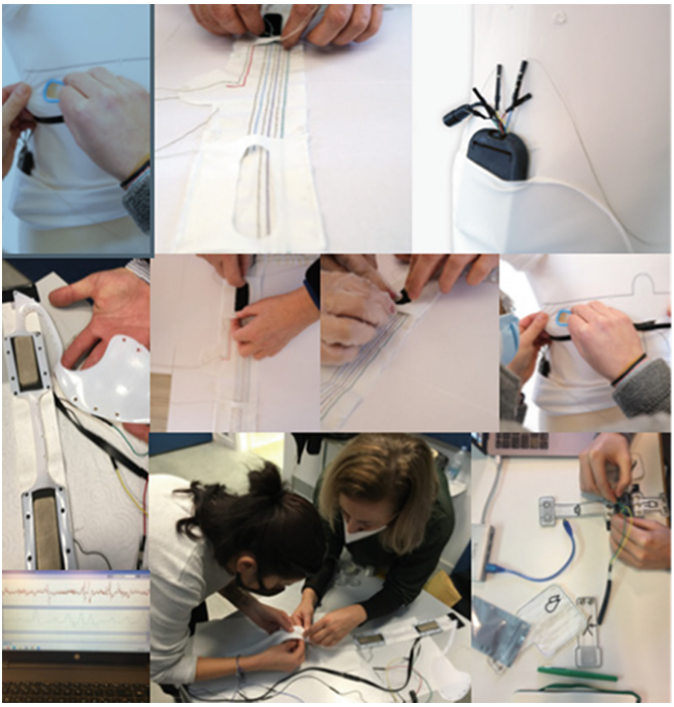

Fig. 4. Approach to active protection system configuration: relationship between jersey and advanced materials; study of electronic circuits and positioning data acquisition card; collaborative experience with teams of experts (doctors, electronic engineers, designers, textile designers, graphic designers) (Sbordone et al., Smart&Safe Project 2020).

Fig. 5. Focus on wearable add-on Smart T-Shirt. Focus on arrangement of conductive yarns by color and type of sensor connection; study of electronics components to operation and monitoring of vital parameters (Sbordone et al., Smart&Safe Project 2020).

5 Discussions

The project Smart&Safe here described is only part of a larger project, which is based on the convergence between different skills and disciplinary fields, to achieve a considerable advancement of the reference state of the art, as well as a response to what the field of e-health and the detection and parameterization of the quality of life of individuals (Sbordone 2021). The results of the project attest the passage from the single Personal Protective Equipment (PPE) to an Individual and Intelligent Protection System (IIPS) that allows the continuous monitoring of the vital parameters of social and health care personnel and at the same time finding a significant reduction in the risk associated with professional practice, especially during the pandemic crisis. The active prevention system aimed at a design solution, natural evolution of the Smart&Safe project, whereby doctors, nurses and patients will be connected, making the processes of prevention, treatment and monitoring more effective and efficient inside and outside the hospital.

The fatigue that affects health and social workers in the management of many monitor alarms is a problem of great relevance in hospital practice, especially in times of pandemic crisis; in fact, the intelligent component of IIPS has been found useful in detecting stress by monitoring physiological parameters and ensuring a continuous preventive action, playing an important role in reassuring the operator from prolonged damage by alarms and similar stress situations. By monitoring physiological parameters with the system connected to data storage and processing software, data is securely stored on a central server, allowing for more accurate documentation of information. IIPS re-proposes the "fatigue alarm", through the smart T-Shirt that, worn as a base layer in contact with the skin, detects fatigue and work-related stress that affects health workers engaged in high-intensity and medium-low care. The system can also be configured to detect alarms tailored to the clinical needs of each operator, allowing a more rapid and efficient intervention in case of clinical deterioration. Clinical data collection allows a significant reduction in the time spent monitoring and transcribing data, enabling widespread and personalized prevention, process simplification, automation of monitoring activities and real-time alarm detection. The research proposed an update in the re-design of individual Personal Protective Equipment (PPE), to explore a new dimension of the project that highlighted the transition to an Individual and Intelligent Protection System (IIPS), relaunching reflections on the various levels of safety to be considered in a critical situation; on the development of advanced performance of devices that now "interact" in a system in turn contaminated by the interactions between man, device and environment.

The overall point of view also pursued the concept of Design as Mediator that helps generate value in the "health" market, drawing from different fields, in the transformation of the health system itself, taking an active role as a leader of change along with new partners in building a secure future. With the new IIPS, de-sign is mediating the dynamics of co-creation between user, health system, and measures for care and heading, demonstrating how new technologies will shape medicine, telecare, integrated into devices that will increase functional performance for humans.

The new opportunities provided by the design and systemic design of health devices, involve government health reform that provides new opportunities in the creation of open systems through a new type of multidisciplinary and inclusive health system. A healthy society is promoted primarily by the attention given to the body's relationships with the

materials with which we surround and cover ourselves, exercise, nutrition, low stress levels, and pleasant social interactions. These aspects turn out to be crucial in the pursuit of ex-tended wellness, as health also needs to be designed, as does any structure. The frontier of new types of markets that health faces needs to build new partnerships and bring health experts into new environments, creating co-benefits, spreading a new value chain.

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Echinodesign: Case Study for Bio-Inspired Projects

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Abstract. The development of projects has more evidently incorporated the inspiration in natural processes for the solutions of artificial systems. Methods that include biomimetics and biophilia have favored analogies and inspirations in nature, as well as encouraging and highlighting the importance of multidisciplinary approaches for translating these analogies into artifacts, constructions or environments. This article aims to present the Echinochess case study. The work points out contributions from morphological and symbolic analogies and presents representative examples in Equinodesign. The design methodology followed the steps: (1) Research and Analysis on the echinoderms; 2) Choice of the bioinspired product; 3) Research and analysis of similar games; 4) Sketches of the pieces and board inspired by the morphology of echinoderms; 5) Selection of alternatives; 6) 3d modeling and 7) Game production.). The result was a chess game inspired by sea urchins, translating the morphological analogy of these animals through symbolic aspects, theme to a traditional artifact that stimulates cognitive development and interaction beyond virtuality; also aiming to provide a new look at this natural reference, as well as to apply the method and the interdisciplinary development process proposed by Perricone, which moved between Design, Science and Art.

Keywords: Biodesign · Biomimicry · Biophilia · Echinodesign · Echinochess

1 Introduction

In recent years, the number of projects inspired by nature has increased, notably in architecture, engineering, and design, favored, among other things, by the emerging new three-dimensional representation softwares that favors easier configuration and testing of complex shapes. One of the ways to use nature in projects is through Biomimicry; Benyus (1997) defines it as a science that studies the models of nature and then imitates and draws inspiration from them or their processes to solve human problems, based on the triad: nature as a model, measure and mentor. Despite deriving from the Greek word "Biomimesis", where "bios" means life, and "mimesis", imitation, the authors of this article consider the biomimetic projects both living (animal, plant, fungi, micro-organisms,

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etc.). And non-living (mineral, phenomena, principles, etc.) systems and processes, since functional morphological characteristics are found in both. It is important to highlight that there are many ways to trans-pose references from nature; in particular, there are several types of analogies and biomimetics tends to emphasize functional characteristics, closely linked to the evolutionary factors of organisms. However, this work is based on the assumption that there are more types of mimesis in nature, such as through its forms, functions, structures, principles, processes, systems, movements, characteristics, behaviors etc., and all these aspects are valid to be translated into solutions of artificial systems. These analogies are related to the interpretation of references from nature, and require a focus on one or more of its aspects, depending on the intention of the project, having as outcome projects of bioinspired artifacts, that is, those that have a reference and inspiration in nature (Oliveira et al. 2021).

Another more recent term that also contributes to this vision of using nature in projects is Biophilia; it means the inherent human inclination to join nature, which is fundamental for people's physical and mental health and well-being (Wilson 1986, Kellert 1997). In ancient Greek, it literally means "love of living things" (philia = love to/inclination to and bio = life). In general, Biophilia connects humans with nature in order to improve their well-being through an innate emotional connection, signifying that people feel a basic need to have contact with nature (Wilson 1993; Heerwagen 2009).

One of the biophilic design forerunners, Stephen Kellert defines a series of attributes to implement biophilic experiences in architectural spaces. Among them, he highlights the use of natural forms, such as: botanical patterns; tree and columnar structures; animal forms; shells and spirals; oval and tubular shapes; arches, vaults and domes; curved organic shapes; simulation of natural resources; biomorphy; geomorphology and biomimetics. He highlights these aspects also in the 3 pillars of biophilic design, more precisely in the pillar of indirect experiences with nature, which indicates the use of shapes and geometries from nature and biomimetics, which according to Kellert and Calabrese (2015), technologically capturing these features of non-human nature can also result in direct utilitarian benefits, as well as elicit admiration for the ingenuity of other lives and the creativity of the natural world. Additionally, Oliveira et al. (2021) state that the use of these natural forms collaborates with well-being by a direct association of these visual characteristics in spaces and products that are innately familiar to the memory repertoire of users.

Regarding the importance and benefits of incorporating biophilia in projects, it is noteworthy to cite the re-port HUMAN SPACES: The Global Impact of Biophilic Design in the Workplace (2015) showed that biophilic environments generate higher levels of well-being and creativity, and its adherence is related to more productive offices, hospitals with areas that enhance patients relaxation, and consequently, a faster recovery; and also, to schools that favor learning.

Therefore, it can be considered that both biomimetics and biophilia support the use of analogies and inspirations in nature, whether for artifacts, buildings or environments. Accordingly, the present research aimed to profitable translate the work of the Italian biologist Valentina Perricone, who studied echinoids (sea urchins) during her doctorate research, investigating their morphological and functional characteristics to acquire new

biological insights as well as identify adaptive strategies to be abstracted and applied in building constructions and bioinspired design products. In her doctoral research and the related EchinoDesign exhibition, different technical information and schematic drawings regarding the main functional skeletal were made available, promoting their dissemination and a better understanding for their implementation into new concept designs. In this study, the objective was to investigate, through a practical experiment, how to transpose the morphological characteristics of sea urchins into artifacts, with emphasis on the Morphological and Symbolic Analogy that will result in the theme for a chess game.

2 Morphological Analogy and Symbolic Analogy

Morphological Analogy is defined by Bonsiepe (1992) as the experimental search for elaborate models of the translation of structural and formal characteristics to transpose into projects. Therefore, this type of Analogy seeks to study and analyze the reason for the natural form and interrelationships of its geometry. According to Wilson et al. (2010), the analysis of morphological phenomena in nature facilitates and encourages the ability to perceive details and principles present in its structure. Often, such shapes are favorable not only for aesthetics, but for the gain in efficiency. According to Soares (2016), it can be translated as a process of interpretation of the macro or microscopic forms of a natural reference, considering its external form (shape) or its parts, com-ponents, elements or systems. Conversely, the Symbolic Analogy acts in the process of personal, artistic, decorative interpretation of the natural reference, its parts, components or systems; in other words, it can be de-scribed as a more creative and poetic way of interpreting the reference, which is based on the vision, values and experiences of the designer, his look to translate the reference, whether through its forms, functions, movements, behaviors, principles, etc. (Soares 2016).

A great exponent of this type of analogy is Santiago Calatrava, Spanish artist, architect and engineer who has as a striking feature in his work the dynamics of living organisms, especially in skeletons and in the impression of movement they give to Calatrava's buildings, including in his works It is possible to perceive this rich imagination of nature, in particular of animal skeletons through the use of metallic elements and reinforced cement, intensifying the size of these structures, as seen in Fig. 1, a compilation of some buildings in which one can see the importance of this symbolic character, which is so distinct that it ends up creating an identity in the architect's works. Dias (2014) confirms this thought, stating that having studied at the Academy of Art in Valencia, Spain, before graduating in architecture and later in engineering, Calatrava certainly incorporated a much more artistic bias into his style, notably based on poetics. Obviously because he also studied engineering, there is a lot of study and structural analysis to make these works possible, however, in terms of design, this personal interpretation of the morphology of nature translated into his works is what makes his legacy as an architect so special.

One of the main references in industrial biodesign is the Welsh designer Ross Lovegrove. Nicknamed "Captain Organic", he defines his creation concept as DNA (Design, Nature and Art), with deep admiration for the genius of natural solutions, his projects

Fig. 1. Images of three different works by Santiago Calatrava. Source: the authors through https://calatrava.com/projects.html?all=yes. Accessed on: Sep 20, 2021.

imprint his exquisite vision of this organicity of forms with a more aesthetic focus than functional. He believes that in the beauty of form lies his personal connection with nature whose configurations are the original source of beauty, which justifies his primacy in poetizing organic forms.

The design of the Ty Nant water bottle is a clear example of this symbolic analogy of the morphology of nature interpreted by Lovegrove, as it represents his personal impression of the shape of water. For this development, he first tried to simulate the organic forms of water in the workshop, but as he was unsuccessful, he then used specialized software to simulate the material and the result was a series of delicate and spontaneous lines that seemed to have the same fluidity as water, conveying the impression of not having the bottle in your hands, but the water itself wrapped in your natural skin. Another characteristic example of this designer's symbolic analogy is the Andromeda Luminaire for the Japanese company Yamagiwa, whose shapes refer to some kind of marine being that projects water reflections into the environment. In Fig. 2, images of these two projects.

Fig. 2. Ty Nant water bottle for Bethania Wales/2000 and Andromeda pendant for Yamagiwa/Japan, 2008. Source: the authors though http://www.rosslovegrove.com. Accessed on: September 20, 2021.

In the example of the water bottle, the formal and semantic essence produced clearly used the principle of nature as a model; the translucent, thin, light, unlabeled, recyclable material reflects the essentiality and "no waste" of nature as a measure; finally, the very inspiration in seeking a solution to the problem of water packaging in a natural element shows that he also used nature as a mentor. The purpose of using Lovegrove and Calatrava as examples was to show that there are other methods, in addition to the

functional analogy of interpreting natural forms and still making Biodesign through a more creative inspiration of personal interpretations of these references to nature, which shows that not only the practical functions of artifacts are relevant, but also their aesthetic and symbolic functions.

3 Examples of Echinoid-Inspired Design

In the field of echinoid-inspired design, interesting examples regard some of the famous ICD/ITKE Stuttgart conceptual pavilions, projects coordinated by professors Achim Menges and Jan Knippers. Among them, the ICD/ITKE Research Pavilion 2011 (Fig. 3) emerged as an outstanding demonstrator, whose biological inspiration was the sand dollar, an irregular echinoid. In this one, the analogy was through the animal's skeletal shell, which is a modular system of polygonal plates, linked together through zigzag calcite protuberances on its edges. In the same way, the Pavilion was designed with geometrized modules of wooden sheets with zigzag connections between the modules, as well as their natural reference.

Fig. 3. ICD/ITKE Research Pavilion 2011 (Stuttgart/ALE). Photo credit: Roland Halbe. Source: https://www.icd.uni-stuttgart.de/projects/icditke-research-pavilion-2011/. Accessed on: 21 Aug 2021.

Also the ICD/ITKE Research Pavilion 2015–2016 (Fig. 4), inspired by the skeleton of both irregular and regular sea urchins, whose lightness depends on the geometry of the hollow double-layer system. In these animals, the skeletal plates are connected through fibrous elements with skeletal protrusions (finger-joints), which play an important role in maintaining the integrity of the entire skeleton during its growth and exposure to external forces. Similarly, the inspired Pavilion was also designed with a modular system and pioneered industrial sewing on thin plywood sheets through robotics on an architectural scale, resulting in a structure with organic aesthetics, extremely light and with good performance. (Soares et al. 2017).

Fig. 4. ICD/ITKE Research Pavilion 2015–2016 (Stuttgart/ALE). Photo credit: Roland Halbe. Source: https://www.icd.uni-stuttgart.de/projects/icditke-research-pavilion-2015-16/. Accessed on: 21 Aug 2021.

4 Studies of Sea Urchins as Inputs to Echinodesign

In the course of time, the unique design of the echinoid endoskeleton has attracted the attention of researchers from different scientific fields due to its unique morphology, structure, and material properties (Perricone et al. 2020). Echinoids are highly adapted to different marine environments: the extant groups of regular and irregular sea urchins are widely distributed from the equator to the poles, from the bright shallow waters to the dark and cold deep-sea. The evolutionary success of echinoids is certainly due to the massive strategic employment of their endoskeleton displaying numerous functional details.

The endoskeleton consists of three main structural components: test, dental apparatus, and accessory appendages. All parts of the echinoid skeleton consist of the same basic high-magnesium calcite material; however, their microstructure displays a great potential in meeting several mechanical needs according to a direct and clear structure-function relationship. This versatility has allowed the echinoid skeleton to adapt to different activities such as structural support, defence, feeding, burrowing, and cleaning. Although constrained by energy and available resources, many of the structures found in the echinoid skeleton are optimized in terms of functional performances and, consequently, can be used as role models for bio-inspired solutions in various industrial sectors.

In this context, Echinodesign was developed as a hybrid investigation of the echinoid skeletal structure in the experimental doctoral research entitled “Mechanical design of the echinoid endoskeleton and inspired industrial details for design engineering in the Industry 4.0 Era”. This research was carried out by an interdisciplinary group of biologists, engineers and designers: Valentina Perricone and professor Carla langella, University of Campania “Luigi Vanvitelli”; professor Francesco Marmo, Ph.D. student Pasquale Cesarano and professor Luciano Rosati, University of Naples Federico II; professor Maria Daniela Candia Carnevali, University of Milan. Through the combination of advanced biological investigation techniques with digital engineering and design

techniques, The EchinoDesign research was intended to: 1) study the morphological-functional characteristics of the skeletal system of the regular echinoid *Paracentrotus lividus* (Lamarck, 1816); 2) identify the motivations and biological principles underlying the different details; 3) select and analyse individual details that can be reinterpreted (according to the analogies with design problems) and transferred to building constructions and industrial products in the form of intelligent solutions.

EchinoDesign involved a trivalent hybrid approach, based on the synergistic cooperation between biologists, engineers and designers, in which each competence continuously interacts with the others leading to a unique and creative process. The results of this hybridization can be identified in new biological species-specific knowledge, abstractable principles and technical innovation. The process can be summarized in six key phases: (1) identification of biological models on the basis of analogical function and problem solving related to the final application; (2) deconstruction survey, where the organism is subjected to a particular "reverse engineering" process and is schematized into functional components at different dimensional scales (shapes, structures, patterns, textures, etc.) in order to reveal its design and architecture; (3) direct investigation to increase the species-specific organism comprehension; (4) identification of functional biological principles and abstraction into design principles; (5) contextualization and transfer of the abstracted models into the design of new bioinspired concepts; (6) development of the bioinspired design artefacts, optimization, prototyping, tests and validations.

Following this process, the sea urchin *P. lividus* was chosen as a biological model and investigated in depth. After an initial description, the *P. lividus* endoskeleton was schematized into different functional components at different dimensional scales and characterized based on current knowledge and accurate visual surveys at a macro and microscale (deconstruction survey). This survey highlighted different details that were categorized and described in terms of functional details, namely: test, dental apparatus, and accessory appendages (Fig. 5). Among these functional skeletal components, the test was taken into consideration for an in-depth study in order to acquire novel understandings regarding mechanical design and adaptive strategies. The support and protection of visceral organs is the primary role of the echinoid test; it must likewise be robust enough to withstand forces acting on it, but also sufficiently flexible to allow growth and movement. Consequently, this skeletal system can be investigated as an engineering structure with possible applications of biomechanic notions. Based on these assumptions, the *P. lividus* test was subjected to a hybrid analysis using stereomicroscopy, scanning electron microscopy, photogrammetry, 3D modelling and Finite Element Analysis (Fig. 6). Once identified shapes and structures corresponding to adaptive strategies and functional principles, they were abstracted and transferred into building construction and industrial design products. As a result, *P. lividus* became a guide and model for the development of different bio-inspired concepts of building constructions and industrial products (Marmo et al. 2019; Perricone et al. 2020).

Successively, an international exhibition called Echinodesign was settled to valorize the results achieved in this research and promote further investigations of the echinoid class between design, art and science in a transdisciplinary way and from a biomimetic perspective. Indeed, the exhibition was conceived as an open call-in which designers,

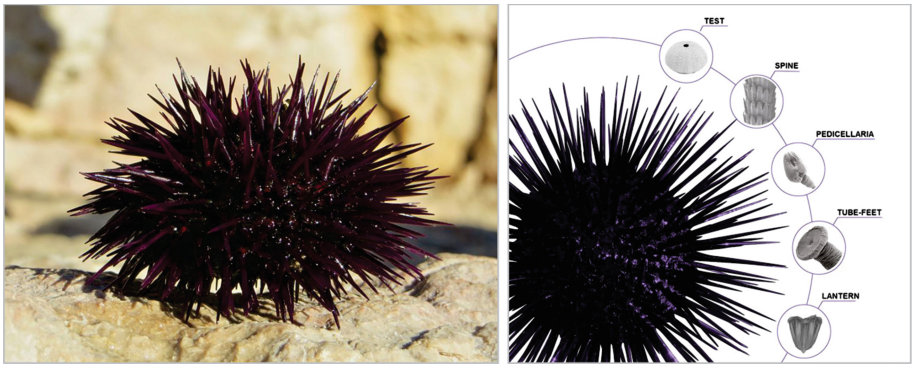

Fig. 5. Deconstruction survey of a typical regular sea urchin with its functional components. Source: SEM images obtained by the authors with the graphical elaboration of Roberta Angari. Tube-feet image retrieved from https://askabiologist.asu.edu/tube-feet.

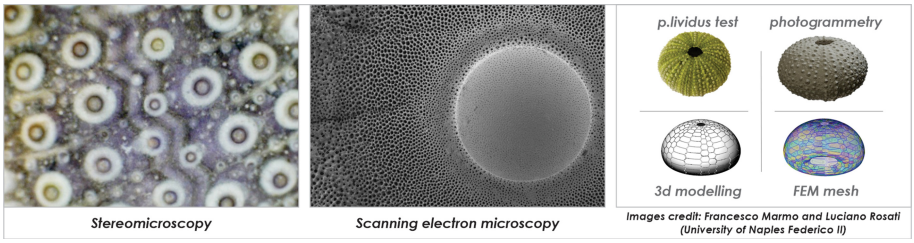

Fig. 6. Visuals Analyses with different images by stereomicroscopy, scanning electron microscopy, photogrammetry, 3D modelling and Finite Element Analysis (FEM). Source: The authors of Hybrid Design lab image bank.

artists and scientists were invited to submit their echinoid inspired projects. The participants were provided with a brochure called "Learning from Echinoids" with all the echinoid functional details and references to study in depth the biological characteristics and find inspiration regarding the possible biomimetic applications in the area retained most suitable between design, art and science (e.g., furniture, medical, sports, jewelry, electronic devices, interaction design, new materials, paintings, sculptures, poems, graphics, visual arts, music, architecture and building constructions, visualization of scientific data and results, digital applications). In this context, numerous proposals were elaborated and submitted to be evaluated by a scientific committee composed by designers, engineers, and scientists of international relevance. Among them, the Echinochess project was selected and successfully evaluated by the committee.

5 Echinochess: An Echinodesign Project Case

The methodological planning of the project was carried out by the designers Theska Laila and Marcelo Vicente in the following stages: 1) Research and Analysis on the echinoid functional characteristics; 2) Choice of the bioinspired product; 3) Research and analysis

of similar games; 4) Sketches of the pieces and board inspired by the morphology of echinoderms; 5) Selection of alternatives; 6) 3d modeling and 7) Game production.

Starting from the echinoid research carried out by Perricone et al., which provided the corresponding components of the sea urchin parts and analogous functions to inspire design applications, the study has been further implemented considering numerous additional images and references retrieved from the internet; as well as a previous study carried out in the Biomimetics lecture offered by the authors in the first semester of this year, whose theme for the final projects was also echinoderm. Another important aspect to be highlighted that further motivated the research is that sea urchins are abundant, mainly on tropical beaches near the authors' city, in particular, Carneiro's beach, where there is a nursery for these animals. It is interesting to note that they are generally perceived in a negative way, since people are afraid of getting hurt on their spines, and this was also a motivation to use them as a thematic reference, allowing a new friendlier look to these important key species.

To increase the visibility of these references, several image panels were built, glued to the wall, the first with approximately 74 image compositions of species of echinoderms, emphasizing their morphological aspects and also with microscopic images, which served for the analysis phase, essential for the insights and realization of the sketches. In Fig. 7 some images show the variety of species of sea urchins and some macroscopic details of these animals.

Fig. 7. Images of sea urchin species and details of their morphology. Source: The authors of the UFPE Biodesign laboratory image bank.

Faced with an infinity of possibilities, the chess game was selected as a product to be developed based on this biological inspiration. This choice was intentional because it favored an interaction free from the virtual scenario, combining cognitive development and fun. The goal was to offer an unusual perception about these animals, bringing an unconventional theme to a traditional artifact, providing an experience of observation and interaction with marine references while stimulating mental exercise and interaction between people. In Fig. 8, some of the similar games analyzed are show.

In the search for similars, 57 games were analyzed including their colors, themes, shapes, textures and dimensions. Subsequently, several sketches were made inspired by the investigated echinoid morphologies. Several insights served as inspiration in this

Fig. 8. Images of chess games analyzed in the similar search. Source: The authors of the UFPE Biodesign laboratory image bank.

design phase, including playing a few matches between one drawing and another, in an initial brainstorming several fun and impracticable ideas emerged, such as the pieces being swallowed by a kind of pedicelery to extravagant materials such as Swarovski crystals. However, in a second moment, the intention was to focus on developing a solution that could actually become a commercial product, not just a design concept. Below, in Fig. 9 are some of the sketches of the third image panel built.

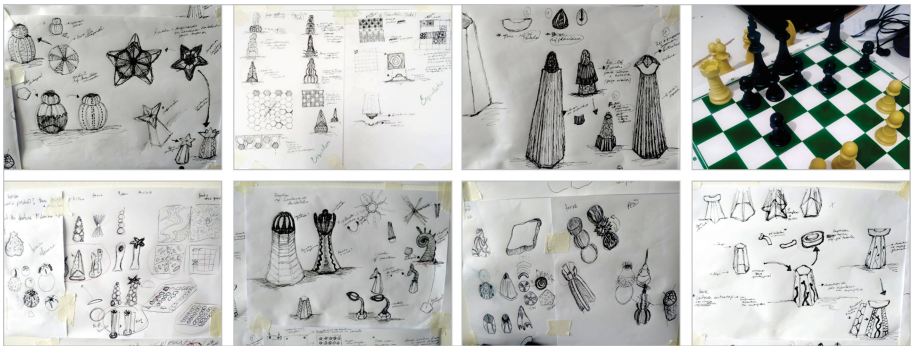

Fig. 9. Images of chess games analyzed in the similar search. Source: The authors.

Then, guiding alternatives were selected for the development of the 3D modeling of the parts. Here it is noteworthy that the choice of design was also related to the degree of similarity with the traditional pieces, as the intention is that the new pieces would not be too different from the traditional ones so as not to hinder the gameplay. The digital modeling was done using SolidWorks software and the parts prototyping process was carried out by resin 3D printer technology, due to the better printing resolution for subsequent mold making and production in epoxy resin. The goal is for them to have more weight, durability and be perceived as having higher manufacturing quality.

The game is designed with 6 different pieces that make up the 32 pieces of the total game and the board. A feature that guided the design of all the pieces is found in the

decagonal base derived from the penta-radial symmetry pattern found in echinoderms. Figure 10 shows this pentagonal symmetry in the skeleton of the sea urchin and from it, the decagonal geometry was traced. It fits better with the curved silhouette of the skeleton, in a similar way, serving as the basis for all game pieces. Then an explanation of the morphological inspirations for each game piece.

Fig. 10. Base of decagonal formation, characteristic of the morphology of sea urchins that was translated in all game pieces. Source: The authors.

5.1 King

The king's piece (Fig. 11) is referenced in the main characteristic of the echinoderms, the spines, its elongated shape based on a decagon is derived from the pentagonal formation characteristic of these animals, a pentagon at the top that refers to several of its components, such as the amount of teeth, Aristotle's lantern, etc. It was also based on the grooves present along its longitudinal extension of the view in microscopic images and has the semicircular projections of the spine connectors that decorate the skeletons, being an element that brings aesthetic unity to all the game pieces.

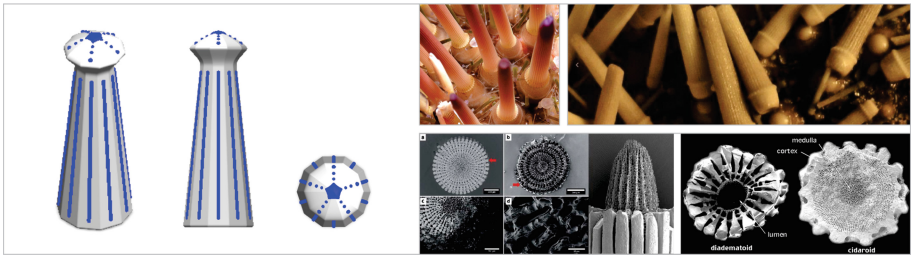

Fig. 11. Images of the King piece mainly inspired by the morphology of the thorns. Source: The authors of the UFPE Biodesign laboratory image bank.

5.2 Queen

The queen (Fig. 12) was based on the rounded silhouette and curved shapes of sea urchins, also recurrent pentagonal shapes, mainly its starry variant visibly present in

Aristotle's lantern, in the inner fleshy part and in other echinoderms such as starfish, by for example, this starry configuration inspired the upper part in a kind of queen's crown. There are also hemispherical protrusions of the spines in their idea of gradation of different sizes, as in animals.

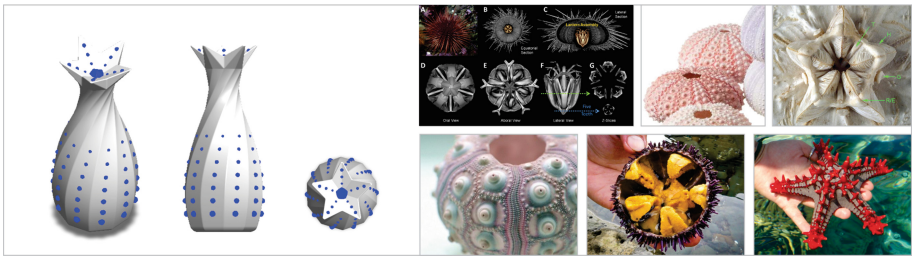

Fig. 12. Images of the queen piece inspired mainly by the starry configuration that manifests itself in several elements of the echinoderms. Source: The authors of the UFPE Biodesign laboratory image bank.

5.3 Bishop

The bishop (Fig. 13) was based on the apical silhouette of the pedicel. There are also the hemispherical protrusions of the spines superimposed on another flatter protrusion, as occurs in some species. Again, the torsion gives the idea of increasing movement that comes out of a decagonal base to maintain the aesthetic unity of the pieces, the more rounded base grows and ends up in the shape of the closed pedicel.

Fig. 13. Images of the bishop piece mainly inspired by the apical configuration of the pedicellariae. Source: The authors of the UFPE Biodesign laboratory image bank.

5.4 Knight

The knight (Fig. 14) is the most playful and conceptual piece, inspired by the functional characteristics of sea urchins, which are coral diggers and rocks encrusting themselves for protection. In the piece, there is an inlay simulation of part of thorns and part of a

skeleton, with pentagon and semicircles at the base of the spines. There is a decagonal formation base as well as in the other pieces and there are also protrusions from the base of the spines in a linear arrangement on the back of the knight piece, this time without gradation, as also occurs in some species.

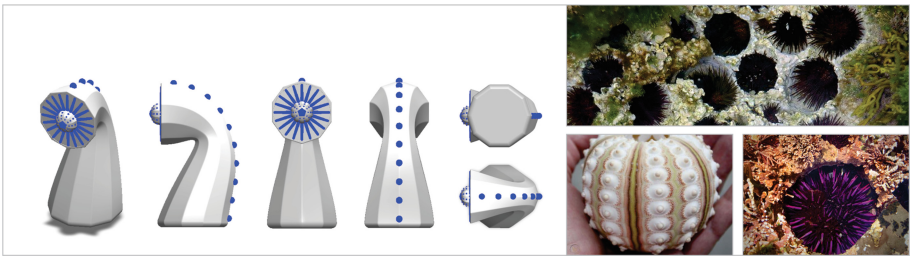

Fig. 14. Images of the knight piece mainly inspired by the inlay of sea urchins in rocks/corals. Source: The authors of the UFPE Biodesign laboratory image bank.

5.5 Tower

The tower (Fig. 15) had as reference the tubular feet with ends in the shape of mini suction cups. There is also inspiration in the ring of the ambulacrum system and in the hemispherical protrusions of the spines in gradation as in the skeletons. The decagonal base of the piece turns into 5 columns, a reference in the pentagonal formation of animals, the pentagon at the top is also another reference to its symmetry.

Fig. 15. Images of the tower piece mainly inspired by the tubular feet. Source: The authors of the UFPE Biodesign laboratory image bank.

5.6 Pawn

The pawn (Fig. 16) was inspired by the skeletal test of the sea urchin, and a composition was generated that refers to the superposition of skeletons, a smaller one on top of a larger one, some species have a similar structure, but the inspiration came from an image with this overlay of skeletons. This was the first piece modeled, so it influenced the others as

they all followed its decagonal base, referenced by the top view of the sea urchin skeleton derived from pentagonal symmetry, as shown above. The protrusions at the base of the spines also translate an aesthetic ornamentation that gives unity to the set of pieces and increases the similarity with the echinoderms.

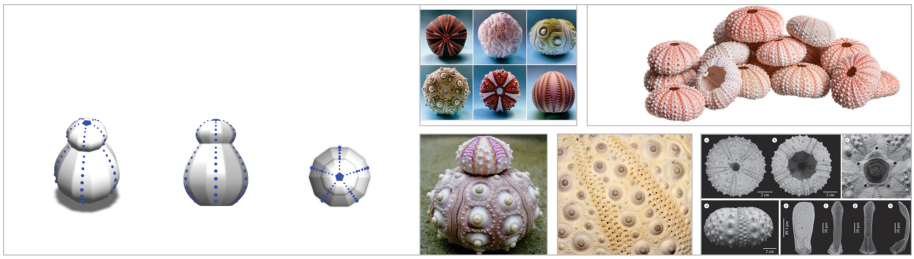

Fig. 16. Images of the pawn piece mainly inspired by the skeleton of the sea urchin. Source: The authors of the UFPE Biodesign laboratory image bank.

5.7 Game Board

The board (Fig. 17) has a compartment to store and display the pieces when not in use, it was designed to be used on the table (during the game) and on the wall (for display as a decorative piece). For this purpose, the top has a design with illustrations inspired by the skeletons of sea urchins on both sides. On one side it works as a game board and on the other side, the decorative illustration when not being played. The idea of functioning as an ornamental piece adds even more value to the artifact, as it brings a new function, as an art object, adding symbolic value and collaborating to prevent its quick disposal. Therefore, the choice of materials mainly took into account the durability factor, with the aim of making the game an artifact loaded with symbolic value, providing playful moments, building relationships between family members, and therefore being passed on from generation to generation.

Fig. 17. Images of the board design (3D Modelling), mainly inspired by the skeletal morphology and the spines. Source: The authors.

As all parts were modeled in 3D, there is also the possibility of later being printed on other materials available for this technology. Although, until now, the echinochess

parts have been prototyped in a resin printer for the quality of the finish, as the intention is to make the silicone mold for the production of the pieces in epoxy resin. In Fig. 18, some images of the prototyping process and pieces.

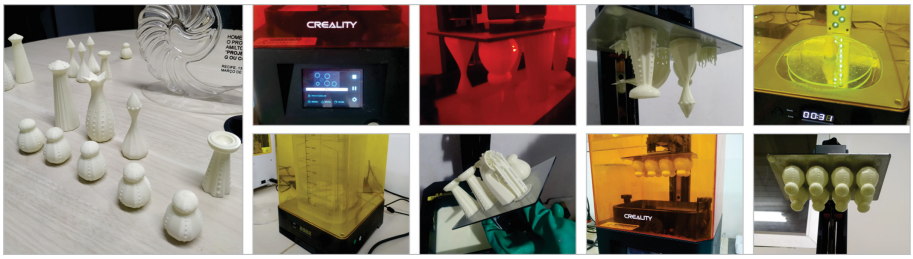

Fig. 18. Images of the printing process of the pieces in resin. Source: The authors.

6 Conclusion

The results achieved from the application of Perricone's studies enabled several insights into the configuration of the Echinochess game, through an aesthetics and symbolism of the animal's morphology, whether visible or microscopic aspects, translated into the 6 different pieces of the game, allowing an aesthetic unity coherent, as if they were a "family of objects" belonging to the same theme, that of the sea urchin, through elements common to all the pieces, such as the semi-spheres that simulate the spines, the composition of the pieces that they have intentionally, the same constructive basis as the animals, that is, they are conceived on a decagonal basis derived from the penta-radial symmetry found in the bases of components such as the test skeleton and Aristotle's lantern. The colors are inspired by the natural color of the skeletons, mostly white; and some details based on the fluorescence effect seen in some species in shades of blue and orange. The color choice also took into account the contrast of the complementary colors (blue and orange) to facilitate gameplay.

The transposition of the forms and characteristics of these elements are perceptible through a previous communication on the theme of the game, and the degree of familiarity with the repertoire and previous experience with these natural systems that inspired its configuration. Therefore, it can also be said that because the theme is inspired by a common animal in the authors tropical region, this artifact also evokes the memory of its users and, therefore, makes the theme of this animal that people tend to avoid more friendly, awakening a new look at it and favoring its usability.

Finally, it is considered that the morphological and especially the symbolic analogy collaborates with the theme of biodesign, biomimetics and biophilia in which it is possible to translate in these artifacts characteristics of natural references in a creative way and under the perspective of the designer, and such circumstance it doesn't diminish the design possibilities but expands them. Echinochess was an efficient echinodesign project that moved between three areas: Design, as it is a product that needs to work to achieve its chess game objective, with dimensions, materials, ergonomics, etc.; Science, as it

uses the knowledge and technical resources of scientific researchers about biological reference, in addition to technological resources, configuration software, etc.; and also Art, as it aims to communicate and make people reflect on the respect and diversity of nature, bringing more of this theme to everyday objects and making it more evident to the general public.

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Design for Social Innovations, Sustainability and Circular Economy

Domestic Space Connections, Relationships and Overcrowding in Affordable Housing

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Abstract. In people's imagination, the dwelling represents a fundamental part of life. The house has forever been not only a shelter, but it also occupies the majority of people's economic and temporal resources. The matter of housing has become however noticeably more complex following the COVID-19 pandemic, since it has imposed a different relationship between the dwelling and the way of living the population was used to, as well as working, entertaining and conducting their own lives. Therefore, in addition to the energetic matters, already highlighted for some time, also problems related to the general welfare have been added, with particular attention to the quality of the space in which the daily life takes place. The paper reports some initial considerations of a piece of research which intends to investigate the domestic space and its relations with the users in the new household configurations and in possible evolutionary scenarios of the concept of house and domestic space.

