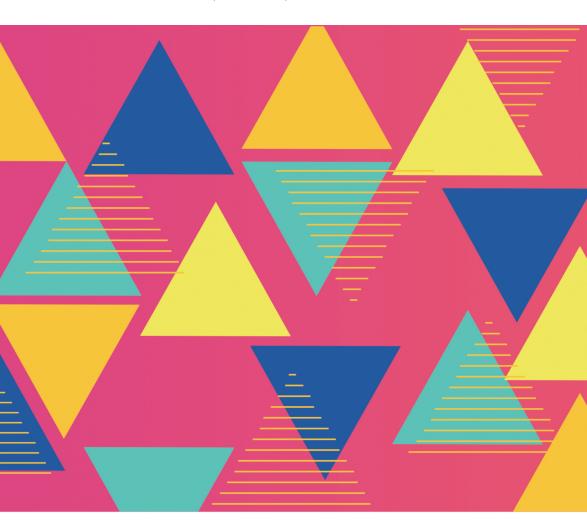# DESIGN RESEARCH IN THE DIGITAL ERA

Opportunities and implications
Notes on Doctoral Research in Design 2020

edited by Lucia Rampino and Ilaria Mariani

DESIGN INTERNATIONAL SERIES

Direction: **Silvia Piardi**

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Over the last few years the international design research network has become an important reality, which has facilitated the sharing of ideas and opinions, improved understanding of the subject and increased awareness of the potential of design in various socio-geographical contexts.

The current expansion of the educational network allows teachers, students, researchers and professionals to meet, both online and in person.

It would seem therefore that the time is now right to propose a new series of books on design, contributing the construction of the international design community, helping authors bring their work onto the world scene.

The Design International series is thus born as a cultural setting for the sharing of ideas and experiences from the different fields of design, a place in which you can discover the wealth and variety of design research, where different hypotheses and different answers present themselves, in an attempt to draw up a map of Italian design, though in a continuous comparison with the world scene.

Different areas of design will be investigated, such as for example: fashion, interior design, graphic design, communication design, product and industrial design, service and social innovation design, interaction design and emotional design.

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Digital Transformation

Ethics and social awareness

Designing in an era of transformation comes with responsibility

Lucia Rampino and Ilaria Mariani
Department of Design, Politecnico di Milano

The PhD in Design at Politecnico di Milano was established in 1990, exactly 30 years ago. It was Italy's first PhD Programme on the topic, and its leading figure was Ulm School of Design former teacher and director Tomàs Maldonado. Its original name was "Doctoral Programme in Industrial Design and Visual Communication," which showed the discipline's traditional legacy as being concerned with the technical study of two-dimensional and three-dimensional artefacts. The thematic areas covered were theory and history of design, product design, visual communication and environmental issues (Pizzocaro, 2003, p. 174). The programme partly acquired its initial approach from being situated in an increasingly complex framework, where innovation was relevant. This fuelled a need to consider the importance of design providing competitive advantages. Hence, in the first years, research themes were focused on the theoretical investigation of innovation-related phenomena (Pizzocaro, 2003). The strict relationship with the architecture field was evident. As a matter of fact, in Italy, the design was born from within the architecture discipline and only recently broke free of it.

From its 1990 foundation, when it hosted two candidates, our PhD Programme has grown significantly in size and has extensively enlarged the range of subjects covered. Now, 20 students join the Programme annually, entering a 250-strong Department, which is Italy's largest design research and education institution, and one of the largest internationally. Both the Department and the PhD in Design programme, welcome International members, embracing the cultural enrichment they bring.

Over its 30 years of PhD in Design, 231 theses have been discussed, and just as many candidates obtained their doctorate. By looking at the evolution of the addressed topics, it emerges that design research at Politecnico is no longer a matter of interior spaces, furniture, artefacts and their users, mass

production or technological advancements. Although the emphasis on conducting innovative research at a social, technical and organisational level is maintained, an updated perspective has consolidated. It reaches out to multiple disciplines and new issues, ranging from sustainability, design thinking, artificial intelligence, creative industries, and design ethics. If we initially systematised the Degree Courses' addressed topics based around the Degree Courses offered from our School – Product and Service, Fashion, Interior, and Communication – such a scheme has become blurred and obsolete. Throughout the PhD theses, the borders between the sub-fields faded, showing a rooted inclination to integrate and hybridise perspectives, towards more inclusive and crossbred ways of looking, studying, and framing our discipline.

To underline such a broadening of disciplinary focus, in 2009 the name of the Programme was changed from the original "Doctoral Programme in Industrial Design and Visual Communication" into "Doctorate of Research in Design", or more informally "PhD in Design." Our PhD demonstrates its cultural roots and consistency throughout its variety of topics and approaches while providing the Politecnico's large design community updated research avenues. The increasing amount of addressed themes tends to strengthen the bond with Italy's typical features, its local identity, mode of production, and the enhancement of our cultural and environmental heritage (Maffei and Bertola, 2008). Meanwhile, enlargement of topics demonstrated design's heterogeneous and multidisciplinary nature.

Over the last 30 years, the design discipline moved from a product emphasis to a broader user and community focus, to looking at wider perspectives that treat users, stakeholders, artefacts, and environments as part of interconnected systems (Rampino, 2008). This process of zooming out and becoming more inclusive is essential when society is seen as a systemic component.

The Milano Design PhD Festival: a public celebration of knowledge

Ideals of openness and inclusivity, which are rooted in the design disciplines are the foundation of the main annual event in the PhD in Design's calendar. Aimed at promoting participation and offering to the large Politecnico design community an "in house" occasion to gain knowledge and nurture debate, eight years ago defending a thesis became a public event – the Milano Design PhD Festival – that is now at its tenth edition.

The discussion partly moved from the traditional "defence" into a "public celebration of knowledge" (Guerrini and Volontè, 2018, p. 9). The main

point was the event's openness towards the reference community, not just for academics, but practitioners, hybrid figures, and stakeholders.

Since its birth, the Festival's aim was to establish spaces and times to spread design culture, stimulate dialogue on its advances, and nurture networking. This last point is boosted by inviting guest international scholars, who are asked, not only to take part in discussion with the candidate but give lectures and participate in panels. By looking at the Festival in its entirety and variety of events we can say it provides an international, extended perspective on design matters, using an original formula. Each year, we are aware of how this formula is a distinctive feature of our PhD in Design, that emphasises the community's desire to grow and share its practices.

The Festival's social dimension becomes even more evident after sunset, when the food and drinks arrive, transforming it into an event that promotes informal conversations on design and design research. At its core is the intent to address a long-standing weakness of the design discipline (Buchanan, 1992) – the difficulty in starting constructive discussions and practical knowledge exchanges between practitioners and researchers, and different design academic communities.

The Milano Design PhD Festival's overall aim is to leverage diversity, interconnections, and reflect on the broad nature of design research. It has become an occasion where advances in design research become known, a chance to meet top international scholars and promote collective learning.

The PhD in Design Network: Feeding debate and growth

The Festival has a twofold intent. The first is spreading local design knowledge by opening the event to different stakeholders, and the second is targeting a growing internationalisation which helps the circulation of people, ideas and research practices. We acknowledge the importance of taking part in the international debate about the nature (structure and learning approaches) of Design PhD Programmes, to provide a fundamental source of continuous improvement.

Seconding our willingness to discuss our research practices with other doctorates that have a long-lasting tradition, in 2018 the PhD in Design played a key role in building a PhD in Design Network with five renowned design schools – TU Delft, Aalto University, IIT Chicago, Carnegie Mellon and London Imperial College. Since its beginning, the Network organised bi-annual meetings among PhD Programmes which shared experiences, reflections and PhD level design education ideas.

To celebrate 30 years of PhD in Design, in 2020, Politecnico di Milano is hosting the network meeting as an official event featured by the Design PhD Festival.

Topics, interests, and directions across multiple research fields

As part of a series launched in 2017, this book presents an overview of the doctoral theses to be defended in February 2020. Every year, it offers an overview of the richness of addressed topics, showing the variety of fields and the multiple aspects of design research carried out at the Politecnico di Milano, Department of Design. Such a variety, ranging from art history to mechanical and chemical engineering, across architecture and sociology, is attested by the many PhD candidates and supervisors disciplinary backgrounds and expertise.[1]

As said, our PhD looks at disciplinary diversity as a remarkable source of richness. We are in a time that recognises the value of research competencies which can explore emerging topics positioned at the intersection of multiple research fields. PhD Programmes promptly responded to this call to renew design expertise, looking at progressive hybridisation with neighbouring disciplines.

The relevance of this disciplinary blend to our Polimi community is shown to a larger extent by the Design Department's research directions. These directions aim at the areas where design overlaps with the other polytechnic disciplines: engineering (as expected), managerial studies, social sciences, arts and humanities. These overlaps define four interdisciplinary research lines, on which the Department has been focusing in the last few years, and will focus in the near future:

• Design for Advanced Manufacturing
• Design for New Business and Entrepreneurship
• Design for Social and Public Sector Innovation
• Design for Cultural and Creative Industries.

Taking advantage of the technological possibilities, and being aware of their implications, the explorations carried out by our doctoral candidates are changing the traditional areas that were once the established main domains

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[1] For the thesis defended in previous years, see: Biamonti and Guerrini, 2017; Biamonti, Guerrini and Mariani, 2018; Rampino and Mariani, 2019.

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of design interest. An inherently distinctive disciplinary trait has emerged: the need to consider and address complex societal and cultural issues, i.e. wicked problems. It is such a need that drives the evolving boundaries of design research, not just in our Doctoral Programme, but also other national and international Doctoral Design Programmes.

10 PhD theses

The 10 PhD theses presented here were started in 2016 and cover the above mentioned four interdisciplinary research lines, sometimes overlapping them. They share a common trait in that they explore the implications of the ongoing digital transformations, from the specific perspective of design research. We are in a time of significant change, led by sequential digital revolutions. Such changes that are impacting our daily life, are not just technological, but also social and cultural. As a consequence, trends that are transversal to different fields are advancing, requiring design to be aware, responsive and, above all, predictive.

Acknowledging the potentialities of IoT, Artificial Intelligence, Additive Manufacturing and Automation, in recent years design has paid increasing attention to the impacts and opportunities related to digital technology. This has naturally slipped into our studies and helped orient them. Throughout the book, the cultural, organisational and social issues raised by digital technology and its applications, are debated, showing how such problems have become the subject of extensive research, analysis and experimentation.

We decided to organise the book into three thematic clusters: "Human-centered design practice," "Digital transformation," and "Ethics and social awareness". The first two clusters address, from different perspectives, how and to what extent the ongoing digital transformation demand reframing of design processes, practices and models. The third cluster taps into a growing but still underexplored issue – the ethics and social awareness which have developed in today's smart and interconnected world.

Each of the three clusters are introduced as follows.