Keywords: Affordable housing · Living space · Housing dimensional requirements · Crowding index · Adaptive building refurbishment · Sustainable living

1 Introduction

The COVID-19 pandemic has forced the population to rethink the way of living and the approach to the living conditions, as well as the everyday way of living their own home and the domestic space. The pandemic has further exasperated the already present "desolate poverty" of the domestic space which characterizes most of the Italian public housing heritage, which was erected in the second post-war building reconstruction. in other words, created from the 60s and for the two following decades. This period starts with the approval of the 1949 law n. 43 "Measures to increase the labor occupation. Houses for laborers", which allows the more imposing period of construction of the "public Italian city". In substance, the entire INA-CASA program begins, consisting of a series of actions and measures aimed not only at the creation of dwellings, but also and moreover to the relaunch of the Italian building sector. In this context, architects, engineers, and workers were involved. In particular, the first two categories were given the responsibility for responding to the idea of "living space" (from the urban space

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https://doi.org/10.1007/978-3-031-32280-8_21

until the definition of the domestic space). This circumstance has originated a fierce cultural debate which resulted into the creation of vademecum called "the INA-CASA booklets" [1]. The typological-functional-distributional model which was created from it by a group of scholars, was formalized within the manuals, "I quaderni INA-CASA, fascicolo 3.". These manuals would have been a concrete guide for all the technicians who would have intervened in the numerous working sites of the reconstruction [2]. In particular, the reflection on the "domestic space" started from considerations which the architect Adalberto Libera had put forward in his written works. [3] on the minimum size of the house and its spaces. In the Manuals distributional schemes were reproposed, as well as special articulations and relations between the rooms and their functions, based on his studies. [3]. The logic at the basis of the articulation of the living space, organized according to the "minimum size of dwellings", is undoubtedly rooted in the existenzminimum of the previous analyses by Alexander Klein and the rationalism, but in the case of Italy, it finds a different compensation outside the dwelling in the adjacent urban space, in which they tried to recreate cost environments, almost continuing the dwelling. Moreover, the house of this period responded to specific demographic demand of that time: lack of housing for the population, mainly composed of large households (on average with two parents and not less than three children, usually accompanied by a grandparent). This was a common and homogeneous demographic condition in the demand of housing for almost the entire Italian population. Therefore, the response was fairly uniform and homogeneous [1]. Contextually, following the first French experiments, the Italian applications of enclosures the enclosures of wall of totally prefabricated systems or mixed systems with the alternation of traditional wall and prefabricated elements began. The prefabricated system was not extended also to the structural apparatus, which instead saw the widespread application of the independent lattice system made of armed concrete [1]. The reconstruction following the WWII was consistent and massive and certainly one of the greatest investments (in terms of sqm built) made in the sector of public building. All this has characterized the majority of the constructions in the peripheries of Italian cities, a model currently in severe crisis and undergoing a deep rethinking, not only from the urban point of view, but also the building one related to the mode of construction and the organization of the living space (surface per person and functional distributional organization of the dwellings). We find ourselves today before a crucial matter in the management of the "housing problem". The contemporary house requires the meeting of several and various demands and related needs. To summarize some of the changes, we could identify among the needs the increase of the population lifespan and the consequent increase of people with functional disabilities [4]; the diversification of the social needs, due to the demographic changes and consequent family changes; the differentiation of the world of work. This not only imposes a different pace of life, but usually leads to an unprecedented rate of commuters, which leads to some components of the family residing in another city for most of the week [5]. Furthermore, the all-Italian condition of leaving the nest in adult age [6, 7], creates the heavy discomfort of inadequate housing in terms of living space and the impossibility to meet the privacy needs; to which are sometimes added the hygienic conditions caused by the unsafety of the overcrowded housing. Lastly, in addition to all this, there are problems stemming

from the climate change and the increasingly growing demand of higher performance energetic systems.

2 Housing and Family

The paper begins from these premises and deals with the matter of the quality of the domestic space in the perspective of a renovation of the relevant public residential housing heritage existing in Italy. The Covid-19 pandemic has significantly reformulated the time and way of use not only of the dwelling, but also its spaces, the relations, and interconnections among them. The contemporary city, with its population and society, can be assimilated to a continuously evolving organism, subject to continuous changes due to the economic, social and space-time conditions of the places where the individuals who belong to them reside. The undisputed protagonist of the society is the family: habitual and privileged resident of our cities. As Giuseppina Sacco states [8] the term family presumes a group of people living together, an aggregate which is formed, transforms, and divides itself giving birth to a familiar structure. From this, other familiar relations originate as well as the relationships that begin between groups that were once separated. It can be stated therefore that the "traditional" model of family, based on the spouses and the centrality of the children, has radically changed.

2.1 Dwelling

In his analysis of the composition of families, Bargagli illustrates how between the XV and XVII centuries, this was varied moving from the countryside to the cities. If in the countryside the family model could be assimilated to the concept of complex family (constituted by more than a household), the situation was more complex in the cities. Here the family models were differentiated depending on the economic class: generally, the craftsmen and the poorer classes created nuclear families, vice versa the richer classes created multiple families [8]. The reflection on the very concept of family is fundamental (in whichever way it was composed and organized): it was based on the model of patriarchal authority, in which the male, leader of the household, held the decisional power and the wife as well as the children were completely subordinated [9]. Another factor which has determined, in alternated periods, the composition and the numerosity of the family (in every social class), were the level of child mortality and the average lifespan in adult age. The first great change in the composition of the family occurred therefore in the period following the WWII where the development of scientific and technologic knowledge and a higher attention to the causes of child mortality [10], have determined substantial changes to the structure of the population and consequently to the family. However, has the composition of the family (single parent or complex) together with the numerosity of its members, determined, during the various historic eras, a relation between the shape and the size of the house, between the shape and organization of the house, between shape and the function of the spaces? The answer to these questions has not been always immediate and unique. It can be read in some es-says on the history of the house [11] how it cannot be stated that there is a direct connection be-tween the various factors. On the contrary, the relation between the

social-economic condition of the family (regardless of its composition) and the size of the dwelling seems more direct. The higher the economic condition, the larger the size of the dwelling regardless of the number of components living in it. Another interesting factor was that related to the function of the environments of the house: in a condition of shortage of spaces, the various functions related to the domestic space overlap without any criterion. In a condition of economic wellbeing there was a differentiation of the spaces and the functions which saw more a division between owners and servants than a real functional distinction based on what the room was destined for [11]. For example, it can be read in the historic bibliography how the servants often had their beds in the kitchens [11]. It is clear that in the course of the centuries the differentiation of the spaces has increasingly become finer with the advancement of the technological progress and with the necessity of housing an increasingly consistent number of people inside the "town houses". Therefore, the INA-CASA booklets arrive in Italy in an era when the "house matter" was to be reformulated and the cultural debate on the subject was extremely fierce. Think about the reflections regarding the MM.

2.2 Family

The starting point for the analysis of the composition of the family in Italy are the demographic and economic changes of the Italian population and the consequences on the housing quality demands [12]. Among the factors which have mostly influenced the change in the composition of the family we can list: the change of the working conditions of women; the reduction of the "total tax of fertility", in other words the num-ber of children per woman; the increase in schooling, which leads to a prolonged permanence of the children within the household; the reduction of the weddings and the increase of the separations and divorces. From the ISTAT data reported below, (Fig. 1), it clearly emerges how the number of families in 50 years (time interval 1971–2011) has increased, condition which could seem positive if it was not cross referenced with the number of components per family (Fig. 2) in which it clearly emerges that in the same years it changed from 3.35 to 2.4 components. Analyzing, in the same time interval, the composition of the families more in detail, it can be observed that the inversion of the trend saw the growth of the single person household which went from 12.90% in 1971 to 31.15% in 2011, value which more than doubled in just 50 years. At the same time if in 1971 the 5 components per family represented 21.51% of the population, that data becomes emblematic in 2011 moving to almost a quarter, 5.75% (Fig. 3).

The situation does not change observing other ISTAT data and statistics, in which the data grouped by annual average clearly sees the growth of the percentage of single person families against the families with 5 or more co-inhabitants.

Therefore, the family is more often composed by households with a reduced number of members. However, what changed is not only the numerosity of the components, but the very structure of the family [13]. The number of single parent families, composed by a single parent with children, (factor fueled by the growth of separation and divorces), the number of elderly people over 65 still self-sufficient who live alone, and young people aged between 18 and 34 who still live with the family increase (Figs. 4 and 5).

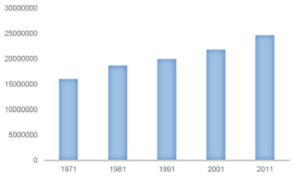

Fig. 1. Number of families resident in Italy, 1971–2011. (Source: ISTAT, general census of the population and dwellings)

Fig. 2. Number of components for family, 1971–2011. (Source: ISTAT, general census of the population and dwellings).

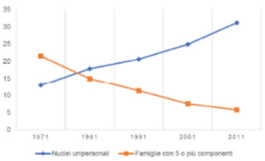

Fig. 3. Percentual variation of the single person households and the families composed of 5 of more members, 1971–2011 (Source: ISTAT, general census of the population and dwellings).

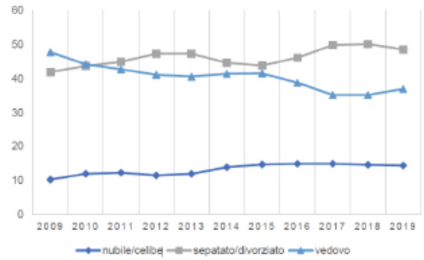

Fig. 4. Marital status of the single parents, 2009–2019 (Source: ISTAT, aspects of daily life – Families).

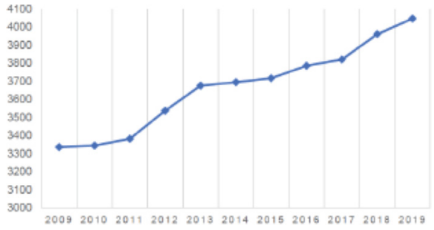

Fig. 5. People of 65 years of age or more living alone, 2009–2019 (values in thousands) (Source: ISTAT, aspects of daily life – Families).

2.3 New Households

From the previous considerations, the presence of new, numerous and different types of households emerges. In this framework identifying common needs that uniform, each with its own needs and lifestyles is complex. The "new categories" of households are varied and can be summarized in the following picture:

Where only in the case of the single person the distinction between "working age and not" can be seen only to identify possible distinctions between single workers and elderly living by themselves. This distinction has been made according to these criteria: the households have been identified according to their number of components; consequently, there was a differentiation of the households composed of several people based on their working condition, marital status, age, presence of co-habiting children and/or elderly. These data have been deduced from the ISTAT reports on the living condition.

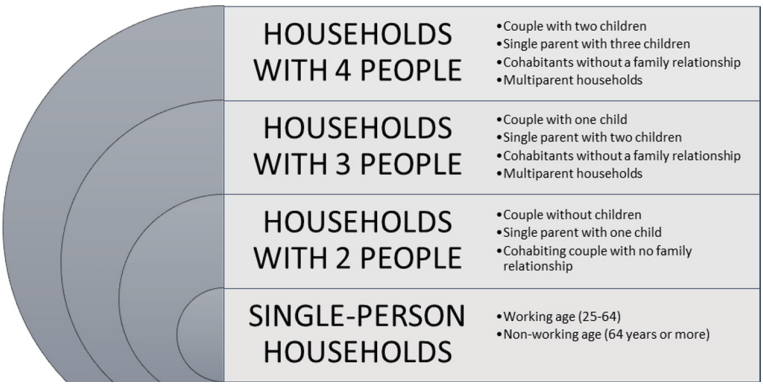

Fig. 6. Summarizing framework of the various types of households

3 Housing and Family

As stated by the European Housing and Health, in terms of living space, the dwelling should be large enough to comfortably accommodate people of different ages and should guarantee a sufficient space to meet the privacy needs of its occupiers [14]. Hence, the main problem lays in the change of the demand of housing, which is not as homogeneous nor standardized as in the past in terms of functions, domestic spaces, and the users. There is an important circumstance associated to this: in order to design and develop the domes-tic space, it is necessary to understand the needs and wishes of its users. In this regard, several currents of thoughts are contraposed, not about the concept of start, in other words the necessity of renovation of the existing building heritage for the new social challenges determined by the varied users, but about the modes of actions aimed at its achievement. Clapham [15], among some of his theories states that Studies on the human behavior have found that the existing housing heritage mostly determines what is possible and therefore what is desirable by the laypersons [15]. Therefore, the users could be strongly conditioned to what they are used to having at their disposal and might not be able to imagine a response to their needs which is effectively innovative since they lack the technical skills which would allow them to find new solutions [16]. In opposition to Manzani [17], argues that the individuals/population is pushed to follow strategies to satisfy their own need of housing. The observation of Pirinen, A., & Tervo, is interesting [16] according to whom, from an observation of the planning of some pilot projects, guided by the residents, the principles of planning were hardly reproduced in other building contexts [16].

Therefore, the ongoing research is based on the construction of a more cogent quality of housing through strategies of action on the public residential housing in the Italian panorama, which include their maintenance by means of the readjustment of the existing building. This is a concept that can be summarized as being able to be replicated, not for a serial re-proposition of the building artefacts, but in the application of a methodology of approach the housing innovation. In this process the relationship among the spaces of the house and the external spaces takes a fundamental role (from the building and the urban space). In the Italian economic and popular buildings of the 70s in fact, the external

spaces (such as balconies, porches, and spaces of outbuildings) have been neglected too often, becoming in some cases completely absent. The analysis starts with the public building stock, as it is subject to strict regulatory parameters based on requirements that set the surface area and corresponding users. The proposal is based on regenerating the built environment, working on existing building frameworks, and avoiding further land consumption.

3.1 The Overcrowding Index and the Quality of the Dwelling

The quality of a dwelling is described and quantified in different aspect which range from its stability, its energetic parameters and so on. In more recent times, the concepts of "grave housing deprivation" have been introduced, identifying as a new fundamental factor the overcrowding of the dwellings, together with the structural problems, the lack of bathrooms and appropriate hygienic services in sufficient numbers [18]. The introduction of the overcrowding index as parameter for the overcrowding of the dwelling, poses some limitations to the modality in which it can be calculated. The parameter substantially tries to quantify whether the availability of space is sufficient within the dwelling, however it is not a unique index but there are several ways of measuring: the American crowding index (ACI) or People Per Room (PPR), Equivalized Crowding Index (ECI), Canadian National Occupancy Standard (CNOS), British Bedroom Standard (BBS), Occupancy Rating standard, and People per floor area index (Goodyear et al. 2011) [19]. In the study by Khajehzadeh and Vale the three main methods of calculation are compared, and a key factor emerges in all of them, the number of bedrooms, regardless of the size of the dwelling. Therefore, an incorrect assessment of this environment in relationship to the users who actually live within the dwelling, could lead to inaccurate considerations. This condition occurs particularly for the dwellings with a number of rooms with non-unique allocation.

However, despite these difficulties of measurement, the calculation is made considering the percentage of users according to the number of bedrooms available, the size of the household and the age of its members. In Italy the method of calculation adopted is the one which sees the ratio between the number of users and the main chambers of the dwelling, intending the bedrooms, where the definition of chamber is the one established by the Italian hygienic sanitary norm. [Ministerial Decree, 5 July 1975]. The ISTAT calculates such index with a ratio between the users and the bedrooms available in relation to the age of the users. Therefore, such index is not a constant and fix figure, but varies according to the evolutionary age of the family. It is important to note that the parameter is not calculated on the area of the total housing, but only on a portion of it. The calculation excludes vestibules, bathrooms, and all living areas of the accommodation. As stated by Khajehzadeh and Vale [19], if for the assessment of the overcrowding index a figure can be obtained anyway, for the assessment of the underuse of the dwellings there are no parameters of comparison, nor calculation. In other words, in the case of a surface exceeding the number of existing users, the overcrowding parameter will be surely respected, but in contrast, there will not be any parameter which can quantify the oversizing of the dwelling. The Eurostat report is interesting [20] which making an assessment on a European scale on the living condition, has compared numerous European countries. However, the limit which seems to lie in this analysis regards the

collating of the data, which is generalized for the entire geographical area of the nation taken in consideration without any distinction of subcategory referrable to more reduced portions of the national surface.

4 Methodology

4.1 The Framework of Needs in Relation to the Overcrowding Index. Application to the Case Study

The study focusses on the analysis and the comparison between the standard of the Italian housing laws (Hygienic Sanitary norm of the 5 July 1975) and the population residing within a building of economic or popular construction located in the city of Bari, Japigia district.

The interest of the study is to detect the idiosyncrasies between the surface of the housing and the effective residents, highlighting the phenomenon of overcrowding in contrast with that of underuse of the house. Using as parameter of calculation that adopted by the Eurostat study [18], we can recognize the conditions of overcrowding in relation to the bedrooms of the dwelling, identifying the following cases:

- one room for the household;
- one room per couple in the family;
- one room for each single person aged 18 or more;
- one room per pair of same sex children between 12 and 17 years of age;
- one room for each single person aged 12 to 17 years of age not included in the previous categories;
- one room per pair of children under 12 years of age.

The following table compares the association between the households in the composition identified in Fig. 6 and in particular referring to the three-person households with associated bedroom requirements (Fig. 7).

	Three-person households											
ROOM TYPE (*)	"Couple with one child (0-17 years)"	"Couple with one child (18+)"	"Single parent with two children of the same sex".				Single parent with two children of different sexes				Cohabiting students	Couple with elderly cohabiting
			both 0-12	one child 0-12 and one 12-17	both 12-17	both 18+	both 0-12	one child 0-12 and one 12-17	both 12-17	both 18+		
Master bedroom	1	1	1	1	1	1	1	1	1	1		2
Single room	1	1				2		2	2	2	3	
Double room			1	1	1		1					
Main bathroom	1	1	1	1	1	1	1	1	1	1	1	1
Second bathroom												

Fig. 7. Requirements framework for a three-person household

Therefore, the basic needs frameworks are created exclusively by taking into consideration the possible aggregational configurations of the households, showing how increasing the number of users and their diversification, the possible frameworks of

the domestic space destined to the sleeping area, in contrast with the living area. This problem starts to manifest itself from the household composed of only two users for which in the three existing cases, three different spatial configurations can be noticed, to which three configurations of use of the surface correspond. When moving to three or four users per household, the situation becomes more complex since the age of the residents influences the need for space and will vary in time with the age evolution of the household components. Therefore, it is evident how the needs relative to the number of rooms within the dwelling change even when referring to households composed of the same number of individuals and classified in the same typology (e.g., in the case of the single parent households), whereby there is a high number of children of different ages.

4.2 The Calculation of the Surfaces

The surface of a dwelling is subjected to normative parameters which relate the number of users to the surface of reference. If we analyze the case of the Apulia Region, apart from the national normative reference [Ministerial Decree, 5 July 1975], we will use the regional normative reference, L. R. 7 April 2014, n.10 (Art. 10). Both the norms establish the total size of the dwelling by dividing it by the users (intended as components regardless of the complexity of the family) and sets without any exceptions, some surfaces, or linear measurements of the bathrooms.

Therefore, the calculation of a possible definition of the surface of the living area has been made by subtraction or deduction. It is clear that this kind of calculation is liable of possible errors related to the assessment of all those environments which do not have a surface established by the norm, such as the corridors or vestibules. Nevertheless, in the ensemble, the percentage error appears negligeable. The greatest problem is to obtain a sufficiently accurate measurement of the surface of the living area or the distributors, as well as the bathrooms. From the total surface of the dwelling, are therefore subtracted the mandatory measurements established by the norm, the measurements of the hygienic services (obtained by minimum assessments of the viewable bathrooms) and a maximum surface of the distributors (in the ideal case it can be assimilated to the surface reported in the various manuals of planning [21].

Starting from this premise, with the same methodology of calculation the measurements of the various domestic spaces can be obtained, not well-defined by the norm for other kinds of dwellings. This has been the premise to obtain the measurements of the living area (kitchen, dining room and living room) to be used then in the calculation of the adequate surface in the case of family.

Afterwards an “ideal” surface for these configurations of family aggregations has been defined. Let us consider for example the calculations made for the three-people households. For this household, as for the others, as surface of the living area has been used the one deducted from the calculation as said before. In the specific case, this surface is 22.5 sqm. It is evident how in this situation the percentage of the living area is almost equal to that of the sleeping area. This shows therefore a correct balance between the two parts of the dwelling. The surface of reference from the norm is 55 sqm, calculated considering a sleeping area with two rooms, one double and one single. It goes without

saying that all the new households that take distance from the "traditional" one present a situation of overcrowding that can only be solved by widening the total surface (Fig. 8).

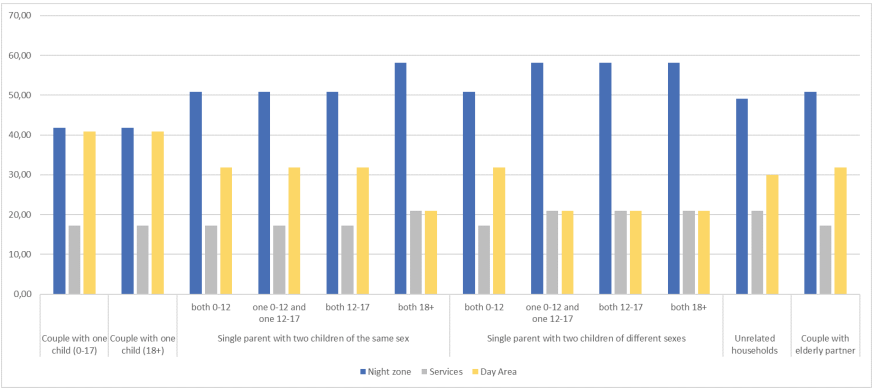

Fig. 8. Percentage of the distributional areas of the dwelling with respect to the surface of reference for the three-people households

5 Possible Measurements of Surfaces

Starting from the schematic considerations highlighted in the previous paragraph, it emerges that in the majority of cases there is the possibility of reconfiguring the dwelling starting from the surface to be destined to the living area. Let us consider as reference again the households composed of three users (Fig. 9).

		Reference surface (L.R.10-2014)	Master Room (mq)	Single Room (mq)	Double Room (mq)	Main bathroom + second bathroom (mq)	Distributors (mq)	K-P-S (mq)	Optimum surface
Couple with one child (0-17)		55	14	9		5,5	4	22,5	55
Couple with one child (18+)		55	14	9		5,5	4	22,5	55
Single parent with two children of the same sex	entrambi 0-12	55	14		14	5,5	4	22,5	60
	uno 0-12 e uno 12-17	55	14		14	5,5	4	22,5	60
	entrambi 12-17	55	14		14	5,5	4	22,5	60
	entrambi 18+	55	14	9 x 2		5,5	6	22,5	66
Single parent with two children of different sexes	entrambi 0-12	55	14		14	5,5	4	22,5	60
	uno 0-12 e uno 12-17	55	14	9 x 2		5,5	6	22,5	66
	entrambi 12-17	55	14	9 x 2		5,5	6	22,5	66
	entrambi 18+	55	14	9 x 2		5,5	6	22,5	66
Non-family related households		55		9 x 3		5,5	6	22,5	61
Couple with elderly partner		55	14 x 2			5,5	4	22,5	60

Fig. 9. Calculation of the most suitable area for households of 3 users in the various cases of family configuration

The surface of reference of the living area calculated for the "traditional family" (couple with a child), is 22.5 sqm, and it has been used to remodulate the surface of the dwelling for other types of households with three users. The percentage gap between the two surfaces in these cases is 9.1% for the single parent with two minor same-sex children, for the single parent with two opposite-sex under-12 children and for the family composed of several households (e.g., couple with cohabiting elderly); 10.9% for the households not related by family relationships; 20% for the single parent with two opposite-sex children, of which one over-12.

6 Summary of the Major Findings or Results of the Study

The multiple aspects emerged relate the families (in the wider sense) and the consequent living condition and involve contextually both the quality of the domestic space and its liveability. The ratio between the total surface of the dwelling and the users requires a thorough revisitation, both in terms of surface per person and in terms of the relation between domestic spaces. The research is in development. After obtaining aggregational cases of the households and quantifying the useful surface of reference, these studies will be applied to a real case. The follow-up idea sees a methodology of planning solutions which involve the remodulation of the dwellings surface in view of a social mix (with dwellings surfaces varying between around 45,00 sqm to around 100,00 sqm) to the structuring of a different economy in the organisation of the domestic space. All this presupposes a deep renewal in the Italian normative apparatus. In fact, the number of components of a dwelling appears to be extremely variable in the lifespan of a family as for times, ages, and sex of its components. This circumstance imposes a series of analyses and reflections on the aggregability of the environments and the functions since, as it has been remarked many times, it is not always possible to find a unique solution while dealing with diversified users in terms of age, sex, and variability in time. Therefore, we try to define a possible relationship between the sizing of the environment and the relation between the various domestic spaces in function of possible family configurations.

7 Conclusions

As previously highlighted, over the last years, the awareness of the importance of the dwelling's quality has noticeably grown [22]. The recent Covid-19 pandemic has highlighted the absolute need to rethink the living spaces focusing on some elements, under study, which would give a more adequate response to the contemporary way of living. The definition of an adequate domestic space to the current needs and to the rapid demographic changes is an extremely complex matter which is also inter-twined with obsolete normative parameters. It should be considered that the national norm in effect is that issued in 1975, which so far has not been updated. Therefore, an update of the standards is urgent also in light of the more cogent pandemic in progress. This should increase the measurements of some and propose the resizing of others, as for example the living area.

A possible solution proposed in the research illustrated in the paper is to provide case studies of technical building solutions able to overlap and integrate with the existing buildings and allowing the users to remain in their dwellings. Moreover, it is fundamental to have the right configuration or re-configuration of the external space. In the economic and popular buildings existing in the city of Bari, very often the limit between the domestic space and the external one (balconies or porches) is inexistent or insufficient. If present, it is abusively closed to widen the domestic surface and it is ascribed to variable functions. These spaces need a significative reconfiguration with the aim of enriching the life of the domestic space and at the same time propose a more efficient energetic consumption of the buildings. In this direction, the reconfiguration of the threshold spaces of the house might propose solutions which are deeply rooted in a Mediterranean

idea of dwelling. The trans-formative actions researched and only briefly mentioned in the paper (since it is still under study) are aimed at actions on the building heritage public which do not involve as unique solution its total demolition.

Acknowledgements. This essay takes its inspiration from some reflections treated within the thesis of the degree course in Construction Engineering-Architecture of the Polytechnic of Bari: Lucente, C., & Morelli, M., (2021). Una casa per tutti. Esigenze, spazi e standard abitativi nella casa post Covid-19. The present author has been the supervisor of the above-mentioned thesis and part of its contents refers directly to her research.

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S&S'21 Marine Plastic Pollution, Design & Circular Economy

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Abstract. Portugal is a country with a long maritime tradition and with a continuous process of extension of its continental shelf; however, to guarantee the sustainability of the oceans, it is necessary to implement mechanisms for cleaning the coast, as well as, the reuse of the collected materials, giving them a new purpose. The circular economy (EC) is currently one of the most discussed terms among scientists in environmental economics and one of the focuses of the European Union's Horizon 2020 strategy (Geisendorf and Pietrulla 2017).

According to this, our project, Blue Circular Postbranding Project, is a pioneering blue circular economy initiative in our country, Portugal, and has emerged as a way to not only tackle the excessive consumption of goods and reduce unnecessary waste while promoting awareness of environmental education with our partners, but also to remove tons of end-of-life materials and products from the ocean, namely fishing nets, and marine litter, to create new and sustainable products, "100% made in Portugal". To do that we've established a value chain and, together with our partners, we've developed a performance scheme that comprises the stages of marine garbage collection, transportation, dismantling, recycling, and creation of new products.

Keywords: Circular Economy · Marine plastic pollution · Ocean literacy · Sustainable consumption · Sustainable production

1 Introduction

Plastics are synthetic polymers that are commonly synthesized from fossil fuels, and there is a wide variety of products composed of plastic due to its ease of fabrication, chemical inertness, resistance to temperature and light, low cost, etc. (Shivika and Subhankar 2017). On the other hand, although plastic is an extremely versatile resource (Parliamentary Office of Science & Technology 2016), its durability also makes them highly resistant to degradation, which is a complicated problem to solve when plastic products become waste (Parliamentary Office of Science & Technology 2016). Therefore, indiscriminate disposal and accidental release of plastic into the ma-rine environment began to occur, resulting in a rapid accumulation of persistent marine plastic waste in the oceans (Parliamentary Office of Science & Technology 2016). This marine pollution by plastic has direct consequences on the environment and biodiversity, as well

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as on several industries, and represents a potential risk to food safety and human health (Barboza et al. 2019).

To address sustainable development, the concept of the Circular Economy is gaining traction and is increasingly seen as a complete or partial solution to these challenges (Geissdoerfer et al. 2018). The Blue Circular Postbranding Project develops work that aims to cover both the social field, involving fishermen in the collection of marine litter; as the establishment of partnerships between associations/institutions/companies with a view to the maximum minimization of plastic in marine ecosystems. To this end, the value chain involves, firstly, the establishment of various partnerships making possible, in this way, to promote a world with less waste by saving scarce raw materials, reducing waste disposal, and contributing to the environmental preservation of coastal and marine areas. With this type of economic system where it is possible to minimizes resources input, it is hoped that environmental impact can be reduced, without jeopardizing growth and prosperity (Geissdoerfer et al. 2018), and that's our goal with the project. The specific objective of this study is to contextualize the blue circular economy model and exemplify it through the illustration of the case of the Blue Circular Postbranding Project.

2 Marine Plastic Pollution and the Sustainable Developmental Goals

Marine plastic pollution (MPP) is an emerging environmental and socio-economic problem that originates mainly from terrestrial sources and that severely impacts the marine ecosystem and undermines the livelihood of biodiversity (Barboza et al. 2019). Plastics permeate the entire width and depth of seas and oceans, both close to well-developed coastal areas and in the most remote locations, decreasing the economic and social value of the oceans, especially in terms of fishing productivity and tourism (Fadeeva and Van Berkel 2021). Marine plastic pollution can be defined as "any persistent solid material, manufactured or processed that has been discarded, abandoned and eventually reaches the marine or coastal environment" (UN 2017, p.VII). Global plastic production in 2017 was about 335 million tons (Plastics Europe 2018) and 2014 estimates predict a doubling of global plastic production in 20 years (Ellen MacArthur Foundation 2016). Marine plastic pollution has consequences on the environment and biodiversity, as well as on industries such as tourism, shipping, and fishing, and represents a potential risk to food security and human health (Barboza et al. 2019).

At European Union (EU) level, the EU Water Framework Directive (60/2000/EC) and the EU Marine Strategy Framework Directive (2008/56/EC) include provisions on reducing pollution and marine litter, respectively. With the launch of the Circular Economy Action Plan, the European Commission committed to "adopt a strategy for plastics in the circular economy, addressing issues such as recyclability, biodegradability, the presence of hazardous substances in certain plastics and marine waste" (COM/2015/0614) (Brink et al. 2018). The international community has recognized marine plastic pollution as an important impediment to sustainable development (UNEP 2016), since at least 8 million tons of plastic are dumped into the oceans annually - which is equivalent to dumping the contents of a garbage truck in the ocean every minute (Ellen MacArthur Foundation

2017). If no action is taken, this numbers are expected to double by 2030 and quadruple by 2050 (Fadeeva and Van Berkel 2021).

At the United Nations (UN) General Assembly (2015, September), Heads of States and Governments agreed on 17 SDGs as framework for the 2030 Agenda for Sustainable Development. The '2030 Agenda for Sustainable Development' (Fig. 1) galvanized the unanimous global commitment to address the unsustainable use of plastic and MPP. Sustainable Development Goal (SDG) 14, 'Life below water', perseveres to conserve and sustainably use the oceans, seas, and marine resources for sustainable development. Some of the guidelines included in this objective 14 are the prevention and reduction of marine litter; limiting the impact of fishing on the marine environment and adapting fishing to the protection of species; promoting the protection, restoration, and sustainable management of marine and coastal ecosystems, as well as marine biodiversity; foster the local development of coastal communities; increase scientific knowledge, develop research and marine technology capacities, between others. The goal 14.1 deals specifically with marine litter by 2025: preventing and significantly reducing marine pollution of all types from terrestrial activities, including marine debris and pollution of nutrients.

Regarding objective number 12, it aims at 'Responsible consumption and production' and comprises numerous orientations, among which, the development of the circular economy with a focus on dematerialization, collaborative economy and sustainable consumption, product design, efficient use and enhancement of resources; the change in production and consumption models; the increase in global and sectorial collection, recycling and recovery rates for the different materials; the promotion of public, ecological and sustainable purchasing practices, among others.

Fig. 1. The 17 SDGs across the three spheres of sustainable development: biosphere, society and economy (UNEP 2021).

3 Blue Circular Economy

A circular economy can be defined as an economic model that aims at the efficient use of resources by minimizing waste, which strives for long-term value retention, based on reducing the need for primary resources, and producing products within environmental protection limits. A circular economy model has the potential to lead to sustainable development, while decoupling economic growth from the negative consequences of resource depletion and environmental degradation (Morseletto 2020).

According to the Ellen MacArthur Foundation, a circular economy seeks to rebuild capital, being it financial, manufactured, human, social or natural, ensuring improved flows of goods and services. To illustrate the continuous flow of technical and biological materials, the foundation drew a diagram of the system through the "circle of value" (Fig. 2) (Ellen MacArthur Foundation 2019).

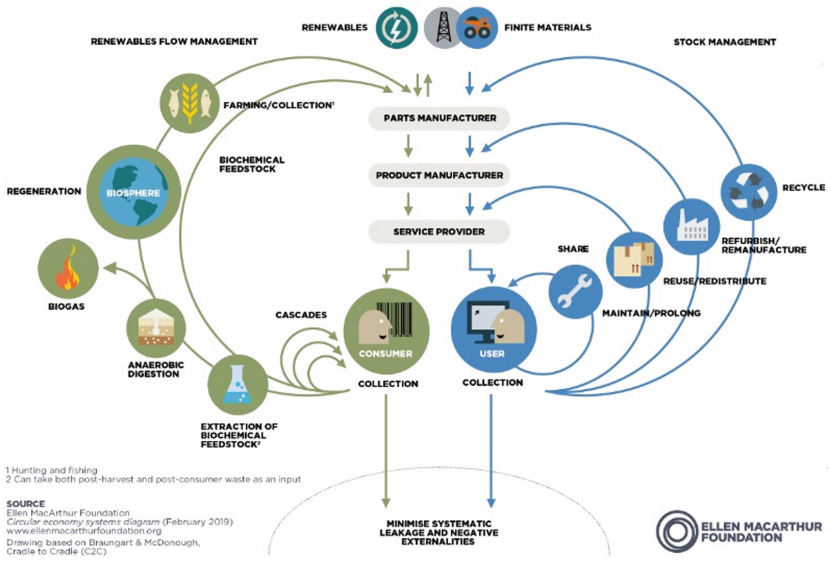

Fig. 2. System diagram through the Ellen Macarthur Foundation's "circle of value" (Ellen MacArthur Foundation 2019).

Circular Economy is increasingly seen as a possible solution to address sustainable development (Geissdoerfer et al. 2018). An economic system that minimizes resource input into and waste, emission, and energy leakage out of the system is hoped to mitigate negative impacts without jeopardizing growth and prosperity (Geissdoerfer et al. 2018). Combining the challenges of putting Circular Economy into reality and the practice-oriented approach of business model innovation leads to the concept of circular business models (CBM), a term used to describe business models that are suited for the Circular Economy by incorporating elements that slow, narrow, and close resource loops, so that the resource input into the organization and its value network is decreased and waste and emission leakage out of the system is minimized (Fig. 3) (Geissdoerfer et al. 2018).

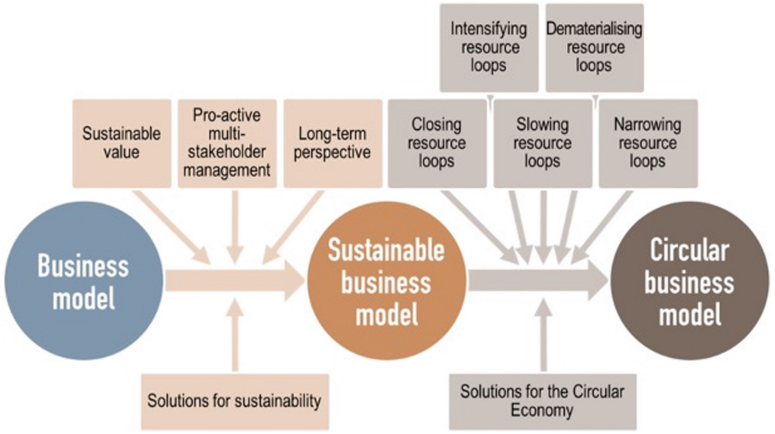

Fig. 3. Comparison of traditional, sustainable, and circular business models (Geissdoerfer et al. 2018).

The basic principles of the blue economy propose that the local environment, with its specific ecological features, is the basis for sustainable solutions. In total, the blue economy is defined by the following six principles (Geisendorf and Pietrulla 2017; quoting Blue Economy 2016).

1. It must be local so that companies use what they have close to them.
2. It should be efficient: Companies should "substitute something with nothing".
3. The surrounding nature is mimicked with a systemic approach.
4. The blue economy aims at profitable solutions through the optimization and generation of "multiple cash flows".
5. It should satisfy "all basic needs".
6. It calls for an innovative culture to create change.

Adding to this it is also important that the social criteria, such as employment creation, are desirable outcomes of an economic transition (Geisendorf and Pietrulla 2017).

With that in mind, we believe that the Blue Circular Post Branding Project (BCpbP) aligns with these principles, as we've created a value chain that power up the interrelation between fishermen that collect marine litter locally and Portuguese brands that take this debris and turn them into new products. Basically, we can say that it combines two strands: The Blue Circular Economy and the Regenerative Design as the last one aims at becoming completely waste free meaning that all materials or waste should be reintroduced into the system or metamorphosed into new valuable resources at the end of the product's life (Geisendorf and Pietrulla 2017).

4 Blue Circular pb Project: Project Description

> "Postmodernism points to a world in which the production of meaning has become as important as the production of labor in shaping the boundaries of human existence" (Aronowitz and Giroux 1993, p.116).

Everything is liquid in postmodernity, including brands. In our postbranding project raw materials are continually reinvented. Lifecycles are therefore circular and not linear.

The project covers different knowledge fields, from Design to Marketing & Communication to Industrial Engineering and footwear and cordage industry. It is guided by scientific standards towards innovative, sustainable, and commercially viable social and environmental solutions. BCpbP is an initiative advanced by the research unit UNIDCOM/IADE, managed by Universidade Europeia. The pilot project (December 2019 to June 2022[1]) is currently at its pre-commercial phase, which is to say that the first months have been used to strengthen our business linkages with our partners, while finding other entities in the country that may help us in scaling up. Besides, the first year has been for litter removal (fishing nets and plastics) and thorough analysis of the collected materials. Only by doing we're able to understand what can or can't be recycled and how.

The founders of the project are deeply involved in the business operations as they act as both the scientific coordinators and managing directors of the daily operations of the project[2]. BCpbP is headquartered at Ericeira Business Factory, where it was presented in November 2019. In July 2020, it was officially launched in Cascais. The project involves the ports of both towns, with the support and the consent of the regional port authority (Cascais) and the Municipalities of Cascais and Mafra, and we work in cooperation with local fishing communities and NGOs (namely, Brigada do Mar and ALP, Ajude a Limpar a Praia).

We have received funding by A2S, a local organisation funding sustainable development program, and MAR2020[3]. We are also looking for further funding opportunities to start operating in other ports. In case we can receive more funding, as well as establish a strong supply chain, we wish to employ more human resources and invest in R&D. We wish to create jobs in the blue economy sector in the country and expand throughout so that we can scale up.

Logistics are a big part of our project as it involves a wide variety of stakeholders. The management of the logistical chain is the main challenge that our project faces, as we need to guarantee that (i) there are enough collected materials to recycle, or otherwise companies may not be interested in the project as it would be too costly; and (ii) our

[1] The project with the code MAR-04.03.01-FEAMP-0294, approved in the scope of the MAR2020 Program, on behalf of European ID - Association for Research in Design, Marketing and Communication managed to get in November the extension of its deadline, until June 2022.