Human-centered Design Practice

Recognizing culture and creativity as assets for competitiveness form one side, sustainable and inclusive growth from the other, this section addresses design for different expressions of cultural enhancement, opening critical

reflections on the role of design in defining approaches and tools for applied research (Battarbee and Koskinen, 2005). By adopting a service design approach, the three featured contributions demonstrate the capacity of design to develop frameworks and tools for complex design process management (Verganti, 2008). These processes involve the participation of players from different cultures, where end-users have an active role as co-designers and co-producers (Manzini, 2016). This resulted in updated models of sustainable and inclusive user involvement.

In the first chapter, Martina Rossi introduces her research on collaborative practices that make use of design tools and methods within private organisations. Emphasising how the design process influences and is influenced by the way people interact, behave and learn, Rossi suggests a framework for a dedicated course of action that can be adopted by private organisations making their first steps towards a collaborative culture.

In the second chapter, Milica Pavlovic addresses the topic of user interaction and experience design by discussing potential design strategies and toolset to be applied in the design of spaces enhanced by digitised services. Dealing with projects of high complexity, the study aims at expanding the current UX practice by providing a toolset as a backbone for structured design processes and creating a common language between the involved stakeholders.

In the last chapter of this section, Shushu He tackles the implications of today's multicultural society, where foreign people offer services to locals. Acknowledging that such services can be stereotyped or rejected because of established cultural biases, her study aims at helping UX designers to gain a deeper comprehension of values in cultural diversity so to enhance cross-cultural experiences.

Digital Transformation

The ever-increasing calculation power of computers makes other digital technologies possible and more powerful too. Digital technologies allow the collection and analysis of a vast amount of data, which processing was unimaginable by the human mind. At the turn of the new millennium, multitudes of people were empowered by Internet-access which could produce and share their own knowledge (Rampino, 2018). According to Brand and Rocchi (2011), one of the most profound social shifts is that now ordinary people can access social dialogue and exchange opinions across geographical boundaries. This is the result of two digital revolutions:

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[…] over the last half century, two digital revolutions have come to pass, more spectacularly than Moore himself predicted. The first digital revolution was in communication, taking us from analog phones to the Internet. The second digital revolution was in computation, bringing us personal computers and smartphones. Together they have fundamentally changed the world. (Gershenfeld, Gershenfeld and Cutcher-Gershenfeld, 2017, pp. 3-4)

A third, more recent, digital revolution is on its way too. It is still in its early stages, but its impact on product design is already significant – digital fabrication. Consequently, new scenarios emerge, such as those of open and distributed manufacturing, experimented by Fab Labs and Makerspaces, and advanced experimentations in traditional sectors, such as Med-Tech and Fashion-Tech. When it comes to interconnected artefacts, the growing availability of embedded digital technologies, e.g. sensors, actuators, and processors, brings profound consequences (Schmidt and Van Laerhoven, 2001; Vermesan and Friess, 2013). Products and systems became dynamic and interactive, aware of their surroundings, with a form and a behaviour that can change in time. Moreover, the application fields have significantly enlarged and diversified, benefitting of integrating a technology that is today cheaper and increasingly diffused (Evans, 2011, 2012). This section outlines how different fields can sharply embed and take advantage of digital transformation.

In the section's first chapter, Carmen Bruno looks at creativity 4.0 and explores the influences of the digital transition on human creative potential. Bruno discusses the cognitive, emotional, motivational and social factors of creativity involved in the design process and outlines a framework that supports digitally enhanced human-centred design methods for innovation.

Arianna Bionda looks at Yacht Design in the second chapter. In an area where Industry 4.0, Internet of Things (IoT) and intelligent products are profoundly transforming design processes and outputs, Bionda presents a systematic and comprehensive study of future alternatives showing how digital technology could be implemented in a Yacht Industry 4.0 scenario, modifying yacht design approaches.

Digitisation of cultural archives and museums opened the way for extensive collections released under open licenses which fostered the creation of cultural content aggregators. Although such aggregators adopt performative technologies and rigorous sharing methods, their user interfaces still present usability issues that keep digitised heritage often invisible to the end-user. In the third chapter, Giovanni Profeta investigates classification systems and interface solutions that may foster the access and use of digitised cultural objects.

Along the same lines, Sara Conte suggests an updated drawing and representation system to enhance the preservation and fruition of modern architecture in the archival sector. She experiments the use of infographic BIM-oriented software and parametric models to preserve and communicate historical architectural documents. In particular, Conte addresses how digitalisation encompasses architectural archive projects, and proposes the valorisation of the heritage of Adriano Olivetti and his company in the city of Ivrea, through the work of one of its most representative, but less well-known designer, Eduardo Vittoria.

Ethics and social awareness

The distribution of digital technologies entails as many opportunities as unforeseen issues that affect our society at different levels.

> […] we built breakthrough digital communication capabilities, but we failed to build in cultural norms, feedback loops, and algorithms that could have reinforced civil discourse. We created incredibly efficient new models of digital commerce, but have also introduced new threats to privacy and security. We value the advances made possible with digital automation, even as we struggle with the impacts of lost jobs due to technology. (Gershenfeld, Gershenfeld and Cutcher-Gershenfeld, 2017, p. 5)

Individually and socially, advances in technologies have always brought significant changes. These are not just economic, but cultural and personal behavioural changes. The unwanted effects of the digital revolution(s) such as compulsive surfing, are becoming coeval wicked problems (Buchanan, 1992; Rittel and Webber, 1974) that require attention and consideration.

The pervasive presence of devices gathering personal data is feeding a growing amount of digital solutions that use this data to tailor and improve their offered services. The collection, storing, exploitation and sharing of this data, however, raises several privacy and security concerns. In her chapter, Laura Varisco addresses this topic, presenting a method aimed at eliciting designers' awareness about the impact of the use of personal information. Ranging from the data implied and the data flow of the designed solution, Varisco encourages the designer to consider possible effects on four "layers": self-awareness, action performance, interpersonal relationships and social agency.

In the second chapter, Mario De Liguori investigates a vital issue of our time: obsolescence in digital products. Positioned in the Life Cycle Design

literature and addressing the human environmental footprint, the study investigates whether lasting emotions towards electronic objects can affect the psychological wellbeing of people. Recognising that the topic's implications range from circular economy strategies to business models, simultaneously dealing with the principles of emotionally durable design theory, the chapter synthesises data and results of an empirical study lead on a sample of about 1.300 young people, mostly belonging to the Z generation.

The last chapter deals with one of the largest, and most challenging industries, Fashion. The Fashion sector has been strongly impacted by the digital wave that pressured brands and retailers into innovation while becoming ethically conscious of their cost. This sector is one of the world's most polluting. Trinh Bui Mai and Alba Cappellieri focus on Accessory Design and tackle the topic of sustainability, by presenting tools aimed at supporting fashion designers towards a more environmentally and ethically sustainable design process.

The overall book, and these last three chapters, are a wake-up call for our own responsibility. While pushing design research forward, we need to address any issue with a constant ethical perspective. In today's complex world, we must keep creating and spreading knowledge, while enhancing openness towards other disciplines and different cultures, taking care of the local environment without overlooking our society.

The fundamental issues that move and nourish design research have been categorised by Sato (2000, p. 137) into two macro-areas towards which the scientific commitment of those who conduct design research is directed. There is a need to deepen "design act" theories and methodologies while increasing knowledge on "design subjects." Due to the constant hybridisation and advancements, these areas are continually expanding. Regardless of the attention that inevitably arises on the mechanical and systemic aspects of artifacts, our context reference educates and prompts us to design with the human element at the centre. An aspect that takes on an ever-increasing dimension, because of the growing technology inclusion in our daily lives.

That is to say that, especially today, designing in an era of digital, social, economic, cultural transformation comes with broad responsibility. Often the impacts of what has been designed is unclear, and that is the scope of our investigation. It is up to us. Reasoning the what-ifs and the implications of what we create is paramount and an intellectual foundation of the design discipline that thoroughly permeates our community, and the PhD in Design, in particular, reflects it throughout its production.

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We thank Politecnico di Milano, Department of Design and everyone at the PhD in Design who provided us with valuable help and assistance. The studies described in the chapters are mirroring our community. We are aware of the role that such an exciting environment plays in reaching advances. We gratefully acknowledge the supervisors and co-supervisors of the newly Doctors in Design[2] who challenged them for the last three to four years, and inspired and shaped their research. Further acknowledgements are made to the PhD Board and committees which over the years made their assessments moments of prolific debate on cutting-edge topics addressed by each candidate.

A special thanks go to Simona Murina and Paola Mosca, for being consistently supportive, as key members of the PhD staff.

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In conclusion, we are deeply thankful to our PhD in Design Coordinator, Paola Bertola, for entrusting us with the responsibility of collecting and give back an overview of what is happening in our Programme for the second year running.

This book is truly a team effort.

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[2] The estimated publishing time is just a few days before the Milano Design PhD Festival, and the defence required for the authors' PhDs.

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Human-centered Design Practice

Human Resource Design.
Steering human-centred innovation
within private organizations

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Abstract

The research investigates collaborative practices that make use of design tools and methods within private organizations. In recent decades, much attention has been put into exploring the effectiveness of service design and design thinking in increasing the degree of innovation of solutions delivered to the market by companies. Less focus has, instead, been placed on understanding how the design process both influences and is influenced by the way people involved interact, behave, learn and grow.

All these aspects concern what I identified as the 'context' of a collaborative design practice.This study proposes a framework defining a dedicated course of action based on design features that can be adopted by private organizations aiming to take the first step towards an internal transformation. The framework provides guidance especially for projects related to organizational change, which mainly appeal to Human Resource Management departments.

Collaborative design practices within organizations

The purpose of the study was, initially, to investigate how private organizations apply design thinking (DT). This first body of research was ignited by my perception, as a design researcher and practitioner in the field, of a lack of focus, and of the misinterpretation concerning the utility and value of design thinking within corporate practices, including interaction with the service design (SD) domain. As scholars report, "in research, discourses of SD and DT have different roots. In practice, they are often introduced simul-

taneously and follow the same purpose: humanizing products, services, and processes." (Augsten *et al.*, 2018).

A general lack of clarity has been considered by many authors, especially in the design sector, as a threat to the professionalism of the design practice (Muratovski, 2015) because, when applied without consolidated understanding and experience, DT could become an ineffective set of tools that, after the 'initial excitement', suffers construct collapse (Hirsch and Levin, 1999).

Indeed, in practice, these notions are used with very similar connotations, and often present blurry meanings.

Therefore, throughout the study, I have defined a set of features that characterize relevant practices for the research, regardless of how they were labelled by the company.

The so-called 'collaborative design practices' could include both practices labelled as SD or DT, as long as they present the following features:

- they make use of methods and tools that refer to the design discipline;
- they imply collaboration among different stakeholders;
- they involve the guidance of a trained designer or a facilitator who makes use of design artifices.

In recent decades, collaborative design practices have caught the attention of stakeholders in various areas of private organizations. R&D, and Marketing and Innovation departments have understood the value of adopting them to innovate products and services for quite some time, but more recently also other business functions have started requesting design interventions.

One of these is Human Resources (HR), which is increasingly considering design solutions to develop innovative services to meet the emerging needs of a new typology of workers.

Major changes in contemporary society, such as demographic transformations, the diffusion of a wide range of new technologies in all aspects of work, and the development of a new meaning of work in younger generations (Bersin by Deloitte, 2016; World Economic Forum, 2018), have led to the development of new workers' behaviours in their relations with the employer and interaction with peers. Hence, with this demand for design, companies try to direct their innovative capacity towards internal users and clients, rather than tackle external challenges.

The emerging needs of employees in organizations are related to the evolution (ibidem) of the work environment and of economic and working processes that inevitably entail a transformation within the organizations.

The concept of Human Resource Design

While discussions on DT and SD are focusing on the transformative power of design as an 'implicit agent of change', the contribution given by this study aims to investigate the possibility of introducing design elements as explicit agents of change. With this approach, design would address its potential towards the internal context of the organization, in a framework where tools, methods and artefacts are functional to improve inner processes and practices, instead of the reverse. According to this concept, the focus of design would shift from the periphery to the core of the organization in order to change norms, values and assumptions, and to shape a culture willing to adopt design solutions (Manzini, 2016; Elsbach and Stigliani, 2018).

Within the scene of explicit interventions for internal change, we can consider design practices 'at the service' of Human Resource Management, referring to the activity of designing services to manage functional processes within the Human Resource department's scope. Those processes, which are associated with very specific responsibilities within the HR function, are siloed and considered also by suppliers as separate markets. They include tools to increase productivity and collaboration, ranging from engagement and feedback services to performance management or well-being solutions (Bersin by Deloitte, 2017).

Within these borders, we can discuss Service Design for Human Resources (SD for HR). For instance, if we consider redesigning the process followed by a company to recruit new talents, the experience of new candidates, the physical and digital touchpoints that characterize it, and their mutual interactions, we are under the scope of service design for HR.

In this regard, HR can be considered just another field of application of service design that, in its implementation, does not imply any significant innovation, besides specificities of the subject area.

It is, instead, revolutionary when design encounters the domain of organizational change and, therefore, implies a series of substantial differences with the abovementioned definition, shaping what I have defined as Human Resource Design (HRD).

Those differences can be found at least in three dimensions of an organization, which I have identified as: (i) the 'place' of design within the organization (Junginger, 2009; Schmiedgen *et al.*, 2015); (ii) the designer-client relationship (Yu and Sangiorgi, 2017); and, (iii) the level of 'humanization' (Augsten *et al.*, 2018).

In this regard, SD for HR and HRD are not to be seen as alternatives but rather as different intensities of integration of design with HR Management.

In general, we can say that lower levels of integration of design in the organizations qualify the realm of SD for HR. By contrast, higher levels qualify HRD.

The 'place' in the organization

According to the classification given by Junginger (2009),[1] design can be found at various levels of depth in the organizational structure:
- **Periphery:** design is considered an add-on resource that can be booked on demand for a specific need and then dismissed;
- **Somewhere:** design is part of a specific organizational function, such as marketing, UX or R&D departments;
- **Core:** design has a central position in the organization and, therefore, has access to its leadership and strategy levels; it questions the organization's vision and purpose, resources, structures and procedures, and integrates products and services "into a coherent whole" (Junginger, 2009);
- **Intrinsic:** design is an established practice and mindset; it can be considered as part of the corporate culture.

Within this dimension, Human Resource Design refers to 'core' or 'intrinsic' penetration into the organization.

The designer-client relationship

The second dimension is to be found in the designer-client relationship. The typologies of relationships could be (Yu and Sangiorgi, 2017):
- **Delivering**: the client plays the passive role of the commissioner, providing a brief and then receiving the designers' output; the client does not intervene in developing the solution;
- **Partnering**: the client co-designs with the designers; during collaborative sessions, clients are engaged with designers in the project, providing them their organizational perspective;
- **Facilitating**: this relationship is about transferring design capabilities in order to enable learners to apply design methods to their own con-

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[1] Found in the essay *Design in the Organisation: Parts and Wholes,* and later reclaimed in the report issued by the Hasso-Plattner-Institute *Parts Without a Whole?: The Current State of Design Thinking Practice in Organisations* (Schmiedgen *et al.*, 2015)

text. Designers become coaches who train employees to change their routines.

Considering these three configurations, 'partnering' and 'facilitating' are the ones that could connotate a Human Resource Design intervention.

The level of 'humanization' of the organization

The third important dimension to consider is the level of 'humanization' of an organization. This concept was proposed by Augsten *et al.* at the *ServDes – Service Design and Innovation Conference* in June 2018. The authors built upon the extension of the human-centred principle of design, addressing it towards the creation of a more humanistic organizational environment rather than the mere delivery of more desirable products/services for the end users.

When talking about Service Design for HR, we refer to the areas of application of the Human Resource Management department – recruiting, onboarding, learning, performance management and more. These areas present a transversal goal, which is often managed by one specific team within HR, precisely employee well-being.[2]

Well-being covers the overall way people work in and experience the organization and beyond, tapping into a more holistic approach to the employee experience, which is in this conceptualization reframed and elevated to what has been called 'human experience' (Bersin by Deloitte, 2019). When design enters this domain, it aims to shape the 'how' more than the 'what' of organizational practices. In fact, HRD implies a course of action that focuses on new ways of working together and on 'how' employees might behave. Instead, for HR, SD focuses on defining 'what' might be designed to meet any need related to the employee's journey and, therefore, new services.

Research questions and methodology

The hypothesis formulated is that design and, specifically, service design could contribute to structure a new course of action aimed at addressing the

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[2] Well-being is one of the norms of a human-centred organization identified by the International Organization for Standardization (ISO 27500:2016), which also includes: "capitalizing on individual differences as a strength in the organization; making usability and accessibility part of the organizational strategy; ensuring health, safety, and well-being; valuing personnel and creating meaningful work; being open and trustworthy; acting in a socially responsible way; and adopting a total systems approach within the organisation" (ibidem).

demand made by private organizations to intervene on employee dynamics within contexts of internal change.

I shaped the above hypothesis with an experimental framework that was tested through a participatory action research.

Hence, the research questions that guided me towards the characterization of the framework are a series of consequential ones that start with a main and overarching inquiry and unfold with more specific sub-questions:

- How can service design **support** and **enhance** effective collaborative practices aimed at organizational **change** within private organizations?
- How should these collaborative design practices be **articulated** and **conducted**?
- To what extent is the **role of the service designer** meaningful and relevant collaborative design practices within private organizations? Within this context, what are the necessary **skills** and **attributes** of this professional figure?

The study has been strongly oriented towards practice, meaning that I always adopted an inductive approach mainly acting as a 'reflective practitioner' (Schon, 1984). In this sense, the methodology used could be considered as 'research through design' (Findeli, 1998), where participating in projects was the main component, thus adopting a practice-based approach (Saikaly, 2004).

The research could be divided into three main phases: (i) a preliminary study carried out through a series of interviews and observational studies; (ii) an in-depth analysis including a second series of longer interviews; and a (iii) participatory action research within two organizational contexts in the private sector and one design training institute.

Participatory action research

The participatory action research intended to test some interventions introduced during projects developed by teams following the design thinking[3] process. Each project was analyzed with the same structure adopted for observational studies, which builds upon the categories used in the book *Massive Codesign* (Meroni *et al.*, 2018). I made some additions that are specific for this research.

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[3] When I refer to the design thinking process, I hint at the Double Diamond framework (Design Council, 2014) because the representation of alternative divergent and convergent phases is the one that most conforms to my way of 'designerly' approaching a project.

The categories include:
- **Company and consultancy name, if any:** the company or the industry sector in which the company is operating and the consultancy agency that was in charge of developing the project;
- **Title:** title of the session;
- **Date and duration:** date and duration in terms of days;
- **Goal:** this category aims at defining if the workshop was mainly focused on reaching consensus and creating commitment on kinds of 'pre-worked' solutions or on generating entirely new ideas;
- **Participants:** the variety of participants in terms of relations with the organization –internal or external–, hierarchical status and business functions;
- **Style of guidance:** defines if the facilitator adopts either a 'facilitating' or 'steering' style of guidance;
- **Extended Double Diamond position:** all projects can be positioned at different stages of the 'extended Double Diamond' –a new extended version of the original Double Diamond defined during the preliminary research– depending on the project's starting point and goal;
- **Tasks and tools:** the process followed during the project with a detailed explanation of specific tasks and the tools used to facilitate them;
- **Extended DD – Tuckman stage correlation:** discussion and correlation of specific tasks with the extended Double Diamond and the Tuckman stages of group development; each task is identified with the name of the extended Double Diamond stage, the specification if it is a convergent or divergent phase and, finally, the Tuckman stage that is the most appropriate for defining the group's status at that point (Tuckman, 1965); analysis of the impact of tasks and specific tools introduced on the interaction of participants;
- **Final output:** an overview of the services envisioned during workshops.

The following is a summary of projects (tab. 1) that make up the participatory action research through which the framework was developed and tested.

Tab. 1 – Summary of projects.

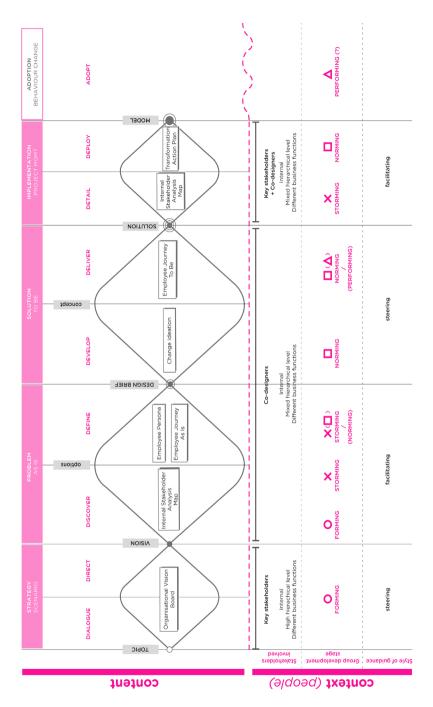| Project no.	1	2	3a	3b
Company and consultancy name (if any)	**Automotive company and Skillab**	**Hasso Plattner Institute**	**OTB Group and ccelera/ Amploom** (part 1)	**OTB Group and ccelera/ Amploom** (part 2)
Goal	**Generate action plans on existing ideas + training**	**Training:** Simulation of a project to be carried out by a team within a fictitious organization.	**Reframing of five HR processes:** recruiting, onboarding, learning, performance management, talent management.	**Redesign of the 'recruiting' process – generating new solutions.**
Participants	Internal – Top management – Different business functions → **low/medium variety**	External – Mixed hierarchical levels – Same business function (HR consultants) → **medium/ high variety**	Internal – Middle management – Different business functions → **middle/high variety**	Internal – Middle management and operational staff – Different business functions → **middle/high variety**
Style of guidance	**Steering** *(designers)* + **facilitating** *(teambuilding coach).*	**Steering** *(designers)*	**Steering** *(designers)*	**Steering** *(designers)*
Extended Double Diamond position	**4th diamond** – implementation space	**2nd and 3rd diamond** – problem and solution spaces	**1st and 2nd diamond** – strategy and problem spaces	**3rd diamond** – solution space
Tools developed and tested	**Stakeholder map**	**Employee persona + change ideation**	**Employee persona + stakeholder map**	**Employee journey + change ideation + employee journey**

Fig. 1 – Proposal for a Human Resource Design Framework

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Proposal for a Human Resource Design framework

The analysis conducted and lessons learnt from the participatory action research allow to hypothesize an interventional framework for a professional that can be qualified as 'human resource designer' when addressing an HRD project. The framework can be adopted by consultancies working in the HR field that want to address experiential and contextual factors of projects through design elements (fig. 1, previous page).