[2] The founders are Prof. Carlos Duarte (PhD in Production Engineering/University of Beira Interior) and Prof. Isabel Farinha (PhD in Sociology/ISCTE-IUL). Prof. Rui Miguel takes part in the project since the beginning as a senior researcher (PhD in Textile Engineering/University of Beira Interior).Mafalda Gil de Carvalho (BSc in Biology. Is currently taking a master's degree in Marine Sciences at the Faculty of Sciences of the University of Lisbon) has joined the Maritime Space Research & Innovation Project as the project manager.

[3]

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partners have the technical and scientific means available to dismantle, recycle and create new products.

Besides, it is clear that the project faces three additional challenges: (1) the transportation from A to B and the storage of the collected materials (fishing nets and marine litter); (2) fierce competition from eco-companies, especially designers and that have put forward products that already use litter from the sea (e.g., fishing nets), though the yarn is imported; (3) and low-cost products available in the market that come from countries with cheaper labour costs and rather poor environmental standards. To deal with market competition, we aim to develop raw materials made nationally. Therefore, we will invest greatly in the label "Made in Portugal", so that consumers choose to buy products fully made in the country for a similar price.

4.1 Blue Circular Postbranding Project (BCpbP): Mission and Aim

Our project is a clear-cut example of a blue circular economy approach. On the one hand, we aim to tackle the excessive consumption of goods and reduce unnecessary waste while promoting awareness of environmental education with our partners. On the other, we wish to remove tons of end-of-life materials and products from the ocean, namely fishing nets, and marine litter, to create new and sustainable products.

We aim to set-up a robust supply chain that, through a wide variety of stakeholders, from fishermen and respective communities, to companies, research units and NGOs, that is capable of (i) creating value from waste while facing the ocean as an opportunity, and (ii) promoting sustainable Design alternatives to current consumption patterns, while promoting awareness on the sustainability of the oceans. The project is in line with the 'European Strategy for Plastics in a Circular Economy', which aims to transform the way plastic products are designed, produced, used, and recycled in the EU.

By acknowledging the accumulation of plastics in the ocean as a big problem as the plastics can actually even turn into micro plastics and affecting, not only, marine animals but even human health, the Blue Circular pb project aims to promote the production of durable articles with environmental, social, visual and conscious consumption impacts, from marine waste, as well as to encourage a transparent and integrated process of circular economy enhancing socio-economic development based on the principle of "I buy what's ours" and enhancing sustain-ability, based on an ethical and creative design process focused on a high standard of quality and environmental awareness, based on the transmission of idea that, under a transparent process, there is life in the plastic collected from the oceans, (re) transforming it into new products (Fig. 4).

As for the project's objectives, these are based on transmitting the idea that, under a transparent process, there is life in the plastic collected from the oceans, (re)transforming it into new products.

4.2 Blue Circular pb Project: Value Chain

We see waste both as a valuable opportunity for the socio-economic development of poorer communities along the coastline, and as an eco-solution to the massive issue of marine pollution. The BCpbP, within a blue circular economy approach, which involves academia, the fishing community, civil society, the political and business sphere, has

Fig. 4. BCpbP blue circular economy process (own elaboration).

as its goal the metamorphosis of daily discarded garbage into something new and with value capable of promoting conscious and globally sustainable consumption.

Our project started as a pilot-project in Ericeira and Cascais (captaincy of the port of Cascais). For the collection process, the pilot-project has as partners the "Fishing for a sea without litter" project (Fig. 5), from the national authority on port infrastructures (Docapesca Portos & Lotas) and the non-profit/non-governmental organization Portuguese Association of Marine Debris (APLM) started in 2016. With a view to improving waste management they on board fishing vessels; sensitize and support fishermen in adopting good practices; and improve environmental conditions of the coastal zone and preserve the marine ecosystems. In short:

- Docapesca/APLM - decided to provide containers to fishermen so that they can collect marine litter during their fishing activities. Fishermen later deposit the waste in the Ecopoints for various plastic materials (Fig. 5) or separately in the Ecopoints for fishing nets and ropes (Fig. 6);

Fig. 5. "Fishing for a sea without litter" project for Marine Litter/Docapesca Portos & Lotas (Source: http://www.marsemlixo.com/)

Fig. 6. "Fishing for a sea without litter" project for Nets/Docapesca Portos & Lotas (Source: https://www.ericeiramag.pt/blue-circular-promove-accao-ambiental-na-praia-dos-pescadores/)

- BCpbP boosted this partnership with Docapesca by wanting to breathe new life into end-of-life fishing nets (Fig. 6). For this purpose, sorting deposits were created in the fishing ports of the Cascais Captaincy (Fig. 7). It is expected that the fishermen, when they reach land, deposit the damaged fishing nets in our containers, which are water deposits that were no longer serving any purpose and were reused for this end, so we are able, in this way, to guarantee the Complete Circular Economy process (Fig. 8);

Fig. 7. Maritime Ecopoint at Cascais fishing harbor (own elaboration)

Fig. 8. Container for fishing nets at Cascais fishing port (own elaboration)

- Big Bags, when full, are collected at the port of Cascais with the support of the municipality and Cascais Ambiente and stored there; at the port of Ericeira with the support of the Mafra municipality and stored in the Ecocentro in Ericeira.
- The Big Bags are then sent to Tratolixo in Trajouce. Tratolixo (a certified intermunicipal company 100% owned by AMTRES - Association of Municipalities of Cascais, Mafra, Oeiras and Sintra for Solid Waste Treatment) is our partner for analyzing the collected material and for storage;
- For the transportation process we are counting on a big supply chain due to their social responsibility program (Jeronimo Martins).
- The dismantling process is done by an industry in Braga, in the north of Portugal;

- Regarding the transformation process, we are counting on Zouri (Fig. 9). A Portuguese handmade brand started in January 2019. This eco-vegan footwear brand emerged from the desire to create something with impact and actively contribute to environmental protection, namely the problem of plastics in the oceans. Thus, the brand decides to integrate plastic waste collected lengthwise the Portuguese coast, along with other ecological and sustainable materials, in its various footwear products. Zouri produced 10.000 pairs of shoes until today, the equivalent to 80.000 bottles of plastic. The brand is delivering worldwide and is represented in 13 countries.

Fig. 9. Shoes produced by Zouri, with ecological and sustainable materials (Source: https://www.zouri-shoes.com/)

In short, to follow a blue circular economy model, it is essential that the most varied organizations and brands are willing to collaborate with each other, so that all parties are on the same page towards a future with less plastics and more solutions and innovative products made from end-of-life marine plastics. Indeed, sustainable development aims at satisfying current needs without harming future generations' ability to satisfy their needs, while considering imitations in the Earth's resources in face of human development, as well as synergies and trade-offs between economic, environmental, and social goals (Geissdoerfer et al. 2018).

5 Conclusion and Forward Steps

To respond to the accumulation of marine litter, the Blue Circular Postbranding Project aims to promote the production of durable articles with environmental, social, visual,

and conscious consumption impacts, from marine litter. The project is in line with the 'European Strategy for Plastics in a Circular Economy', which aims to transform the way plastic products are designed, produced, used, and recycled in the EU. We also believe that litter is a Design error and that linear models will be replaced by circular economy initiatives, particularly Cradle to Cradle. We are strongly committed to conscious consumption and deeply motivated to push recycling and especially upcycling initiatives forward, so that fewer resources aroused. BCpbP sees waste both as a valuable opportunity for the socio-economic development of poorer communities along the coastline, and as an eco-solution to the massive issue of marine pollution.

We are committed to reaching a solution that, through R&D, can transform disposable materials into recycled yarn, without lowering both high-quality manufacturing standards and aesthetics. The main outputs of our project are both scientific and commercial. The scientific outputs will be in maritime affairs and will promote R&D in ocean-related areas, such as: ocean literacy, best practices' handbook, BCORP certification, blue circular economy workshops, academic conferences on the economy of the sea, scientific articles in the fields of Design, Textile engineering, etc.

We aim to promote knowledge sharing in academia on environmental & ocean-related issues and sustainable practices to reach sound scientific results and relevant tested hypothesis, while sharing the results with local communities and the general public through mass media. Through our network of colleagues and academic institutions we will be able to challenge current consumption patterns, promote the conservation of the oceans and the cultural heritage of the Portuguese communities along the coastline. In addition, we will set-up a laboratory so that collected materials are studied. Once our supply-chain is established (i.e., from recovering materials to separating, converting, and manufacturing them, to designing new products), we envision to collabo-rate with the suppliers of different industries, such as of shoes, fishing nets, among others.

Our acquired knowledge in Marketing and Communication will let us reach out to different targets through multiple strategies (B2C, B2B – NGOs, industries, etc.; others – digital marketing). The SOSTAC methodology will allow to develop the cardinal points of the communication proposal of this project with the purpose of a call up to this environmental cause. In short, the synthesis of promoting this cooperation between public and private entities and the joining of efforts, allow a better understanding of the problematic theme of plastics in the ocean and the desired mitigation of them. Furthermore, this union is also the starting point for the blue circular economy approach, which is necessary to resolve the issue of excessive consumption of goods.

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Critical Transition: Merging Approaches Toward Sustainability

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Abstract. This paper suggests that merging Critical Design and Transition Design approaches might mutually complement them and increase their efficiency in inducing change. The discourse departs from acknowledging the necessity for a large-scale transition towards sustainable lifestyles. It recognizes as problematic the current mainstream design approaches that are focussed on immediate problems and 'technological fixes' within the dominant socio-economic paradigm. The emerging Transition Design is a promising step towards tackling transition as a systems-level issue, and towards conception of entirely new lifestyles. Critical Design is already recognized as a useful tool within one stage of the Transition Design – the visioning. In this paper, however, the two design approaches are shown to have considerable similarities and hence their relationship could be expanded. Critical Design could productively contribute also to adopting a different mindset, proposing other values, and in facilitating research and participation.

Keywords: Critical Design · Transition Design · change · sustainability

1 Transition, Sustainability and Sustainment

We live in times of the "great transition" (Manzini, 2015b, p. 2). Western societies are beginning to realize that there is need for change in order to save the planet and maintain our well-being. In their 1972 project on the predicament of mankind, Club of Rome defined the most pressing issues of our time, warning that the resources of our planet pose limits to the economic growth we have been pursuing in the preceding decades (Meadows, et al. 1972). However, now 50 years later there is still no shared understanding of how to tackle this situation: solutions vary in the range from the traditional 'technological fixes' to regulations and standards, to social entrepreneurship and individual commitments to live more sustainably according to one's conception of sustainability. Manzini compares the scale and the character of this process with the changes that Europe underwent in the transition from the feudal civilization to industrial urban society (Manzini, 2015b, p. 2). There are changes on both local and global level, in culture, economics, politics and technologies, with different parallel regimes conflicting with each other in attempt to either support or oppose the transition.

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Despite the rising societal awareness and even actual transformations on the ground, design professionals largely avoid considering design as an agent capable of contributing to this change and instead continue to support unrestrained consumerism (Fry, 2017, p. 99). There is no consensus on prerequisites of sustainability and respectively – on how to design sustainably. Even the most frequently quoted definition of sustainability – "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland and Khalid, 1987, p. 54) – contains several significant shortcomings. Firstly, it is still closely linked to economic growth, secondly, this definition of sustainability is anthropocentric and ignores the interdependence of all life forms, and thirdly, it does not take into account the extreme socio-economic inequalities (and the associated incomparable environmental damage caused) that remain unresolved already today, not to mention some abstract future generations. (Fry, 2009, p. 42).

Considering this ambiguity of definitions, Fry suggests entirely new naming associated with a new conception of sustainability. He also introduces the term 'defuturing', which is intended as a "conceptual tool needed to define the unsustainable and identify how it takes the future away" (Fry, 1999, p. IX). It describes the actual state of affairs, including the mainstream limited idea of sustainability. As an alternative to the "discredited rhetoric of Brundtland-style 'sustainability'" Fry suggests the term 'sustainment' and argues that it "will not occur of itself; it can only occur by design" (Fry, 2009, p. 45). Furthermore, the practice of design needs to undergo a significant change in its economic and cultural role in order to support the sustainment.

In relation to his aforementioned historical comparison Manzini identifies three main regimes that coexist at this moment: Regime1 with its mainstream 20th century economy of scale and a product-oriented well-being; Regime2 with its emerging winner-takes-all economy and an individualized service-oriented well-being; and the Regime3, in which limits of the planet are recognized in conceiving and realizing new kinds of ideas, practices and networks – small, open, connected, localized and resilient. This is where also a new design culture emerges (Manzini, 2015a, p. 58).

2 Design for Sustainment

With this intention – to seek ways in which design can contribute to systemic and definitive change towards sustainment, a new approach to designing was conceived in 2015 by a group of like-minded scholars at the School of Design, Carnegie Mellon University. This new approach, named Transition Design, acknowledges that we live in transitional times, and is based on the premise that there is "need for societal transitions to more sustainable futures and the belief that design has a key role to play in these transitions" (Irwin, Kossoff, and Tonkinwise, 2015, p. 4). It is seen as four interrelated and mutually reinforcing areas of knowledge, action and self-reflection: visions; theories of change; mindset and posture; and new ways of designing. Advocates of this new design approach believe that the whole society, including designers, needs to reconsider its expectations and assumptions, and set new goals accordingly in order to achieve the necessary change. They urge designers to revise their mindsets and adopt a new paradigm in design to discontinue the defuturing effect.

Another, more established design approach, called Critical Design, emerged in the 1990s at the Royal College of Art, London. Although not intentionally related to sustainment, it also aims at challenging narrow assumptions and preconceptions, and disrupting the status-quo. By use of design proposals that are fictional and provocative, in form of objects and their use scenarios (often depicted in photographs and videos) Critical designers attempt to raise awareness, expose bias and provoke discussions on the role products play in everyday life (Raby, 2008, p. 94).

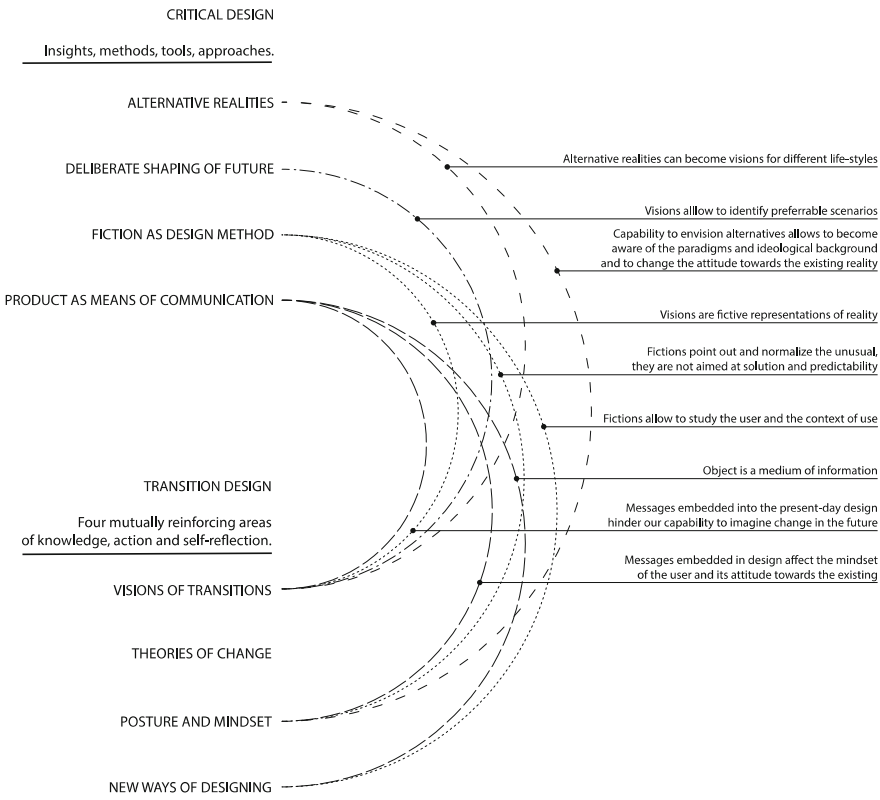

Fig. 1. Points of overlap or continuity between the insights, methods tools and approaches of Critical Design and the four mutually reinforcing areas of knowledge, action and self-reflection of Transition Design. The left side of the scheme shows certain concepts and insights discussed in preceding body of literature on Critical Design and Transition Design, while the right side of the scheme is the contribution of the author, identifying the points of overlap or continuity.

However different they might seem, there strong overlaps between Critical Design's and Transition Design's objectives and methods. Both are deliberately aimed at challenging the capitalist mindset, conformist values, consumer culture and related phenomena, and are determined to tackle them as a disciplinary issue addressing also the design community. Becoming aware of these overlaps opens up new opportunities for further practical and academic research on the wider integration of the two design fields. This

paper identifies and discusses these similarities and proposes a synthesis of the two design approaches. The findings are represented visually in the Fig. 1 designed by the author of this research.

3 Learning for and Through Design

This proposition of this paper departs from the perspective of Critical Design, as the author's previous research has allowed to conclude that this design practice offers designers opportunities for learning and emancipation. That is also the motivation for suggesting integration of Critical Design into the Transition Design approach, as it could similarly contribute positively to the self-awareness of the practitioners of Transition Design.

Critical Design was largely conceived and developed in an educational safe space – open for experimentation and free from market constraints. Although in certain cases it has also found instrumental application within commercial context, Critical Design is still predominantly practiced as a specific form of exploration and cognition. Its products are recognized as providing new knowledge in themselves – "a kind of tacit knowledge creative professionals possess which cannot be separated from their perception, judgement, and skill" (Seago and Dunne, 1999, p. 16). Critical designers seek for new ways to expand design's innovative potential, even if it entails unorthodox methodologies, such as 'design-centred' approach (as opposed to 'user-centred'), "as a way to help potential users see possibilities beyond those they already know" (Dunne and Gaver, 1997, p. 362). Critical practices are being used to build intellectual basis for design, and to promote its theoretical development through and from within design practice (Mazé and Redström, 2009, p. 28). Critical Design has already been integrated into curricula and design research spaces assuming the role of a research method (Boserman, 2019, p. 125). These practices also allow for disciplinary criticality: on the individual level – in relation to the practitioner and their own effort to become self-aware or reflective (Mazé, 2009, p. 389), serving as "a professional ethical stance for designers" (Bardzell and Bardzell, 2013, p. 3298); on meta-level as a kind of "criticism from within" engaging in "ideological or intellectual" questions of design (Mazé, 2009, p. 391); and as a medium to express critique of other issues in society (Mazé, 2009, p. 395).

Critical Design approach gives designers the opportunity to consider our world through different paradigms. This capability to envision alternatives to the mainstream Western capitalist worldview is a crucial prerequisite also within the framework of Transition Design. However, that is not enough, – designers also need to become aware of the "historical forces that have created the context in which design has emerged as a particular kind of delimited practice" (Willis, 2015, p. 73). That implies understanding the principles of many other fields of Humanities, at the same time not seeing those as a kind of 'complimentary studies' or appropriating them instrumentally, but instead, finding new ways to connect them with design (Willis, 2015, p. 73). It is also necessary to comprehend the process that Willis has named the 'ontological designing' or the relation between people and their material environment. In this theory she points out that design is far more pervasive than it is generally recognised, and that we are influenced by the process of designing as well as by the product of our design, without even realizing that (Willis, 2006, p. 80).

To conclude, Critical Design practices can provide new insights to complement Transition Design approach, but knowledge from other fields of study is crucial to build awareness, facilitate self-reflection and adoption of new paradigms.

4 Similarities Between Critical Design and Transition Design

This incentive to propose merging two seemingly very diverse design approaches is grounded in the following conditions. Firstly, Transition Design framework already includes indications to Critical Design approaches as possible tools for 'Visioning' – one of the four areas of knowledge, action and self-reflection (Irwin, Kossoff, and Tonkinwise, 2015, p. 8). Scholars behind the Transition Design concept are convinced that uniting different parties under shared future lifestyle visions can be a much more powerful motive for change than the traditional design approaches, which would focus on forecasting possible technological solutions (Irwin and Kossoff, 2017, p. 10). These visions need to be made tangible by means of design in order to be appealing, and they also need to be based on signs in the present that look promising, instead of showing futuristic things 'never seen before' (Manzini and Jégou, 2003, p. 17). Another kind of visions that are suggested as potentially useful and stimulating are the ambiguous or even the clearly dystopian Critical Design proposals: they "can serve as measures against which to evaluate design moves" (Irwin, Kossoff, and Tonkinwise, 2015, p. 8); and as "cautionary tales warning us of what might lay ahead if we are not careful" (Dunne and Raby, 2013, p. 73). Critical Design also offers space for debate about how things might be fundamentally different. Critical artefacts help to suspend disbelief, as they are grounded in reality – in how people are and behave, – but they propose other values, which are communicated through these objects. This approach is accordingly called 'value fiction' (Dunne and Raby, 2001, p. 63), and it has been acknowledged as potentially useful in shaping policy planning, market economies and cultural imaginaries, by means of preferences, norms and ideals embedded in these scenarios. Design visions can render "previously textual analyses (such as policy scenarios) and abstract concepts (such as "sustainability") in forms available for empirical (i.e. bodily) experience and public deliberation" (Mazé, 2019, p. 24). It is hence possible to conclude that visioning is broadly recognized in design as a useful method or tool for public engagement, and that Critical Design visions can provide space for revising values, beliefs and preconceptions, which hinder transition to sustainment.

However, reducing Critical Design to merely a tool for vision generation is a narrow view, considering its other qualities, which present a considerable overlap with the Transition Design theory. Their identification is the second reason behind the incentive to merge Transition and Critical Design approaches. The aim of this paper is to highlight these similarities and to suggest that Critical Design might be seen as a method within a broader scope of design towards transition.

4.1 Alternative Values

As already introduced in the previous section, visions are not only about 'showing' and 'experiencing' how things might be in the future, – visions are always associated with

values and are made primarily to propagate those values. Furthermore, visioning is not something only Critical or Transition designers do. Traditional industries also widely implement visions, mostly in form of video scenarios promoting future products, which are imbued with corporate values and aimed at promoting consumerism, – "perfect worlds for perfect people interacting perfectly with perfect technologies" (Dunne and Raby, 2013, p. 28).

The objective of the Transition Design visions is to suggest alternative values and even alternative economies. Transition Design is proposed as further development of design approaches in a continuum where it follows Design for Service (which is based within business and dominant economic paradigm) and Design for Social Innovation (which aims for emerging paradigms and alternative economic models). Transition Design is supposed to implement speculative, long-term visions of sustainable lifestyles in order to fundamentally challenge existing paradigms, and to envision new ones (Irwin, 2015, p. 231). It is clear that technologies will not save the world, nor solve the pressing ecological and social issues, and hence it can be more productive to address our way of being in this world, our values and expectations, instead. But this is also one of the greatest challenges, as we all, including designers, are strongly conditioned by the dominant paradigm, to the point that we are not even aware of that. Our values are also shaped by our personal and collective histories, memories and experiences, and this context influences our understanding of reasonable and fair expectations.

This resonates strongly with the basic principles of Critical Design, which is aimed at challenging dominant ideologies: it acknowledges that all design is ideological unless the designer deliberately takes a critical stance towards the status quo. Critical Design therefore is aimed at providing critique of the dominant ideologies and exploring alternative social, cultural, technical or economic values (Dunne and Raby, 2001, p. 58). Furthermore, it is an emancipatory act, rather than an ideological one, because Critical designers "attempt to liberate themselves from all ideologies, as these impede seeing beyond what currently exists, in the conviction that this is the only possible, viable or right way to be" (Jakobsone, 2019, p. 566). Critical Design poses critique of design that enforces and works "'in service' to any imposed ideology" (Mazé and Redström, 2009, p. 30).

Critical Design is also aimed at exploring how could the purview of the discipline be extended and what could be addressed beyond the fiscal and technological drivers (Malpass, 2012, lpp. 226). Designers practice Critical Design as a means of developing a personal understanding (Malpass, 2012, p. 163), which means that it can be particularly useful as part of design curricula. The ideological awareness, along with its emphasized focus on futures have been recognized as some of the most valuable qualities of this practice, which would benefit considerably any kind of design approach if adopted as part of a critical mindset (Jakobsone, 2017, p. S4254). Critical Design proposals offer alternatives to the current way of being, thus allowing us to relativize the present reality and consequently to think more deliberately about our own existence and agency (Jakobsone, 2019, p. 566).

All this suggests that there is a clear overlap between the objectives of Transition Design and Critical Design, and that the latter can be proposed as a method or tool to be implemented in the framework of the former, both for learning to reconsider one's

own values and place in this world, and for creating compelling alternatives for public engagement.

4.2 Mindset and Posture

One of the four elements in the Transition Design framework is named 'Mindset and Posture'. It "calls for self-reflection and a new way of 'being' in the world" and acknowledges that "our individual and collective mindsets represent the beliefs, values, assumptions, and expectations that are formed by our individual experiences, cultural norms, religious/spiritual beliefs, and the socioeconomic and political paradigms to which we subscribe" (Irwin, 2015, p. 235). This excerpt shows strong similarities with what was discussed in the previous section of this paper, but also with Critical Design literature in general, which tackles extensively the same issues, and urges designers to adopt a critical mindset. One could even argue that this is one of the main objectives of Critical Design, – offering 'strangeness' to allow us to reconsider the 'normality', and to realize the relativity of what we assume to be absolute and universal.

The dominant mindset in conventional design is described as striving for predictability and control. It views chaos as problematic and attempts to 'fix' it by design solutions that are pre-conceived and implemented in a top-down manner. Ambiguity and uncertainty are also considered undesirable and seen as a problem to be addressed. In contrast, the new mindset or worldview of Transition Design is intended to remain open and willing to acknowledge that the perceived chaos might also be an essential characteristic of the system and contain 'seeds' for the solution. This new mindset also needs to embrace ambiguity and uncertainty as possible sources of new ideas and ways of acting (Irwin, 2015, p. 236).

A similar attitude is present also in Critical Design, which is defined as "a response to the fact that design views its users and consumers as obedient, largely uniform, and predictable whereas nearly every other area of culture acknowledges people as complicated, contradictory and even neurotic" (Raby, 2008, p. 95). Ambiguity in critical practices is considered to have advantages: it allows designers to engage users without constraining how they might respond and to enable them to find their own interpretations (Gaver, Beaver, and Benford, 2003, p. 233). Speculative projects by Dunne and Raby (such as 'Hertzian Tales' and 'Designs for Fragile Personalities in Anxious Times') or Noam Toran (such as 'Desire Management' and 'Object for Lonely Men'), just to name a few, also show interest in the complicated nature of people and challenge the stereotypical and narrow user profile adopted by the mainstream industries. In these iconic Critical Design projects designers have conceived fictional products that embody "understanding of the consumer/user as a complex existential being", and that accept "how people really are rather that how they are supposed to be" (Dunne and Raby, n.d.). These works also hint at the innate creativity, which allows people to find the weirdest solutions to satisfy their desires instead of conforming to the dominant paradigm.

Critical Design, since its conception, has largely been about attempting to assume a different point of view, to consider alternatives, to cease being judgemental and biased. It has tried to find a role for design that is less dependent on the technological development and capitalist market economy. Considering that, Critical Design's mindset and approach

is very similar to that of the Transition Design, and a designer who has exercised the former could relatively easily embark on the latter, contributing to the great transition.

4.3 Goals

Transition Design and Critical Design both have approaches that are fundamentally different from those of traditional design practices. Instead of studying the context in order to offer the best solution within the given situation, both are set to change the society's attitude to the current state of affairs. Transition Design challenges the mainstream understanding of development and well-being. By adopting a new mindset, it attempts to direct our expectations away from the satisfaction of consumerist desires, while also trying to 'save the planet', and to guide us towards more sustainable lifestyles. For the designers it means abandoning the solutionist approach that is based on searching for problems (real or imagined) and rather focus on complex overarching lifestyle visions that would tackle the root of unsustainability and defuturing. In comparison, Critical Design also challenges assumptions, norms and habits, and explores the complexity of human nature: our dreams, desires, fears and insecurities. Furthermore, this enlightenment remains its only 'functional' contribution as for the rest it is not aimed at providing solutions to practical problems.

Central to the Transition Design is the notion of 'wicked problems' – ill-defined societal problems that rely upon an elusive political judgement for solution (Rittel and Webber, 1973, p. 160). Although this concept has been known already since the 1970s, design and design education has not been particularly engaged in understanding these problems, nor the dynamics of change within complex systems in general (Irwin, 2015, p. 242). As a result, designers fail to grasp the extreme interconnectedness of smaller problems, which they approach as isolated cases, eventually causing much more serious problems elsewhere.

Wicked problems are characteristic to complex systems, such as societies or ecosystems, hence before tackling the problems, one should get familiar with systems in general. Meadows's study "Leverage Points: Places to Intervene in a System" (1999) provides a simplified and useful insight into how systems function and how can change in systems be induced. She identifies 12 elements of the system (the 'leverage points') where one can intervene and arranges them according to the effectiveness in changing the system. The top most effective points in this classification are 3) the goals of the system; 2) the mindset or paradigm out of which the system arises; and 1) the power to transcend paradigms (Meadows, 1999, p. 3). That means that when the goals of the system are set, all the other elements further down the list will be changed to achieve that goal (Meadows, 1999, p. 16). However, according to Rittel and Webber, the scholars behind the concept of wicked problems, setting goals can be one of the most challenging tasks of planning (Rittel and Webber, 1973, p. 157). Furthermore, also separate elements of the system have their own goals, and mostly these tend to be confused with the whole-system goals, as even people within the system often don't recognize what whole-system goals they are serving (Meadows, 1999, p. 16). In case of design, for example, one might be working on an innovative solution thinking that they are serving the society, without realizing that their products are simply a way of increasing stockholder wealth and market share – a goal of a larger scale system.

Setting goals is a crucial part of the process also within the Transition Design, especially since finding the cause (and consequently – a solution) of a wicked problem is difficult if not impossible, because every wicked problem can be considered to be a symptom of another problem (Rittel and Webber, 1973, p. 165). Furthermore, these problems involve whole societies, and different stakeholders often have conflicting agendas – solution to someone's problem causes a new problem to someone else. Therefore, participative design processes are necessary to find compromises and to develop visions that work for everyone (Irwin and Kossoff, 2017, p. 9–10), as participation in design implies that a solution is sought in collaboration between the designers and users (or those affected by the intervention). This approach is particularly efficient in realising shifts in organisational cultures, when the members of the organisation are also the "users" of the solutions thus developed (Dust and Jonsdatter, 2008, p. 291).

As discussed in the previous sections, visioning is an integral part of Critical Design, and the purpose of these visions is the provocation and the debate it initiates. In contrast, Transition Design aims at setting common goals for societies that are facing wicked problems and it implements visions in formulating these goals. It is thus possible to suggest that the two approaches might benefit from each other also in this higher goal setting endeavour.

Critical designers have tested and analysed tools and methods for creating plausible and engaging visions of alternative worlds for almost three decades now. These methods have been successfully implemented also in participatory design processes, in combination with role-playing, fore- and back-casting and other more traditional design methods, allowing designers to move beyond the typical approaches to sustainability, which tend to "privilege the current needs of proximate stakeholders within near-future proposals" (Mazé, 2019, p. 29). Specific to Critical Design is the use fictional things that are "not understood as ends in themselves but, rather, as a means to curate and stimulate reflection within and among stakeholders" (Mazé, 2019, p. 33). They are "materializations of questions that can only be answered collectively and from the heterogeneity of positions" (Boserman, 2019, p. 135). Fictional design products have also been adopted as tools for research and exploration of stakeholders and potential users, in which case designers confront them with skilfully crafted, realistic but somewhat strange products in order to engage in discussions and gain insight. These things, called cultural probes (Gaver, Dunne, and Pacenti, 1999), epistemic objects or diegetic prototypes, are "research objects that are sufficiently vague and indeterminate to allow discovery" (Boserman, 2019, p. 134).

It can hence be concluded that Critical Design approach could become an instrumental part of Transition Design during the participative engagement with stakeholders, whether it is to discuss possible futures or to investigate their values and beliefs. Both applications could add another critical dimension to the process of goal-finding.

5 Conclusions

Design in the midst of transition requires new approaches, tools and attitudes. Unfortunately, it can be observed that there is no global consensus on what sustainability means, nor is there a common understanding on how to tackle that from the design perspective.

However, signs of an emerging culture are appearing in different areas of design. These practices are aimed at changing the way we live and reshaping our expectations, instead of adapting the world to our perceived consumerist needs. Recently conceived Transition Design approach is one of these promising movements.

Critical Design – another alternative to the mainstream design – has been developing for almost three decades now. Although not directly associated with sustainability, it also seeks to challenge narrow assumptions and to query the role of industrial products in our life. Critical Design has a close connection to academia – it emerged in an academic context, it offers space for investigation and research, and it allows for a particular kind of professional and personal enlightenment.

Although seemingly different, these two design strands present meaningful overlaps. Transition Design framework proposes Critical Design as a tool for visioning; however, it is possible to identify some other similarities, too:

- This paper has exposed how both seek for alternative values and imagine other ways of living in this world. Both also aim at acknowledging the existing societal complexity and diversity without being judgemental and biased.
- Further, there are also similarities in the mindset and posture that Transition and Critical designers assume. They remain open to ambiguities and uncertainties of real-world situations, embrace 'strangeness', and move away from seeing people as obedient consumers.
- Focus on setting appropriate goals, instead of immediate problem solving (especially by use of technology) is at the core of Transition Design. According to the systems theory, this is also one of the most efficient ways to achieve fundamental change in a system. Critical Design, as already ascertained, can be an effective approach in visioning and fostering debate, which is a crucial part of goal finding process. It has also proved to be a useful tool in facilitating participative generative processes.

It is also possible to observe that some of the precedent or current design projects already demonstrate more or less outspoken signs of such integration. A clear intent at implementation of the speculative approach of Critical Design as a method to reflect on more sustainable futures is present in 'Static!' and 'Switch!' – two research programs carried out at the Interactive Institute of Sweden tackling the issues related to the energy consumption. Ramia Mazé, one of the researchers behind these programs, acknowledges, that "sustainable and critical design might seem to be at odds" (Mazé, 2008, p. 44) as the Critical Design practice has mostly "been confined to galleries and books, rarely moving outside the ideological modes of production in the art and the media" (Mazé, 2008, p. 47), while the sustainable design is practically trying to solve pressing global problems. At the same time Mazé notes that "sustainable and critical design intersect in contesting – rather than affirming or acquiescing to – mainstream or traditional notions of production and consumption" (Mazé, 2008, p. 44).

All the aforementioned allows to conclude that merging Transition Design and Critical Design approaches might increase their efficiency in promoting change. The changes needed to achieve sustainment (as opposed to the various arguable interpretations of sustainability currently in use) and to discontinue defuturing, are much more comprehensive and radical than those which are aimed for by the most conventional design approaches.

The first steps to be taken before starting to solve concrete specific problems by designing products or services, ought to be critically assessing the values, adopting an appropriate mindset, and setting the goals respectively. At a practical level, however, this doesn't mean that designers should only focus on systems-level solutions, as all the aforementioned is equally relevant in design projects of any scale. Critical Design is based on a premise that every design product affects the way we perceive our world and act in it, hence, every product that doesn't critically engage with the status-quo is a missed chance to change this world.

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Perceiving Grown Bacterial Cellulose

An Aesthetic and Sensorial Evaluation of a Bio-Fabricated Material

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Abstract. Biofabricated and grown materials are an emergent trend in the design discipline. The push towards the re-search of innovative and sustainable material solutions has recently increased since there is a real necessity to find solutions compatible with sustainable production paradigms. In the presented work, bacterial cellulose (BC) from kombucha tea fermentation has been chosen for investigation. The biofabrication of this peculiar material enables the realisation of several textural and aesthetical features, giving the designer important freedom. However, to properly look for possible applications in products design, some precise characterisations must be observed and discussed. In this contribution, the authors analysed the sensorial and aesthetical dimensions of six different BC samples to highlight and assess the peculiar element of this promising material.

Keywords: Circular Economy · Growing Materials · Sensorial Material Characterisation · Bacterial cellulose · Material designer

1 Introduction

Linear production characterised the last fifty years production system, and this practice profoundly modified Planet Earth on several levels [1, 2]. As a response, research in diverse fields moved towards finding new paths to overcome the linearity and embrace more holistic production practices. From an economic perspective, new models have been widespread over the last years [3–5]. Consequentially, the design discipline evolved in the same direction, looking for new practices to respond to the transitional urgency toward new modes of designing and producing goods. Hence, many different possible approaches to shift productive paradigms arose. Design activism [6], eco-design [7], design for sustainability [8] are just a few examples of the different focuses design discipline is envisioning as possible solutions to promote shift.

Another significant trend emerging in design research seeks to join design and other research fields, with the specific objective of emulating and designing with Nature [9]. In 2012, Myers described for the first time Biodesign as an "approach to design that draws on biological tenets and even incorporates the use of living materials into structures, objects, and tools" [10]. In recent years, design academics have shown an increasing

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interest in bio-manufacturing, understood as a process of materials production - e.g., growing materials (GMs) and complex objects through the growth of living organisms - based on the dialogic exchange between the world of design and that of applied sciences. Biodesign's origin and community are characterised by a DIY and open-source approach [11], contributing significantly to the new perspective of creating experimental materials through innovative, productive processes. In recent years, in the context of material education and design, direct experimentation with material samples has been widely implemented. The importance of the materials' sensoriality and the direct involvement between the designer and the physical samples of the materials were therefore recognised [12–14] as a way to encourage creative practise and experimentation. In this process, emerging practices of Material Tinkering [15] arises as a hands-on, creative and imaginative approach to material exploration, understanding, and development. We can easily apply this direct and creative way to experiment with materials for self-produced, underdeveloped, and low-tech materials, i.e., Do-It-Yourself (DIY) Materials [16, 17]. As a new way of crafting, the self-production of materials allows designers to control the whole process independently and make technical and sensorial material customisation according to their visions and creativity.

These activities result in a multitude of different material outputs that have powerful experiential potential. Therefore, it is necessary to map in a univocal way the materials sample properties, allowing practitioners and designers to apply them to design projects properly. Hence, the objective of the presented work will assess the aesthetic and sensory characterisation of diverse biofabricated material samples. Since GMs [18, 19] can be considered inherently sustainable as they are renewable and biodegradable, current studies in terms of circularity are just at the beginning. Good examples to mention are the grown fungal biotechnologies [20] or kombucha-based leather alternatives [21]. In the frame of the project DE_FORMA, funded by Design Depertment of Politecnico di Milano with research grants, the authors are trying to highlight the potentiality of the development through hands-on experimentation of bacterial cellulose (BC). In this study, BC is obtained from a by-product of Kombucha tea fermentation, using the SCOBY, a biofilm of cellulose that contains a symbiotic culture of bacteria and yeast.

Authors in this work are focusing on the programmability and assessment of the aesthetic features of the BC, finalised to envision its possible application in the initial design stages. The aesthetics dimension is closely dependent on both functional aspects and sensory perception. Therefore, designers usually analyse it while selecting raw materials for their projects. Working on the intrinsic characteristics of a "living" and "growing" material is a significant and attractive challenge for designers, who can operate on colonies of bacteria/yeasts to encode the aesthetic aspects of the final biofabricated material. The aesthetic elements on which it is intended to intervene because relevantly perceived by users in contact with the finished product are mainly: a) surface qualities, e.g. consistency, flexibility, texture; b) optical qualities, e.g. transparency, colours, photoluminescence. In the presented work, the authors will assess the aesthetic and sensorial evaluation of a selection of grown BC samples produced within the project DE_FORMA, considering users' tactile, visual and combined experiences to define their perception upon materials samples, through a designed protocol.

2 Methodology

Relatively unknown materials, like BC, imply complex and novel experiences and aesthetic-sensorial patterns that designers need to comprehend and master to design or integrate them into applications that foster people's appreciation and acceptance. The aesthetic-sensorial evaluation of materials has a long tradition in the design discipline [22–24]: at least four different analysis levels have already been studied and framed within the notion of Materials Experience. Since materiality contributes to the definition of product experience [25], the concept of materials experience, introduced by Elvin Karana [26] and then further investigated, developed and extended [27, 28], is defined as the experiences that people have with, and through, the materials embedded in a product. It describes a holistic view of materials for design, emphasising the role of materials as simultaneously technical and experiential. By taking materials experience as an entry point, it is possible to understand and describe how people experience materials and how physical, biological, social, and cultural conditions constitute these experiences. These four levels are not separated, but they actually interrelate each other and collectively constitute our ultimate experiences. As studied by Karana [29] and subsequently integrated by Giaccardi & Karana [27]:

- The sensorial level concerns the experience that originates from perceiving and noticing material sensorial information by senses. The sensory experience of a material is related to sensory information, e.g., material softness or roughness;
- The material interpretive deals with meaning attribution to the materials (e.g., it is modern or nostalgic);
- The affective level relies on emotions provoked by the user-material interaction (e.g., it is surprising, disgusting);
- The performative one suggests the interaction modalities (e.g., invites me to touch).

Meanwhile, sensorial material characteristics could be led back to numerical, quantitative values, meaning attribution, affective and performative levels of analysis strictly depend on personal's users' culture and, in a broader perspective, in the referring application context (e.g., a specific market or a particular application).

The following methodological path has been adopted in the presented work to collect information on mainly sensorial and interpretative levels of material samples. A panel of design students has been allowed to interact with the material samples at a given time. The samples have been developed to show different aesthetic and sensory characteristics, implicitly communicating the potential customisation of the grown materials in terms of sensorial (e.g., tactile and visual) and aesthetic properties (e.g., colour, material and finishing).

In the framework of descriptive test typology [30], the scaling method will assess the samples' specific material aesthetic and sensorial properties [31]. According to traditionally coherent sensory vocabulary, the scales have been elaborated to evaluate specific perceived qualities, as for the semantic differential methods [32]. The descriptive test typology has been preferred for the possibility to assess qualitative sensory profiles in a measurable output [33]. Moreover, this methodology is going to allow researchers to evaluate properties linked to different sensorial registers (as sight and touch). BC, as a semi-unknown material - or in any case little used in design applications-, can be qualitatively evaluated also through the structuring of "sensory path" for the survey participants. This approach incorporates the study already carried out on the evaluations of innovative materials [34] that underlined how important it is to pay attention to the relationship between optical qualities and tactile expectations related to them. To facilitate data collection processing, the authors paired the in-person testing session with an online data collection form to allow participants to respond consistently and not interrupt the perceptual assessment by altering it through contact with other materials to be manipulated (e.g., paper).

2.1 Test Protocol Design

A specific protocol has been designed following guidelines found in literature to collect data uniformly.

Safety Rules. To realise the sensorial test in total security and within respect for COVID-19 health security restrictions, the protocol includes safety measures as:

- Hands and personal electronic device sanitation with alcohol-based sanitiser;
- Face mask requirement;
- One person per time evaluating samples.

Test Development. The test room has been set to introduce test attendants in a sensorial iter. At the entrance of the test room, a hands sanitiser has been provided, and a QR Code has been shared to directly guide personal electronic devices (Cellphones, Tablets) to the online evaluation form. Once accessed, some questions upon the test attendants' profiles have been asked, in particular:

- Gender Identity Information: Sex (Non-binary/Female/Male);
- Test Attendant Background (Professional/Student);
- Nationality.

The survey attendants have been then invited to start the test through a tactile evaluation, followed by a visual assessment and, finally, a visual-tactile evaluation of the six different samples among the various produced within the DE_FORMA project, carefully selected to represent a wide range of variations, both visual and tactile in terms of colour, texture, thickness, opacity, etc. The samples selected and tested have been chosen for their aesthetic and sensorial properties, strongly determined by the production processes and surficial treatments adopted. In Table 1, a resume of the different production processes and subsequent samples are presented.

Table 1. Samples Description.

Sample n°	Production process	Ingredients	Color	Texture treatment	Inclusions (perceivable at touch)
	Grown, Dried	Green Tea + Vinegar +Sugar + Food Colouring	Green	None	None
	Grown, Cut & Mixed, Dried in mould	Green Tea & Karkadè Scoby + Textiles fibers	Grey/ Blue	None	Fibre chops
	Grown, Cut, Dried in mould	Karkadè Scoby + Glycerine	Dark Red	Glycerine	None
	Grown, Dried in mould	Karkadè + Vinegar + Sugar	Red	Impressed texture	None
	Grown, Dried	Green Tea + Vinegar + Honey	Brown/ Yellow	None	Honey
	Grown, Dried	Water + Vinegar + Sugar + Pepper Powder	Light yellow/ Avana	None	Pepper Powder

The descriptors used in the test, inspired by referring literature [33], have been adapted for activity purposes. Descriptive tests are usually carried out using scaling methods to assess the material samples' specific aesthetic, sensorial and intangible properties [30]. Therefore, the test attendants evaluated different sensorial properties through five-point scales, providing a neutral evaluation value. Coherently with Osgood et al. [32] Semantic Differential Method, unstructured scales with verbal anchors at the extremities, were provided in the questionnaire. The verbal anchors have been defined through adjectives for each specific sensorial, aesthetical or intangible material characteristics (Table 2).

Table 2. Attributes and Descriptors

Survey sections	Sensorial property	Descriptor
A - Tactile Evaluation (Blind)	Roughness	Rough - Smooth
	Warmth	Warm – Cold
	Stickiness	Sticky – Non Sticky
	Flexible	Rigid
B - Visual Evaluation (No Touch)	Glossiness	Shiny - Matte
	Surface Evenness	Uniform – Non Uniform
	Colour Intensity	Intense – Light
	Transparency	Transparent – Opaque
C - Intangible Evaluation (Free interaction)	Quality	Premium – Poor
	Elegance	Elegant – Cosy
	Innovation	Modern – Traditional
	Cost	Expensive – Cheap
	Pleasure	Like – Dislike
	Naturalness	Artificial - Natural

For the tactual and visual experience (sections A & B of the survey), vision and touch have been respectively isolated to allow a better focus on a specific sensory register per time. In doing so, physical supports were needed to assist the evaluation. For the tactile analysis, the samples have been inserted one per time in an especially designed box, ideated and fabricated by one of the authors, allowing the tester to touch the sample without looking at it (Fig. 1).

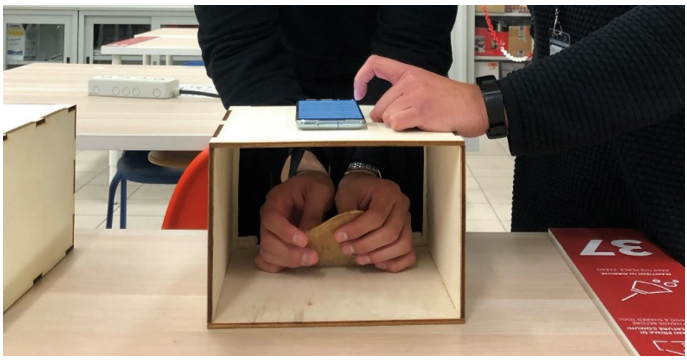

Fig. 1. Touch blind evaluation through masked boxes

For the visual experience, samples have been positioned on plexiglass stands to allow the user to look at the material and perceive its translucency. According to literature [33],

the stands have been inclined of 45° to guarantee the same incident light on the material's surface (Fig. 2).

Fig. 2. Visual evaluation, no touch allowed.

On the contrary, for the samples' intangible evaluation (survey section C), since it comes to meaning and appreciation of presented material samples, authors identified the interaction with touch and sight together as the most effective registry combination to introduce intangible evaluation of the samples (Fig. 3).

Fig. 3. Visual-tactile evaluation

3 Results

A total of 35 students took part in the test activity (Fig. 4). The majority of participants were students (34 on 35 attendants) and of Italian nationality. However, a symmetric balance between males and females has been reached (respectively 16 and 19).

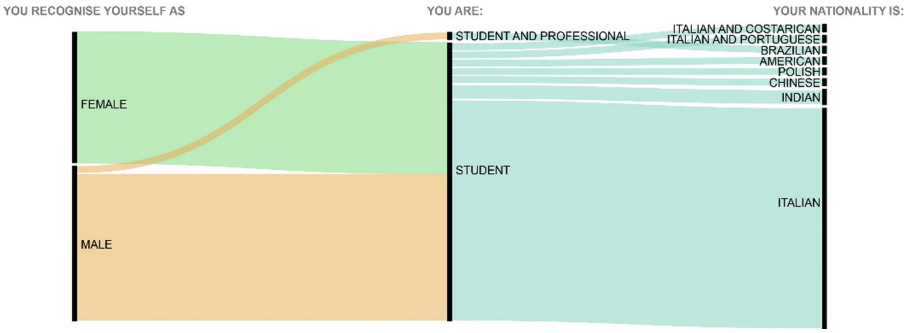

Fig. 4. Participants' Profile

Thanks to their participation, a precise aesthetic-sensory profile of the six different BC samples has been retrieved through average values (Fig. 5).

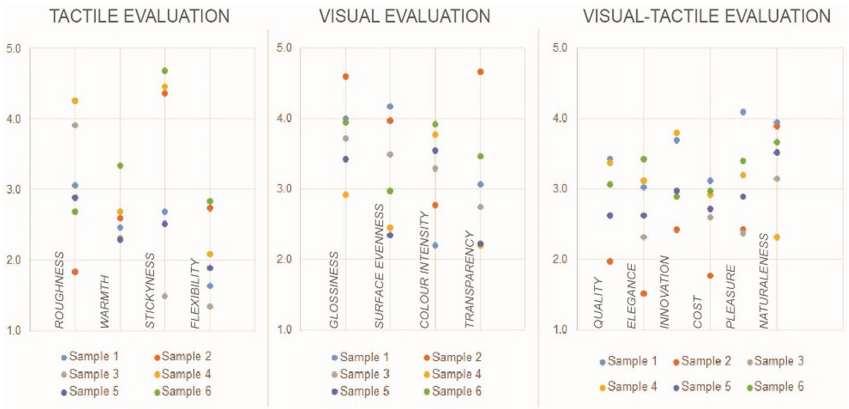

Fig. 5. Cumulative collected data per test section (ROUGHNESS: 1 = Rough and 5 = Smooth; WARMTH:1 = Cold and5 = Warm; STICKYNESS: 1 = Sticky and 5 = Non-sticky; FLEXIBILITY: 1 = Flexible and 5 = Rigid; GLOSSINESS: 1 = Shiny and 5 = Matte; SURFACE EVENNESS: 1 = Uniform and 5 = Non-Uniform; COLOUR INTENSITY: 1 = Intense and 5 = Pastel; TRANSPARENCY: 1 = Transparent and 5 = Opaque; QUALITY: 1 = Poor and 5 = Premium; ELEGANCE: 1 = Cosy and 5 = Elegant; INNOVATION: 1 = Traditional and 5 = Modern; COST: 1 = Cheap and 5 = Expensive; PLEASURE: 1 = Dislike and 5 = Like; NATURALENESS: 1 = Artificial and 5 = Natural).

The authors analysed and collected numerical data emerging from the survey responses to give numerical dimensions on specific aesthetic and sensorial attributes of the analysed material samples. No univocal associations emerge from analysed results (e.g., numerically, an elevated stickiness does not directly generate a poor perceived quality). Sample 1 is considered very flexible, quite matte, with a non-uniform surface at sight, and a high evaluation in terms of pleasure. Sample number 2 is less elegant, considered with lower quality and less loved by the users. On the contrary, Sample 1 and

6 are the most appreciated at visual-tactile evaluation average. Sample 3 is considered pretty sticky and flexible, despite to author's beliefs: if fact, by suppositions, the sample number 5 containing honey was supposed to be the stickiest material, but thanks to its major rigidity, probably has been sensed ad less sticky. Sample 4 presents one of the smoothest surfaces at touch, meaning that the impressed texture does not affect surface irregularities. Sample 5 has no particular excellences, resulting as the most anonymous profile by data analysis. Sample 6 is the less sticky and the second in pleasure, according to test attendees. Almost half of the test attendees (16 on 35) admitted not knowing what the analysed samples were made of, affirming having nearly no experience with similar materials (Fig. 6). On the other hand (19 on 35), the second half of the test attendants affirms recognising the materials but not having high experience with them. This insight is particularly interesting since design students who attended the experimentation proved to be not confident in general with biofabricated BC overall, even if some perfectly recognised the presented materials.

Fig. 6. Identification of presented material samples

From the free comments collected at the end of the test during an informal interview, SCOBY-derived materials appear to be still unfamiliar for designers. It is evident in some participants' comments describing the samples with conflicting definitions, such as stating them look and feel like "synthetic gums or natural materials". Various associations have been made with foods (e.g., salami, nori algae, pomegranate, among others). Also, natural elements, such as leaves or bio-based materials (paper, leather, bioplastic), have been quoted in the attempt to describe the samples. Sight and touch seem to give the most conflicting sensations: at sight, the samples were defined as "weird", "futuristic", and "beautiful"; while at touch, the stickiness is the most impacting sensation, being associated with cheapness, poor quality and dirt, but also cosiness and growth. A participant commented that the samples had a "good appearance but a bad tactile sensation". However, few candidates also related the stickiness (when not too excessive) to tactile satisfaction. Three participants associated sample n° 6 to the Moon, making an associate unrelated to the most recurrent "organic" and "edible" classifications.

Among the sensations aroused, a strong call with nature emerges and, in several cases, an association with childhood games. Several participants grasped the scientific world, the experimental and DIY side behind the creation of the samples, and some associations

were made with the theme of innovation, also related to recycling processes. This may have been somehow influenced by the context and location where the test took place: a room - although neutral - belonging to the Prototype Laboratory of the School of Design; this may have produced preconceptions in students who are used to attend those spaces to carry out activities related to DIY.

The quantitative and qualitative data emerging from the experimental activity became fundamental and exhaustive for the authors since their systematisation conduced to realising the following sample ID cards (Fig. 7). ID cards like these are essential tools for characterising and documenting novel and underdeveloped materials. Indeed, they have a twofold objective. On the one hand, they are tangible tools for designers and makers to represent, interpret and comprehend the outputs of their material tinkering and experimentations – i.e., material samples – from the angle of the sensory and intangible qualities they integrate and express. By reporting the main features of each sample, they facilitate the material's author in identifying similarities and differences among the vast and varied collection of samples they fabricated, creating an idea of taxonomy in their

Fig. 7. Material Samples ID Cards

personal material archive or library. On the other hand, they can be used to communicate the inherited and unique materials qualities and identity to other people that may be involved in the process of materials development and application – e.g., other designers, engineers, companies, users. To keep track of the biofabrication processes and the possible interventions to determine some specific aesthetic-sensorial aspects of material samples, together with an efficient communication of this information, according to authors, represents a critical step to provide an efficient application in the design projects of these innovative materials.

4 Discussion

The experimentation demonstrated that with a biotinkering approach, it is possible to realise a wide range of different colours, finishes and textures can be easily obtained. Nevertheless, only through the application of a culture control and verification protocol it is possible to consciously ensure replicability of the finishes to ensure effective applicability in the industrial design domain. Some of the very different samples – belonging as well to the same material – have been recognised as very natural (thanks to the colour or the presence of veins). Stickiness, instead, has been identified as a primarily negative feature at the touch, so further research into treatments and finishes needs to be experiment. In particular, stickiness was primarily associated with the image of a poor material, not treated properly, or even merely not pleasant for subsequent design applications. This aspect is to be considered particularly relevant when designing a material not only as a mere sample, but also aimed at its scalability in productive contexts of circularity.

The majority of participants were able to associate a bio-based origin to the material samples, recognising their natural origins, even if rarely referring to BC, a material that is familiar in terms of knowledge of the literature but that very few have had the opportunity to interact with in practice. In fact, almost half of the candidates said they had no previous experience of the material, and in general, no one has declared to be an expert connoisseur. Sample 6, among others, demonstrated to be the most interesting since it strongly detaches from other material samples for both tactile and visual evaluations, often generating surprising expressions during the blind evaluation. The inclusion of textiles has been evaluated negatively in respect of different samples, probably due to two elements: on the one hand the presence of a very rough surface generated by the inclusion of textile fibres, on the other hand the loss of transparency of the material, which therefore appears very dark compared to the others.

Since some of the samples created a certain disambiguation between tactile expectation and visual feedback, some tests with some swapped phases [34] could be experimented in future to enrich the evaluation. The accordance or discordance between the expectation of tactile qualities by vision compared to the actual ones by touch may be significant for relatively unknown materials like BC, in order to unfold people preconception and sensory associations with familiar or well-known materiality, to stimulate other sensory interplay and better define perspective on BC perception.

The test attendees, as mentioned, were mainly coming from Italy or, however, they were friendly with both English and Italian language. Imagining widening the test evaluation to different audiences, the introduction of different anchors at end of the scales

-that can be complemented with pictures [34–36]- could facilitate in setting approximate standards for the minimum and maximum values and mitigate eventual linguistic misunderstanding or cognitive overload.

At the end of the test, everyone wanted to know what materials they had interacted with: according to the authors, this phenomenon is probably driven by the modality of carrying out the analysis in the presented sequence (blind, view without touch and final interactions). This modality created a particular curiosity during the initial phase of the test and aroused the participants in the following steps. This interest can also be traced back to the type of participants' training: the desire for knowledge and in-depth analysis of the nature of materials and objects with which one interacts is an intrinsic characteristic at the basis of designers' training.

In future developments, to provide a complete characterisation of the grown BC, the research group will further analyse the material's functional properties. In this way, it will be possible to evaluate the proposed material by its characteristics and properties so that design practitioners and students will have complete and integrated [33] information to embody the material into their projects. Ultimately, this aesthetic and sensorial information can be interpreted by designers to enhance meanings and positive experiences in material development, fostering their appreciation and acceptance by people. It should be pointed out that BC is in fact a highly explored material in terms of research and experimental applications, but at the same time, it has not yet found stabilization in large-scale applications. At the moment, most of the evidence in the literature [19, 37–39] proposes an interpretation of this material in comparative terms, in relation to other already known materials that occur in sheets, such as animal leather. However, it should not be forgotten that BC is in fact a completely different material, both in terms materials class and in terms of its production system, as well as its intrinsic qualities. The approach to this material from the point of view of its perceptive qualities is certainly a necessary step to be able to give the right peculiarities to BC: in this way BC deploy can become a conscious choice to be approached not in terms of replacement, but for its actual technical and perceptive characteristics. It is important to emphasise how a study on the quality of materials can open the door to other possible project impacts in which environmental, economic, social and cultural circularity are central. In particular, starting from studies on the quality of materials to be optimised in terms of reproducibility and scalability, creating new production processes, also to be designed, prototyped, tested and evaluated, is also advisable. Therefore, a fundamental role can be played not only by, e.g., virtual prototyping technologies but also rather by the designer as the planner of a visionary future aimed at plausible sustainability.

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S&S'21 A Matter of Clay: New Scenarios of Ceramic Material Composed of Algae

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Abstract. This article examines how through material experience, glocal philosophy of "think globally act locally", and experimentation of tinkering, it's possible to renew and imagine new materials, products, and processes in a specific territorial context. During the research, a design framework on materials and territories emerged, starting from research on the context and territory, analysing the economic, social, tangible, and intangible factors that compose it. Moreover, it's necessary to understand what type of resources it offers in terms of materials and processes to start active experimentation with the material by adding biological resources or reusing waste. The new material will experiment with local workers or the community. As a result, human capital and companies are involved in restoring the economy and cultural heritage to lead to social innovation. This framework was then applied in the case of ceramic processing in Nove territory (Italy). This enabled a different design approach to re-discover and re-innovate traditional materials and a renewed vision of their role as bearers of local values. Researchers and designers, through this framework, play a fundamental role in conserving and implementing the territorial cultural heritage.

Keywords: Clay · Algae · DIY-Materials · Biofabricated Materials · Social Innovation

1 Introduction: Humans and Matter

Human history is studded with materials and experimentation materials that would support the creation of artefacts. Their importance is highlighted by the fact that some prehistoric and historical periods are indicated with the name of materials: stone age, copper age, bronze age, and iron age. The ability to transform natural substances through simple but precise techniques leads to obtaining new materials, such as ceramics, fabrics, and subsequently, metals. For 9,000 years, these have been the materials with which man has built all the necessary things to live and inhabit (DiSalerno et al. 2010). Nowadays, the era we live in has been identified as the nuclear era, then the space era, and today as the Internet era. Materials seem to be disappeared; they lost the centrality they had for our ancestors.

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On the contrary, modernity has been the cradle of incredible materials development, such as steel, plastics, semiconductors, and in recent years, nanostructured materials. What radically changes from prehistoric eras to modernity is the relationship between materials, technologies, territories, and the social sphere (University of Milan Bicocca 2014). The approach starts to change with the first industrial revolution and the birth of design as we conceive it today. Ezio Manzini theorises a re-definition of the relationship between designer and materials; he says, "matter becomes material when it is incorporated into a design process and becomes part of a product" (Manzini 1987). Today due to the DIY phenomenon and through the direct manipulation of materials, it's possible to investigate new forms of aesthetic-expressive characterisation that led to new project scenarios. It has also allowed experimentation of these materials on new industrial technologies defined as "democratic", such as 3d printing (Rognoli et al. 2015).

Moreover, they focus on sustainability, a topic that is increasingly becoming fundamental due to the unsustainability of today's production cycle. The importance of sustainability in materials has been discussed from various perspectives, such as the use of production waste that can be a resource for the constitution of a material (Parisi et al. 2016), as well as the use of natural elements, readily available, renewable, and biodegradable (Sauerwein et al. 2017). The availability of these new materials doesn't exclude the use of the materials of the past. Still, it transforms them into the function of the new production reality so that they can acquire a unique appearance and performance compared to the past.

This concept relates to Giorgio Pietroni's philosophy regarding the dynamics of innovation inside traditional technology companies where the 'new' occurs only within a process of specialisation of the old, that is, within the company know-how. The scenario of materials turns out to be composite: a mix of different materials, traditional and new, increasingly performing, and more sustainable and compatible with the environment and human life.

2 New Craft, New Thinking

The above considerations lead to the fact that the evolution of time has not been the same for everyone, and knowledge of different types must define specific elements in material and immaterial cultures.

These specificities manifest themselves in manual skills and the construction of territorial identities (Bettiol et al. 2019). In this context, the processing of materials is interpreted as a distributed heritage, that is, a knowledge-centred cultural process, in dialogue with new production models and technical knowledge (Lupo 2019). This scenario can be created by making cultural resources converge with new models of distributed micro-production with a high development of territorial capital (Maffei and Bianchini 2013) by imagining real and widespread impacts, applications, and results in life, work, education, and people's free time, through craft making. This vision intends to overcome the naive idea of local, regionalism, or ethnic crafts, often linked to developing economies and exotic or vernacular contexts. But also to reposition the myth of social and distributed fabrication in a cultural way (Lupo 2019). In this virtuous scenario, the craft heritage and the workers would benefit from an infusion of new production

processes, accelerated and shared, thanks to the use of advanced digital technologies, and vice versa, makers and designers could draw on knowledge systems of excellence and quality of heritage. They can introduce it into their productions, thus creating ecosystems, digital and analogue, not only productive but also cultural, in which the production itself becomes a value for the value it produces (Lupo 2019).

In our age of post-industry, post-modernity, and the devastation of the environment, words like new, innovative, sustainable, and progress have become fetish words passed into language with such an extensive meaning that they have lost their sense (Fagnoni 2018). According to Sanders, we can speak of a people-centred design revolution (Sanders 2006). The ordinary people we help through design are increasingly proactive in their request for better ways of living: they propose actions, events, temporary and foreseeable moments, and ephemeral acts but at the same time expression of a community that takes effort to recover and rebuild (Fagnoni 2018). In this direction, the project addresses the activities of the territory with the local people. The products take on a symbolic value and are affirmed for the meaning that the user attributes to them as a bearer of the importance of the identity of the place they refer to (Parente 2017). In detail, the specific function of the product (the knife to cut or the lamp to illuminate) loses its importance compared to an emerging role as an amplifier and witness of traditions and identity values.

Therefore, products are markers, defined by Dean MacCannell as those information elements capable of activating the transformation of a place into an attraction. They differ from others based on a code of meanings through shapes, materials, colours, or branding (MacCannell 1976). In this regard, the concept of track proposed with the intention of opening a reflection hybridises the concept of permanence with something that triggers a process, a new life cycle, a triggering action. Events, actions, or markers are an opportunity to regenerate, offering an opportunity for awakening, a promise of redemption to memories, and a future perspective for what has become obsolete from a circular relationship perspective (Fagnoni 2018).

3 Think Globally, Act Locally

Until recently, speaking of innovation meant addressing only the issue of technical change (Maffei 2012). Techno-scientific research made the concepts of artificialisation, mechanisation, and technological change coincide with the consequent opening of new markets, the insertion of competitors that force a response from traditional and historical actors, and the introduction of original possibilities to production and distribution levels. Instead, it's essential to understand that today's genuine innovations are those capable of involving the social dimension and environmental problems, with consequences on consumption models, new economies, and, finally, on the world of needs and objects (Tamborrini and Stabellini 2018). Today innovation is described as a unique behavioural attitude that can inevitably be activated by meeting others, integrating experiences and information, empathising with the surrounding world, a tool capable of improving behaviour, and promoting social transformations (Rossi 2016). In this scenario, innovation is not only in the intelligence of technology. Still, it is strongly influenced by education, knowledge, sharing, and relationships that can create new technical and organisational expertise and play an active role in social relations

(Rossi 2016). Accordingly, on what Hannah Arendt has enunciated, innovation becomes a way in which "the potentialities of life are put to work in a commitment of an ethical and not a moral nature" (Arendt 1958).

Link to the concept of innovation comes social innovation, an approach to reconsidering the idea of territory, placing it at the centre of the project (Whyte 2001). Current research in this regard aims not to cancel the biodiversity of a place but to promote and improve cultures, and resources, generate a new sustainable local production chain and relate it to the rest of the world (Catania 2011).

The new philosophy that theorises a relation between local and global is defined by sociologists and economists as "glocalism" (Orser 1996). The theory leads to re-evaluating the territory by designing and creating products and services linked to the local culture but projected towards a global vision (Orser 1996). The correlation between local and global responds positively to the current debate, linked to cultural homogenisation and the loss of peoples' identity, on the processes of globalisation. In addition to this, it's essential to specify that a re-evaluation of the local dimension, understood with all the social, cultural, and economic characteristics, corresponds to a local economic, cultural, social, and environmental development that: interacts with public and private actors active in the own territory in the national and World one (Phills et al. 2008). It must be sustainable at all scales and concern a territory's natural, cultural, social, and institutional resources (Franzato 2009).

The idea of glocalism was born in the eighties thanks to the philosopher and sociologist Ren Dubos, the fundamental principles of his humanistic philosophy are the following: global problems are conditioned by events and choices made locally (Dubos coined the famous environmental motto: "Think globally, act locally"). Social evolution allows us to rethink social actions to change direction to have an ecologically more balanced environment. Accordingly, to Dubos, we can look to the future with optimism because life and human nature are flexible, and humans have become more aware of the dangers inherent in natural forces and human activities and can benefit from successes by applying what they have learned to solve other environmental problems that arise (Dubos 1981).

"Think global, act local" is not only a critical reflection, but it's the synthesis of how we'll probably have to approach the future world, the synthesis between global thought, which considers the planetary dynamics of interrelation between peoples, their cultures and their markets, and local action, which takes into account the peculiarities and history of the area in which you want to operate. Glocalisation places at the centre of its "philosophy" the human person, the material and immaterial local patrimony of the person, and the group to which he belongs. It doesn't ignore the dialectic that derives from the encounter-clash of the various groups within the system-subsystem logic but never loses sight of the micro in its relationship with the macro (De Kerckhove 2014). What can local raw materials teach us about where they are found? Can the place of origin of local raw materials inspire the designer to use them more wisely? Can local raw materials improve the economy and society of that specific place?

In recent research by Rognoli and Ostuzzi (2019), they denote the similarity by assonance between the term "Sustainability for all" and "Design for all", in that, in both cases, it is a "project for diversity human rights, social inclusion, and equality"

(Stockholm EIDD Declaration 2004). Although the term refers to universality, it has an opposite meaning; it instead proposes to "think globally, act locally" (Dubos 1981). To prove the thesis, it's evident that in Design for all processes applied to the project, it's rarely possible to follow the classic design principles such as high and standardised production volumes. On the contrary, sustainable solutions are far from being universal or definitive (Ostuzzi et al. 2015). In this regard, Manzini states that planning interventions for sustainability should be small, local, open, and connected (Manzini 2010). The principle for designing a material within the Design for Sustainability area is minimising the consumption of material, selecting non-toxic substances and harmless, renewable, and biocompatible materials, and extending the life of the materials themselves through recycling and recovery (Sauerwein et al. 2017). It's also necessary to consider the fact that they must be placed in an environmental, economic, and social framework, understood as the use of local materials or waste easily available on a territory, and must prefer the use of local labour that helps the economic development of the interested area and preferably manages to involve different actors and bring culture to the social sphere (Catania 2011). Scholars developed research linked with the abovementioned principles, and they called this approach DIY-Materials (Rognoli et al. 2015; Rognoli and Ayala-Garcia 2021; Parisi et al. 2016). This new approach to the project has led to new relationships between designers, technologies, production processes, and above all, materials, which consists in "creating", "working", and "self-producing" (Bettiol et al. 2019). It's based on accessible, low-investment technologies and on sharing production processes knowledge.

Using local materials or waste from unconventional processes or products to regenerate and create new, more environmentally friendly materials (Rognoli and Ostuzzi 2019). This method also allows using simple technologies that can be inserted in different contexts, especially in areas with economic and social difficulties, to rehabilitate them and lead to socio-economic development or implementation (Rullani 2004).

4 Designing Material Experience Through Ceramic Experimentation

This research understood how using material experience, and its tools can lead to social innovation in a particular context. In detail, the way to renew a material through the tinkering process through direct manipulation was analysed, and new forms of aesthetic-expressive characterisation have experimented with that led to new poetic visions of the project (Rognoli et al. 2015). These "restored" materials (Sauerwein et al. 2017) have a sustainable nature as they are composed or hybridised with waste or biological materials. These materials can be processed and transformed with specific technologies or new processes and tools defined as "democratic" and "widespread", such as 3D printing.

Concluded the analysis of the possibilities of innovating the material it's necessary in-depth knowledge of the context in which it will be inserted and its natural, social, economic, and cultural components; in this way, it is possible to design a material that could be innovative, culturally accepted, economically advantageous and sustainable (Phills et al. 2008). Accordingly, we have a material innovation that leads to more sustainability, less waste, and renewal of the material; it also becomes the actuator

of processes that generate social, cultural, and economic change, therefore to social innovation. More in-depth, we start from a study of the context in which we want to act. We analyse the territory, its economy, the social and cultural factors, its history, its human capital, and all those elements that can be enclosed in the concept of cultural heritage. After the territory study, we highlight what kind of resources it offers regarding raw materials, how they can be processed to become workable materials, and what processes can be modelled. The research program goes on with the direct experimentation on the material through either the addition of biological resources or the reuse of waste.

It continues with the forming tests, understood as the ability to be worked and transformed; this phase is in close collaboration with the local workers or the community. Following its transformation, the material acquires specific expressive-sensorial qualities that allow us to identify the values that the material itself transmits. Lastly, this material is inserted within the community and the territory with the prospect of involving human capital and companies, and restoring the economy and cultural heritage, essentially leading to "social innovation".

For the following case study, we applied a new research method (Fig. 1) that examines four different stages: 1. study of the territory heritage (natural, cultural, social, and institutional resources of a territory) 2. finding autochthonous materials 3. tinkering process with those materials (both on materials and technologies). 4. community acceptance of the new above points.

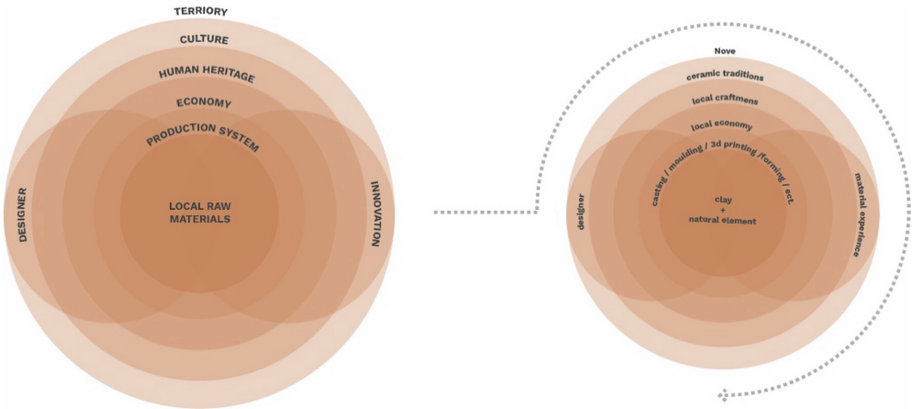

Fig. 1. Research method on materials, design, and territories.

5 A Matter of Clay Case Studies

The research method was then applied to the town of Nove (Vicenza, Italy), famous since 1400 for its ceramic manufacturing. Everything in town speaks of ceramics, architecture, nature, and above all, people. At the beginning of the 90s, a profound crisis began for the ceramic sector, leading to the closure of 90% of the ceramic factories and a change in the country's culture. Today there are few craftsmen left; the industries that operate in the

sector are still gradually losing the ceramics know-how and the memory of the material. From this reflection born the desire to investigate the ceramic material, understand its peculiarities and expressive-sensorial sphere, and find its potential to renew it so that it becomes the starting point for social innovation. Three main players were analysed to develop a concrete answer to this question: design, territory, and materials. Subsequently, through the discipline and tools of the material experience, especially by using tools such as the perceptive sensorial boards of materials and the designers in the lab, the main material present on-site, clay, was renewed. Through the previous considerations, the research aims to enhance local raw materials to re-model the local material culture, a new approach to design that involves raw materials and their premises and design potential.

The first phase of the experimentation starts with identifying the type of clays to be used; a series of local clays called "wild" were collected. Natural clays have, since ancient times, characterised the ceramic productions of various regions and areas around the World. Wandering around our countries, you can find production areas of different types of ceramics, some specialising in the production of stoves, others of majolica, and still others of ornamental objects in white earthenware or porcelain. Through these clays, it's possible to rediscover the identity of our territory and its history, but above all, the intelligence of our body which learns through the hands (Rognoli and Rausse 2020). These clays were then processed and refined to find a comparison by colour and peculiarity with stable mixtures suitable for mass production (Fig. 2).

Fig. 2. Collection of local clays and purification process to make them workable

The second phase focused on searching for natural elements in the area that may be suitable for hybridisation with ceramic material. The story of Nove indicates the solution, ceramics developed in such a flourishing way gave the presence of a nearby river that in 1400 allowed the birth of ceramic factories through the channelling of water (Stringa and Rigon 1984).

Currently, the river has no longer important for ceramics, and its history and importance for the territory have been forgotten; from this assumption, we went to investigate how the river could return to being a resource. We start to collect what comes from the

river in the form of natural elements and human and animal waste. Everything that could be of interest for use was collected and tested in dough and cooking. The element that stood out considerably compared to the others was the most unexpected and present in the river: algae. After identifying algae as a potential hybridisation element, it was necessary to investigate how they could be effectively used and what type of algae had been collected. For some years, algae have also entered the world of design and architecture, stimulating designers to design with them. The world of algae is extremely wide; from them, it's possible to obtain an almost infinite number of products, thanks to the vast number of species whose composition can be influenced by changing the conditions and the place of growth. To understand which typology had been collected, we first investigated the visual aspect of and the area where they were collected; the water is shallow, the appearance is green, and the shape is indefinite.

Fig. 3. Algae hunting

From the green colour, we can assume that it is Chlorophyte algae (Chlorophyta Reichenbach 1834), a division of unicellular, colonial, and multicellular algae even of considerable size and including most of what is commonly called green algae. From the external aspect, the fact that they are indefinite and float on the surface of the water, we can narrow the field and define that they belong to the category of filamentous green algae, scientifically called Oedogonium Capillare, which are single algae cells that form long chains that, attaching themselves form filaments that intertwine with each other forming a mat that resembles wet wool. In nature, there are different types of filamentous algae, the most widespread in Italy and throughout Europe is the "Capillary" they were first discovered in the fresh waters of Poland in 1860 by W. Hilse and subsequently named by the German scientist KE Hirn, belonging to the Oedogonium family of the category of chlorophytes also called green algae (Hirn 1900). Despite the scientific terms, it is a very common alga that grows in stagnant areas of rivers and is commonly referred to as mucilage. They possess chlorophyll a and b, accumulate starches and cellulose, silicates in minimal doses, polyxacrides, proteins, and lipids. Recent studies (Gupta and Rastogi 2008) from 2008 onwards have revealed that this type of algae has a maximum metal adsorption capacity (QE) (Fig. 3). Their use in ceramic took place both on hybridisation

of the material before firing (on dough) and after firing (as a finish), opening up new visions and expressiveness of the material. Comprehending the characteristics of the algae, we assume that given the presence of chlorophyll, cellulose, proteins, and lipids, the dough is more elastic and allows it to reach thinner thicknesses.

Fig. 4. Sample making

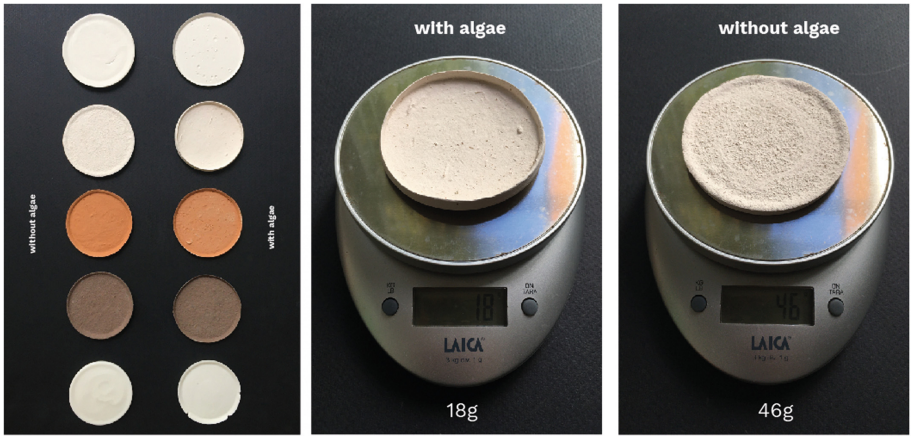

Fig. 5. Comparison between samples with and without algae to highlight the potential of the new mixture

The presence (albeit minimally) of silica and silicates allows for replacement or adding the silicates from mineral extraction present in the mixture; this promotes compactness and acts as a deflocculant that favours the non-absorption of liquids after cooking the ceramic mixture. Overall, the insertion of algae into a clayey mixture has shown considerable potential; the mixture proves to be more viscous and consequently more elastic.

The elasticity allows reaching very thin thicknesses without the dough cracking or deforming. In addition, the algae don't create problems of colour defects during cooking,

and during it, there is a significant shrinkage, for the same volume, the mixture with algae shrinks more while maintaining the resistance of the piece. This allows for thin but strong pieces (Fig. 4 and 5).