1st diamond: Strategy

The first macro-phase of an HRD project is about defining, with the client, the strategical scenario to be pursued.

Micro-phases: *dialogue and direct*

These phases imply a divergent moment followed by a convergent one. The approach in the divergent phase is 'dialogic' (Sennett, 2012), where different opinions are welcome in order to expand possibilities. Then, all the contributions are analyzed to define an agreed common vision. This study takes a rather dialectic approach for the group to converge (ibidem).

Tasks and tools

Organizational Vision: the goal of this phase is for the group to come out with an agreed and shared vision on a specific topic. The vision should be framed as an inspiring statement that describes where the company aspires to be upon achieving its mission. It should envision a scenario that depicts not just what the company wants to achieve for itself but the impact it will have on the community – the internal employee population. This task is inspired by scenario-building and future studies techniques.

Participants: *key stakeholders – internal – high hierarchical level – different business functions*

This phase has a strategic purpose; hence, it involves the key stakeholders who commissioned the project, the sponsors (Aricò, 2018) and other actors who hold strategic roles in the company, typically in a high level of hierarchy – top or, eventually, middle management – and representing the main business functions.

Extended DD – Tuckman stage: *forming*

Since this phase occurs at the beginning of the project, people are excited to undertake a new path and, at the same time, they still feel distant from the effort required for change; therefore, they feel in a 'safe' condition to express their idea without the perception of taking an inalterable decision. The mood was relaxed and harmonious; hence, we can define the status as 'forming'.

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Style of guidance: *steering*

The HR designer is crucial in the 'direct' phase. He needs to adopt a 'steering' style of guidance that can persuade and lead the group towards a direction he deems to be the most promising. In this case, the designer's leading role also counterbalances the status of 'forming' that often dampens the group's creative potential.

2ⁿᵈ diamond: Problem

The second macro-phase aims at investigating the 'as is' situation and the specific problem to be tackled. This phase ends with the definition of the design brief and its core specifications.

Micro phases: *discover and define*

'Discover' is a divergent phase in which participants take into consideration the overall set of options to investigate the context to be analyzed.

The 'define' phase leads the group to converge around the most relevant options for the project, and to the definition of the design brief.

Tasks and tools

> discover

Internal Stakeholder Analysis: the organizational component that is central for human resource design are people. Therefore, it is crucial to start the analysis of the current situation by mapping the internal stakeholders and their importance in terms of power and project-related impact.

> define

Employee Persona: once the Internal Stakeholder Analysis Map is completed, it offers a valuable framework for the group to decide which personas are more representative in order to deepen the analysis of the problem. The persona is a fictional character, whose profile gathers up the features of an existing social group. The *Employee Persona* has some additional organizational context-specific features, namely:
- Level: the hierarchical position in the organizational chart;
- Department: the business function where the employee works;
- Drivers: a set of drivers that help to analyze employee motivation.

Employee Journey As Is: the aim is to describe the journey of the persona depicted in correlation with the colleagues he or she interacts most often. The final goal is to draw out the persona's pain points.

The journey, which is represented by a large horizontal board, comprises five parallel sections that trace: (i) the user's experience; (ii) a set of lines tracking the actions of the other people and correspondence with the actions

of the main persona; (iii) the persona's emotions; (iii) the touchpoints and, finally, (v) the pain points.

Participants: *co-designers – internal – mixed hierarchical level – different business functions*

Participants in this phase are at the operational level of the organization, possibly mixed with some middle managers and, occasionally, with a few representatives of the top management. They should be chosen by HR with the support of the HR designer to create a good balance of content expertise and context adaptability.

Extended DD – Tuckman stage: *(forming) and storming*

If it is the first time that participants meet, they will go through a preliminary forming stage that can be facilitated with a warm-up activity, but as soon as they start analyzing the current situation on the topic, they will probably come out with different and conflicting perspectives.

Style of guidance: *facilitating*

In this phase, it is important for the HR designer to ensure that everyone is contributing and bringing his/her point of view to the table with the aim of creating the most realistic and complete picture of the current situation. The goal is to facilitate the emergence of information from participants without taking any stance. Indeed, participants are 'experts' in the specific topic, and they are the ones who best know the current situation.

3rd diamond: Solution

This diamond is aimed at generating solutions and at envisioning new concepts for the future: the 'to be'.

Micro phase: *develop and deliver*

The 'develop' phase aims at generating solutions following the design brief identified. It is a divergent phase with the goal of generating a large number of possible solutions to be later selected.

The 'deliver' phase is dedicated to converging and selecting the most promising ideas.

Tasks and tools

> *develop*

Change Ideation: in order to facilitate the generation of solutions, teams can use the *Change Ideation Toolkit,* which comprises:

- Change Brainstorming Deck: a guiding layout that represents the rational process leading from 'pain points' to possible solutions; it comprises: (i) spaces to summarize previously identified 'pain points'; (ii)

an icon of the *Behavioural Insights Cards* pack*,* and (iii) spaces dedicated to formulate solutions for each pain point;
- Behavioural Insights Cards: a pack of cards portraying a selection of behavioural economic principles, which can be leveraged to ideate solutions. Each card represents a principle through an evocative image and a brief description. In addition, it provides a 'collaborative tip', which is a suggestion to overcome the specific behavioural bias and enhance collaborative behaviours.

> *deliver*

Employee Journey To Be: this format represents the evolution of the Employee Journey As Is, and aims at mapping the journey when the solutions brainstormed in the previous task are in place.

Participants: *co-designers – internal – mixed hierarchical level – different business functions*

Participants in this phase are the same who were involved in analysing the 'as is' situation.

Extended DD – Tuckman stage: *norming*

The group's mood at this point should be stabilized into 'norming'. Most of the tensions should be absorbed during the previous phase, and efforts are channelled into envisioning desirable solutions.

Style of guidance: *steering*

At this point the role of the HR designer is crucial to lead the group towards innovative solutions and come out with proposals as well. The designer can count on envisioned abilities, while he or she can rely on his/her experience as innovator, stimulating the group with best practices from other fields, acting as a 'proponent with content' (Selloni, 2017).

4th diamond: Implementation

This diamond is aimed at developing strategies for the implementation of solutions. It is a very analytical phase inspired by business administration and project management techniques.

Micro phase: *detail and deploy*

As with the other diamonds, this phase too sees an alternation of divergent and convergent tasks to first conduct a detailed investigation of the specific context in which the solution has to take place and, secondly, to plan the action plan for implementation.

Tasks and tools

> detail

Internal Stakeholder Analysis: this activity deals with the development or specification of the first similar analysis performed during the 'discover' phase. The task starts by taking back the previously defined *Stakeholder Analysis Map* and updating or modifying it according to the new scenario depicted by the *Employee Journey To Be*.

The goal is to adapt the map to suit the new scenario, enriching it with potential new actors.

> deploy

Transformation Action Plan: this activity aims at developing a roadmap of implementation focused on people who will be involved in each task, and the role they will have in it.

The template requires a section to be filled in for each milestone of the project and related task. For each task, the group shall specify the following roles when performing it: the leader, the main project team, the decision makers and the sponsors.

Participants: *key stakeholders + co-designers – internal – mixed hierarchical level – different business functions*

In this diamond, key stakeholders and co-designers converge to work on the final steps of the design for the HRD project. It is advisable to involve a subgroup of the total number of co-designers participating in the previous phases, typically the ambassadors, who will act as witnesses of the work done until this point and represent the bridge between the diamonds.

Extended DD – Tuckman stage: *(forming), storming and norming*

As regards the first Stakeholder Analysis activity, conflicts can arise due to discussions about stakeholder positions on the map. During the subsequent stage of the Action Plan, conflicts should have already been solved and conflictual opinions should have come to a shared picture; therefore, the group is 'normed'.

Style of guidance: *facilitating*

At this point the HR designer comes back to acquire the attitude of an 'active listener', rather than a 'provoker'. He or she needs to be aware of and be ready to manage possible conflicts, and in this phase it is particularly important for the group to reach a resolution because it is already at an advanced phase of design for the project.

Further phase: Adoption

This further phase has to do with enacting the action plan that has been drawn up. Since HRD projects have to do with change in the way people interact, this phase will imply enacting a behavioural design intervention.

If it still managed by the HRD, then the relationship with the client will have to be 'facilitating' (Yu and Sangiorgi, 2017), a relationship in which the designer acts as a coach who enables the client to enact the change, transferring capabilities with a consultancy, which closely resembles training.

In this regard, it must still be clarified whether the facilitator of this phase can be recommended as designer educated in behavioural science, a combination of designer and professional coach with a background in social science or another professional profile (Auricchio *et al.*, 2018).

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Designing for Ambient UX:
Design Framework for Managing User Experience within Cyber-Physical Systems

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Abstract

The research aims to contribute towards the field of User Interaction and Experience Design by proposing a design strategy and toolset to be applied within emerging projects for spaces enhanced by digitized services, based on an Ambient UX design approach. This particular design field deals with highly complex projects focused on user experience, which does not seem to be addressed appropriately with current tools employed in practices. Therefore, the research identified the need to expand current practices in the UX field by supporting them with the set of upgraded tools to be used as a backbone for structured design processes. In this context, design tools facilitate the creation of a common language between all parties and stakeholders involved in the design project for identifying and communicating user values.

The main overview of the tailored research methodology will be provided in this chapter, along with the main results derived from the research presented and discussed. The methodology comprises three main research areas: (1) hypothesis for a design strategy for Ambient UX, deriving from literature review; (2) verification of the Ambient UX framework hypothesis through practical design projects; and (3) analysis of UX value alignment tools and proposal for their upgrade.