The algae are then also used in the finishing (waterproofing) of the material, particularly as glazing. The first tests were carried out with crystalline and enamels; from them, it was clear that they release only a slight pigmentation which consists of a series of black dots. Later it was tried to apply the algae to another type of ceramic finish called "frit" the result from these first tests proved to be extraordinarily promising; the algae in contact with some components of the frit reacted and released considerable quantities of pigmentation that allowed, therefore, to create surfaces with unexpected chromatisms (Fig. 6).

This type of alga has, compared to the others, a high metal absorption capacity (Gupta and Rastogi 2008). This suggests that the absorption of metals by the alga (which by nature is a phyto-purifier) in life allows them to be released in the form of pigments during firing.

These assumptions allow us to start research in which, through the collection of algae samples from different places, it is possible to have numerous colour variations but, above all, to monitor the quality of the water where the algae were collected. In practical terms, the sample becomes a data viewer on the presence of heavy metals within the water (Fig. 7).

Fig. 6. Making of glazing samples

Therefore, in addition to determining a new sensory expressive characterisation, in ceramics, Algae can be used directly on the dough and thus modify its malleability and plasticity, thus creating shapes of the material that was previously difficult to reach. The algae influence the material in the round, from the chemical composition to the workability up to the expressive-sensorial characterisation (Fig. 8).

After the research and the experimentation, the samples were submitted to some relevant persons in Nove. They come from different fields, but all are related to the ceramic sector in detail, a clay hunter, a clay producer, a ceramist, a producer of glazes

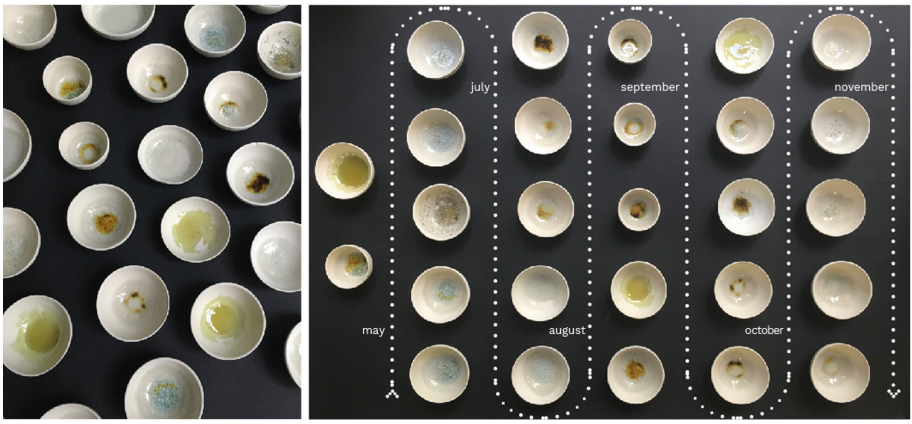

Fig. 7. Glazing samples (river pollution data viewer)

and crystalline, and the curator of Nove ceramic museum. We submit five open questions, two on clay samples, two on finishing samples, and one on the role that this research can play in the Nove area. The material is an exciting starting point for industrial engineering and creating the new ceramic dough. But also a starting point for ceramic research in a country without innovation for some years.

Fig. 8. Objects made of clay+algae were created to understand the expressive sensory characteristics of the new material and its behaviour during the forming processes.

Elena Agosti, director of the Nove ceramic museum, said that "this work could bring attention back to the ceramic material for itself; in this work, it's not the artist who leaves his mark, but it's the material that expresses himself.

Moreover, the fact that you have developed a system, a toolkit, which allows you to apply the methodology you used in this project also in other places could enable you to create a sort of mapping of the state of ceramics in Italy". Again, Fabio Poli, Founder

of Cibas Ceramics Doughts "You need a part of the engineering that makes the project replicable in an industrial way, but I think we are facing a small discovery. Indeed a rediscovery of working with ceramic".

These scenarios allow new uses of ceramics; this material is reintroduced into the economic cycle of the town of Nove and can be a starting point for the renewal of the country's ceramic culture. Furthermore, cities and territories emerge increasingly as critical economic actors: they become objects and subjects of exchange, attractors, and amplifiers of the economic, cultural, and productive systems connected to them, bearers of material and intangible values, incubators of social and cultural developments. The materials come into play from the point of view that re-enhancing local resources by transforming or re-discovering them allow not only to create an economically and ethically sustainable project but also to raise the culture of the territory through a reinterpretation of the values of the territory itself.

6 Conclusions

This article examined how the material experience and the innovation it brings to the materials field can lead to social innovation in a particular territorial context. Through the philosophy of thinking globally acting locally, a synthesis between global thought, which takes into account the planetary dynamics of interrelation between peoples, their cultures, and their markets and local action, which takes into account the peculiarities and historical peculiarities of the area in which we want to operate, we went to elaborate a design framework on materials and territories.

The method involved research that began with the study of the context and the territory, analysing the economic, social, material, and intangible factors that make it up, studying its history, the people who make it up, and elements that we can enclose in the concept of cultural heritage. After analysing the territory's cultural heritage, it's necessary to understand what kind of resources it offers in terms of materials and processes. From this point, the experimentation on the material starts through either the addition of biological resources or the reuse of waste. Investigation continues with trial experimentation, understood as the ability of this new material to be worked and transformed; this phase is in close collaboration with the local workers or the community. The research program goes on with the reintroduction of the processed material, the community, and the territory with the prospect of involving human capital and companies and restoring the economy and cultural heritage, essentially leading to "social innovation".

This framework has been applied to the case study of the city of Nove and ceramic processing. However, it is possible to believe that this approach can be applied to other case studies with different materials and territories. Considering the increase of new materials on the market and the consequent lack of natural resources, this approach allows to re-discover the beauty of ancient materials (such as ceramic) by renewing them in their consistency and giving them new expressive sensory characteristics, but above all a renewed vision of the role of materials as bearers of local values. By renovating them, designers play a fundamental role in preserving and implementing the cultural heritage of a territory.

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Bio-Sustainable Materials for Tailor-Made Well-Being: A Case Study of Behavioral Packaging for Cosmetics Self-Production

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Abstract. This paper provides a critical overview of Design for Sustainability (DfS) and Design for Well-Being practices as, today, sustainability, human behavior, and well-being are inextricably linked. We present a case study in response to a pharmaceutical company brief about cosmetic self-production packaging. Since the research takes place during the first lockdown due to Covid-19, it depicts quite a complex and extensive desk phase and a limited field phase. The research is approached on two levels. First, is the intention to change the way we interact with the packaging. As a container of elements, packaging can be a resource on all levels, not only because we can recycle it but also because we can replant it. In this way, we would return part of what had been taken away to the environment while also improving the product's life cycle. Thus, packaging becomes "behavioral", producing and stimulating conscious behavior and motivating end-users while also educating them about environmental norms. Second, the Critical Design method traces the connections between DfS and Design for Well-being by leveraging the two practices within product design, clarifying the role of the designer in this transdisciplinary integration.

Keywords: Design for Sustainability · Design for Well-being · Behavioral Packaging · DIY · Product Design · Industrial Design

1 Introduction

Today, the terms well-being and sustainability are increasingly used. The purpose of well-being research and sustainability science is to promote health where sustainability and well-being are twin concepts with ethical implications [1]. Both aim to understand how people can live comfortably without hurting the environment on a large scale, or the individual on a local scale (See Fig. 1) [2]. Despite this interconnection, there is a lack of integration between sustainability and well-being research in the design industry.

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However, there is a strong potential synergy between them (Kjell 2011), and hence between the two approaches of Design for Sustainability and Design for Well-being.

Design is fundamental to all human activities [3–5]. As connectors of values, attitudes, needs, and actions, designers have the potential to act as transdisciplinary integrators and facilitators [6, 7]. The vision of designers with a strong sense of responsibility for their work and who are concerned with the ethical implications of the use of technology is increasingly being clamored for by many traditional designers [4].

Mike Monteiro (2019) urges designers to think about the consequences of their actions before focusing on the brilliance of their ideas [8]. Cennydd Bowles' statements (2018) are much stronger in his book, in which he defines design as applied ethics and every act of design as a statement about the future [9]. Whereas Olaf Diegel (2010) states that designers have a moral and ethical obligation to be responsible for their designs and the impact of their work [10]. Thus, designers can integrate concepts of sustainability into our lives through the products they create. It is more efficient and effective to make sustainability considerations early in the design process, rather than correcting problems afterward. As argued by Helen Lewis et al. (2001), it is in the planning and design phase of the product that waste reduction and source reduction can be incorporated into products and services [11, 12].

The product and process design function contributes to an organization's sustainability actions by implementing measures to minimize and manage waste through these designs, identifying and minimizing environmental impacts through a product-based management system, and balancing the needs of the organization and its stakeholders by managing risks to citizens. The commitment of designers to the new models of Circular Economy and Sustainable Development is fundamental. The design phase determines

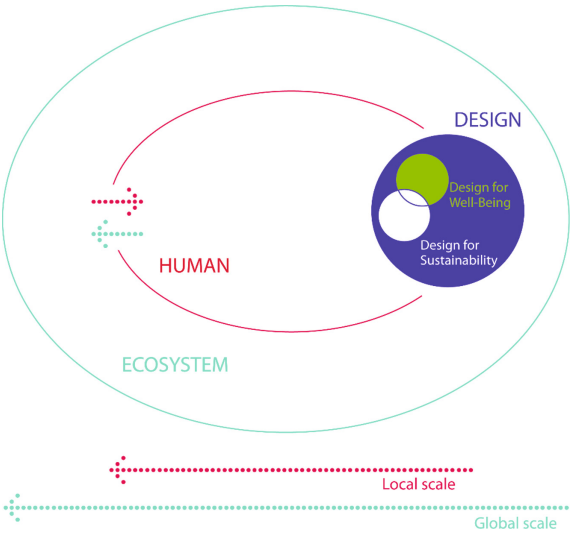

Fig. 1. Sustainability and Well-Being connections through systems (1) Human, (2) Ecosystem, and (3) Design, on a local and large scale.

about 80% of the environmental impact of the products, services, and infrastructures that surround us [12].

1.1 Design for Well-Being

The word well-being is not easy to define. However, "well-being" is always linked to the satisfaction of needs [13, 14], which inevitably has social and ecological consequences. The quest for well-being should be founded on a balanced and responsible human-nature interaction to be sustainable. In this regard, Design for Well-Being should be considered as an integrative and interdisciplinary practice operating in a complex set of values, methods, roles, and professional responsibilities.

Collaboration with technical, business, and administrative partners is vital for effective design, as projects should be socially useful. When we talk about well-being or quality of life [15], we are talking about a core value in the design of technological artifacts, especially consumer products. From this standpoint, companies and designers are often proud to develop products that claim to improve well-being, quality of life, or other similar notions. Furthermore, well-being is a term that refers to a person's quality of life with a much broader meaning than health, a healthy lifestyle, or fulfilling social interactions. Well-being is something that is experienced individually, but at the same time, it is fundamentally social and dependent on the environment created by human beings (i.e., by design).

1.2 Design for Sustainability (DfS)

Since the second half of the last century, the reaction of humankind to environmental degradation has moved to the theme of prevention, through research and innovation [16]. Given this progress, it is evident that the role of Design for Sustainability (DfS) has expanded over time.

In this framework, DfS represents an eco-design concept that has evolved to include both social and economic elements of production [17, 18]. Thus, DfS integrates the three pillars of sustainability - people, profit, and the planet - and meets consumer needs more holistically and sustainably.

Companies that incorporate DfS into long-term product innovation strategies strive to alleviate negative environmental, social, and economic impacts along a product's supply chain and through its life cycle. From this perspective, design is not just about giving shape to something, but it serves as a tool for transformation that must consider social and ethical points of view, maturing an ecological conscience.

The challenges for DfS are to generate knowledge supporting the innovation and design engineering of products and service systems with superior sustainability [17, 19] and to make optimal use of networking and entrepreneurship as success factors for implementation [17].

1.3 The Research Problem: Cosmetics Self-production

Product culture is now widely regarded as a critical component of economic growth and business competitiveness, to the point where it is considered an intangible capital that

has become embedded in products, production, and consumption processes because of people's intellectual activity and creativity. In this paper, the research problem is the self-production of cosmetics.

The cosmetic good is defined by the notion of well-being culture, a trend that leads to consumers' ongoing search for a rediscovery of themselves and their bodies, beginning with their care for them. The cosmetic is the protagonist of the Do-It-Yourself (DIY) process, as a product that is no longer completed but rather modular in its components. In this approach, the consumer becomes the final link in the manufacturing chain, rather than just a passive participant in the purchase process. Users develop an expert attitude and deepen their knowledge of their purchases in this vision of new cosmetics. The conscious philosophy of DIY meets another theme of utmost sensitivity: sustainability. In this perspective, we need to rethink our relations with nature, other species, and communities. Design can contribute with concrete actions to implement behaviors that can have significant effects on environmental impact.

The case study focuses on the development of a kit for the self-production of cosmetics that is environmentally friendly. The need to return to ancient ways to meet the needs related to survival is due to technological development. The increasing use of machines and the unlimited use of fossil fuels are drastically damaging the biological mechanisms of plants and animals, the climate, and the health status of entire populations. From this point of view, it is necessary to understand the essential role that the philosophy of self-production can have, educating people to behave in a virtuous way and introducing the concept of "limit" towards the planet.

2 Methodology

2.1 Desk Phase

The research aims to define a new packaging concept and to clarify the role of the designer concerning DfS and Design for Well-Being practices. The activities were supported by a pharmaceutical company (i.e., a research partner) to develop a bio-sustainable packaging concept combining material design with human behavior.

2.1.1 Design Requirements

The task is to develop bio-sustainable packaging for tailor-made cosmetics manufacturers. The design phases involve the work of an interdisciplinary group of professionals from the corporate team, including the research and development manager and employees, pharmacists, and the marketing manager.

2.1.2 Research Method

Critical Design explores the effect and potential implications of new technologies and policies, as well as worldwide social and environmental trends, and establishes new aims and topics of interest for designers [20].

The goal is to provide the various players in the supply chain with ideas and useful indications for an innovation that is focused, in a synergistic way, on economic, environmental, and social aspects aimed at stimulating the social sensitivity of all citizens.

Critical Design must be founded on a solid understanding of current trends and technologies to be studied to be successfully practiced. Only by adopting an "expert attitude" can this be accomplished.

This method, on the other hand, does not instantly result in practical items, but rather food for thought. No rational decision, according to Isaac Asimov, could be taken without considering not only the world as it was now but also as it will become. This strong focus on the need for ethical and responsible use of the creative process can be considered not only to technology but also and above all concerning the environment and sustainable choices and of vital importance for our future. The choice of one material over another can be crucial. Anthony Dunne and Fiona Raby (2013) argued that by speculating more, at all levels of society, and exploring alternative scenarios, reality will become more malleable, although the future cannot be predicted [21]. Thus, we can help in the implementation of variables that will raise the possibility of more desired scenarios occurring now.

2.1.3 State of the Art

The literature survey concerns the theme of Circular Economy, with a focus on materials [16, 22–25]. Materials are fundamental for our ecosystem since they are the raw components for everyday items, due to extraction from the natural world to be processed and sold.

Antoine-Laurent de Lavoisier stated that "Nothing is created, and nothing is destroyed", referring to the atomic mass and the product of the reaction between elements. His statement, more than three centuries old, lends itself well to describing the reason for a modern-day necessity: eliminating waste.

The world's growing population, rising energy, environmental costs in the manufacturing of raw resources, and unsustainable pollution levels [26] increasingly necessitate a "closed-loop" approach to addressing a society's demands. The number of resources needed for human activities must be found within existing and available resources (e.g., by transforming goods that have reached the end of their useful life). Thus, the circular economy considers waste a failure of the system and wants to enhance the reuse of products at the end of their life cycle and the recycling of recovered materials. Everything can, and therefore must, find a second life while what has been deemed a waste in the old system could become a valuable resource.

The circular economy has its roots in Kenneth E. Boulding's study from 1966, which mentions a circular circuit of materials [27]. The strategy begins with design: a product should be built to survive if feasible, be repairable, and - when its time comes - decomposable so that each of its pieces may be reused. An economic environment, in practice, should function as a biological environment. In nature, everything is functional and everything regenerates. The concept of waste does not exist because "waste" becomes the basis for the development of other forms of life in a general framework of balance.

The circular economy thus becomes a paradigm of sustainability. Companies can be regarded to be sustainable to the extent that they integrate these practices into their core business because sustainability can only be achieved if it successfully incorporates the company's regular goods, services, and operations materials are, therefore, key elements of the circular economy. The first classification of materials was made in 1735 with the

Systema Naturae by Carl Linnaeus in which a real taxonomy was defined [28]. Linnaeus' work, the Imperium Naturae, is the reference manual of modern taxonomy. The relevance of this system illustrates the strength and the disruptive impact that Linnaeus' work had on the natural sciences.

Bio-based materials

The study starts with bio-based materials, which are bio-based products that are made entirely or partially from bio-based components. Some of the reasons for the growing interest in bio-based products are the benefits of bio-based products in terms of resource depletion and climate change. These products could provide additional product functionality, less resource-intensive manufacturing, and efficient use of all-natural resources. People have been using biomass energy - energy from living things - since the earliest cavemen who created wood fires for cooking or heating. Biomass is organic in the sense that it is made of material from living organisms, such as plants and animals.

Different combinations of materials have characterized the last fifteen years. In chronological order, the first examined project is the Honeycomb Vase Made by Bees from 2006, a prototype made by Tomáš Gabzdil Libertíny (See Fig. 2, left) [29]. The designer builds a vase-shaped scaffold removed at the end of the process and then lets nature take its course. A group of bees set to work building a hive, layer by layer, following the very shape of the scaffolding. It takes one week and about forty thousand bees to complete this honeycomb pot. The slow prototyping process creates a circular phenomenon, starting with blossoms, which feed the honeybees and permit them to deliver the vase, and ending with a vase that will hold flowers [30, 31].

In 2008, The Royal College of Art graduate Alkesh Parmar's APeel Materials project aims to design a fully biodegradable and sustainable material from oranges (See Fig. 2, middle) [24, 32]. The designer focuses on materials that are normally destined to become waste products. APeel is an innovative new process for turning waste citrus peels into a versatile new material with a wide range of potential uses. The project maximizes the use of natural resources, creating added value by taking waste from existing processes to produce end products that are environmentally friendly, sustainable, and biodegradable.

In 2010, the duo Formafantasma create Autarchia, a collection that consists of vases and lamps made from flour, agricultural waste, and limestone (See Fig. 2, right). The material can be hardened by cooking at low temperatures or natural drying then dyed with plant extracts. Further developing the material and concept of the previous cooked project, inspired by the popular event of San Giuseppe dinners in Sicily, Autarchia is an installation that proposes an autonomous way of producing goods and outlines a hypothetical scenario where the community wants to cultivate, harvest, and transform the earth personally, to nourish and create useful tools. A collection of utilitarian and solid vessels and lights, normally dried or heated at low temperatures, are produced using a biomaterial made of 70% flour, 20% agricultural waste, and 10% natural limestone [33]. Differences in the color palette are achieved by selecting distinct vegetables, spices, and roots that are dried, boiled, or filtered for their natural dyes.

Another relevant example of bio-based material and their applications can be found in the Decafè project (See Fig. 3, left). Spanish designer Raùl Laurì invents and experiments with coffee grounds, creating a line of refined furniture with a high sensory level: sight, touch, and smell united in a single warm and intense experience. Decafè matures after

a long process of material experimentation for two years, during which the fusion of culinary techniques and material research, has managed to give the coffee a life beyond the cup.

Impasto, on the other hand, is a self-invented biodegradable composite made of natural fibers composed of residues from the production of wood, coffee, and leather (See Fig. 3, middle). The raw materials are mixed with pigment into slurry, pressed, rolled, and folded into flat sheets, the colors become partially mixed which makes each sheet unique, and then the sheet can be shaped by vacuum forming. The project was based on the search for sustainable materials. This led to experiments with different fibers and natural binders, to create a new material that is biodegradable, easy to work with, and simple to understand. The development of the manufacturing process is driven by the idea of creating a process that is adaptable to the industry but has a unique output as if it were handmade.

In 2018, several experiments are performed on waste materials at Bauhaus Universität Weimar. The first entitled Coffungo, developed by Alessa Dresdel, is an attempt to develop pedagogical materials for use within Biology and Ecology classes in schools. It illustrates how from coffee grounds mushrooms can originate within materials (i.e., porcelain and glass) that are both solid and fragile at the same time, giving a sensory experience to the user (See Fig. 3, right).

The second one, entitled Leek Fibers, is designed by Maximilian Schatz using fibers produced by trimming and sheeting leeks that are immediately discarded during harvesting and processing (See Fig. 4, left). The goal of the project is to redefine this waste material, transforming a previously worthless substance into a valuable resource for the manufacture of biodegradable products. The properties of this new material are examined in a series of experiments. The research inspires the design of a shoe made from processed leeks, demonstrating the innovative possibilities of producing sustainable components from compressed and molded leek pulp.

Wine Matters, on the other hand, a project created in 2018 by designer Ludovica Cantarelli at Central Saint Martins, creates a virtuous circle and allows the recovery of wine waste, making it an integral part of the production, only after a long series of experiments and an in-depth study (See Fig. 4, middle). Today wine labels are mainly made of plastic or plastic paper and applied with chemical glue. On the other hand, Wine Matters uses biodegradable starch-based glue for its labels.

The latest contribution was also presented at the Broken Nature exhibition at the Triennale di Milano in 2019: Algae Lab (See Fig. 4, right). It is a bio-research facility made by Atelier Luma as a team with Studio Klarenbeek and Dros to investigate the development capability of micro and macroalgae on a local level. Algae are mixed with biopolymers to produce a fully bio-sourced material that can replace non-biodegradable fossil-oil-based plastics [22, 34]. The project proposes a new model for circular production through bio-fabrication and decentralized manufacturing such as 3D printing.

One of the century's greatest challenges is to change our existing economy into one that is both environmentally friendly and self-sustaining. One innovative approach is to use materials that are grown from living organisms, such as fungi, bacteria, and algae. As seen with Coffungo and Algae Lab, many designers are now "growing" their materials, exploring their potential for product design, such as their increased sustainability and

novel aesthetics. This emerging material practice, which we call Growing Design [35], is transforming designers' workspace into biological laboratories, where designers mix their creative attitudes with a scientific mindset. This requires a new set of skills, to enable an understanding of nature's modes of production and interaction with the living organisms used for material fabrication. Despite the great interest shown, this material-related practice is still poorly understood in the design literature.

All these contributions provide significant experiences in the field of bio-based materials, illustrating how useful items for our survival may be reborn from trash and utilize elements from nature.

Fig. 2. On the left. The Honeycomb Vase "Made by Bees", Tomáš Gabzdil Libertíny, 2006; In the middle. APeel Materials, Alkesh Parmar, 2008; On the right. Autarchia, Formafantasma, 2010

Fig. 3. On the left. Decafè, Raùl Laurì, 2012. In the middle. Impasto, Nikolaj Steenfatt; 2013. On the right. Coffungo, Alessa Dresel, 2018

Fig. 4. On the left. Leek Fibers, Maximilian Schatz, 2018; In the middle. Wine Matters, Ludovica Cantarelli, 2018; On the right. Algae Lab, Atelier Luma, 2019

Plantable materials for packaging

To be sustainable, the search for well-being and the struggle to meet human needs should be based on a balanced and responsible relationship between mankind and nature [1].

In this sense, the preservation of the ecosystem and, on a smaller scale, of one's land is important, symbolically links not only to individual well-being but also and above all to socio-environmental well-being. From this consideration comes the desire to explore a particular type of materials, plantable materials.

Although there is no established literature about these materials, the paper tries to draw a picture of the last ten years of material experimentation in product design. The experiments have led to new material solutions starting from waste in such a way that the product itself or its packaging could be planted and give rise to a new form of life by returning, at least in some sort, what the earth itself has been deprived of.

The first relevant project is the 2010's Life Box, a cardboard box filled with hundreds of tree seeds that can be easily harvested, designed by mushroom expert Paul Stamets (See Fig. 5, left). The seeds are interwoven with beneficial mushrooms to help them grow better. The cardboard can be torn out and dipped to start germination, which sees, after about two years, the birth of small trees. The tree species have been carefully selected from those native to the United States and Canada and include birch, alder, pine, stork, and cedar. Life Box is produced in the United States using recycled cardboard and soy-based inks. Once the trees are planted, it is possible to visit the company's website to enter the GPS locations of each tree so they can be tracked. Planting trees has serious benefits, with just one seed in the box, you can plant a tree that lives an average of 30 years, removing about a ton of carbon.

In 2011, Ben Huttly, an art student from the UK, develop an innovative and environmentally friendly design solution to avoid excess in product packaging: Zero Waste Plantable Packaging (See Fig. 5, middle). Using entirely biodegradable and recyclable paper, he creates fruit and vegetable labels with seeds embedded in them. In addition to reducing waste, the packaging promotes local gardening, which is another significant way to have a positive impact on the environment. In addition, natural cotton twine is used to package the products in this design, as an alternative to the commonly used traditional plastic twine. Another very innovative feature of the packaging is that the text on the labels is laser cut, without the need for ink, which can emit hazardous chemicals into the environment.

In 2013, five projects take place in sustainable design. The first is Bloom Everlasting Chocolate, a packaging for chocolates designed by British designer Connor Davey (See Fig. 5, right). It is a wrapper containing seeds, which can be planted to grow the ingredient with which the chocolate itself has been spiced. In this way, the mint chocolate packaging, when planted, grows mint.

The second project is Eden's Paper, a line of 100% plantable wrapping paper created to eliminate gift wrap waste, designed by BEAF, a U.K. innovation agency (See Fig. 6, left). The paper is produced in nine varieties: sunflowers, English wildflowers, onions, carrots, tomatoes, beets, peppers, gem lettuce, and broccoli. Data report that in 2011, Britain alone racked up 227,000 miles of paper waste after the holiday season. Eden wrapping paper works cleverly with seeds embedded between layers of paper. All layers are held together without glue, a harmful addition to the soil. The ink used in the printing process is also plant-based.

The third project is Crush Bean, the first food packaging obtained from bean processing waste, 100% recyclable (See Fig. 6, middle). Favini, an innovative Italian paper mill,

in collaboration with Pedon, a Vicenza-based company in the cereals, legumes, and seeds sector, gives birth to Crush Bean, the first paper obtained from bean processing waste, destined for food packaging, and certified for direct contact with food. The creation of this new ecological card is part of the "Save the Waste" ethical project, promoted by Pedon, which supports the culture of corporate responsibility, from the producer to the consumer, guaranteeing the selection of non-GMO seeds grown by thousands of farming families within economic and agricultural development programs. Crush Bean comes from the by-products of beans, reducing the use of virgin cellulose from trees by 15% and reducing greenhouse gas emissions by 20%. The result is ecological GMO-Free and FSC-certified packaging, which contains 30% post-consumer recycled fiber.

Also in 2013, the Pangea Organics Bar Soap printed fiber box by Pangea is designed for eco-centric products for body and skincare (See Fig. 6, right). Pangea Organics, an eco-friendly cosmetics company based in Boulder, Colorado, has partnered with Seeds of Change, the largest US organic seed producer, and UFP Technologies to create the first 100% compostable and schedulable product packaging. The packaging is produced with zero waste and created 100% from post-consumer cardboard, without glues and matrices, only with paper pulp modeled and set with spruce seeds. After the product has been used, the consumer immerses the fiber box for one minute in water, and the plant about 1 inch deep into the soil, releases medicinal herbs, causing germination.

Tree in the Bottle, on the other hand, is a packaging designed by the O'right Company made from vegetable waste, not only it is 100% compostable, but it contains a seed inside the bottle to give birth to an acacia or coffee plant (See Fig. 7, left). Once planted, the bottle is made with fruit and vegetable starch, completely biodegradable materials, and is closed with an original Taiwanese Moso bamboo cap. On the bottom are Taiwan acacia seeds. Consequently, once all the shampoo has been used up, it is possible to plant the bottle in the ground and grow a tree. The bottle disintegrates in about 6 months/1 year, the maximum time to consume the products inside.

Live Food Bar Packaging is a package designed to sustainably manage takeaway products for the Live Food Bar in Toronto, a gourmet restaurant for vegans and vegetarians (See Fig. 7, middle). The paper is produced by Botanical Paperworks of Manitoba and is made from recycled paper and embedded seeds of basil, parsley, and oregano. The graphics, on the other hand, are printed with ecological soy or vegetable ink. Once the consumer has finished their food, they can scan the QR Code and fill out a review for the restaurant. It is possible to tear off one end of the packaging to keep Live's URL handy, as well as a link to plant instructions. To grow herbs, it is necessary to wet the packaging and put it in the garden soil, a planter, or a flowerpot, water it and give it plenty of sunlight.

The Sustainable Tea Packaging is a concept designed in 2014; a 100% compostable tea package made of biodegradable materials, including a printed fiberboard incorporated with medicinal herb seeds (See Fig. 7, right). The retail outer carton is made with a minimum of 85% post-consumer waste, conserving trees, saving energy, and reducing greenhouse gas emissions. When the inner packaging is planted in about a foot of soil, the seeds embedded in the carton sprout, and new plants can be grown and harvested.

In 2015, the Biodegradable Coffee Cup project is born, a coffee cup with native seeds incorporated into the material to be used for reforestation in local communities

(See Fig. 8, left). Created by a creative company based in California, it is a cup of coffee that is not only biodegradable but also has seeds in its perimeter so it can be planted and transformed into saplings and flowers. Participating stores encourage people to plant the cups themselves or return them for the company to plant. They run tests with a handful of native wildflower seeds in California and germination was successful.

In 2016, Crush Lentil, the twin project of Crush Bean, is born by producing paper by Favini using waste from lentil processing, saving up to 15% of pulp from trees and reducing greenhouse gas emissions by 20% (See Fig. 8, middle). During Pedon's quality control phase, lentils that do not meet the necessary quality standards are discarded. With a view to a circular economy, all the seeds that are no longer suitable for human consumption are collected to be subsequently purified, micronized, and introduced into the paper production cycle, partially replacing the cellulose. The result of this process is a paper with a natural white color, slightly porous to the touch and with legume residues visible on the surface. The lower quantity of cellulose does not affect the quality and printability of the paper.

In 2017, Use-and-Plant Packaging was created with the slogan "Eat your food, grow a plant, save a planet" (See Fig. 8, right). The food packaging business is created by Slovak designer Michal Marka, after usage, the package turns into a bowl for growing herbs. The materials used are all biodegradable and under the adhesive label are the seeds to be planted, according to the traditional sprouting technique.

Later in 2019, Cerveza Patagonia, Argentina's largest craft brewery, prototypes an innovative ecological packaging for its products: Eco Pack (See Fig. 9, left). It is a packaging made of paper that contains live seeds in its composition. Once drunk the six beers in the pack, it is possible to plant the packaging. Eco Pack can be divided into several pieces and put in a pot; if watered and cared for, the packaging will give life to vegetable seedlings. To this end, the packaging is made of 100% biodegradable paper and printed with non-toxic, water-based ink. Eco Pack is the result of a partnership between Cerveza Patagonia and Papel Semente, the latter specializing in the production of "paper packaging for planting".

The latest project dates to 2019, Biodegrapack, created by Greek designer George Bosnas who comes up with the idea of creating an eco-friendly egg carton (See Fig. 9, right). Biodegrapack is innovative because, after use, there is no need to throw away the container, but it is already ready to be transformed into a small legume plant right at home, on the windowsill, or in the vegetable garden. The container is made of paper pulp, flour, starch, and organic legume seeds. It is solid and sturdy, therefore suitable to protect up to four eggs and, once consumed, should not be thrown away, but planted. Biodegrapack decomposes on its own releasing the seeds contained within. The designer's goal is to create a product that is genuinely environmentally friendly. After about 30 days the seedlings should germinate and grow, enriching the soil as well.

These projects help lay up a framework for bio-sustainable /plantable packaging and advance a material and design hypothesis for the reference brief.

Fig. 5. On the left. Life Box, Paul Stamets, 2010; In the middle. Zero Waste Plantable Packaging, Bun Hutty, 2011; On the right. Bloom Everlasting Chocolate, Connor Davey, 2013.

Fig. 6. On the left. Eden's Paper, Beaf Agency, 2013; In the middle. Crush Bean Favini and Pedon, 2013; On the right. Pangea Organics Bar Soap, Josh Ivy, 2013

Fig. 7. On the left. Tree in the Bottle, O'Right, 2013; In the middle. Live Food Bar Packaging, Botanical Paperworks, 2014; On the right. Sustainable Tea Packaging, Daniel Stankus, 2014.

Fig. 8. On the left. Biodegradable Coffee Cup, Reduce. Reuse. Grow., 2015. In the middle. Crush Lentil, Favini, and Pedon, 2016; On the right. Use-and-Plant Packaging, Michal Marka, 2017.

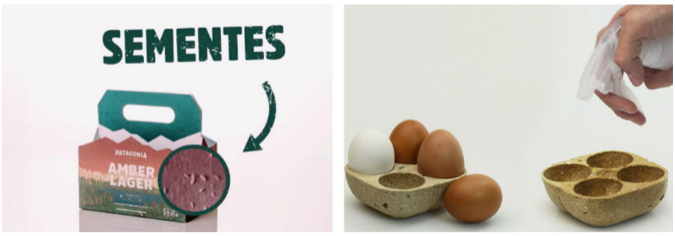

Fig. 9. On the left. Ecopack, Cerveza Patagonia e Papel Semente, 2019; On the right. Biodegrapack, George Bosnas, 2019.

2.1.4 The Outputs of the Project

Packaging is a strategic component that has a significant impact on a company's image and competitiveness. If, until recently, the substance was what was purchased, now the choice is more influenced by the packaging and the values it portrays.

According to a study commissioned by Tetra Pak, over 70% of consumers are prepared to pay extra for an environmentally friendly product, not just for the product itself, but also for more environmentally friendly packaging [36]. This type of packaging helps to improve the perception of the product and makes it more attractive to the discerning consumer. As a result, the packaging industry has seen a significant change in recent years, resulting in novel shapes and materials. The global green packaging market size has been estimated at $274.15 billion in 2020 and is expected to grow at a compound annual growth rate (CAGR) of 6.1% from 2020 to 2028. Thus, growing consumer awareness of sustainable packaging, coupled with strict rules regarding single-use plastics, is expected to fuel the industry's growth [37].

Fig. 10. Behavioural packaging prototype: closed and open packaging with the cosmetics components.

In addition, from the state-of-the-art analysis, the need to innovate packaging and its life cycle has arisen, granting it a new life that is different from traditional recycling (See Fig. 10).

Material hypothesis
It was feasible to make assumptions about the material to be used via the investigation of current projects on the market and at an experimental level. A plantable material was used in the design, and three material components were hypothesized for the packaging's development (See Fig. 11):

1. Wastepaper. The paper is obtained from recovered fibers obtained from paper or cardboard already used in the past with which it is possible to obtain recycled paper as a final product. There are two categories of wastepaper:

   - Industrial wastepaper. This type of wastepaper comes from the production waste of industries.
   - Domestic wastepaper. This type of wastepaper is derived from the waste produced in the domestic context.

2. Seeds. They are responsible for the plant's germination from the packing, as well as its development and blooming phases. The hypothesis proposed about this aspect of the packaging is that the seeds inside the box might be customized based on one of the ingredients in the unique cosmetic formula.
3. Dyes. These are responsible for the different colors of packaging and its components. They are obtained from vegetable waste.

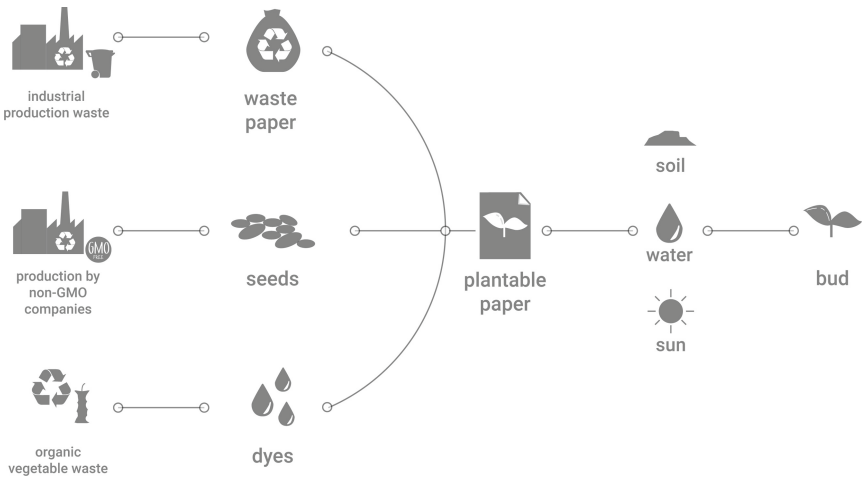

Fig. 11. The hypothesized material life cycle

We assume some of the basic operations of papermaking with the inclusion of seeds for the material's creation (which has yet to occur owing to Covid-19). Various germinability tests need to be performed because not all seeds are suitable to be combined with paper. In particular, the seeds must be non-GMO and must be produced by companies that guarantee conformity to legal requirements. The future results concerning this material present the need to perform tests to define, respectively, (1) Young's modulus, (2) mechanical strength, and (3) durability through water absorption tests.

Color selection

Natural dyes are extracted from fruits, vegetables, spices, herbs, and other natural substances and can then be used in many ways. To understand which dye to use and from which source to extract it, it was important to organize the pharmaceutical company's DIY cosmetics and categorize the items.

Four macro-categories can be defined, respectively: care, hygiene, aesthetics, and prevention. The appropriate color choice for each category is influenced by the *semiotics of colors* [38–42], that is, the study of their meanings. It was, therefore, possible to choose different colors (See Fig. 12), as follows:

- The *green color* for the care category, for its link with nature and the concepts of sustainability and ecology.
- The *pink color* for the prevention category, for its link with the prevention of diseases and disorders.
- The *brown color* for the aesthetic category, the color of the earth, as the excipients contained in the products are all extracted from nature.
- The *blue color* for the hygiene category, as the color of cleanliness, is a symbol of water and purity.

Fig. 12. Behavioural packaging prototypes of different categories, as follows: blue for hygiene, pink for prevention, brown for aesthetics, and green for care

Once the colors are defined, a study is carried out to understand what vegetable component could be extracted from the waste (See Fig. 13), as follows:

- For the *green dye*. Mint: it can be crushed, blended making it homogeneous or boiled.
- For the *pink dye*. Red cabbage and lemon: the reaction between these two substances that can be pounded together in a mortar or combined only after boiling the red cabbage, will create a pink that tends to fuchsia.
- For the *blue dye*. Red cabbage and salt: boil the cabbage and add salt until it turns its color.
- For the *brown dye*. Coffee: use finely ground powder.

Fig. 13. Dye extraction. From left: Mint for the green dye; Red cabbage and salt for the blue dye; Red cabbage and lemon for the pink dye; Coffee for the brown dye.

2.2 Field Phase

Tests were severely hindered by Covid-19 and the impossibility to test the material hypothesized at the laboratory level. As a result, the only experimentation carried out was the *extraction of natural dyes* from vegetable waste in a domestic environment to demonstrate how dyeing scrap cardboard can be done through this technique (Fig. 14) [43].

Extraction was performed following techniques outlined in the literature from foods selected for coloration. Next, the juice extracted from red cabbage was divided into two bowls: one to react with lemon (pink dye) and the other with salt (blue dye). The mint dye, on the other hand, is in a separate bowl (green dye). Finally, coffee grounds were crumbled, placed in water, and mixed in the bowl (brown dye). By keeping samples of wastepaper soaked for 48h and allowed to dry for 24h, prototypes were then obtained. An abacus was recreated to observe the different color gradients and shades of the dyes (See Fig. 15).