Introduction

This doctoral thesis is developed in collaboration with TIM S.p.A., Services Innovation Department, through Joint Open Lab Digital Life in Milan. The telecommunications company is looking into designing meaningful services supported by the new stream for the 5G network that will be guiding the company's business application fields in the current and following years (Notiziario Tecnico TIM, 2017, 2018). The network promises to have significant higher speed and reliability, thus easily enabling the employment of complex connected services, which rely on the diversity of sensor and actuator systems implemented within the physical space (Li *et al.*, 2014; Gupta and Jha, 2015). This comprehension of an emerging application field helped to shape the main research field of the doctoral thesis. The research aims at responding to observed emerging needs of novel design systems, which are becoming ever more complex in terms of connected elements supported by AI algorithms.

From the stream for development of meaningful application areas for connected spaces and the Internet of Things (IoT) systems (Atzori, Iera and Morabito, 2010; Gubbi et al, 2013), the research refers to a vision of Ambient Intelligence (AmI) (Aarts and Marzano, 2003; Augusto and McCullagh, 2007; Mukherjee, Aarts and Doyle, 2009; Carneiro and Novais, 2014) and Cyber-Physical Systems (CPS) (Rajkumar *et al.* 2010; Yang 2014; Bier *et al.*, 2018). This vision and the application area find their connections within diverse fields that finally merge towards the same practices. The fields are Artificial Intelligence (AI) (Ferber and Weiss, 1999; Russell and Norvig, 2016; Gams *et al.*, 2019), Pervasive and Ubiquitous Computing (Lyytinen and Yoo, 2002; Chen *et al.*, 2004), and Interactive Architecture (Fox, 2016; Dalton *et al.*, 2016). CPSes imply interactive spatial systems where human activities are enhanced by digitized services. The study addresses this application field with an approach of designing for user/customer experiences (UX) (Hassenzahl and Tractinsky, 2006; Meyer and Schwager, 2007; Hassenzahl, 2008), as such an approach looks into sustainability and durability of design systems in terms of user engagement over time. Furthermore, as the application field represents a convergence, the design approach is observed through convergences as well, positioning itself on the merge between Service and Interaction Design, and AI and Spatial Design.

Research questions arose from the identified research area of design practice, targeting the identification of an Ambient UX approach. It is to note that Ambient UX is not a currently existent and defined field of practice, as this thesis is shaping the notion of a novel emerging design field.

Research Objective and Methodology

Specific research questions are shaped, and an objective is posed to define an Ambient UX strategy as a possible suitable approach to respond to the focus application field. The aim is to develop a framework for a design process that emphasizes user experience values, and a toolset that would support such processes within a multi-stakeholder work environment.

Research questions are shaped as following:
- What might be the suitable design strategy for Ambient UX?
- How to map the user experience and how to represent its values within Cyber-Physical Systems?
- Are the currently practiced UX design tools enough to address projects of Ambient UX? Is an update needed?

To respond to the above questions, the selected research methodology comprised three main areas of inquiry (fig. 1): (1) hypothesis of a design strategy for Ambient UX; (2) verification of the Ambient UX framework hypothesis; and (3) design tools for the Ambient UX framework.

The needs of novel design practices are shaped around the imposed complexity of CPS, where a holistic UX approach is a necessity. Facing the imposed complexity, as well as its implications on the user's experience, is a challenging quest. In this context, the aim is to propose a strategy for a holistic UX approach, while building up a common language among practitioners in the field. Common language for novel design practices would bridge the communication gaps between the diversity of professional backgrounds regarding project stakeholders gathered around a cyber-physical project with a focus on UX.

The research contributes to translate the very fuzzy moments of shifting from user research to design hints within a design process by proposing a conceptual framework for a design strategy, and design tools that help to implement the framework within a process in a tangible manner. The outcome provides industry practitioners with a solid comprehension of designing for a holistic UX in CPSes through the proposed conceptual framework. Moreover, with design tools it provides a tangible introduction to the framework in practices, while nurturing the development of a common language. In this context, industry practitioners range from companies offering differentiated services, also including digitized ones, as well as hardware product development, for architects and governing organizations and institutions. Estab-

lishing a strategic design framework based on user values can support the process of building sustainable systems comprising pre-thoughts regarding societal impact and long-term usage.
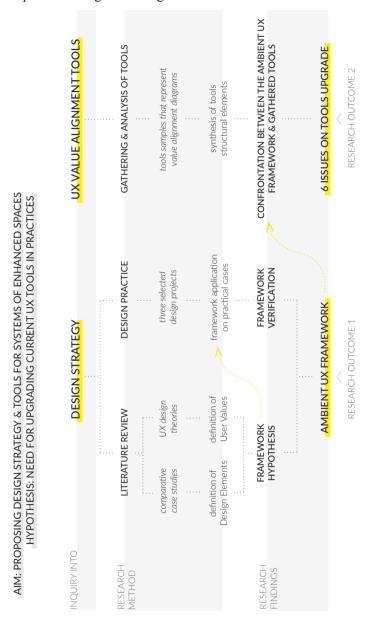

Fig. 1 – Research methodology plan with areas of inquiry, applied methods and main findings.

Main research methods employed throughout diverse inquiry phases include: literature reviews, gathering and comparative analysis of case studies deriving from practice, research-through-design employed using practical design projects that participated, analytical confrontation between the defined Ambient UX framework and practical design projects that participated, gathering and critical analysis of design tools deriving from practice, analytical confrontation between the defined Ambient UX method and gathered UX design tools.

An initial case study of a dynamic lighting system for a workspace is presented to verify the overall Ambient UX framework by confirming the Design Domains (DDs) and User Values (UVs) during the designing process. Furthermore, three case studies of participating projects were taken as research samples to verify the framework through an analysis of dominant UVs and their relations with DDs (*Humanitas*, *MEMoSa*, and *Connected Lighting for a Caring City*). Precisely, user experience was shaped within diverse environments (hospital, automotive, city) in these projects to enable observations based on a broad range of Ambient UX applications. The three projects also reflect on one of the three architectures (i.e., Design Domains), which appears as the dominant one in each of them. UX values emerging during the research phases in case studies showed the importance of identified UV levels, thus confirming their importance for the Ambient UX framework. During the design practices developed through three case studies, UX design tools had to be modified according to the needs of the CPS and adapted to the complexity encountered within UX.

Providing a tangible form to the Ambient UX framework, explorations on design tools were made with the intent of shaping a backbone for the design strategy. Currently employed design tools were analysed, focused on value alignment between user values and stakeholders developing the project. A comparison of tools gathered with the Ambient UX framework detected mismatches that were further highlighted by six thematic issues. The issues are proposed as an upgrade of currently employed tools in the UX field to address the complexity of CPS projects. The analysis of tools and the conceptual framework are a base and/or a starting point for the development of a novel design toolkit.

The research contributes towards both design practices and design education files. The originality of this contribution lies in its close relations with fast-paced changes in design practices, and its translation into an upgrade proposal for a common language shared through design tools.

Design Strategy for Ambient UX

During all the steps within a design process workflow, various design tools can be employed to support the diversity of needs of the ongoing work, from ideation to prototyping and testing. It can, therefore, be said that ideation and evaluation are always present and iterate constantly within a design process. The two phases, **ideation and evaluation**, respond to the questions concerning what is/can be designed and why it should/will be deigned in a specific manner.

With regard to the design process, a UX practitioner (UXer) is positioned between the individuals, i.e., users and customers, and the organization providing an interactive system, i.e., one or group of stakeholders involved (fig. 2). The in-between space reflects the interactions between the two sides, where the UXer empathizes with the individuals and evaluates these interactions from both sides to define and/or reshape interaction touchpoints. For the envisioning phase, the UXer comes up with a set of guidelines and requirements that are shaped into final design outcomes with a team of diverse design profiles (from architects to UI designers), developers and makers.
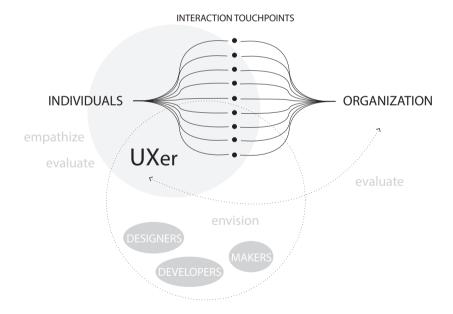

Fig. 2 – Diagram to position a UX practitioner within the design process, taking into account relations with project stakeholders.

Ambient UX Framework

Ambient UX is a conceptual framework, which provides a strategy for structured design processes that target CPSes. Dealing with abstract and intangible concepts like experience is challenging for practitioners in the field, as well as for design educators within the same theme area. Indeed, another layer of complexity is added to these efforts, when it comes to designing systems of intelligent interactive spaces. A shared comprehension of peculiar UX practices within these complex projects is required.

The Ambient UX framework consists of a definition of Design Domains (what is to be designed) and of User Values (why it is designed) observed within Ambient UX and CPS.

Design Domains are analysed through possible outcomes of complex systems of enhanced spaces, in terms of what a designer can manipulate and shape in a certain sense. Precisely, what domains and elements a designer can manipulate to create enablers and constraints for certain activities, thus influencing the user's experience. The observations provide grouping options for design outcomes, such as physical products, information flows and triggers for social relations. In this context, the Design Domains are interpreted through three architectures within targeted design systems: Spatial, Informational and Relational. Besides the architectures, the element of Time is also considered, presented as a variable between the architectures which impact on activities and experience has the same significance.

Defined Design Domains are directly related to the user's experience and, therefore, to the User's Values, perceived as such regarding the interaction with a designed system. Experience is, thus, influenced on diverse levels, scaling from personal to social perceptions and acceptability. The levels are herein discussed as: Usability, Meanings & Motivations, and Social Consensus. This is to say that architectures and time are acknowledged as a variable influence on comfort and well-being, creation of meanings and motivations over time, and social relations within the interactive system.

Usability concerns the modalities of user interaction, which are natural and multimodal. This level implies comprehension of functions and usability, and it includes ergonomics of material solutions as well as their pleasantness in direct interaction (Gibson, 1977; ISO, 2015; Nielsen, 2013). Creation of Meanings & Motivations over time entails analysing and un-

derstanding motivations and goals, acceptability and desirability, as well as context-aware interaction (Desmet and Hekkert, 2002; Blythe *et al.*, 2005; Hassenzahl, 2006; Verganti, 2008). The level of Social Consensus is referred to as the level, which deals with acceptability on a social scale (Battarbee and Koskinen, 2005; Bevan, Carter and Harker, 2015; Steen, 2016; Pavlovic *et al.*, 2019). It concerns data usage (data privacy and security), as well as stimulated behavioural changes.

Verification of the Ambient UX Framework Hypothesis

The Ambient UX framework hypothesis is verified by comparing the proposed design strategy with research projects that satisfy the Ambient UX concept and involve studies on user experience. This is done by identifying what is perceived as User Values in all of them, and what is the relationship between DDs and UVs.

Initially, first testing was carried out to verify the framework hypothesis with a case study of a dynamic connected lighting system within an office working environment (Pavlovic *et al.*, 2018). The verification consisted in identifying the DDs as such, as well as their influence on the hypothesized UV levels. After running this first holistic check of the framework, i.e., the existence and suitability of hypothesized DDs within the project and the suitability and existence of influenced UVs within the same, three case studies took part to further verify the hypothesis and observe the connections between DDs and UVs within a project, also considering their mutual influence. The three projects are selected according to their diversity in terms of different dominant architectures, diverse product complexity and nature, and diverse levels of user or automated input (through sensors). Moreover, they are all placed in different environments, namely: hospital, automotive and city (outdoor and indoor) environment. The projects are:
1. Humanitas (hospital environment; green colour in fig. 3),
2. MEMoSa (automotive environment; pink colour in fig. 3),
3. Connected Lighting for a Caring City (city environment; purple colour in fig. 3).

Project Humanitas refers to a holistic overview and evaluation of UX, where users are influenced by the sensitive ambient context, the interaction with digitized kiosks that support hospital administrative services, as well as interactions with hospital staff. Project MEMoSa considers an approach of de-

Fig. 3 – Radar diagrams showing the diversity between the three projects, according to: architectures as Design Domains (above), system input modalities (below).

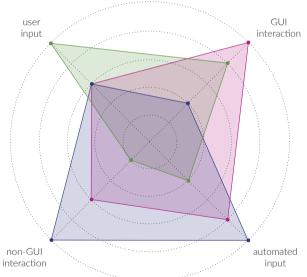signing for user's experiences within a car interior environment, having as a core concept an IoT system that supports safer driving behaviours. Connected Lighting for a Caring City project considers an approach of designing for user's experiences within an urban environment, following user's daily activities within diverse outdoor and indoor ambient contexts that are being enhanced by digitized services, using lights as a medium of communication and interaction.

For each of the projects the conducted UX research led to a discussion on User Values and their fluidity, and the projects contributed to provide an overall Ambient UX framework verification.

Design Tools for Ambient UX

This section aims to identify design tools that could support a design process for an Ambient UX strategy. Hence, the research methodology comprises two macro steps: (1) Overall analysis of current UX tools employed in practice to understand User Values and Design Domains they refer to; (2) Comparative analysis of the tools with the proposed framework for Ambient UX Design Domains and User Values.

During the first research step, tool samples were collected with a majority of them deriving from practices in industry as well as from design consultancies. The search focused on tools that support design processes targeting value alignment (Kalbach, 2016; Pavlovic and Pillan, 2018). Such tools are: Customer Journey Maps, Experience Maps, Mental Model Diagrams, Service Blueprints, Spatial Maps, Ecosystem Models, Stakeholder Maps, Storyboards, Touchpoint Matrix, Business Model Canvases, Value Proposition Canvases, and Empathy Maps. The analysis discussed structures for each of the tools to identify Design Domains and User Values. Finally, all the tools were compared, and possible emerging grouping patterns were observed.

During the second research step, tool samples were compared against the proposed framework for Ambient UX, in terms of DDs and UVs it considers. The framework is based on a design strategy deriving from literature review; therefore, this comparison is between the theoretical methods presented in literature and tools employed in design practices. Discussion is shaped according to encountered mismatches between the gathered tools and the method, and proposals to upgrade tools that could support a designing process for Ambient UX were made accordingly.

Six Issues on Tool Upgrades

This research relates to experience mapping in order to create a common language for physical/digital ambient design. The discussion is supported by case studies of tools that are suitable for a conversation on drawing principles for experience design. These tools are discussed as the foundation to establish an emergent design language.

Three case studies showed that UVs vary depending of the context and design outcome, and that particular values appear to be more dominant than others in certain projects. Comparing the dominant UVs derived from the projects, it is noticeable that they are matching with gaps identified in the current UX design tools. Namely, the values reflect, through concrete examples, a correspondence and overlap with the gaps encountered in the tools when confronting them with the Ambient UX design framework. Main observations are based on the following theme elements:

- All three architectures should be considered simultaneously within the tools,
- Tools should enable an analysis of alternative user journey paths,
- Tools should enable a zooming in and out perspectives in regard to design outcomes,
- Tools should support analysis and discussion on social acceptability of the design outcome,
- Tools should enable observations on different time spans of user engagement and their analysis,
- System intelligence levels should be taken into consideration within the tools.

First five, out of the six, theme elements are the issues recognized as gaps within the overlap between the Ambient UX framework and tools currently employed in practices. Through analysed project case studies the five gaps have been observed and verified and a new one emerged that did not appear before, referring to intelligence levels (Pavlovic *et al.*, 2019).

All the presented projects contain the recognized Design Domains, i.e., architectures. When some architectures are more dominant than others in certain projects, they all still require a holistic comprehension of the design system. Furthermore, all the projects presented have possible alternative pathways. It is hardly possible to have only one determined path within a design system. Paths depend on many DDs and variables, and thus should be faced as such. Comparing and analysing alternative pathways helps to identify desirable ones as well as to anticipate potential problems a design system might cause.

It is necessary to change perspective and scales in all the observed projects, as the design process is a constant iteration, which faces refinement of the concept and outcome in various moments. The UX design process supported by research is never a linear process; rather, it requires the ability to constantly zoom in and out of social impact of the design solution on interface features and usability issues. Therefore, design tools should respond to this need by enabling a change of perspective at any moment, providing a holistic overview of the system, scaling from very broad strategical levels and impact to very small detailed considerations for a design artefact.

Dealing with design concepts that shape user values through complex data flows, also involving sensitive personal data, raises many considerations in terms of data treatment, privacy and transparency. This consideration is observed as a need to establish a social consensus for data processing, which touches one's experience levels beyond personal perceptions and expands on ethical levels of a society. Since this particular consideration is interwoven with the design process, an evident need to shape design tools that support its implementation arises.

We must take into account the different time spans to plan design system implementation within a timeline, as well as to analyse any impact the system might have on users within diverse timelines of use. The design tools collected consider the diversity of time spans, but usually only one of the possible scales, without reflecting on shorter and longer terms of combined use within one holistic representation. Design tools should enable planning and analysis across various time spans to envision and develop design concepts of changes they might cause in user perceptions over time, and the creation of meanings.

Considering the emerging systems of AI applied to design practices, we notice that the design field for these applications is still young, though AI is not a novel research area at all. Novel systems supported by AI require reasoning on intelligence levels that influence the user's experience and, therefore, novel design processes require design tools to be shaped accordingly.

These six conceptual issues are a proposal for an update and expansion of tools currently employed in UX practices that regard design strategies supporting the Ambient UX framework.

Conclusions

The research provides strategic support to bridge the fuzzy phase from user research to design hints. This strategy is translated into a conceptual framework to design for Ambient UX, while targeting CPSes. The framework can be used both to analyse and plan novel design systems supporting the design process. The research contributes to this context by providing a base to support design processes focused on user experiences, which enable to build CPSes that are sustainable in terms of user values and, thus, acceptability over a certain time period of use and engagement.

Facing the complexity imposed by CPS, the research proposes a holistic approach to UX. This approach is embodied through an additional proposal for design tools to be used during a design process. Tools are also the backbone to build a common language among all stakeholders involved in a project who represent professionals from diverse backgrounds. Hence, the common language can be observed as common understanding of the process of translation and interpretation from user research to design hints.

The UX tools currently employed in practices do not seem sufficient to cover all aspects of the Ambient UX framework; for this reason, the research proposes updating tools and/or developing a novel toolkit for the framework. The main six conceptual issues were identified as mismatches between the framework and the tools gathered and, as such, are proposed as issues for an upgrade to a novel toolkit. Recommendations on including novel conceptual issues imply having: (1) all 3 architectures considered simultaneously; (2) analysis of alternative pathways; (3) zooming in and out; (4) social acceptability; (5) different time spans; (6) intelligence levels.

Being deeply grounded within a design practice, the research provides contributions on two levels, namely the academic theoretical research body on design, and the emerging design practices within industry. The contribution to the academic research body on design is reflected in the manner of reasoning about building the conceptual hybrid framework. The manner of reasoning could be repeated for similar research scenarios that need to establish a strategy to support design processes with regard to Design Domains and User Values. The contribution to design practices within industry is the concrete strategy proposed, which can be re-used during design processes for Cyber-Physical Systems. By making the strategy more tangible, design tools are also another research outcome that provides support to design practices.

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Design For Intercultural Experience: A Design Framework within User Experience Approach

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Abstract

The multicultural society has become a widespread phenomenon nowadays in which foreign people often offer services to locals. The services provided by foreigners can be stereotyped or rejected due to people's mental frames formed by different cultures that call for designers' contributions to service experience in the multicultural environment. This research aims at helping UX designers to gain a comprehension of values in cultural diversity to improve the cross-cultural experience through their designerly expertise. Through the study of cultural models in sociology and anthropology and the study of the investigation tools in experience design, the research adopted an ethnographic approach within UX tools. The fieldwork takes place in the Chinese catering services in Milan and consists of three phases: snapshotting the context, identifying the diversity, and representing the cultural value. The research developed the Framework of Designing for Intercultural Experience which can be regarded as a reference for cross-cultural designers to refine design questions, to plan the design ethnographic practices, and to identify appropriate research tools in the field.

Introduction: Challenges and Opportunities for Designing in a Multicultural Context

In this more and more physically and digitally connected modern world, people gain more and more opportunities to be exposed to different cultures. Design practice cannot be separated from cultural contexts, and designers inevitably have to design in a multicultural environment. Designers who are

short of knowledge about the targeted multicultural context, may experience many challenges in their design processes, or even mislead these design processes. Meanwhile, the intercultural experience calls for UX designers' contributions. The interactions among different cultural groups, such as foreigners providing services to locals, may result in stereotypes or rejections due to people's mental frames formed by their home cultures that call for designers' contributions to help different cultural groups to better present the cultural value attached in the service experience.

As a Chinese sojourning in the city of Milan, I personally experienced the complexity of multicultural environment firsthand. It grants me a dual role as a multicultural observer and as a cross-cultural designer. The cultural differences and similarities have always been a hot topic which brings opportunities to create pleasant conversations that allow people to share their experiences through similar or strange instances. The stereotypes usually played a significant role in initiating the topics. Such as when I mentioned that the fortune cookies are not traditional Chinese food, it immediately caught people's interest, and the conversation expanded to the fortune cookie's origin, the adaptation, cultural features, and differences in diets. Such a personal experience led me to think that if the designers could identify the meaningful features in cultural diversities, they would be able to raise empathy with people from different cultures, or, attract their curiosities.