Fig. 14. On the left: The ingredients required for dye extraction; On the right. Pieces of wastepaper soaking in coloring juices

Fig. 15. Wastepaper abacus with different color gradients and dyes shades

3 Case Study Findings

The following are the research contributions:

- Definition of a "behavioral packaging", able to trigger sustainable behaviors by the consumer.
- Definition of the role of the designer within the practices of DfS and Design for Well-being, investigating this trans-disciplinary connection.

3.1 The Behavioral Packaging

A significant number of plantable materials and plantable packaging were discovered during the state-of-the-art study; however, there is no definition of this kind of packaging in the literature. Thus, we define *behavioral packaging* as a type of packaging that triggers sustainable and virtuous behaviors in the consumer. This type of packaging, in particular, does not fit into either the return or refill systems [44] but instead provides a third system, that of *rebirth*. This is possible thanks to the material component of the *seeds*, present in a certain percentage inside the packaging, capable of allowing germination. After the packing has been emptied, it will be feasible to plant it and return to nature a portion of what has been taken away. The possibility of replanting the packaging is not only suggested by the organic shape but, in this case study, it is also supported by the presence of two QR Codes (See Fig. 16):

- Recipe. It illustrates the recipe and the method of self-production of the cosmetic contained within the packaging, showing the actions to be performed in the right sequence.
- Plant me! Suggests how to germinate the packaging and the steps needed to plant it.

QR Codes, once scanned, can be saved on devices, so that users can plant the label as well.

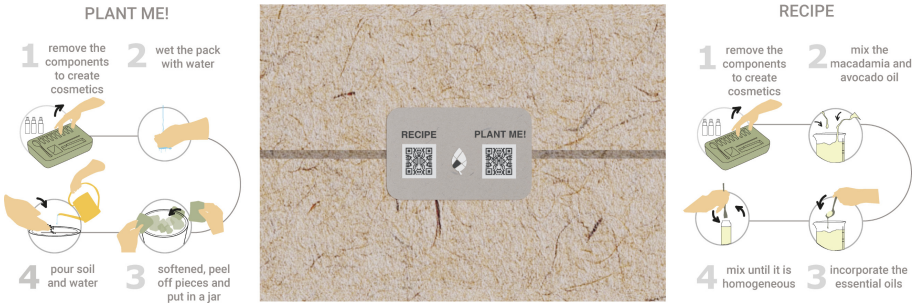

Fig. 16. Packaging label usability and QR Codes linked to downloadable infographics from devices before replanting

3.2 The Role of the Designer

Today, design must deal with the creation of products and services considering environmental, social, and economic impacts. In this framework, design connects the dimension of well-being with that of sustainability, as a transdisciplinary connector. The practices of Design for Well-Being and DfS share goals, values, and even design methods, with a focus on their impact. Thus, designers contribute to making our lives better by integrating the concepts of sustainability and well-being into our lives through the products they create. For packaging design, the designer's choice of materials, for example, becomes a

determining factor that can lead to experimenting with new solutions, making the material the absolute protagonist of the project, and ensuring a positive impact on a large and local scale.

To conclude, the key role and the most significant contribution of the designer is in creative and strategic thinking, and in proposing new concepts that have a strong impact on increasing the desirability of these products or creating new consumer behaviors.

4 Conclusion

This study not only contributes to the design literature with the transdisciplinary perspective of DfS and Design for Well-being practices but also for the notion of behavioral packaging. As a result, the packaging is a product that allows the designer to engage in cross-disciplinary research and design. Since the two practices are interrelated, it is beneficial to refer not only to the world of DfS but also to the world of Design for Well-being when developing packaging from a research topic.

Understanding the literature and developments of these practices allows the designer to operate consciously, following an ethical rationale. Promoting behavior change towards sustainability and collective well-being by acting through materials in product design is a virtuous goal. This social action is made possible using packaging that we defined as "behavioral". Within the case study, this goal was perpetrated through the coexistence of the plant material component and the technological component of the QR Code that allows the use of digital information and, therefore, without the need for disposal. In addition, the only limitation of the research was the lack of material prototyping in a laboratory environment to investigate the percentages suitable for packaging of the three components (1) wastepaper, (2) seeds, (3) dyes.

In conclusion, although user well-being and ecosystem sustainability are not the only goals of design, most designers would be glad to believe that their work contributes to these two objectives.

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Sustainable Development Goals Enabled by Additive Manufacturing: A Design Perspective

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Abstract. The human exploitation of resources is currently exceeding the real possibilities of the planet. New sustainable models of consumption and production have been implemented in the last years to limit the impact of human activities, i.e., the definition of the 17 Sustainable Development Goals (SDGs) in 2015. Design and digital technology can potentially foster the achievement of these goals, although their real contribution to this transition has not been defined yet. This paper aims to investigate the link between additive manufacturing technologies and design for sustainability for the achievement of the 17 United Nations SDGs. After a preliminary review of the goals and the theoretical framework, the most relevant case studies from the practical context were selected to deepen the investigation. Three matrixes were then created to detect the possible interconnections with the SDGs and the key aspects of the theoretical framework. Potential links were found with 15 of the 17 SDGs. Accessible additive manufacturing technologies can foster sustainable models, especially within local scales and communities. Designers can be seen as facilitators or creators of this transition from a practical point of view, fostering behavioral change towards more sustainable models.

Keywords: Additive Manufacturing · 3D Printing · Design for Sustainability · Circular Economy · Sustainable Development Goals (SDGs)

1 Introduction

Nowadays, human activities strongly affect the global environment at different levels and, consequently, the future of the planet. Due to the noticeable impact of the human-induced changes, the current geological era has been renamed the "Anthropocene" [1]. One warning alarm is represented by the increase of the material output from human activities, namely the "anthropogenic mass", which will exceed the living mass present on Earth in the next few years [2]. It means that new models of sustainable production and consumption have to be investigated in the short and mid-term since the current exploitation of natural resources is overcoming the real possibilities of the planet. For

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these reasons, the concepts of sustainability, sustainable development, and circular economy have been assuming a crucial role for a broader audience of stakeholders that aim to reach the transition toward more sustainable models such as industries, researchers, and policy-makers [3–5]. New sustainable practices and initiatives have been encouraged and implemented in the last years. In 2015, the United Nations (UN) defined 17 Sustainable Development Goals (SDGs) to be achieved by 2030. These goals were meant to facilitate the transition toward more sustainable paradigms from an integrated perspective involving the environmental, social, and economic dimensions. In other words, UN SDGs defined some practical targets to be globally reached by the next decade [6, 7].

Within this context, the design discipline represents a key aspect of facilitating the sustainable transition. In particular, the research area of Design for Sustainability aims to increase the awareness of the new generation of designers on these topics, developing new connections and transdisciplinary tools for the practitioners [8, 9].

At the same time, digital technologies have shown the potential to significantly contribute to this transition and the achievement of the SDGs [10–12]. In particular, Additive Manufacturing (AM), also known as 3D printing, seems to foster the development of new strategies that involve sustainability and circular economy since its use has been gradually changing through time. As a matter of fact, 3D printing is increasingly considered a proper process available for the users rather than a prototyping tool for generating new products [13–17]. Despite this current situation, the role of AM in the achievement of the SDGs has not been clearly defined yet, especially considering its potential links with the field of Design for Sustainability. Only a few works focused on the potentials represented by AM at the intersection with design and circular economy [18, 19].

From literature, the development and the use of new materials also influence the transition toward more sustainable models of production and consumption. New hybrid practices and professional figures have emerged to implement sustainable models, namely the Do-It-Yourself (DIY) materials approach and the material designers, respectively [20, 21]. In the light of the above, new synergies can be detected at the intersection of design, materials, and AM for new circular economy models [22], but there is no clear evidence of their contribution to the achievement of the SDGs.

This paper focuses on the interconnection between AM and design for sustainability for the transition toward more sustainable ways of living from an environmental, social, and economic point of view. In particular, the goal is to review and examine the role of accessible AM technologies in achieving the 17 United Nations (UN) Sustainable Development Goals (SDGs). Afterward, it also detects the main aspects of AM technologies related to the SDGs by analyzing the most relevant case studies from the practical context.

This paper mainly addresses the following three Research Questions (RQs):

1. How can AM technologies, especially accessible and low-cost 3D printing, foster the SDGs?
2. Which are the main aspects related to AM that contribute to achieving these SDGs?
3. What is design practice's role in this sustainable transition enabled by accessible and low-cost AM?

After preliminary literature on the theoretical framework of this topic, the UN SDGs were analyzed considering the potential links with AM. A total of 8 key aspects were defined at the intersection of AM and the SDGs, and they helped deepen the analysis through selected practice-based case studies from 2015 to 2021. Three different matrixes were then created to highlight the possible interconnections between the selected case studies, the SDGs, and the 8 key aspects to address the RQs. Possible interconnections were found with 15 of the 17 UN SDGs, and extrusion-based AM processes appear to be the most appropriate 3D printing technologies that foster sustainable transitions, especially low-cost 3D printers. As a matter of fact, a larger number of bottom-up initiatives and local scale closed loops have been implementing sustainable and circular practices. In the next few years, new strategies can be implemented to promote the achievement of the SDGs, and design practice can play an active role in fostering behavioral change towards more sustainable ways of living.

2 Research Methods

This work aims to better understand the role of design practice and accessible AM technologies to achieve the SDGs by reviewing the main practice-based case studies. A preliminary literature review was conducted on Scopus to assume the theoretical framework related to the interconnection between AM and design for sustainability. The 17 UN SDGs were then analyzed considering the potential contribution of AM.

In detail, the analysis was focused on the specific targets and indicators that AM can influence, and the previous literature review helped in detecting the main concepts related to the SDGs. The SDGs were also divided into three main clusters according to the contribution of the Stockholm Resilience Centre (SRC). From this analysis, the goals can be related to the Biosphere, the Society, and the Economy, and these three aspects should be seen as embedded parts where the Biosphere includes the Society, which in turn includes the Economy [6, 7]. These aspects were then linked with the SDGs and the analysis of this paper. These two steps were also helpful in defining 8 key aspects related to AM that mainly contribute to SDGs achievement. More in detail, these key concepts can be defined as transdisciplinary aspects where AM plays a crucial role in the practical transition toward more sustainable models. Further details are described in the next section.

Afterward, a deeper analysis was done by selecting the most relevant case studies within the practical context from 2015 to 2021, which means from the designers' and practitioners' ongoing projects and activities. Only works published from 2015 were considered because the UN SDGs were adopted for the first time in 2015 [6, 7]. To this end, the main repositories and blogs related to design practice and 3D printing technologies were searched instead of scholarly databases, i.e., 3dprint.com; 3dprintingindustry.com; dezeen.com; designboom.com. As a matter of fact, practice-based projects can be easily explored within those kinds of repositories. After a first screening to remove the duplicates, the link with at least one of the 8 key aspects and the use of extrusion-based AM technologies were considered the main eligibility criteria. The latter aspect derives from the preliminary literature review of the theoretical framework that showed this AM category as the most common to foster the transition towards sustainable ways of production

and consumption. After detecting 31 case studies, a deeper analysis was then performed by checking the completeness of the information on the websites of the specific case study, i.e., the project or the partner websites. Works with a clear link with at least four of the 8 key aspects were considered for the review, while projects with weak or unclear connections were discarded, such as not enough information or theoretical concepts and proof-of-concept.

In the end, a total of 10 case studies were collected for the analysis. The 17 UN SDGs, the 8 key aspects, and the 10 selected case studies were then described and combined to create three different matrixes for the data analysis. In particular, these matrixes aim to underline the interconnections between:

1. The 10 selected case studies and the 8 key aspects from the preliminary review (matrix 1).
2. The 10 selected case studies and the 17 UN SDGs (matrix 2).
3. The 8 key aspects (preliminary literature review) and the 17 UN SDGs (matrix 3).

The possible interconnections between the rows and the columns were marked by X. The three columns with the highest number of X for each matrix were highlighted to indicate the most frequent interconnections derived from the analysis, i.e., the 3 key aspects or 3 UN SDGs according to the specific case. In the end, these results were discussed to address the RQs considering the three dimensions of sustainable development, and some future perspectives were briefly depicted.

3 Results and Discussion

3.1 SDGs Analysis

The general analysis of the SDGs aimed to highlight the potential contribution of design practice and AM technologies in fostering their achievement. In detail, possible interconnections were detected by studying the specific targets of the 17 goals. In the beginning, these potential links were expressed through some keywords. Afterward, a total of 8 key aspects were defined thanks to the preliminary literature review. In general, accessible AM technologies can be linked with the UN SDGs, especially considering the activities related to the design practice [6, 7]. Possible interconnections were therefore found for 15 of the 17 SDGs:

- **SDG 1** (No Poverty) aims to eradicate poverty situations, ensure social protection measures, and equal rights, reduce exposure to extreme events, and support policy frameworks for new development strategies. Within its 7 targets, AM and design practice can mainly contribute to targets 1.4 and 1.5 through concrete local actions for the democratization of technology and open and frugal innovation.
- **SDG 2** (Zero Hunger) wants to end hunger and malnutrition, promote sustainable and equitable agriculture, and increase investments and food security. Targets 2.4 and 2.a can be fostered thanks to AM and design practice by promoting the use of technology in rural and local communities.

- **SDG 3** (Good Health and Well-being) focuses on ensuring healthy lives amongst the individuals by reducing mortality ratios and epidemics, promoting mental health and well-being, and supporting the research of new treatments. 3 of the 13 indicators (3.3, 3.4, and 3.8) could be supported by AM and design through customized and distributed assistive or medical solutions and bioprinting technologies.
- **SDG 4** (Quality Education) is related to inclusive and equitable quality lifelong education avoiding discrimination. AM and design practices could enhance targets from 4.1 to 4.5 and 4.a thanks to open innovation principles and accessible facilities, i.e., makerspaces.
- **SDG 5** (Gender Equality) aims to empower vulnerable subjects through participation and equal opportunities. Target 5.b seems to be particularly connected with AM and design practice since accessible and open technology could be a powerful way for empowerment.
- **SDG 6** (Clean Water and Sanitation) ensures sustainable accessibility of water and sanitation considering vulnerable situations, water-use efficiency, and technologies for waste treatment and ecosystem restoration. To this end, targets from 6.6 to 6.a focus on the use of strategies and technologies, including the contribution of AM and design practice.
- **SDG 7** (Affordable and Clean Energy) wants to give access to affordable energy, especially from renewable sources and new technological progress. The contribution from AM and design practice seems to be limited considering these topics.
- **SDG 8** (Decent Work and Economic Growth) promotes sustainable economic growth and employment through innovation, creativity, technological upgrading, resource efficiency, equitability, and safety. Within its 12 targets, AM and design can contribute to targets from 8.2 to 8.6 and 8.9 through local actions for accessible technology, distributed manufacturing, and open innovation.
- **SDG 9** (Industry, Innovation, and Infrastructure) wants to create resilient, inclusive, and sustainable infrastructures for innovation by supporting technological progress, accessible communication, and small-scale enterprises. AM and design can strongly contribute to targets from 9.2 to 9.5, 9.b, and 9.c through distributed manufacturing, open innovation, and circular economy principles.
- **SDG 10** (Reduced Inequalities) aims to reduce inequality at different levels. Within its 10 targets, design practice and AM may foster the inclusiveness of individuals of target 10.2 through accessible technologies and customizable solutions.
- **SDG 11** (Sustainable Cities and Communities) wants to create inclusive, resilient, and sustainable human settlements by ensuring access to essential services and enhancing participation, integration, and resilience in local communities. Targets 11.1, 11.3, 11.4, 11.6, 11.7, 11.b and 11.c can be influenced by design practice and AM technologies through local-scale actions, accessible technology, and open innovation.
- **SDG 12** (Responsible Consumption and Production) fosters sustainable consumption and production models through efficient management of resources and wastes, awareness of sustainable lifestyles, and technological progress. Targets 12.2, 12.4, 12.5, 12.8, 12.a, and 12.b can be supported by circular design practices and AM technologies in distributed manufacturing contexts.

- **SDG 13** (Climate Action) wants to contrast the impacts of climate change through new strategic policies and awareness-raising actions. Target 13.1 can be supported by resilient and circular local activities.
- **SDG 14** (Life below Water) aims for the sustainable use of marine resources by reducing pollution and protecting marine ecosystems. Design practices and AM technology can contribute to Targets 14.1 and 14.2 through circular economy practices and ecosystem restoration strategies.
- **SDG 15** (Life on Land) is meant to protect and restore terrestrial ecosystems and biodiversity through concrete actions and prevention. Targets 15.1, 15.2, and 15.5. can be linked to AM and design practices through circular economy principles and open innovation.
- **SDG 16** (Peace, Justice, and Strong Institutions) promotes inclusive societies and accountable institutions. Due to the extension of this topic, the contribution of low-cost AM combined with design practices seems limited at the moment.
- **SDG 17** (Partnerships for the Goals) aims to implement the global partnership for sustainable development. Targets from 17.6 to 17.8 can be linked to global and local actions for accessible technology and open solutions.

In addition, the UN SDGs can be divided according to the environmental aspect (Biosphere, SDGs 6, 13, 14, and 15), the social aspect (Society, SDGs 1, 2, 3, 4, 5, 7, 11, and 16) and the economic aspect (Economy, SDGs 8, 9, 10, and 12) as embedded clusters of sustainable development [6, 7]. SDG 17 could be set apart from these three clusters since it is not focused on a specific aspect and mainly encourages global actions towards more sustainable models.

3.2 Key Interconnecting Aspects Between AM, Design Practice, and SDGs

After the previous analysis, practical interconnections toward more sustainable models were translated into 8 key aspects. The keywords from the possible connections were further defined through the preliminary literature review, resulting in the following key aspects:

1. **Democratization of technology, open and frugal innovation** as vehicles of inclusive and participative knowledge sharing processes [23–25].
2. **Personal fabrication and Do-It-Yourself (DIY) practices** for "on-demand" products and materials [17, 21].
3. Distributed Manufacturing, local scales, and **communities** for the creation of global sustainable networks of local production [26–28].
4. **Assistive technology, bioprinting, and medicine** to fulfill user-specific needs [29].
5. **Mass customization** for personalized products [30–31].
6. **The spread of fablabs/makerspaces** for global open networks of exchange [27].
7. **Circular economy enabled by AM** according to the implementation strategies based on the R-imperatives, i.e. Recycling, Reuse, Repair, and Repurpose [22].
8. **Ecosystem restoration and preservation through AM** as an open and accessible tool [32, 33].

From the literature review, extrusion-based AM seems to be more used than the other 3d printing processes to create new design projects and strategies for achieving the SDGs, i.e. some FFF (Fused Filament Fabrication, also known as Fused Deposition Modelling) printers [34]. This category ("Material Extrusion" AM) is based on the extrusion of a specific material through a nozzle that selectively reproduces the desired shape layer-by-layer [35]. Its spread in the sustainable transition can be related to several reasons such as: (i) its capability to foster new DIY and bottom-up initiatives from local scales and communities, (ii) the reduced costs compared to other AM technologies while allowing to achieve complex customizable shapes, (iii) the possibility to use local resources and places for new closed loops, and (iv) the implementation of new circular economy strategies. Despite other projects involving different AM technologies linked with the SDGs, the analysis focused on the accessible and low-cost extrusion-based AM since its potential can be related to a more significant number of SDGs, i.e., democratizing this technology for a broader audience. Designers may assume a crucial role in facilitating the sustainable transition by fostering the use of this AM technology within their professional activity, starting its exploitation.

3.3 Practice-Based Case Studies

A total of 10 practice-based case studies were detected considering the SDGs and the 8 key aspects explained in the previous paragraph. Table 1 collects the selected practice-based case studies from 2015 to 2021 following the chronological order and resumes their main details such as year, name, partners, together with a brief description. Despite the limited number of case studies, an increasing interest in sustainability-related topics can be noticed in the last two years since half of the case studies appeared in 2020 and 2021. Some case studies have been currently going on with their primary activities, i.e., n. 2, 6, 9, 10, whereas other ended projects were part of wider strategies or entrepreneurship visions, i.e., 1, 3, 4, 7, 8. Hence, the different stakeholders seem to be aware of the necessity to plan mid-and long-term actions to foster the transition towards sustainable models of production and consumption. Also, Table 1 shows that several actors are involved in encouraging this behavioral change, and it can be done at different levels. Some projects involved partners from the academic and industrial contexts (n. 3, 4, 5, 6, 10) or even volunteers and end-users (2, 9).

On the one hand, industries and design practitioners appear as the main actors that can spread concrete practices to achieve SDGs, especially at local levels. On the other hand, global actions can be encouraged by creating virtual networks of interested stakeholders, including non-design professionals and volunteer figures (n. 2, 3, 9). For this reason, matching global intangible networks and local practical actions could be an interesting way to spread new ways of living towards the perspective of the SDGs. Finally, the heterogeneity of the case studies demonstrates that different approaches can be followed to achieve these goals thanks to the intrinsic flexibility of both design practice and AM technologies.

Table 1. Year, project name, partners, and brief descriptions of the practice-based case studies described in this work.

N.	Year	Project name	Partners	Project description
1	2016	"Maker economy starter kit"	WASP S.r.l	Container kit for local and open source self-production of 3D printed products [36]
2	2016	"E-Nable"	Volunteers network (makers, designers, engineers)	Global network for the local production of accessible 3D printed assistive technology devices [37]
3	2018	"One Hand for Syria"	WASP Hub Mantova, AMAR, Creative Lab, Damascus University, Fab Lab Mantova, Helpy Technology, NUR, Mondoinsieme Foundation	Local manufacturing of 3D printed free prosthetic limbs for Damascus war mutilates [38]
4	2018	"Kijenzi"	Michigan Tech's Open Sustainability Technology Lab, Pennsylvania State University	Development of an open-source 3D printer for humanitarian crisis response [39]
5	2019	"H.O.R.T.U.S. XL"	ecoLogicStudio, CREATE Group, WASP Hub Denmark, University of Southern Denmark, YIP Structural Engineering, Ecoduna AG, Extrudr, Synthetic Landscape Lab	Development of 3D printed bio-digital architectures for oxygen and biomass conversion [40]
6	2020	"Hiveopolis"	University of Graz, EPFL, Université libre de Brusselles, Frei Universität Berlin, Pollenity, Latvia University of Life Sciences & Technologies, Humboldt-Universität zu Berlin	Development of 3D printed beehives for cooperation between humans and bee colonies [41]
7	2020	"Community First! Village"	Mobile Loaves & Fishes nonprofit foundation, ICON Technology Inc	3D printed welcome and home structures for homeless people [42]
8	2021	"The Elements"	The New Raw, Coca-Cola (Greece), Ogilvy Greece, EcoRec	New 3D printed furniture from upcycled marine plastic waste [43]
9	2021	"3D Africa"	Youth for Technology Foundation, volunteers' network	Global network to support the empowerment of African young people and women through STEM disciplines and 3D printing [44]
10	2021	"Rrreefs"	ETH Zürich	Startup for ecosystem restoration through 3D printed artificial coral reefs [45]

3.4 SDGs, Key Aspects, and Practice-Based Case Studies

The SDGs, the key aspects, and the case studies shown in the previous paragraphs were then combined in three different matrixes to further analyze the interconnections. In detail, the first matrix aims to highlight the links between the practice-based case studies and the key aspects from the preliminary literature review, while the second one is focused on the connection between the practice-based case studies and the 17 UN SDGs. After the previous matrixes focused on the case study analysis, the third one links the 8 key aspects with the 17 UN SDGs to detect some possible trends.

The first matrix is visible in Fig. 1 and resumes the connections between the selected case studies (rows) and the key aspects (columns). Four key aspects appear as more

considered by the practitioners for more sustainable lifestyles, which are n. 1, 2, 3, and 6. As a matter of fact, personal fabrication and DIY practices represent a possible way to spread local actions in resilient communities, which can be globally connected from online networks, i.e., Appropedia [46]. These connections can be locally shared thanks to the makerspaces and fablabs. These spaces can have an active role in sharing open knowledge and more sustainable ways of living through their initiatives. For instance, developing 3D printed assistive technology devices contributes to creating new products and knowledge that can be freely accessible thanks to open access repositories, allowing the distributed manufacturing of those products in different emerging countries or fragile contexts, as for case studies n. 2, 3, 4 and 7. Design projects involving AM can foster resilient local communities with efficient resource management, i.e. through ecosystem restoration, circular economy principles, and interspecies cooperation (case studies n. 5, 6, 7, 8, 10). Furthermore, designing for new knowledge and technology sharing can also facilitate new project collaborations amongst expert and non-expert users, inclusiveness and the fulfillment of specific user needs through mass customization, i.e., case studies n. 2, 3, and 9.

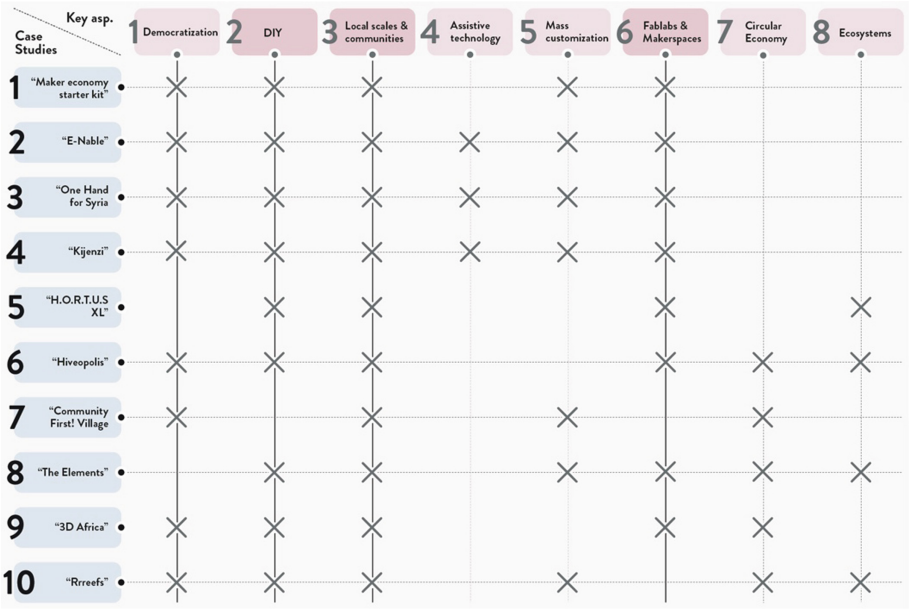

Fig. 1. Data analysis matrix with the connections between the transdisciplinary key aspects (rows) and the practice-based case studies (columns) from this work.

Figure 2 shows the second matrix with the connections between the selected case studies (rows) and the 17 UN SDGs (columns). As for the previous matrix, the three columns with the highest number of possible connections were highlighted to emphasize the SDGs that design practice and AM can mainly influence, which means SDG 10

(Reduced inequalities), SDG 11 (Sustainable cities and communities), and SDG 12 (Responsible consumption and production).

As can be noticed, the economic and social aspects show a higher number of possible connections concerning the environmental one, although the consequences of non-sustainable models often pass on to the Biosphere. However, the influence of human actions is more perceived in the Economy and Society. Indeed, they can be seen as embedded parts of the Biosphere, and concrete actions linked to the Biosphere are also connected with the social and economic aspects of sustainable development models [6, 7]. Local communities also play a crucial role in the transition towards sustainable models of consumption and production that can reduce inequalities amongst the citizens (case studies n. 1, 3, 4, and 7). These local actions can be achieved thanks to the collaboration amongst different stakeholders of a resilient community or through global exchange networks for ideas and knowledge sharing, i.e., case studies 2, 9, Appropedia platform [46]. These online collaborative environments can also promote the active implementation of the main best practices within different communities, encouraging their refinement and spread them globally. Here, designers can help in developing these concrete strategies by using low-cost and accessible AM technologies as a tool for resilient and sustainable local communities.

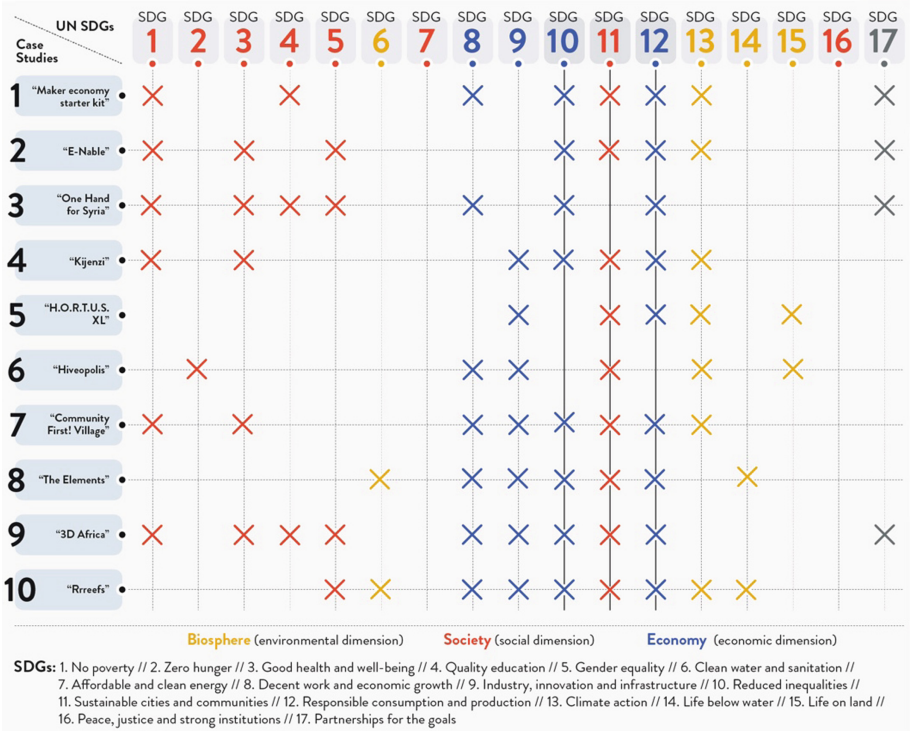

Fig. 2. Data analysis matrix with the connections between the practice-based case studies selected in this work (rows) and the UN 17 SDGs (columns).

3.5 Design Practice and AM Role in Fostering SDGs

As shown in Fig. 3, the third matrix resumes the possible links between the key aspects (rows) and the 17 UN SDGs (columns), and it can be seen as a way to find some possible trends by resuming and generalizing the two previous matrixes. In short, the key aspects of AM and design practice can be linked with the SDGs and the three aspects for sustainable development as it follows:

1. **Democratization of technology, open and frugal innovation** with the Biosphere (SDGs 13, 15), Society (SDGs 1, 2, 3, 4, 5, 11), Economy (SDGs 8, 9, 10, 12), and SDG 17.
2. **Personal Fabrication and Do-It-Yourself (DIY) practices** with the Biosphere (SDG 13), Society (SDGs 1, 3, 4, 5, 11), and Economy (SDGs 8, 10, 12).
3. **Distributed Manufacturing, local scales, and communities** with the Biosphere (SDGs 6, 13, 14, 15), Society (SDGs 1, 3, 11), and Economy (SDGs 8, 9, 12).
4. **Assistive Technology, Bioprinting, and Medicine** with the Society (SDG 3).
5. **Mass Customization** with the Society (SDGs 3, 11) and Economy (SDG 10).
6. **The spread of Fablabs and Makerspaces** with the Society (SDG 4, 11), Economy (SDG 8, 12), and SDG 17.
7. **Circular Economy enabled by AM** with the Biosphere (SDGs 6, 13, 14, 15), the Society (SDG 11), and Economy (SDGs 8, 9, 12).
8. **Ecosystem's restoration and preservation through AM** with the Biosphere (SDGs 6, 14, 15).

In other words, the key aspects 1, 2, 3, and 7 can be linked to the three aspects of sustainable development, which means the environmental, social, and economic ones. Biosphere mainly relates to: (i) personal fabrication and DIY practices, (ii) distributed manufacturing, local scales, and communities, and (iii) circular economy enabled by AM. Society is linked to: (i) democratization of technology, open and frugal innovation, and (ii) personal fabrication and DIY practices. Finally, Economy is more related to: (i) democratization of technology, open and frugal innovation, (ii) personal fabrication and DIY practices, (iii) distributed manufacturing, local scales, and communities, and (iv) circular economy enabled by AM. As for the second matrix, social and economic aspects count more possible connections. As a matter of fact, the columns of SDG 8 (Decent work and economic growth), SDG 11 (Sustainable cities and communities), and SDG 12 (Responsible consumption and production) show the highest numbers of links with the key aspects detected in this work.

The third matrix of Fig. 3 confirmed some trends considered during the analysis of the case studies, adding the contribution of circular economy practices in achieving the SDGs through design strategies enabled by AM. Resilient local communities and the global collaboration of different stakeholders can also contribute to spreading more sustainable ways of living. Furthermore, open innovation principles may foster this behavioral change in society, mainly thanks to the activities promoted by makerspaces and fablabs.

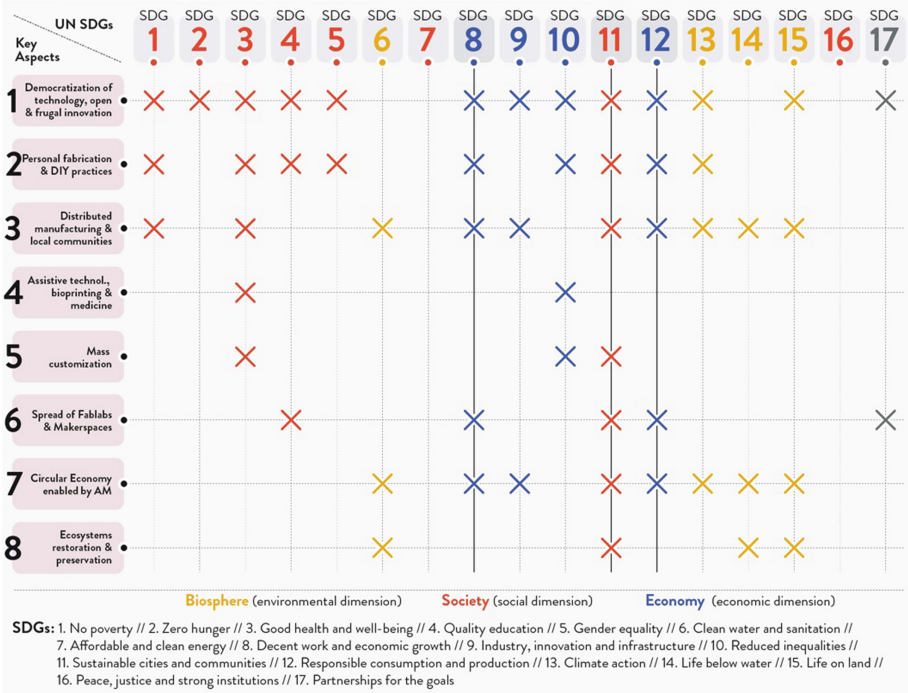

Fig. 3. Data analysis matrix with the connections between the transdisciplinary key aspects detected in this work (rows) and the 17 UN SDGs (columns).

To sum up, AM technologies, remarkably affordable and low-cost 3D printing, can promote SDGs in several ways. From the analysis conducted in this study, the contribution of AM is almost 360 degrees, except perhaps only in the energy sector at an affordable price for everyone and in the context of policies (SDGs 7 and 16). As for the other points, AM technologies can contribute thanks significantly to their main characteristics: (i) being low cost; (ii) being flexible and able to respond to various problems; (iii) being consistent with the logic of open innovation, inclusiveness, and empowerment; (iv) giving tailor-made answers to different needs; and (v) being consistent with the principles of circularity.

The role of design practice in this sustainable transition is to make the know-how of the project available to find intelligent solutions that users can accept. The designer facilitates a change of behavior in users by making them accepted and desired the consistency of their actions with the SDGs. Hence, designers can be considered the potential facilitators for their achievement, and they can rely on AM technologies when and where needed, supporting resilient local communities.

4 Conclusions

To conclude, this paper aimed to connect AM and the design discipline by considering the environmental, social, and economic aspects of sustainability for new models of

living. This review paper is particularly meant to link the 17 UN SDGs and AM through the lenses of the Design for Sustainability discipline, focusing on the roles of design and AM. Therefore, the main aspects of AM technologies and connections with the SDGs were detected thanks to the review of the most relevant case studies searched within the design practice. Accessible AM technologies can stimulate the development of a holistic approach to accomplish most of the UN SDGs, giving a concrete contribution to the transition toward more sustainable models of living. This can be done by defining several strategies based on the combination of the different key aspects explained before.

At the moment, particular interest was shown in spreading personal fabrication and DIY practices (Key aspect 2), developing distributed manufacturing strategies within local scales and communities (Key aspect 3), and creating global networks through Fablabs and Makerspaces (Key aspect 6). Reducing inequalities (SDG 10), creating sustainable cities and communities (SDG 11), and looking at responsible consumption and production ways (SDG 12) are the main sustainable development strategies that emerged from the case study analysis. Furthermore, reaching decent work and economic growth (SDG 8), sustainable cities and communities (SDG 11), and responsible consumption and production (SDG 12) currently appear as the main sustainable development strategies enabled by AM and design practice especially thanks to open and frugal innovation (Key aspect 1), distributed manufacturing within local scales and communities (Key aspect 3), and circular economy principles i.e., Recycling, Reuse, Repair, Repurpose (Key aspect 7).

Currently, there is an increasing interest in AM technologies such as extrusion-based processes since they may be seen as accessible enablers for new projects and bottom-up or DIY initiatives, especially for local communities and developing countries. Furthermore, a significant role is represented by the development of new materials, which allows new strategies based on the recycling and reuse of waste and local resources for AM. Within this general context, designers can be considered facilitators who take advantage of AM only "on-demand", which means just when and where needed. For these reasons, AM can be seen as a tool to foster a behavioral change toward more sustainable ways of living. Although some UN SDGs show more synergies with AM, other transdisciplinary strategies may be developed in the future to achieve all the SDGs, including SDG 7 (Affordable and Clean Energy) and SDG 16 (Peace, Justice, and Strong Institutions). Moreover, they would be used not only by the design practitioners but also by all the stakeholders actively involved in achieving the goals and fostering the sustainable transition, among which the end-users for self-productions and co-creation activities. Since this work is meant to give a preliminary overview of the possible interconnections with the UN SDGs, further work should be done to deepen the aspects detected by this work. Other repositories should be detected to widen the case study analysis and some considerations could be done considering different AM categories. As other projects will appear in the next decade, additional case studies can be detected in the next future, and they may potentially affect the current framework highlighted in this work.

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Design for Digital Interaction and Communication

Design & Technology: Mediation by Digital Advents in Avatar Therapy

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Abstract. This research presents an analysis of Avatar Therapy, a method of treating auditory hallucinations for patients with schizophrenia through images that supposedly represent the voices that people with schizophrenia hear. The objective proposed here is to understand how the aesthetics of these images can successfully produce their therapeutic effect through design and technology tools. The study conceives the therapeutic process as an intersemiotic mediation and translation. In addition, it aims to analyze the processes of figuration and representation and the characteristics of the graphic software. It is an internal validity study with external validation capacity in its applicability and generalizability character. The research modality performed here fits (1) in the theoretical scope for aiming at fundamentals and structuring systems that can help in improvements for the development of Avatar Therapy; and (2) in the bibliographical scope for recovering the scientific knowledge of the followers of C. S. Peirce's semiotics and applying it to the design of this therapy images.