Culture is such a classic theme that it is widely studied by numbers of disciplines. The culture considered in this research refers not only to a set of manifestations that are developed and shared by groups of people such as artifacts, languages, and behaviors (Geertz, 1973b; Kroeber Kluckhohn, 1952), but also to intangible manifestations like perceptions of value, mental models, and ways of communication (Barber and Badre, 1998; Straub *et al.*, 2002). Many design practices in multicultural environments are considered as cross-cultural design in this as these design activities usually stand by a dominant culture and try to bridge with other cultures through design (Choi, Lee, Kim and Jeon, 2005; A. Marcus, 2006; Rau, Plocher and Choong, 2012). The advanced stage of the cross-cultural design would result in the intercultural dialogue that fosters multifold and equal interactions among cultural groups.

Research Objectives and Methodology

Main and specific research objectives

The cross-cultural design capability has become increasingly important for developing and launching products and services in multicultural environments. Like all humans, designers are members of cultural groups, so they are constrained by their own cultural backgrounds. Especially when designing in the multi-cultural context, designers usually are from one of the cultures involved, or may not belong to any, meaning no one can have an omniscient understanding of all the cultures involved. However, designers have discipline-specific ways of knowing, thinking, and acting that are distinct from other disciplines (Cross, 1982, 2001). The UX designerly way to study a multicultural environment revolves around focusing on the experience. The multicultural environment can also be regarded as a context, but more complex than many other design contexts. UX tools should be suitable to investigate within such a context.

The research objective proposed in this research is therefore: ***How can UX designers gain a comprehension of values in cultural diversity and improve the cross-cultural experience through their design expertise?***
To answer this main research question, there are several specific questions that require answers. These are as follows.
The cross-cultural study is well-developed in some other disciplines such as sociology and anthropology, and scholars have defined some models to compare cultural differences across different cultures (cf. Geertz, 1973a; Gillham, 2005; Gudykunst, 2003; Hall and Hall, 1990; Hofstede, 1984). These studies provide constructive references to cross-cultural design activities; however, there are some gaps in applying the generic cultural models to specific design practices. This leads to the first specific research question: *How can we make better use of cultural studies from other disciplines in design practice?*
Different from traditional ethnographic research which requires months and even years of fieldwork, design projects usually have more limited budgets, schedules and shortages of researchers. The second research question thus: *How can we provide a snapshot of the complexity of the multicultural environment to identify the values in cultural diversity?*
While conducting fieldwork, the designer has dual roles as both a member of a cultural group and an observer, often leading to biased perspectives. Thus, the third research question is: *How can we prevent perspective biases while conducting UX tools?*

The designers have known various UX tools, but the multicultural environment is more complex than the usual design contexts, so the last research question is: *How do we identify the appropriate tools for applying cultural inquiry?*

Research methodology

Field setting

Fig. 1 illustrates the current study's research methodology and fieldwork phases. The fieldwork is the necessary part of ethnographic research and the field of this research is set on the Chinese catering experience in Milan. The Chinese in Milan have reached a considerable business scale and developed a socio-economic enclave (Cologna and Mauri, 2004) that calls for communication across the ethnicities to update the stereotypes and better the acceptance of each other. The catering business is one of the Chinese community's traditional strengths in Milan, and the stereotypes and prejudices align with cultural values, which is a vivid microcosm of the multicultural situation in Milan. Customers' experience is especially important for catering service. The increasing competition makes the restaurateurs to will to have a conversation with UX designers. It grants the designers easier access to the field than the other businesses. Therefore, I consider it as an ideal field to study and to experiment designing for the intercultural experience.

Methods

The research method is accordingly under the guidance of ethnographic approaches and UX tools are field research instruments.

The ethnographic research is widely employed in anthropology to understand a community or a culture (cf. Crabtree, Rouncefield and Tolmie, 2012; Geertz, 1973a; Hammersley and Atkinson, 1983; Malinowski, 1922). Such an approach inspires the design research which is known as design ethnography (Button, 2000; Crabtree *et al.*, 2012). Compared with traditional ethnography, design ethnography has a specific focus which is predefined by the design project, and the data sources are not limited in the natural settings but also the design interventions. Other than UX research, design ethnography regards individuals as "people" but not simply as "users" (Nova, 2014). Through design ethnography allows design researchers to intertwine the observation, the analysis, and the design-to-change (Salvador, Bell and

Anderson, 1999). The delivery of design ethnography has various forms as to outline design hints and/or reinterpretation and scale-up of one design to multiple contexts (Baskerville and Myers, 2015). The design ethnography is taken as the most significant research approach in this article. Its ethnographic core guides the cross-cultural study, and its designerly mindset leads the fieldwork to the designable findings.

Numerous definitions of User Experience can be categorized into two perspectives, the reductionist and the holist (Blythe, Hassenzahl, Law and Vermeeren, 2007; Karapanos, 2010). Concretely related to the specific context of this research, designing for intercultural experience, the holistic view benefits the investigation of individuals' experiences in the past and now as to envision the experience in the near future (Sanders and Stappers, 2014), and, to understand how individuals' experiences are associated with cultural contexts (A. Marcus, 2006). Designing for experience requires understanding about not only the end-user but also the other individuals who are involved in the experience of co-creation of a product/service and share the same societal needs (Battarbee and Koskinen, 2005; Forlizzi and Battarbee, 2004; Forlizzi and Ford, 2000; Hassenzahl, 2010). The designerly expertise falls on the strategy of selecting and/or combining the research instruments according to various design contexts. Experience also matters a lot for the services due to its intangibility, inseparability, heterogeneity and perishability (Zeithaml, Parasuraman and Berry, 1985). The notion of designing for services encourages to adopt different approaches to improve the service experience which provides an inspirational insight (Kimbell, 2011; Meroni and Sangiorgi, 2016; Zomerdijk and Voss, 2010). Hence, I propose that designing for experience and designing for services can mutually compensate for investigating the individuals involved in a cross-cultural service by the human-centered perspective and creating meaningful connections in the net of stakeholders of the service (Forlizzi and Zimmerman, 2013; Zomerdijk and Voss, 2010). The research combines different ethnographic approaches with different UX research tools in each phase of fieldwork.

Fieldwork

Fieldwork unfolded in three phases. The first phase is mapping the overall multicultural context in Milan. I adopted a digital ethnographic approach that enabled me to gather as much online data as possible within a short period. Such an approach helped me to overcome the problem of gaining field access at the beginning and planning stages of the ethnography. I used two tools in
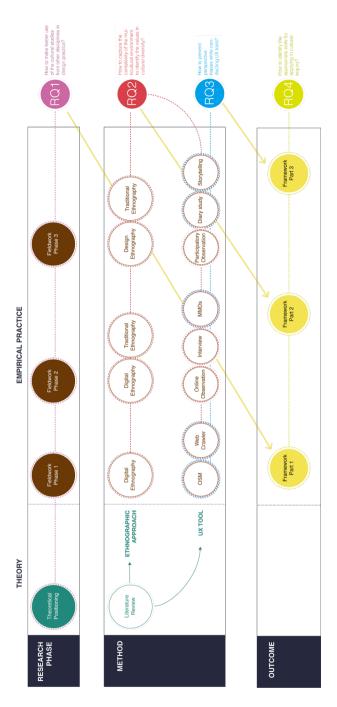
Fig. 1 – Research method.

this phase: OpenStreetMaps (OSM) was used to map Chinese-owned restaurants in Milan, while Web Crawler was for extracting the most frequent words in TripAdvisor's comments.

In the second phase, mapping the current Chinese catering service experience, I identified four Chinese restaurants in Milan according to the findings of the previous study. I gathered data from the Chinese and Italian customers' online comments, as well as interviews with service providers who own or owned the Chinese restaurants. There is a need for user group triangulation for comparing the data from different sources. I regard the UX tool, Mental Model Diagrams (MMDs) as an ideal instrument. I verified MMDs' use in the cultural inquiry through the UX course of Politecnico di Milano and refined it for triangulation purposes. This let me outline any deficiencies and design opportunities of the cross-cultural experience of Chinese catering services.

The last phase is the co-design with a new Chinese restaurant in Milan. The fieldwork was led by participatory observation within my roles as both a group member and a designer. The diary inquiry was the tool for self-reporting the observation under the guidance of Participatory Action Research. I also employed storytelling as a 'soft tool'. Other than the common use of storytelling tools in UX (i.e., Empath Maps, Persona, Storyboard) there are three ways to use stories in this research phase: to facilitate communication in co-design, to identify the opportunities of intercultural communication, and to analyze fieldnotes. Through co-design, the restaurant owner is able to better present cultural values in the service. The restaurant started to play the role of refreshing customers' stereotypes of Chinese catering business in Milan.

The design framework of designing for intercultural experience

The layers of designing for intercultural experience

Cultural models in anthropology provide cross-cultural designers with references for identifying cultural diversities across cultures, as well as for exploring cultural values hidden in the societies (cf. Hall, 1976; Hofstede, Hofstede and Minkov, 2010; Trompenaars and Hampden-Turner, 2012; Tudor *et al.*, 1997). However, these models see the culture at the national level which is too generic to be applied to cross-cultural design practices.

Fig. 2 – Approaching cultural values through layers of ethnographic and design practices.

The layers of designing for intercultural experience are proposed on the basis of Hofstede's cultural onion model (Hofstede *et al.*, 2010), and the reflection of the models of cross-cultural design (Leong and Clark, 2003; Lin, 2007; Norman, 2005). As shown in fig. 2, three layers are between the layers of symbol and hero of Hofstede's cultural onion model. Hofstede (2010) points out that the layers implied outsiders could observe cultural meanings through practices, and in this research sees the practice specifically as the ethnographic practice and the design practice. Designers can refine the design questions of their design practices according to the aim of different layers. By the ethnographic practice viewpoint, the layers are identified as:

1. the situation − the multicultural context wherein the cross-cultural design takes place. Design projects usually have limited time, and designers need to understand the context as much as they can within such a short time. In order to keep the richness of the materials collected from the field, the thin description is suggested for turning designers' critical attention to the various influences at play in the realization of richness.
2. the instances − the typical examples of the multicultural context. For instance, this research takes Chinese catering service in Milan as the

field understudy, and four restaurants are selected as instances. The thick description is encouraged for further understanding the cultural values hidden beneath the stereotypes in respect of a focused area. When merging the instances, the overlapped features can be the re-confirmation, and the distinct ones are the compensation. Designers' expertise draws on employing the appropriate research instruments for observation and analysis so to highlight the design opportunities in respect to values of cultural diversity.

3. the leader − the positive example fostered by design that stands for meaningful cultural characteristics. Designers first need to identify a target with some potentials, such as the preconditions of the cultural characteristics, the service people's will to collaborate, the feasibilities of conducting fieldwork and so on. The service providers and the designers have different knowledge; thus, they usually hold distinct perspectives of the service. It is important for them to figure out how to share knowledge and communicate about cultural values equally. Since the communication is not only between designers and service providers, but also between the service people and their customers, designers also need to consider how to enable the service providers to communicate the cultural values with their audience and customers. In this layer, the designers' significant role is both as a participant and as an observer, so that they all employ tools that help communicate the design insights with non-designers and record the change process.