Keywords: Schizophrenia · Avatar Therapy · Intersemiotic Translation · Figurativity · Representation

1 Introduction

Julian Leff developed avatar Therapy at University College London in partnership with Geoffrey Williams, Mark Huckvale, Maurice Arbuthnot, and Alex Leff. They presented different stages of this study in different articles such as "Silencing voices: a proof-of-concept study of computer-assisted therapy for medication-resistant auditory hallucinations" (2013), "Avatar Therapy: an audio-visual dialogue system for treating auditory hallucinations" (2013), "Avatar Therapy for persecutory auditory hallucinations: what is it and how does it work?" (2014) and "Avatar Therapy" (2015). In these studies, the authors demonstrated that this type of therapy was developed based on computer software that allows patients with schizophrenia to contact the entities of their hallucinations through avatars. The therapy pilot project was carried out between 2009 and 2011 and was applied in 6 sessions of 30 min in 16 patients.

When approaching Avatar Therapy, what is sought here is to understand signs capable of visually representing the auditory hallucinations of a person with schizophrenia.

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This process points to a re-signification in a three-dimensional technological environment that enables a sign equivalence through intersemiotic translations. This research seeks to consider schizophrenia and auditory hallucinations, understand the digital environment made possible by Avatar Therapy, and evaluate the graphic construction of avatars intended for this type of therapy.

2 Avar Therapy

For Avatar Therapy studies, schizophrenia is a persistent and disabling mental disorder that causes involuntary perceptions and can lead to disorganized thoughts, among other symptoms. The primary activator of this symptom is the hearing of voices, as seen in the Avatar Therapy protocol for schizophrenia and other related disorders:

> Hearing voices (auditory hallucinations) is a common symptom of schizophrenia, which is often treatment-resistant. For those people with schizophrenia who suffer from hearing voices, around 30% will have auditory hallucinations that are not alleviated by taking medication (Kane 1996). (Moazzen; Shokraneh, 2015:1)

Many of the symptoms of schizophrenia are treated with medication. However, auditory hallucinations are the symptom that has the most evident resistance to treatment. Even cognitive-behavioral therapies that do not require drug-based psychotherapeutic interventions also have little effect on treatment:

> Antipsychotic medications are the main line of treatment for schizophrenia; however, some of the symptoms of schizophrenia, such as auditory hallucinations, are treatment-resistant (Kane 1996). Non-pharmaceutical psychotherapeutic interventions such as Cognitive Behavioral Therapy (CBT) are often suggested as additional treatments. (Moazzen; Shokraneh, 2015:1)

With this background, Avatar Therapy was developed by Julian Leff, professor emeritus at UCL Mental Health Sciences, and seeks to treat strictly auditory hallucinations, which are the most characteristic and evident symptoms in patients who have schizophrenia. The therapy makes it possible to reduce the frequency and severity of hallucination episodes without antipsychotic medications. It is what reveals the importance of this process: stopping drug treatment that often inhibits synaptic processes that are important to the daily lives of patients, as revealed by Leff, Huckvale, and Williams when citing Kane's work:

> About 25% of people with this diagnosis continue to experience persecutory hallucinations and delusions despite treatment with antipsychotic medication (Kane, 1996). Their capacity to work and make relationships is grossly impaired, often for the rest of their life. (Leff; Huckvalle; Williams, 2015)

In addition, hearing voices is distressing not only for patients but for everyone who lives with the person. There are even reported cases of violence against family members or others, which are incited by the voices heard. The scope of application of the therapy only in patients with strictly auditory hallucinations happens precisely because of the

difficulty of maintaining a dialogue with an entity that is not seen. Therefore, Avatar Therapy works as a process of the embodiment of the hallucinated voice that enables a conversation between patient and entity.

McCarthy-Jones and Resnick's (2014) studies identify the typical and atypical properties of auditory-verbal hallucinations in order to establish which types of voices may be related to the context of a schizophrenic hallucination. With this, one can also identify the types of entities materialized through avatars in Avatar Therapy. Therefore, as can be seen, in order for a patient to participate in Avatar Therapy, their hallucination must follow the following principles:

- Appear with external ideas and sensations;
- Be clear in sentences;
- Be experienced as real speech;
- Not being tied to a dream or delusion;
- Being understood externally, but coming from internal factors;
- Not being understood as self-talk;
- Not having a physical identity;
- Be constant;
- Involve action or judgment commands;
- Not having patient control.

Thus, with this list of characteristics, Avatar Therapy can begin to constitute an attempt to materialize voices through a three-dimensional computational system. This system is used to create avatars that represent the voices that patients believe are talking to them. It is already possible, at this moment, to understand a preliminary intersemiotic study in the translation of a sound matrix into a sound-visual matrix.

3 Avatar Development Methodology

Many steps are required in the process prior to the actual application of the therapy. The beginning of this is with the psychiatrist collecting qualitative information imagined by the patient about the possible physical characteristics of the entity. Thus, a session is held, supervised by the therapist, with a designer and the patient. This patient, in turn, describes how they imagine the face and voice of the hallucinating entity to be. It is a process similar to the production of sketches through descriptions of general physical features. It should also be noted that avatars do not always need to follow strictly human characteristics since the patient's hallucinations may be based on characteristics from animals, mythological beings, etc. Here, we deal with descriptions of sensory qualities of what the patient imagines the hallucinated entity to be. The patient seeks to describe analogous forms that represent the performance of the hallucinated entity in their daily lives.

With this pre-established description, it is the moment when the designer has enough support to digitally model the face of this entity in three dimensions. Thus, these qualitative characteristics described by the patient are materialized through computational tools belonging to the FaceGen Modeller software to try to embody the hallucinated

entity. Unlike a portrait process, this three-dimensional modeling cannot be assisted by the patient, as this process would reveal the software's internal characteristics and could compromise the understanding of embodiment before the person with schizophrenia (Fig. 1).

Fig. 1. Screenshot of FaceGen Modeller. Source: http://facegen.com/images/modeller_capture.jpg

With the prototype ready, the three-dimensional model is presented to the patient, a process fully assisted by the psychiatrist. It is time to approve or change/reshape the avatar. When having full approval of the modeling, it is the moment to notice a representation of visual elements with a mimetic vocation, that is, an avatar that tries to portray a resemblance to the hallucinated entity, but which also works as a singular record of an existing one, the voice heard (Fig. 2).

Fig. 2. Ready-made avatar templates. Source: http://mosaicscience.com/extra/avatar-therapy-video

Thus, with this approval, the designer can finalize the avatar in a software development kit (SDK - Software Development Kit) made available by Annosoft, commonly

used for speech animations in characters for movies and video games. It is the moment when the modeled face is configured to move orthogonally and reproduce some expressions such as blinking the eyes, movements of the cheeks and jaws, and, the main one, the movement of the lips as a speech simulation. It is this process that will allow the psychiatrist to speak through the avatar. When the model is created, the computerized system is configured to move its lips in a synchronized way with the psychiatrist's speech. The psychiatrist will interpret themselves and the hallucinated voice, allowing the therapist to speak in real-time in the following sessions. Psychiatrist and patient will be in different rooms with computers connected so that the patient can see and believe that what is being said by the avatar comes from the hallucinated entity. From this process, the beginning of the application of Avatar Therapy can start since all previous phases consist of the development of the avatar, which will enable the treatment. It means that the therapeutic process begins only with the finalization and approval of the avatar (Fig. 3).

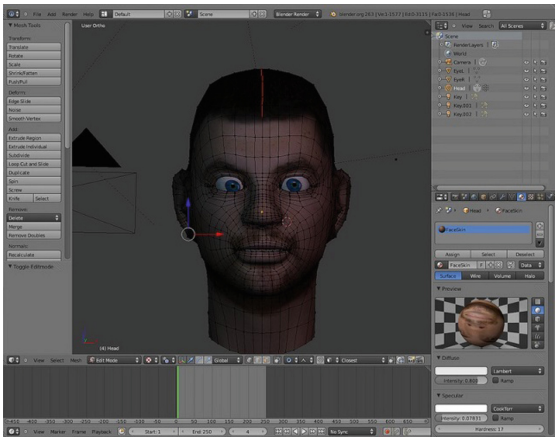

Fig. 3. Avatar animation process. Source: http://farm9.staticflickr.com/8298/7934630282_5a67686c17_h.jpg

By modifying the psychiatrist's voice, using software for this purpose, it is possible to choose the voice that best fits the entity. In cases where the patient is unable to convey what they believe the entity sounds like, they are instructed to choose the voice they feel most comfortable talking to. Patients suffering from multiple auditory hallucinations need to focus on the dominant voice that most harms them or the voice they would most like to get rid of. This is still the part of the process that needs more adjustments since the patient has a direct relationship with the voices, and it is not always possible to reach the hallucinated entity's vocal qualities. Here, there is a differentiation in the process of visual representation and sound representation. Since the patient does not have visual contact with the entity, the representation process becomes more abstract. In contrast, their sound contact with the entity is more palpable, making representative fidelity difficult through the software available for the therapy (Fig. 4).

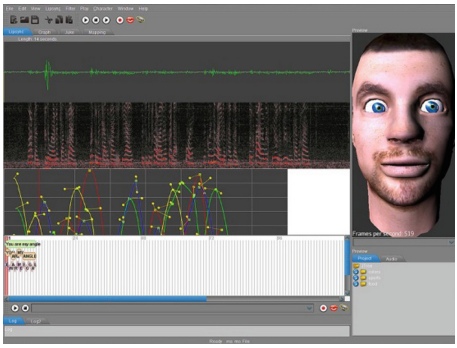

Fig. 4. Avatar vocal process. Source: http://farm9.staticflickr.com/8298/7934630282_5a67686c17_h.jpg

4 Applications and Conclusions About Avatar Therapy

With this entire system in place, it is possible to start the application of Avatar Therapy. In this process, the patient and the therapist are situated in separate rooms, and each is placed in front of a computer, which are connected to each other and in which the patient can see and converse with the representation of their hallucinated entity while the therapist has control about the avatar. Only the controlled avatar is projected on the patient's screen, while on the therapist's screen, it is possible to access the avatar's facial movements and the audio control of the room where the patient is. By clicking on the right side of the computer screen, the therapist can speak to the patient through the avatar, using the modified voice. However, by clicking on the left side of the screen, the therapist can speak, give instructions or warnings to the patient with their actual voice, as in standard therapy. What happens is that the therapist's audio is captured and transformed so that it comes out in a different voice on the patient's computer, then the patient's audio is captured and sent unmodified to the therapist's computer. The patient also has a "panic button" in their room that can be pressed when they feel the need and that, when pressed, immediately turns off the avatar, starting a sequence of relaxing images and music (Figs. 5 and 6).

Fig. 5. Therapist's environment. Source: https://www.youtube.com/watch?v=aYfG53fgwXc

Fig. 6. Patient's environment. Source: https://www.youtube.com/watch?v=aYfG53fgwXc

On the design of the dialogue system with the synthetic voice of the avatar, it is essential to highlight that the content of the therapist's words expressed through the avatar guarantees a large part of the process of understanding reality for the patient. That is why the use of a voice is chosen, even if it is not fully representative according to the characteristics of the hallucinated entity, as the use of text insertion would bring unacceptable delays to the flow of dialogue and would result in the revelation of digital processes that would impede immersion the patient's experience.

During therapy sessions, the therapist begins to speak through the patient's avatar and conducts a dialogue, encouraging the patient to talk to the entity and making the avatar lose its power of persuasion. The speech starts becoming less abusive, giving way to gradually the patient starts to win the argument, which makes them feel more and more encouraged to face what the voices tell them and start to control their hallucinations.

Although it is not a complex immersive environment, it uses a Virtual Reality (VR) platform to create and display a human/non-human identity to the patient to facilitate a real-time voice "trialogue" between the participant, a computerized representation of their voice and the therapist (Leff et al., 2016:193).

The "three-way dialogue" cited by Leff et al. is understood in Avatar Therapy as an activity between the person with schizophrenia, the psychiatrist, and the avatar as a computerized representation of the hallucinated voice. This triple interaction places each party as actors who have active roles in the therapy process, with the third element, the avatar, being interpreted by the psychiatrist, who also constitutes the second element. This detail shows that each part is structured somehow with the other, in a triangular configuration. These levels of interaction are all important individuals within the therapy, as each maintains some relationship with the other on more than one level, promoting a circuit of communication in which:

- The psychiatrist conducts the session by interpreting themselves;
- The psychiatrist interprets the hallucinated voice;
- The avatar serves as a vehicle for the psychiatrist's performance;
- The avatar works as a representation of the hallucinated voice;
- The person with schizophrenia is supported and encouraged by the psychiatrist;
- The person with schizophrenia believes they are dealing with their hallucinated entity.

This process reveals six types of interaction pertinent to Avatar Therapy:

Person with schizophrenia → Avatar
Avatar → Person with schizophrenia
Person with schizophrenia → Psychiatrist
Psychiatrist → Person with schizophrenia
Psychiatrist → Avatar
Avatar → Psychiatrist

Such flows reveal that the three-way dialogue of this type of therapy works not only as a triangle but also as a cyclical system, as shown in the following image (Fig. 7):

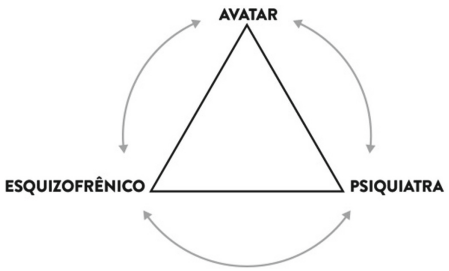

Fig. 7. Communication flow in Avatar Therapy

As can be seen, the communication flows in this system must be understood from the following aspects:

- The schizophrenic's speech with the avatar, believing that it is the materialized entity of their hallucination so that they can confront it;
- The avatar's speech mediated by the psychiatrist to interact with the person with schizophrenia through pre-reported verbal characteristics;
- The schizophrenic's speech with the psychiatrist in the search for therapeutic support in order to face the avatar's speech;
- The psychiatrist's talk with the person with schizophrenia in order to provide support for the dialogue with the avatar;
- The psychiatrist's interaction with the avatar in an attempt to represent the hallucinated voice through the embodiment of the avatar;
- The avatar's interaction with the psychiatrist in the graphic software's response to performance during the session.

In this process, it is necessary to understand that, for the "Person with schizophrenia ® Avatar" vector to have functionality through the "Psychiatrist ® Avatar" vector, the psychiatrist's interpretation must be based on identifying the verbal character of the speech.

There is speculation about the association of old traumas in the development of these auditory hallucinations, as some patients notice that aspects related to this are echoed by

the voices, such as their low self-esteem. Thus, the exteriorization of a psyche component starts losing the argument and help the patient to overcome this. Weston comments that Julian Leff says:

> Even though patients interact with the avatar as though it was a real person, because they have created it, they know that it cannot harm them, as opposed to the voices, which often threaten to kill or harm them and their family. As a result the therapy helps patients gain confidence and courage to confront the avatar, and their persecutor (Weston, 2013).

It is still possible to say that this type of treatment also differs from others regarding the role of the psychiatrist as a guiding agent since, in traditional treatments, patients are commonly advised not to create emotional bonds with hallucinated entities. In Avatar Therapy, people with schizophrenia are encouraged to dialogue with the voices heard, as seen in the preliminary analysis studies of this type of therapy.

The Avatar Therapy pilot study, carried out between 2009 and 2011, demonstrated its basic principles with a small number of patients (16), and in a significant portion of them, there was a finding of a reduction in symptoms, in addition to 3 patients stating firmly that they are not affected by voices anymore.

Currently, the study brings together groups containing around 140 patients and is conducted by brief interventions carried out weekly, no more than seven sessions, with each session lasting about 30 min, but most dialogues with the avatar usually have only 15 min. Sessions are also recorded and given to patients to hear the audio outside in other moments, which helps them strengthen their control over their voices. The patient must meet specific criteria to participate in the study, including being over 18 years old and suffering from auditory hallucinations for at least 12 months.

Avatar Therapy can be understood as cognitive-behavioral therapy for medication-resistant symptoms. It is evident that other studies on the same aspect had already been developed throughout history, as highlighted by Leff, Huckvale, and Williams when discussing the evolution of this type of treatment in the last fifteen years:

> In the past 15 years or so in Britain, randomized controlled trials (RCTs) have been conducted to test the value of cognitive-behavioral therapy (CBT) for persistent medication-resistant symptoms of psychosis. While these have shown some effect in reducing auditory hallucinations, they have been criticized on grounds of experimental design. One more recent RCT of CBT, while not affecting the frequency or intensity of auditory hallucinations, did succeed in reducing the power of the dominant voice as perceived by the patients, and their distress (Leff; Huckvalle; Williams, 2015).

What the authors highlight is precisely the differentiation of Avatar Therapy by taking into account elements of the design universe, which consequently allow, for the first time in the history of treatments for schizophrenia, that patients interact directly with what they believe to be their controlling voices. Moreover, it is precisely in this context that the aforementioned intersemiotic translation is revealed. Julio Plaza says that,

> if at the level of "inner" thinking, the semiotic chain is already established as a process of translation and, therefore, dialogic, what about the one that establishes itself in the exchange between sender and receiver as differentiated entities? In this case, though, which is already a sign, has to be translated into a concrete and material language expression that allows for communicative interaction. Now, the sign is the only reality capable of crossing the border between the inner and outer worlds. To that extent, even the most "inner" thought, because it only exists in the form of a sign, already contains the social germ that gives it the possibility of crossing the boundary from the self to the other (Plaza, 2003:18–19).

Given the way described for the development of this therapy, it is necessary, above all, to understand that the schizophrenic person describes their hallucinatory entity from general characteristics of what they imagine to be the physical characteristics that make up this personality since hallucinations are only part of the auditory and non-visible aspects. This patient's given report already reveals a translation of a thought that exists in the schizophrenic's mind, and that needs to be expressed through verbal language. Once again, referring to the concepts already explored of the real as a hallucination in the face of the repertoire of the person who hallucinates.

It is necessary to understand that the report of the person with schizophrenia is already a mediation process that reveals the physical characteristics of the hallucinated voice from a necessarily social verbal language. However, the object determining this verbal sign reported by the patient is a hallucination only perceived by them. Therefore, this thought translated into verbal language is what allows the designer to become the interpreter of this information in the first instance. In other words, the designer who will constitute the avatar shape starts to reinterpret data already mediated by the schizophrenic's repertoire. It demonstrates that the first contact of the developer of three-dimensional forms is through verbal representations, which also reveals the process of semiosis in the growth and evolution of the sign.

This process of reception and interpretation of the patient's report made by the designer is given through signs that have the nature of a law, a rule, a habit, a sign that carries a convention based on the schizophrenic's previous repertoire. Moreover, this is precisely what will determine an interpretation according to the designer's repertoire. It is up to the designer's collateral experience to search for the interpretation of the verbal signs reported by the patient: a subsequent process of intersemiotic translation.

The interpretation made by the designer can be considered an equivalent sign or a more developed sign of the patient's report, that is, the meaning or interpretant of the first sign. However, at this moment of reception of the report, what the designer constitutes is a mental image of the hallucinated entity. This type of image is under the control of the immaterial, that is, "in this domain, images appear as visions, fantasies, imaginations, schemes, models or, in general, as mental representations" (Santaella; Nöth, 1998:15).

> We must distinguish two types of representation: there are representations internal to the device of the information process, that is, mental representations, and there are representations external to the device […], that is, public representations. There are, then, two classes of processes […]: intra-subjective processes of thought and memory and intersubjective processes through which the representations of one

> subject affect the representations of other subjects through modifications of their typical environments. (Serber apud Santaella; Nöth, 1998:16).

This intra-subjective process of thought and memory will serve as a basis for the development of the avatar as a public representation, that is, a material image as an audiovisual representation. However, before that, it is still necessary to understand that this other intersemiotic translation that materializes the avatar through the mental image constituted by the designer still undergoes another process of mediation coming from the characteristics of the development software. This software (FaceGen Modeller), while generating conventional three-dimensional mesh data, uses a fixed set of parameters through algorithms that include a limited number of parametric control of facial expressions, which also limits further use of the animation features in the software development kit.

The theme of translations relevant to the Avatar Therapy process applied to design must be understood as a translation activity, as it is a fundamental aspect of interpretation processes given by both the person with schizophrenia and the designer.

Thus, it can be seen that the object to be translated in Avatar Therapy has a structure based on the repertoire of the person with schizophrenia, on the designer's repertoire, and the possibilities of graphic software. It is an object that goes through different mediations and has no tangible features for reference. For this, then, it is possible to understand the designer as a translator who conceives their activity through an interpretation process, in which the object to be translated is the product of a sign generated by another sign.

The translation activity performed by the designer is a type of intersemiotic translation that involves a model of an interdependent sign system. Therefore, for the intersemiotic translation process to generate avatars that try to represent the voices hallucinated by patients, it is essential to take into account that, in Avatar Therapy, the translation activity is strictly linked to design as a process of shaping an object that only it has a verbal meaning re-signified by different repertoires, a common-sense between the person with schizophrenia and the designer still unstructured in the context of visual language.

In order to make an evaluation of the translation process in Avatar Therapy possible, one can use Salvatore Zingale's (2016) scheme for the design translation process (Fig. 8):

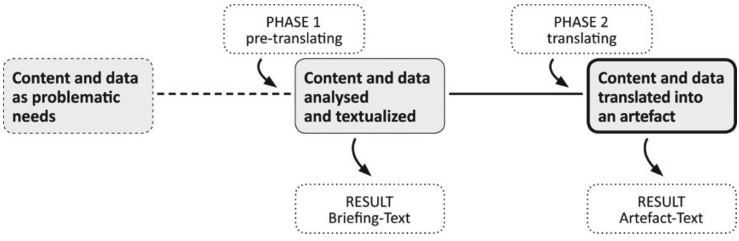

Fig. 8. Design translation process. Source: Zingale, 2016:9

As can be seen, the author presupposes a graph that contains: (1) content and data as complex needs, (2) content and data analyzed and textualized, and (3) content and data translated into an artifact.

Since the problematic need pertinent to the graph above corresponds to the dynamic object in Peircean theory, in Avatar Therapy, this first stage can be understood as the hallucination itself, the object to be translated in the context of the therapy.

The second stage contains the first stage established in the graph, that is, a stage aimed at textualizing the social needs of the initial problem. Such textualization works as the transformation of the problem into common and shared discourse. This phase can be understood as the discourse of the person with schizophrenia to describe the hallucinated entity's physical characteristics.

The third stage contains the second phase of the process and is related to the result of the translation activity, that is, the designer's role. Therefore, this second phase explicitly deals with the intersemiotic translation that involves the passage from textualization to a material artifact. In Avatar Therapy, this can be understood as translating the patient's report into a three-dimensional avatar.

It is essential to highlight that the model proposed by Zingale does not understand the designer's repertoire as an element within the intersemiotic translation process, nor the possibility charts of the technical apparatus to be used, which makes two essential parts of the process to be sublimated. For this, a new model can be proposed as follows (Fig. 9):

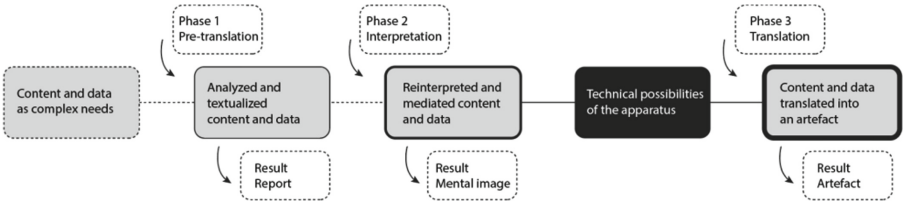

Fig. 9. Adaptation of the design translation process.

From this adaptation of the design translation process, the following relationship pertinent to the context of Avatar Therapy can be conceived as: step one consists of content and data as complex needs and essentially deals with the verbal auditory hallucination heard by the patient which, in turn, has its pre-translation in phase 1, with the discourse of the person with schizophrenia when reporting the imagined physical characteristics of their hallucinated entity; leading to the second step, which consists of the content and data analyzed and textualized, resulting in the patient's report. Consequently, the second step of the process leads to phase 2, that is, the stage of interpretation of the patient's report made by the designer and which leads to the third step with reinterpreted and mediated content and data, resulting in a mental image that is given by the designer's repertoire in interpreting the patient's speech. This mental image, so that it can be translated into a new matrix, goes through an intermittent step that presupposes the technical possibilities of the apparatus and the designer's ability to manipulate such tools; in Avatar Therapy, this intermediate step reveals the specific characteristics and possibilities of the software used in the avatar creation process, as well as the designer's

abilities to manipulate them. It is only then that phase 3 of the process leads to an intersemiotic translation of content and data translated into an artifact, which, in this case, actually results in a three-dimensional avatar.

It is possible to see that design, in this case, shows itself as an element of mediation between a set of contents and promotes intersemiotic translation so that the schizophrenic person gains access to previously inaccessible semantic data due to a language barrier.

The translation activity exposed here reveals the ability to use different languages to express content, looking for a form of expression. In other words, the designer becomes an interpreter and producer of content through a form of expression that makes these contents more accessible. Thus, the design itself can be considered a form of translation, as it is a means through which it is possible to re-signify languages with techniques and instruments to reinforce expressive efficiency. Thus, this process indicates that Avatar Therapy is not just the materialization of a hallucinated voice but the facilitator of immersion in reality.

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Interactions to Be: The Case of Speculative Interactive Print Media

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Abstract. As interaction design is clarified as a physical/digital area, media usually considered to be devoid of interactive capacity can gain new encouragement in their relationship with people. Print media, which have played an important cultural, economic and social role, have been declining in recent decades, becoming a preferred media for experimenting with interactive features. We have conducted an exploratory study of print related media as interactive systems, by making a characterization of print media, articulating with physical interaction and presenting different cases, their characteristics and relevance for interactive purposes. We collected several projects as examples of print media being understood or connected with interactive systems. For each project, in addition to a synthesis description, we noted the type of media, materials and technologies used, types of interaction and usage context. Results show that approaches to relate interaction with print media are experimental, most at a prototype stage and with a speculative design proposals frame, revealing interventions that allow us to understand printed artefacts as interactive interfaces and as opportunities for future work in interaction design.

Keywords: Interactive Print Media · Interaction Design · Speculative Design

1 Introduction

An interactive presence in print media has been a claim for some time, motivated in part by a presumed threat over the production and distribution of communication media that are gradually disappearing. Replacing print-based media by digital versions, and information that passes from physical to interactive environments, with generalized and uninterrupted access, made those who value close relationships with materials to speak out [1]. A reaction to realizing print media experience and influence on our thinking and on our perception of the world was endangered.

Print media occupy a great importance in our information needs, although they span through different activities. They contribute to knowledge acquisition, daily tasks, content distribution or mobility. Their tradition and functionality is based on the notion of 'mass media', – the sharing of the same communication media for most people –, which

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contrasts with interactive digital media and their functioning designed for individual choices.

With the emergence of the Internet and computerized devices, we have been witnessing a progressive decrease in the use, purchase and circulation of print media. Digital alternative [2] brings convenience, speed and simplification of access, facilitating tasks and operations, while presenting us with opportunities for participation and generation of personalized content. But also, a marked influence on cognition, literacy and development of younger generations [3]. Digital technologies approach to print media has led to the appearance of objects with electrical circuits, sensors or QR codes that provide transition from print to digital or examples of augmented reality on smartphones. However, these creations do not retain haptic properties of paper and analogue reading.

Therefore, several proposals have appeared to combine concerns about the disappearance of print media with digital media interactive capabilities [4–14], who challenge established conventions of our relationship with them.

Endowing print media with an interactive capacity has faced material, procedural, and technological difficulties inherent to an apparent print/digital dichotomy, which has faded [15, 16]. Besides, difficulties in accepting transformations, in which remaining print media are filled with new possibilities of contact with people and new combination of elements where lasting materials are positioned to maintain haptic and sensory features. This physical existence offers interesting advantages for designers to know and work with, as they allow storage of large amounts of information for a long time; they can enhance experience, through touch and smell; they resort to tangibility, making use of texture; and do not depend on electricity to function.

In this paper, we identify and characterize works that resort to printable related technologies where interactive features are paramount. Interaction and design processes have the potential to associate a multisensorial perspective and behaviors with print media, helping them to preserve importance and contribute in an innovative way to the hybrid physical/digital landscape.

Our research deepens an understanding of interaction design approaches and their application to print media, by stating conditions and interactive ways to create and develop products and systems involving print. It leads to an appreciation of print produced objects as non-digital or hybrid interface, recognizing the main means for these proposals to be effective or relevant.

2 An Unfavorable Framing

Several studies point out the decline of print media around the globe [17–20]. Based on industry sources, Pew Research Centre [21] covered the latest newspaper trends. In 2020, in the US, the circulation of weekday newspapers was 24.3 million and for Sunday newspapers it was 25.8 million, both a year-over-year decline of 6%. As a base of comparison, in 1990, the weekday newspaper circulation was 63.2 million and for Sunday newspapers it was 62.6 million, almost three times what it is today. Since then, circulation has been steadily dropping, reaching an all-time low in 2020 [20]. Richter [22] points out that the past decade has been rough for print publishers around the world. Increase in smartphone usage accelerated online consumption of news at the expense of

newspapers and magazines, which caused advertisers to gradually move their budgets online as well, forcing many print publications out of existence. Richter [22] suggests that magazines are facing a similar fate with ad revenues expected to drop to US$6.6 billion by 2024, down from US$20.6 billion in 2012.

According to Paxson [23] the newspaper readership skews towards older segments of the population. A 2016 study [24] found newspaper readership tended to be highest among older populations. Newspapers today struggle to draw younger readers, who tend to be more attractive to advertisers than older ones, however they are more likely to get their information from digital sources. Paxson [23] highlights that since 2000, some newspapers have quit publishing print editions, or have ceased entirely. Several major newspaper publishers have filed for bankruptcy reorganization in recent years, and other newspapers, including the New York Times, have laid off employees [23].

Industries traditionally focused on printed products such as the print industry, the editorial industry, and news media have undergone profound changes in their production processes, leading to a decrease in revenues and employment [25, 26].

The traditional news media business model has also been greatly threatened in the last decades, worldwide, since sales and circulation of major newspapers have plummeted. Between 2014 and 2019, there was a descent of approximately 65 million copies sold in Portugal [27]. Newsrooms had to diversify their means of financing to avoid downsizing or closing. A solid financing system allows hiring qualified professionals, the continuity of printed formats, maintenance of infrastructures, and, ultimately, the role of journalism as a pillar of a democratic state. Although the publishing sector is one of the largest culture industries in the EU, there is a declining trend that was amplified by COVID-19 pandemic [28]. In Portugal alone, book sales declined 30% between January and June 2020, while digital formats, like ebooks and audiobooks, had sales increases [29].

Print-related products, services, and systems may benefit from innovative processes and technology incorporation, namely through the inclusion of interaction strategies, adding value to users, and expanding markets [28].

3 Print Media Characterization

We start a characterization of print media by understanding it as communication and knowledge materials, subject to creative intervention and meant to instruct, communicate, educate or be a combination of all this [30]. Different categories can be identified such as books – including school textbooks, catalogues and brochures –; periodicals, as magazines and newspapers; promotional media, as posters and billboards; packaging; and others such as signage and merchandising materials [31]. Kipphan [31] explains that printed products are categorized into commercial printing and periodicals. This classification differentiates printed matter depending on its frequency of publication. Commercial printing refers to print products that are produced occasionally (e.g., catalogs, brochures, leaflets, business cards, etc.). Whereas periodicals are printed matter that appears in a determined frequency (e.g., newspapers, journals, magazines). There is a wide range of printed artefacts for different types of users and contexts [31] which influences their characterization. They vary in intention, sector of activity, relation to information and material production.

3.1 Print as Mass/Personal Media

Still, one of the main characteristics of traditional print media is its compliance with mass communication. According to Baran [32], mass communication is the process of creating shared meaning between mass media and their audiences. Mass media commonly includes television, radio, advertising and newspapers, and offers the same message to every person, while keeping indirect feedback from the audience. Something that contrasts with interpersonal or bidirectional communication which allows for distinct messages and direct feedback.

Immediacy and directness of feedback in interpersonal or bidirectional communication free communicators to gamble, to experiment with distinctive approaches. Their knowledge of one another enables them to tailor their messages as narrowly as they wish. As a result, interpersonal communication is often personally relevant and possibly even adventurous and challenging. In a different way, the distance between participants in the mass communication process, imposed by whatever technology is used, creates a sort of conservatism and conformation. Feedback comes too late to enable corrections or changes in communication that fails. The sheer number of people in many mass communication audiences makes personalization difficult and as a result, mass communication tends to be more constrained. Personalization of digital products became a necessity, while for physical products, we went from mass communication to mass customization [33]. This does not mean that mass media is less influential in shaping our understanding of ourselves and our world but has a limited sense of choice and less fluency in communication.

Print is an essential part of our culture and society, as a production technology and way of communication and print media have been designed to reach many people in the same way. However, mass media can be analyzed from an interactivity perspective, considered as a perceptual, individual and technology-enabled variable [34].

3.2 A Media for Interaction

Recent resort to distance learning has enhanced inequalities and digital exclusion, as it remains out of reach for at least 500 million students worldwide [35], increasing the need to maintain print materials to guarantee this function. Imposition of online classes has emphasized difficulties for some students to keep up with school and over digitalization of services tends to exclude individuals with no or difficult access to the internet [36]. On the other hand, reading on paper is still more effective than on screen [37, 38], while learning online competes with entertainment sources leading to dispersion. Textbooks are then essential instruments to support writing, reading, and learning mathematics; placing the materiality of books still as fundamental to successful learning [39].

Despite the advantages of print media, it is understandable to adhere to digital situations, where people have been a central point when planning actions and functions, and where some characteristics of mediated interaction can be well observed, as most are aimed at a multitude of recipients [40]. These media have a direct and indirect influence on our experience of print media [41], since we can observe other ways in which objects are proposed to people, especially in a two-way communication. But the relationship between print and digital media has not had the desired effect. Techniques,

such as QR codes or augmented reality had a sense of novelty, were quickly overcome. Simultaneously, there are positive results in the combined reading between printed books with e-books and audio-books [3], readers have more memory of a story read in printed books than in e-books [37], or that compared reading comprehension reveals print media advantages [38].

A common point that stands out in this relation is interaction, understood as a physical sequence of actions and reactions between a human being and that which surrounds him [42]. Although interaction design emerged in a context of digital technologies and human factors, there is still the designer's intervention as creative mediator, in evoking situations and languages for the future [43]. Interaction design acquired a multidisciplinary character [44], gathering knowledge from psychology, sociology or education and simultaneously, involving tasks and elements of graphic design, product design and architecture [16] while implying user participation with alternate messages over time. Norman [45] defends interaction as something that must be oriented towards the use given by people, even in an analogue way. Dubberly, Haque and Pangaro [46] also note it when observing interaction with static and dynamic objects, moving interaction away from technological dependence, but closer to the medium in which it manifests itself.

Some devices and systems are designed so that the physical part is decisive in interaction. Recognition of physical elements as necessary for interaction is related to technological contributions, such as portable objects and wireless networks. However, interaction in physical environments leads us to three-dimensional objects. Margetis, Antona and Stephanidis [47] state situations to allow natural interaction with physical 'smart objects', although, such an effort has not been made with paper, which is a material that can become interactive through 'technological augmentation', with the advantage of providing interaction in a more immediate way. Paper is present in various objects with which we already relate, such as most print media, and its interactive inclusion is beneficial because it does not become intrusive.

4 Interaction as Physical/Digital

Interaction design can be studied and interpreted, not only in the sense that it produces suitable artefacts and systems for those who encounter them, but also as a creative process that raises questions [48].

It is customary to consider interaction as dependent on digital media [49], but interaction also allows an understanding far from technology itself and directed towards human contact [50]. As a central object in this, the computer, besides having transitioned from an analogue existence to one dominated by digital technologies, has also passed over time, from a tool to a means of communication and its interference with interaction design, occurs especially in the conceptualization and structure of a process [51]. So, a close and regularly updated relationship with technology, does transform interactive approaches and imposes consequences on our contact with artefacts, but their suitability varies depending on the means involved and some of these means are constantly changing.

Perhaps more important than approaching technology is to understand the means that allow interaction, without constraints and without restricting interaction to a single

elaboration. Interfaces spread across various materials and are now present in various objects and everyday situations. It is possible to check interactive situations in brand stores, museums, public spaces, specific events, etc. Integration of interaction in diverse physical contexts [52] aims to create more useful, meaningful and context-appropriate experiences. Interaction design became understandable and feasible in several behavioral systems, digital or not [53]. Beyond its origins, it now seems to be framed by a relatively stable set of procedures that allow different situations which focus on the creation of significant relationships between people and systems.

Existence of environments, filled by objects with which we relate and where intuitive interfaces are integrated, such as paper or print media in a broader sense, presupposes consequences in terms of genre, content and functionalities, worth studying.

5 Interactive Print Media Cases

To better understand how this physical presence of paper can be harnessed to support interaction, or how interaction can provide beneficial possibilities for adapting print media, we gathered, described and analyzed eleven projects with different types of interaction levels and depths, made using technologies and materials where printing and the possibility of interaction are highlighted.

SmartSkin [4] is a study that includes two functional prototypes, a table and a tablet, to introduce a new sensor architecture for the design of interactive surfaces touch sensitive. Both prototypes use capacitive sensors and two different types of mesh-shaped antennas. However, the second prototype can also use capacitance tags that allow identification of certain physical objects on the surface.

The first interaction technique for the first prototype resembles that of a mouse. An estimated 2D position is used to replicate the movement of a mouse cursor, and the hand distance from the surface mimics the action of pressing a mouse button. Users can use both hands and arms to manipulate digital objects on the surface and more than one user can interact with the system simultaneously.

In the second prototype, fingertips are used to perform tasks. For instance, it is possible to use two fingers simultaneously (by fingertip detection) to pan, scaling, rotate or to pick up objects (multiple finger tracking and gestures). It can also be used for other types of interactions like hand or finger shapes as input.

One of the main purposes of this research, and one of its possible contexts of use, is to extend the workspace by turning real surfaces such as tabletops or walls into interactive ones, although, authors aim to extend this sensor architecture to non-flat surfaces such as armrests, table edges or even surfaces of pet robots, which can also be used for entertainment purposes.

PaperWindows [5] is a window-like environment prototype that simulates the use of flexible ‘paper’ displays in digital shape. The system uses paper as an input device with infrared reflective markers attached to its edges and to the user’s fingers, which in turn track the movement and shape of the paper that is read by a Vicon Motion Capturing System and then changes what is seen through a digital projector. Users can interact with the paper document using their hands, fingers, a digital pen or a set of gestures.

Interactions in this prototype were inspired by natural manipulation of paper but also by interactions commonly used in graphical interfaces, such as: hold, collocate, collate, flip, rub, staple, point and two-handed pointing.

Like SmartSkin [4], this prototype was also envisioned to assist users in their workspace, especially for photography-related tasks, as it was inspired using contact sheets by professional photographers.

Bookisheet [6] consists of two prototypes of bendable interfaces for browsing content based on the metaphor of leafing through the pages of a book.

The first prototype is a dual display structure while the second prototype is only a single display. Both prototypes use flexible displays, bend sensors and a PC host. The first prototype also uses a light-dependent resistor (LDR), which serves to detect brightness and understand open/closed states of the prototype. The second prototype also uses two speakers and two micro switches.

The first prototype has two modes of operation: discrete jumping and continuous scrolling. The first mode is to use the markers along the edges of dictionary pages, which indicate alphabetical order and are used to find certain words. This mode is activated when two plastic sheets are close together. Starting points are predefined, for instance at each index position of a dictionary. If the user folds the sheet, keeping the 'root' of the two sheets together, the focused index jumps from A to Z. The second mode corresponds to normal page turning, for instance, the user can turn pages one by one by curving the left or right sheets. It is activated when two sheets are facing away from each other. If the user curves the right leaf, contents scroll from right to left. It moves one by one continuously and scroll speed changes by changing curvature degree.

The second prototype has continuous scrolling and a finger-bookmarking feature.

These devices allow users to interact with a computer almost like a mouse or keyboard, and are thus suitable for use in applications and websites whose content is presented in pages, such as Wikipedia.

PaperPhone [7] is a smartphone-sized flexible E ink display which serves to evaluate bend gestures with a flexible display when performing tasks that are normally executed on a conventional smartphone, such as navigate in a list of contacts, play a song on a music player or navigate through a map.

The prototype works by physically manipulating flexible displays with bending gestures. Thus, it consists of a flexible E ink display that uses Flexible Print Circuits (FPC), bend sensors and an Arduino Microcontroller.

Direct and physical manipulation of the display can be done by pointing with fingers or through a digital pen but also by deforming the displays through bend gestures. To achieve a general interaction language that satisfies criteria of orthogonality, consistency, polymorphism and directionality a study was conducted to set up an interaction grammar for the prototype. It consists of: hold, collocate, collate, flip, rub, staple, point and two-handed pointing.

Based on a study of user-defined bend gestures, results showed that users saw great potential for using bend gestures when wearing gloves and that could also be useful for interacting without visual engagement with a device. They also reported to be appropriate for navigating pages in a book reader or even navigating through maps.

Display Stacks [8] is a system that enables physical stacking of digital documents using flexible E ink displays. In addition to the displays, a conductive dot pattern sensor is used, which is attached to the displays and allows tracking their position and orientation in relation to each other.

This project also introduces mechanisms for interaction, access and manipulation of information by asymmetric bimanual interactions. It explores interaction techniques by stacking the various displays facing the same direction and based on traditional interactions users usually have with paper documents such as pile, stack and bend, linear overlap and collocation.

This system is intended to be used in a mobile context and can have several types of applications, such as productivity or creativity. Users can take a stack of displays with them wherever they want to and use several of them simultaneously. For instance, to take notes while holding a videoconference or to study maps while outdoors.

FoldMe [9] is a device concept for double-sided displays that can be folded. This prototype contributes to understanding of bending gestures by exploring various types and ways of bending. The simulation system consists of an Optitrack motion capture system with 6 infrared cameras, a ceiling mounted full HD projector, and several bendable prototypes with infrared retroreflective markers. Information provided by the tracking system (position, orientation and folding status of the prototype) is used to distort an image projected onto the prototype in real time.

Physical interactions through folding that one can have with the prototype fall into three categories: types of folding; ways of folding; and folding and touching. In the first category, physical interaction types are: flat state, symmetrical fold downwards, symmetrical fold upwards, fold-to-front (valley fold), front-unfold, fold-to-back (mountain fold), back-unfold, continuous fold, complete fold, temporal fold. In the second category, we have three ways of interaction in folding forms: centerfold, partial fold and various combinations and in the third and last category we have one-handed and bimanual.

This project also features a set of more advanced interaction techniques that make use of direct touch input during folding. These interactions are foldable multitasking, foldable tool palette, foldable layers and foldable spin control.

This device cannot be yet used in mobile settings due to technical issues, however, despite limitations, two user studies suggest that this type of device can improve the way users manipulate information on handheld mobile devices.

PaperTab [10] is a paper computer with multiple functional flexible E ink displays. Each display window is an Android computer that can present various digital documents. Displays also use bend sensors, an Arduino board, a host PC and a desk that features three levels of focus called PaperTab Desk.

PaperTab Desk features three levels of focus (hot, warm and cold) that are related to how close display windows are to users. Display's location is tracked on the desk using electro-magnetic trackers. The hot zone is immediately within reach of the user's hands and arms and represents the active documents. The warm zone has an intermediate range and represents documents that are 'locked' or stacked. The cold zone is out of reach for users and represents documents that are archived.

This prototype addresses how office workers use paper documents and the advantages this medium has over graphical user interfaces, combining the advantages of electronic documents with paper tangibility.

PaperPixels [11] is a toolkit for creating subtle animations and environments on paper. It consists of plain paper that can have various colors and on which heat-sensitive thermochromic inks are applied in an illustration process. Peltier elements, which the authors call PaperPixel Elements, are attached to the back of the sheet of paper to allow animation. A driver platform and an animation software allow users to create the animation through a timeline.

Users can create animations by following eight steps. The first step consists of selecting materials, like paper and thermochromic ink pens; in the second one, users mark pixels onto the paper and then proceed to draw animation frames; thereafter mark pixels on a tracing paper and cut them; then place the PaperPixels elements, specify the animation sequence and finally play the animation.

PaperPixels has two goals. The first is to generate a tool that allows users to be part of a process where they become creators by experimenting, customizing and improvising animated paper. The second goal is to interact with paper manually, like what is done with origami and other paper crafts, allowing users to be involved in processes with paper such as drawing or cutting. It also presents possible usage scenarios based on feedback given by participants of a workshop conducted to test the toolkit. Therefore, it can possibly be used to animate storybooks, wallpapers or paintings.

Sensory Fiction [12] is a set that consists of an augmented book which uses connected sensors, LED lights and a modular vest wearable. It is an exploration about augmenting emotions in readers by using a vest that stimulates physiological responses, like a change in heartbeat (by means of compressed air bags), localized fluctuations in temperature and others, while interacting with the stories in the book. Main goals are to reflect on current trends in wearable computing and to enhance the reading experience through emotions.

Electrolibrary [13] **and Blink** [14] are both hybrid books that seem traditional physical books but integrate digital content using printed electronics. Both offer a multi-sensory reading experience by preserving haptic features of paper and augmenting interactions by adding digital capacities. These two projects differ in one aspect, while in Blink, book content, such as text, images or animations are shown on a computer screen by clicking on a printed button on a page, in Electrolibrary, digital content is shown in the computer when pages are physically turned, acting like an input device such as a mouse or a keyboard. Both hybrid books are intended to be used in an indoor space, much like at an office or at home.

6 Findings

Most identified and analyzed projects correspond to experimental prototypes and not products or implemented services of commercial endeavor.

Technical components seem to occupy an important part of attention and description of each project, which reveals how close and influent materials and technologies have

been in producing interactions, but also show these experiences as early stage ones, where it still does not seem possible to assume each achievement as a specific artefact or device aimed at groups of users, usage situations and specific sectors of activity.

In most cases, we can observe an intersection between digital and physical elements and the choice of media reflects today's understanding of the hybrid interaction landscape. Interactive surfaces, bendable interfaces and flexible displays share most options with augmented books and digital elements replicating paper-like features. The same can be acknowledged in material choices, which attempt to maintain paper with electrical and digital elements, such as sensors, E ink or conductive inks. There is prevalence for the use of flexible displays, or what can also be called 'smart papers' or 'e-papers' that use E ink, bend sensors and Arduino boards usually connected to a host PC. Such technologies are usual in conventional electronics prototypes, although nowadays, it is also common to use materials of printed electronics, such as conductive inks, to function as sensors in hybrid media. While these materials require an external device to display digital content, printed electronics have much potential as they are more affordable, renewable and biodegradable than conventional electronic components.

Most of the interactions explored in these projects show a close relationship with the possibilities we recognize in digital artefacts. Whether responding or trying to replicate the performance of common tasks in a digital environment. But we also observed the use of printed material as media with its own characteristics that allow new modes of interaction, such as folding or bending. All of them stand in the use of hands and gestures as a preferred sense for interaction to be accomplished.

Given the fact these cases are experimental prototypes, they seem to focus on possible ways for people, in a general way, to use and interact with something, rather than defining specific users' groups to be brought into research. They all seem to be more directed at reaching ways to maintain print as an option, by finding interaction and connectivity and not so much at solving clear problems or situations. By print, we do not observe just a concern with maintaining reproduction technology, but print as a cultural phenomenon, which shaped habits and relationships with materials. In cases where books were developed, this aspect is more notorious. There is an attempt to extend individual experiences of reading and close contact with objects, benefiting from the ability to deal with information differently.

Although not enough information is provided about each context of use, some cases lend themselves to more identifiable contexts. Most are close to concerns about work environments and productivity, which perhaps stems from business concerns. Other cases are governed by maintenance of the typical experience of print media, of individual enjoyment. However, some cases seem to address mobility situations, in aid of mobile devices, thus countering a tendency to establish a single space for the experience.

There is not enough information on which activity sectors can benefit from these prototypes and not sufficient indications on possible future applications for each of them.

6.1 Prototypes as Speculative Proposals

The fact that these projects are prototypes does not detract from their importance in contributing to understanding print media as interactive, nor in their framing as an

interaction design practice. Prototyping is understood as a very recurrent procedure in design to develop products and services [54] and constitutes a fundamental stage, with advantages in the organization of artefacts and in the ability to generate qualitative changes in the project. For Coughlan et al. [55], a useful version is the development of rapid prototypes, which have three main objectives: to create a tangible version of the ideas to work on; to allow learning of the shortcomings considered in the project; to allow approaching new behaviors and observing them. Potential users can then test prototypes and offer better input for project development [54].

Ultimately, the constitution of several prototypes early in the process paves the way for the realization of versions with greater fidelity. The purpose of the prototype is in fact the simulation of a final design proposal [56] as it integrates physical modeling, flow of thought, experimentation, observation of behaviors and technological components [57].

From our systematization and comparison of different cases, it results that these proposals have a speculative value. They are positioned not as a final object, as a product or solution to a problem, but rather as proposals that activate discussion around the concepts they reflect. Regardless of the purpose for which they were carried out, we can recognize matters of literacy, different ways to access knowledge, improvement of work conditions, and mainly distinct approaches to media falling in some disuse and worthy contributions to rethink an industry that has been in decline. Presented cases deal with some uncertainty, with the risk of being proposed and, therefore, with a lack of definition inherent to speculative approaches. They do not fit the common and known perspective of expected products or systems, but rather, like speculative design, with the purpose of changing that perspective [58]. If speculative design is to relate to everyday life and 'engage' people [59], then the use of paper and printing surfaces seeks to ensure proximity to people in different situations.

7 Conclusions

Print media are not interactive by themselves like digital media. However, print media can benefit from interaction features, possible by material augmentation and connection to computer systems and even from interaction as a broad concept, that encourages different and ambitious relationships with people. Print media is still a material embodiment that constantly relates to various audiences and yet seems unchanged when confronted with nowadays contexts, filled with interaction-based user experience.

Our study brings us closer to material and technological conditions that allow interaction in print media, introducing an understanding of the nature and purpose of projects developed so far as proposals for the future, where printing maintains its usefulness and value. These proposals approach a design territory named as speculative and critical, where design raises questions about the time to be, revealing social and cultural maturity.

There is a need to extend the work developed so far, to improve understanding of the interaction relationship with print media and to deepen the study and knowledge of specific matters, which have yet to be carried out. Discussed cases still do not have clearly defined user groups, which allow for ideas and details to be better suited to any proposed solution and to contexts of specific use. Each case seems to result from concerns with

some audience or group, but still without a delimitation capable of providing relevant data on use.

Types and techniques of interaction found in these cases point to an influence of digital artefacts and their possibilities. To provide print media with interactive capacity, an attempt was made to transition from already known solutions that guarantee the possibility of action-reaction and feedback. The same goes for exploring senses for this interaction to take place. Gesture and hands are the focus of attention to maintain the use of print media. However, tangibility characteristics of these media or the opportunity for voice interaction can be further explored. Also, to be considered is the perspective of attributing continuity and portability to these experiences, typical of print media, but which for now seem to be absent from the description of each project. Exception made to cases that relate to mobile devices, namely by size.

Despite the technical apparatus and the contribution of most proposals based on the explanation of materials and technologies used, each case also reflects an underlying concern, in maintaining tangible and tactile characteristics of print media, for the phenomenon of reading, viewing and access to information, whose cultural and relational aspects, over time we associate with print.

Although one should not assume the disappearance of print media, our analysis indicates a need to rethink or adapt them, in their relationship with people, who face changes and as such, challenge the objects around them. Connection to systems that promote interaction, renew people's experience and expectations.

This directly affects designers in their process, especially in idea generation, but also in developing interactive prototypes. Our synthesis represents possible solutions that designers should consider when designing artefacts produced by printing technologies, so that they foster interactive experiences with people.

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A Design Approach to Protect Children's Rights to Privacy and Freedom

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Abstract. The lack of privacy in digital services is one of the main features of contemporary surveillance capitalism. Privacy can be understood as the right not to have intrusions into one's private life and information, which we call negative privacy. Conversely, we regard positive privacy as the right to have personal data processed by service providers in a way that respects and enhances users' preferences and tastes. This paper—which is part of a PhD project in design, ethics, and privacy—explores the relationship between UX design and positive privacy for a specific group of vulnerable users and citizens: children. In particular, this paper analyses to what extent design patterns found in YouTube Kids protect and enhance their positive privacy by recommending content consistent with the videos they (and their parents) have previously watched and searched for. The methodology followed involves field research and an assessment of the legal provisions governing the processing of children's data under European and American legislation, along with YouTube Kids' privacy policies. Our research reveals that the app's UX has major loopholes that do not guarantee users' positive privacy adequately.

Keywords: Design Ethics · Human-centered Design · UX Design

1 Introduction: Surveillance Society, Privacy, and Children

The history of the Internet for private and commercial, non-military purposes is relatively short. At least in the most economically developed countries, households began connecting to the Internet around three decades ago. However, being constantly online, whether through a fixed or mobile connection, is the normal condition for a considerable part of humanity. Mobile networks are the preferred and sometimes the only way to surf the Internet for billions of users, particularly in developing countries [1]. As the Internet became pervasive, the boundaries between online and offline everyday activities began turning increasingly tenuous. Therefore, as Luciano Floridi notes [2], we could say that we now experience a continuous "onlife" rather than separate online and offline lives. This onlife condition has, nonetheless, grave consequences.

Having constant access to valuable information, regardless of our location, and being able to communicate with loved ones at any given moment are aspects that make our life easier, safer, and more prosperous. However, not everything about pervasive communication is positive. For example, could we say that constantly connected humans enjoy

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more freedom than their ancestors living permanently offline? Some people would argue that the Internet, which was initially touted as a promised land where freedom of speech would reign and that would offer endless possibilities for human communication [3], has turned into a virtual "Panopticon" [4]—a sort of digital building where every user can be constantly observed, without her awareness.

Everything that we do online can be potentially monitored, except for activities performed in the so-called "dark web" or when using VPN connections or similar tools designed to protect users' anonymity on the Internet. Given the degree of access that service providers have to users' activities, it may be argued that we live in a global Panopticon, in which some countries have implemented more dystopian measures than others to spy and control their citizens. China's social credit system, based on the massive and constant surveillance of people [5], is a prime example but not the only one. Within this system, citizens' everyday activities, social interactions, and even finances may positively or negatively weigh on their "social credit". A person with low credit may be denied certain benefits such as loans or housing and even be barred from booking flights or using the high-speed train system [3, 5]. While China's case is extreme, citizens in the so-called "free world" also have plenty of reasons to worry about violations of their privacy and freedom through digital technologies.

Some authors claim that we live under a new economic system they call "surveillance capitalism" [6, 7] or, more appropriately, "surveillance society" [8]. Both private companies and governments frequently monitor users' behavior online for business or political reasons, often under the pretense of protecting national security from criminals and terrorists. It is important to note, however, that digital surveillance is not always imposed. People often willingly embrace 'voluntary surveillance' when sharing their private information on social media [9]. Surveillance as an economic model exists and thrives because users actively surrender their data to service providers, e.g., when posting their activities on Facebook, Twitter, YouTube, or other content-sharing platforms. Although not exclusively, this behavior is more common amongst the younger generations of users, who do not conceive life without social networks. These so-called "digital natives" [3] are exposed to digital content and tools from the moment they are born.

Many of the most popular social media services and content platforms are controlled by a few large companies that have built their business model around extracting, accumulating, and trading users' personal data. While these practices are blatantly unethical [10], they are extremely profitable. So much so that entire services are designed to extract as much data as possible from their users. This information is used to gain insights into users' behaviors, for targeted advertisement and even to manipulate people's political inclinations. Such data extraction is pervasive nowadays, but it is particularly alarming in the case of users with a limited understanding of how mishandling their data can limit their choices and freedom: that is, children.

This paper discusses the protection of children's privacy from a user experience (UX) perspective by analyzing a real case example: the popular video application YouTube Kids, which YouTube developed specifically for children. As far as privacy is concerned, we will focus on a positive notion of data protection, i.e., the processing of personal data to enhance the users' freedom of choice [11]. In particular, the goal of this contribution is to present some preliminary conclusions regarding whether the algorithm of YouTube Kids

is designed to protect, respect, and enhance the children's preferences and selections. Limiting to a negative conception of privacy would imply that the service provider does not share children's personal data with third parties for marketing or advertisement purposes and that it does not track users across different platforms and sites. However, negative privacy does not mean that the users' data collected and processed are effectively used to provide children with meaningful content that respects their preferences.

The second section of this paper includes a brief analysis of European and American law provisions concerning the handling of children's data. More specifically, we will assess whether legislation embraces a positive notion of data protection for children. Next, in the same section, we will review YouTube Kids' terms and conditions to understand to which extent children's positive privacy rights are effectively protected. Due to the extension and complexity of these policies, which in practice are accessible only to the most literate users [12], we will assess if these legal documents are suitable to inform children and adults about what happens with their personal data. In the third and fourth section of the paper, we will analyze and discuss the design of the platform from a UX point of view to verify whether users' preferences and choices are respected. More specifically, based on the personal information directly collected from users, focusing on tastes and preferences, we will study the content proposed to children accordingly to understand whether the app protects and enhances children's positive privacy rights. Finally, the last part of the paper will present our broader findings and introduce further research developments.

The methodology employed comprises literature, legal, and policy review and research on the field, using the account of a fictional 5-year-old child: "Berenice", who lives in Portugal with her parents. The authors (a.k.a. Berenice) will access YouTube Kids native App on an iPad to understand to what extent YouTube Kids and its algorithms are designed to enhance users' privacy, autonomy, and freedom. This paper is part of an ongoing PhD research project which focuses on developing a universal, ethically minded, and privacy-focused human-centered design (HCD) framework for designers of digital services. Ensuring that the rights of the most vulnerable users are respected and that their choices, tastes, and preferences remain as free as possible from improper external interferences, allowing them to grow and learn in safety, is a central concern for our framework.

2 Privacy Laws and YouTube Kids' Policy for Children

To protect citizens, governments and lawmakers throughout the world have attempted to limit indiscriminate data collection through legal instruments such as the General Data Protection Regulation (GDPR)[1] in the European Union (EU) and the Children's Online Privacy Protection Act 1998 (COPPA)[2] in the United States. Contrary to COPPA, the GDPR is not specifically aimed to protect children's personal information, but it

[1] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons concerning the processing of personal data and the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), OJ L119, 04/05/2016, p. 1–88.

[2] 15 U.S.C. §§ 6501–6505 (Pub.L. 105–277, 112 Stat. 2681–728, enacted 21 October 1998).

includes various provisions about youngsters' data. Recital 38 requires specific protection for using children's data for marketing purposes or for creating personalities or user profiles, and in general, for collecting information about services offered directly to children. Specific protection is also required by recital 58 as far as information and communication is concerned: where the processing involves children's data, information should be in clear and plain language that the child can easily understand. However, we notice two important issues when applying these rules: first, the GDPR does not define what 'specific protection' exactly means; furthermore, services (such as YouTube Kids) are often addressed to children that cannot read yet. In general, one may argue that expecting that a child, even if literate, is at ease with concepts such as personal data, data processing, and the technology behind the services she uses is unrealistic.

Parental consent is required by both GDPR and COPPA to process children's data. In the EU, processing of youngsters' data below the age of 16 (or 13, when allowed by the national legislation of the Member State) shall be authorized by the holder of parental responsibility (art. 8). In the US, parental consent is required for processing data of children under the age of 13—§ 312.4(a) specifies that the digital service operator must provide notice and obtain verifiable parental consent prior to collecting, using, or disclosing personal information from children. Tastes and preferences of specific users indisputably are personal data for the GDPR. For COPPA, we propose to interpret extensively the provision of § 312.6(a)(1) that considers hobbies and extracurricular activities as personal data that deserves protection, with the effect to grant protection to tastes, choices, and preferences.

Both the GDPR and COPPA embrace a negative notion of privacy, rightfully setting limitations to service providers and requiring extra care duties such as parental consent. We assert that privacy is not only related to the collection of users' personal information and to what happens with that data, but is a major constituent of personal autonomy and freedom [13]. In that case, we realize that current legislation is insufficient to adequately protect and enhance users' rights. Our previous research demonstrated that these legal tools are necessary and vital, but a purely legal approach is not enough to genuinely protect users since legislation typically lags behind technological development [14].

YouTube Kids privacy policy is presented to users after they download the app. The parent needs to agree on it before she and the children can have access to the content. In the case of unregistered users, the policy states that the information collected is based on the use of the app by the child, including the videos watched, search terms, and other interactions. The information is also used to offer personalized content. In particular, YouTube Kids associates a unique identifier to the profile the child uses to watch videos and considers the search terms to recommend similar content and serve contextual advertising. However, the app does not allow interest-based advertising or remarketing. Users can also create a profile for the child or children associated with the parent's Google account, as we did in our research. In this case, the app uses the information tied to each profile to offer the child or children personalized content that is likely to match their interests, subject to the control features that registered parents have (more on this below in the next section).

This policy reveals that the service provider is aware of children's (and parents') positive privacy rights: the personal data collected are allegedly processed to offer personalized content based on the user's choices and preferences, including both registered and unregistered users. In the next section, we will assess to what extent our field research reveals that this claim is accurate.

3 Field Research: YouTube Kids' UX

This paper presents our ongoing research and its preliminary, non-conclusive results about YouTube Kids and how its UX is designed to promote and enhance users' positive privacy rights. This section summarizes our field research about YouTube Kids' UX from the point of view of positive privacy. In the paragraphs below, we present some cases selected from our investigation, with no ambition to provide the reader with a complete overview of how the app works.

To perform the field research, we created the profile of a fictitious user: Berenice, a 5-year-old child. Berenice lives in Portugal and uses her parent's iPad to access YouTube Kids app. Since the language of the device operating system is English, the app works in that language too. By design, the app allows only adults to unlock it by confirming their age. Children cannot unlock the app by themselves unless they are mature enough to select 'I am a parent' and confirm a suitable birth year. Furthermore, the app can be used without signing in; however, users who sign in through a Google account have more control over the content that their children can watch. YouTube Kids operates as a signed-out service so that children cannot sign in by themselves, and no parent's Google account is required for the app to work—unless a parent decides to log in to the app with her Google account.

In particular, logged-in parents can approve content—their children will be allowed only to watch videos or channels picked by parents from trusted sources, disabling the searching function— and choose content settings. Their children will allegedly experience enhanced customization preferences. YouTube Kids explicitly prompts parents to sign in with their Google account and create a profile for their child, at least in some countries. In the case of Berenice, the authors selected content recommended for children aged 5 to 8 (other options include content for children up to 4, and older children aged 9 to 12; as said above, irrespective of the age, parents can choose content by themselves, thus dramatically limiting the children's freedom to choose the videos to watch, and consequently the overall, interactive UX of the app). In this case, the system works to exclude content that is not suitable for children, but the app warns that no manual review of the videos and channels occurs (Fig. 1).

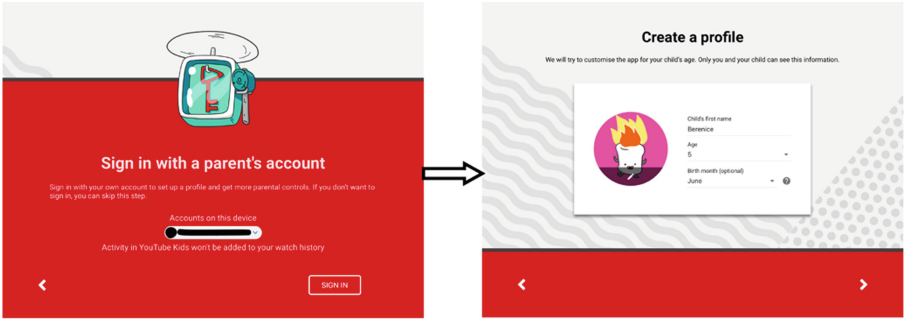

Fig. 1. We signed it to YouTube Kids using an author's Google account and then we created Berenice's profile.

Berenice's exploration of YouTube Kids started with a video of a popular Portuguese group famous among toddlers and children for their music and videos (Fig. 2). Then Berenice wanted to get entertained with a famous Australian cartoon translated into Portuguese (Fig. 3). Both videos have been accessed through a specific search performed by Berenice's parents since the 5-year-old still cannot read and write. Interestingly, below the video played, the app suggests content that is relevant for the user. During this first phase of the field research, only videos related to the ones chosen by Berenice's parents appeared as suggested. However, the app proposes content in English, despite that both videos explicitly selected were in Portuguese.

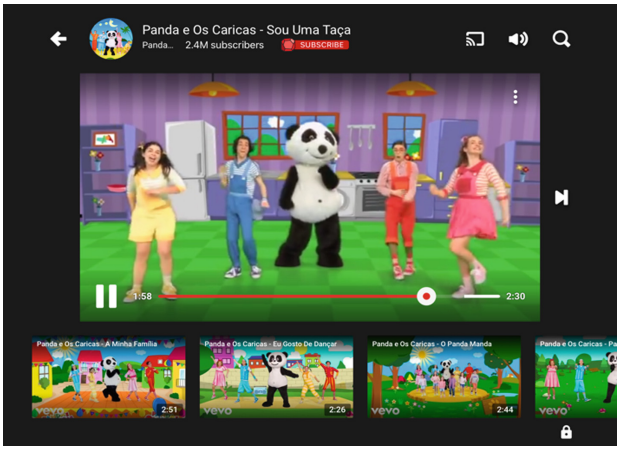

Fig. 2. The suggested videos are clearly related to the one selected by Berenice's parents.

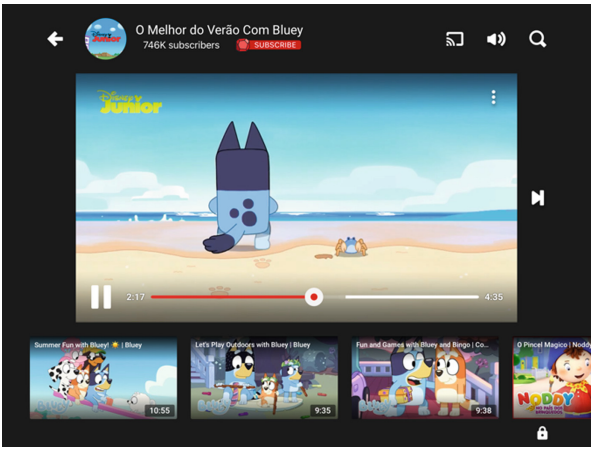

Fig. 3. The app suggests Bluey's videos in English.

Then, Berenice's parents pick a video collection with explicit educational content, called "Best Learning Video for Toddlers", among those suggested by the app for the child (Fig. 4). We notice that a video for toddlers should not be listed among those indicated for children aged 5 to 8, for a child who is aged 6 or 7 may have little or no interest in content developed for 1-year-old toddlers. Although YouTube Kids does not manually control every video assigned to the various age categories, an automatic selection based on titles should do the job.

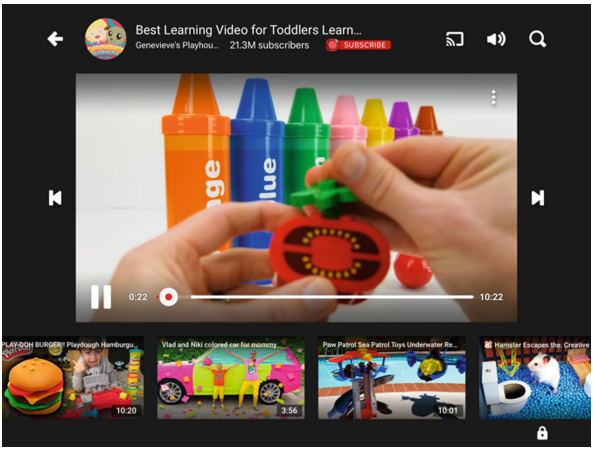

Fig. 4. Why content for toddlers is suggested to a 5-year-old child?

More worryingly, in the carousel below the recently played video, the app suggests content that is patently unrelated to education and learning, including a video that promotes a brand of toys (Fig. 5), one with links to content outside the platform (Fig. 6),

and a video that depicts questionable behaviors (two children covering their mother's car with post-it notes and kicking its tires to provoke the alarm to sound— Fig. 7). Furthermore, the app suggests videos in English and in Turkish. If the app's language settings justify content in English, we have no explanation for YouTube Kids proposing videos in Turkish.

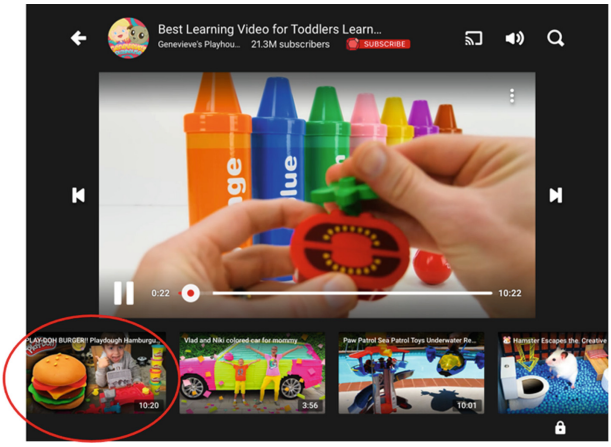

Fig. 5. This video clearly promotes a popular toy brand.

Fig. 6. Children are pushed to check the characters' Instagram accounts.

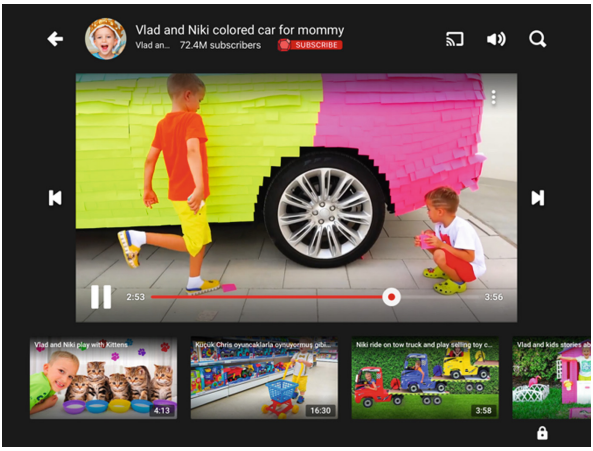

Fig. 7. Parents may find this content harmful for Berenice.

In the next section we will discuss whether YouTube Kids' UX defends and enhances children's positive privacy, and we will draw some preliminary conclusions arising from our field research.

4 Discussion: YouTube Kids and Positive Privacy

The analysis performed shows that YouTube Kids took—at least apparently— some concrete and positive steps to protect users' privacy. In particular, the privacy policy (called "Notice to Parents") that is presented to users when they begin using the service is readable, understandable, and short. As we commented above, the opposite tends to be the rule [12, 15]. However, the Notice to Parents refers to 3 more documents: the YouTube Kids Privacy Notice, the Parental Guide, and the Disclosure for Children document. The YouTube Kids Privacy Notice, dated 7 August 2019, further refers to other policies: the Google Privacy Policy (a complex document composed of several sections—however, in case of conflict between the YouTube Kids Privacy Notice and the Google Privacy Notice, the former overrules the latter) and, when applicable, the Privacy Notice for Google Accounts Created with Family Link. The Parental Guide is an exhaustive guide for parents about the app's functionalities that refers to the YouTube Kids Privacy Notice as far as privacy is concerned. The Disclosure for Children document, called YouTube Kids Notice for Children, dated 7 August 2019, explains in plain language how their data are collected and processed (Fig. 8).

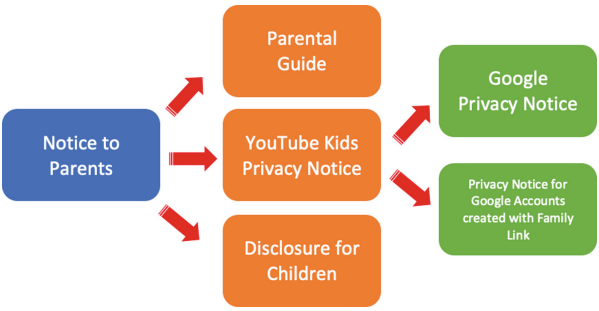

Fig. 8. The Notice to Parents refers to other legal documents.

An assessment of the documents involved shows that their content is consistent. However, this does not mean that the company applies its policies consistently: in 2019 the US Federal Trade Commission sanctioned Google and YouTube for alleged violations of children's privacy rights and COPPA legislation to pay a 170 million USD fine for serving targeted advertisement on channels directed to children on the YouTube and YouTube Kids platforms.[3] This paper is concerned with understanding whether YouTube Kids protects and enhances the right to choose the content to visualize without undue external interferences. Assessing if the app respects users' negative privacy and, in particular, if their personal data are collected and processed lawfully, goes beyond the scope of this contribution. YouTube Kids offers the possibility of restricting navigation to content priorly approved by parents. This feature, however, limits tremendously the functionalities and possibilities offered by the app, and arguably hinders children's capacity to learn and develop their abilities. Maximum control by parents implies poor UX for youngsters, denying them the right to choose which videos to watch. Paradoxically, the feature that most protects users' negative privacy rights—for the amount of data collected and processed, such as the videos watched and searches performed, is dramatically reduced—is the one that most narrows their positive privacy expectations. This finding confirms that data protection is multifaceted and cannot be reduced to one fits all solutions and definitions [11].

We notice some features that restrict children's positive privacy rights when the app is used normally, i.e., without strict filters and restrictions. YouTube Kids suggests content that is not relevant for the child, nor related to the videos watched. We proposed to Berenice cartoons adapted for her age, videos with music from a popular Portuguese group of artists for children, and educational short films. However, the algorithm of YouTube Kids invited Berenice to explore content that, the more she browsed through the suggested videos, the less it had to do with the original content searched and watched. More quantitative research is necessary to confirm our findings, but we realized that this happens irrespective of the child's age. E.g., videos of the famous YouTube Kids stars Vlad and Niki depicting them playing rather aggressively were proposed by YouTube Kids even after we altered the age of Berenice to the group of 0 to 4 years.

[3] Source: https://www.ftc.gov/news-events/press-releases/2019/09/google-youtube-will-pay-record-170-million-alleged-violations (last accessed 25 October 2021).

Furthermore, we identified a tendency to suggest videos that promote toys and other products, either directly in the name (as shown in Fig. 5) or indirectly in the video. This phenomenon has been extensively analyzed in the literature that agrees that influencers often include sponsored content in their videos to earn money [16]. The reason behind this is that children rely on YouTube for entertainment more than on traditional media such as television [17] and that they develop long-lasting relations with YouTube influencers [18, 19]. Influencer marketing on YouTube raises ethical questions, for it integrates commercial content in an alleged non-commercial video created by independent content creators [16]. This issue is particularly worrying when the content provider does not explicitly inform users that the video includes sponsored content. During our survey, we encountered several videos showing branded toys used by YouTube influencers without any disclaimer.

Influencer marketing is often more subtle. In the clip in Fig. 7, the YouTube stars cover with paper notes a car whose brand is recognizable along with the video. It is not uncommon for the influencers' parents to drive expensive cars that can be easily identified. Is it by chance, or is it part of an accurate strategy to promote specific brands among youngsters and their parents? Providing an answer to this question goes beyond the scope of our contribution. However, we accept the possibility that this phenomenon is one of the many sides of surveillance capitalism—that could be summed up in the precept "capture consumers' data and educate consumers to buy more".

Our field research noted a tendency to nudge users to watch videos from specific channels or content creators, irrespective of the videos previously watched, of the child's age, and the language of the content accessed and of the device's operating system. More research is necessary to understand if there is a reason behind it: does YouTube Kids pushes users to watch videos from content creators that generate more revenue for the platform? Similarly, Berenice experienced that YouTube Kids suggests videos in languages (e.g., Turkish, Russian, Hindi) that have no relation to the content she watched. These considerations indicate that YouTube Kids' UX is far from being entirely satisfactory for users—at least, for users that have a clear, complete understanding of the content they are watching. More research is necessary, using real children to assess how they react to the videos proposed by the platform. E.g., do they dislike videos in languages that they do not understand, or is this not a significant issue for youngsters? Are the visual content and the engagement and connections they create with characters more important than the language spoken? Research using children raises ethical questions but can provide valuable answers to the above questions.

As far as positive privacy is concerned, our investigation suggests some preliminary answers. YouTube Kids' UX does not fully respect children's (and parents') positive privacy, for it nudges users to watch content that has nothing to do with their preferences and search history. Our analysis reveals that the UX has major loopholes: irrespective of what users want to watch, and unless parents set up strict filters and restrictions, the algorithm suggests content with no connection with users' tastes and choices.

5 Conclusions

Privacy is much more than hiding personal information. Privacy allows us to fully develop our personalities, interests, and tastes [11, 13]. For this to happen, we must be allowed

to explore the world as freely as possible, without undue external interferences. In other words, we should be treated like valuable human beings and not simply as sources of data that uncountable (and unknown) third parties can monetize. When talking about children, negative and positive privacy go hand in hand: EU and US service providers on the Internet are legally obliged to collect and process users' personal data fairly and transparently, but they should also allow children to develop their tastes without constraints. Positive privacy is not a legal requirement in the jurisdictions assessed in this paper but is an ethical necessity. YouTube Kids explicitly declares that it collects and processes youngsters' data to provide them with relevant content. However, our field research proves that such a mechanism has many loopholes. From a UX point of view, the service provider has two options: (1) it does not offer any suggestion about videos that may be of interest for users; (2) it offers suggestions really and strictly based on the user's age and interests, based on the videos she watched, and she (or her parents) searched for. YouTube Kids does not follow any of these paths.

Furthermore, and more worryingly, the logic that moves the algorithm when suggesting content is not transparent. The opacity of algorithms is an issue well known and assessed in the literature (see, e.g., [20, 21]). However, more research is necessary to understand the impact of digital algorithms on younger users and citizens.

Children are vulnerable, at risk of having their privacy violated and being manipulated [22]— i.e., to have their negative and positive privacy infringed. However, this author poses a disturbing and provocative question: why should we care about privacy while children in many world regions do not have access to education, food, and clean water? [22] The more obvious answer is that a problem does not eliminate the other. In other words, disregard for children's privacy on the Internet does not help solve more imminent and, objectively, tragic issues.

Furthermore, other authors claim that leaving big tech companies thrive without controls and burdens paves the way to a poor future for our children [23]. The concentration of power and health in the hands of a few companies restricts competition [24] and, ultimately, is terrible for the economy and society. Although alternatives exist, lack of competition between platforms [25] and algorithm transparency are significant issues that prevent the affirmation of children's positive privacy expectations. We are careful in using the word 'right(s)', for it is problematic: do children have positive privacy rights? EU and US legislation does not recognize them explicitly. However, YouTube Kids' privacy policies explicitly state that the content proposed is based on what the users watched and searched for. For this reason, we advocate that the app users contractually have such right—or, at least, a legitimate expectation.

Our future research will focus on expanding our knowledge about the relation between UX design and privacy. Regarding children, more investigation is necessary to confirm the preliminary findings presented in this paper and better understand how the algorithm of YouTube Kids works in practice, despite its opacity. More generally, our research aims at building a universal privacy ethical framework that designers could apply when dealing with services, solutions, and applications that involve the processing of personal information. Ideally, such a framework will be applied to the design of algorithms to protect the users' negative and positive privacy rights. The scope is to

provide designers with a valuable tool to improve the products they create and, more importantly, our societies at large.

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