The circle of observation-analysis-improvement

The cultural inquiry is one of the most common means of conducting cultural studies in which the ethnography is considered as an effective approach. The traditional ethnographic approach shows some limits to apply to the design projects directly, three of which are pointed out in this research: 1) the field limit, 2) time limit, and 3) access limit. In the case of this research, digital ethnography can be considered as one of the complementary approaches. Making use of digital sources, such as big data and small data, is time/labor-saving and access-opening (Masten and Plowman, 2003) (Kozinets, 2010) (Ferguson *et al.*, 2014). The other complementary approach, the design ethnography, which derived from traditional ethnography, broadened the traditional ethnographic implementation in the design context (Crabtree *et al.*, 2012; Nova, 2014; Van Dijk, 2010). Design ethnography does not necessarily require the thick description of the observation and analysis in the

field; rather, it embraces various feasibilities which seemed unconventional approaches in traditional ethnographic practice, such as digital sources, thin description, design interventions and design artefacts (Baskerville and Myers, 2015).

OBSERVE
What is happening/
happend before?

Tools for collecting data:
e.g. participatory/non participatory observations, user-generated data, interview, generative tools, context map, cultural probes, questionnaire, focus group…

Tools for communicating values:
e.g. persona, scenario, storytelling, user story mapping, customer journey, experience map, prioritization schemes…

ANALYZE
What do people
say/do/think/feel?

IMPROVE
What are the existed/neglected/upcoming opportunities?

Tools for seeking mismatches:
e.g. affinity diagram, Cluster identification, User group triangulation, Mental Model Diagrams, customer journey, user story mapping, service blueprints..

Fig. 3 – The circle of observation-analysis-improvement.

Thereafter, fig. 3 illustrates the second part of the design framework which is a circular process composed by three elements: observation, analysis, and improvement. This circle plays a role for guiding designers' practices in each layer of the first part of the design framework. The observation refers to the activities of data collection as to understand what is happening and/or what happened before. Usually, the oral accounts, physical resources (e.g. written documents and physical artefacts), and digital resources (e.g. user generated data) are considered as significant channels for collecting data from the field (Hammersley and Atkinson, 1983; Wang, 2016; Wittel, 2000). The analysis is the step of extracting meanings from the raw materials collected from the field, always along with the observation in traditional

ethnographic practice. Social researchers produce the thick description for explaining cultural phenomena or cultural groups according to their knowledge of society and culture (Geertz, 1973a; G. E. Marcus, 1998). The focus of analysis in design ethnography differs from traditional ethnography. Designers can benefit from the traditional ethnographic analysis approaches as to grasp meanings and processes are under the guidance of the ethnographic approach but with variations.[1]

The matrix of designer's perspectives

One of the most debated topics in traditional ethnography is the researcher's perspective as an insider or outsider. The insider's perspective refers to the informant's view within a specific culture, which provides insights into cultural nuances and complexities; and the outsider's perspective refers to the researcher-relevant view by observing the culture in a general, non-structural, and objective way (Berry, 1989; Headland, Pike and Harris, 1990; Morris, Leung, Ames and Lickel, 1999; Pike, 1967). Researchers may adopt different approaches according to the insider/outsider's perspective, which may lead to distinct results. Thus, choosing the appropriate angle is significant for carrying out the fieldwork, and both the perspectives have pros and cons.

Researchers hold distinct views of user experience that also lead to different research approaches and results. Roller and Lavrakas (2015) pointed out that designer's role in design ethnography can vary from nonparticipant observation to participant observation. Blythe *et al.*(2007) carried out a grid analysis on five dimensions (reductive-holistic, evaluation-development, quantitative-qualitative, work-leisure based, personal-social) in respect of HCI study. When it comes to the cross-cultural experience study, the researchers' focuses vary from the prior.

Therefore, the research points out that designers' perspectives of what user experience is and what culture is intertwined to influence the choice of the research approach and the design tools. The third part of the design framework is proposed as the matrix of the designers' perspectives. As shwon in fig. 4, the horizontal axis stands for designers' variable perspectives while carrying out the cultural inquiry that extends from the outsider's view to

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[1] The dissertation elaborates the use of Mental Model Diagrams as an example of going through the circle of observation-analysis-improvement in the middle layer of the design framework. This article does not entail the example.

insider's view, and the vertical axis stands for designers' variable perspectives regarding UX as the individual experience or co-experience while doing cross-cultural design[2]. This matrix provides a reference to cross-cultural designers to pick up the suitable tools from the "armory of UX tools".

Co-experience

Outsider's view   Insider's view

Individual experience

Fig. 4 – The Matrix of Designer's Perspectives.

Conclusions

This research developed the framework of designing for intercultural experience through the ethnographic approach within UX tools. Fig. 5 summarizes how this research takes benefit from this design framework to identify design tool in different phases of the fieldwork. The fieldwork shows an example of how this research attempts to foster the intercultural dialogue in the context of Chinese catering service through UX design.

As pointed out earlier, one of the challenges of cross-cultural design is that the designers have dual roles in the fieldwork, both as a designer and as a group member, which prompted designers to gain a comprehension of the field under study.

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[2] The dissertation gives four examples reflecting the four quadrants for spelling out how to chose the research instruments in different phases of the fieldwork. This article does not entail the examples.

Open Street Maps		Web Crawler
Online Observation		Interview
	Coding the transcripts	
Verifying Design Tools with Design students	User Group Triangulation	Design Hints
	Co-design with a Chinese restaurant	
	Diary-keeping	
	Coding the diary	
	Attach cultural value through storytelling	

FIELDWORK PHASE 1

FIELDWORK PHASE 2

FIELDWORK PHASE 3

Fig. 5 – The panorama of the framework of designing for intercultural experience.

The design framework plays the roles as following:

a. **Study an unfamiliar context.** Our identity as a group member defines our mental frame for perceiving the situations, and it makes us familiar with our own groups but not necessarily with the others. Thus, the multicultural context always remains unfamiliar for cross-cultural designers since there are different cultural groups coexisting and designers usually belong to one of them or even to none. It is important to study an unfamiliar context while doing cross-cultural design. The design framework developed in this research provides a general structure of investigating in a multicultural situation. Within our design framework, designers are able to identify what to investigate according to the specific position of the design process within the multicultural situation. They can also identify the appropriate UX tools according to the specific design questions and certain research steps.

b. **Think out of the mental frames.** As a member of a cultural group, no matter it is one of the groups in the multicultural environment or not, the designer has his/her mental frame shaped by the cultural background. The designer's mental frame may lead to some preconceptions while doing fieldwork. We discussed the risks of perspective bias of doing design ethnography in this research. The design framework enables cross-cultural designers to take different perspectives into consideration while designing for intercultural experience as to prevent the limits of their mental frames.

c. **Share with non-designers.** The other advantage the design framework brings to designing for intercultural experience is that designers can share their design expertise with non-designers, as well as within the design team. The UX design tools enable us to work efficiently in designing for the intercultural experience. These tools seem to be handy for designers but not readable for people who lack knowledge of design. The design framework helps designers to keep their design activities clearly in mind, and when they need to communicate with non-designers, they know which part of activities they shall wrap-up and interpret to their audience. For instance, the MMDs is a convenient tool for mapping the mismatches and alignments of a product/service, and we used it to identify the design opportunities for the Chinese catering service in Milan. We introduced this tool in the UX course and the students in the class did not report any difficulty in use. However, when we brought this diagram to the restaurant owner and waiters, they found out it was difficult to read. We had to communicate the findings gathered through storytelling.

d. **Share with design team.** Designers from different subjects have their special expertise and making use of their designerly expertise for improving the intercultural experience is significant. The design framework provides a theoretical structure of how to refine design questions and identify appropriate design tools while doing cross-cultural design. Such a structure embraces the variation of the specific design activities. In this research, we elaborated the use of UX tools in the fieldwork, however, we do not exclude the possibility of adopting tools from other design disciplines to conduct fieldwork. The design framework can play the role of leading designers to investigate in the field according to their different expertise and share the process and findings within the same structure.

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Digital Transformation

Creativity 4.0.
A method to explore the influences
of the digital transition on human creativity
within the design process

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Abstract

A new digitally enhanced humanity is growing up totally immersed in a digital world, accepting digital enhancement as an opportunity and an integral part of their existence. Developing creative skills thus becomes a mission to adopt and guide the future technological development. The research aims at providing a method to deeply understand the main positive and negative influences the current scenario of digital transition is bringing to the cognitive, emotional, motivational and social factors of creativity involved in the design process for innovation.

The research contributes to structure a scientific approach to systematize the knowledge produced in the rapidly evolving emerging realm named "Digital Creativity" where multiple disciplines investigate the relationship between the factors of creativity and digital technology from several and fragmented perspectives. This resulted in the definition of a Creativity 4.0 Model and Framework that supports the development of digitally enhanced human-centred design methods and tools for creativity enhancement.

Co-evolution between human and digital technology

In the 21st century we are witnessing massive economic and technological changes, with the introduction of completely new devices, sensors, robots, and applications that are totally affecting the ways in which people live and work, and also how society is viewed and organized (Sahin, 2009).

The emerging digital technologies have the potential to revolutionize all sectors of our society (i.e., healthcare, transportation, manufacturing, enter-

tainment, and even art), playing a key role in the creation of new business models and transforming the industrial economy and the associated job market (National Research Council, 2008).

Ubiquitous, invisible and affective computing, artificial intelligence, machine learning, big data analytics, robotics, virtual/augmented reality and all the emerging technologies, are changing skills requirements and capacity building for 21st-century digital economy. This specific phase of technological progress seems to be very different from all the preceding ones: it involves a combination of transformative and cognitive digital technologies, tools and processes and most importantly people, in terms of culture, skills and mindset. Therefore, the interconnection between technology, human cognition and human life in general will become much more intrinsic, invisible, and impactful.

This digital transition is profoundly changing the human condition, especially for the digital native (Prensky, 2009) generation that is growing up with information and communication technology (ICT) as an integral part of everyday lives.

As we move further into the 21st century, the generational gap is narrowing, and the concept of digital natives is evolving since we all are growing up and adapting, each at our own speed, to this era of digital technology. A new distinction can be made in terms of digital wisdom , "the ability to find practical, creative, contextually appropriate, and emotionally satisfying solutions to complicated human problems through the support of computer enhancement" (Prensky, 2009, p. 2).

We can define these new individuals as **digitally enhanced people**[1].

Digital enhancement is already available for just about everything we do, and digital tools already extend and enhance our cognitive capabilities in a number of ways.[2]

The human being is indeed co-evolving with digital technology (Corazza, 2017) as it modifies our "relationships to ourselves (who we are), the interaction with others (how we socialize), our conception and interaction to the real world" (Floridi, 2015, p. 7). Neuroscientists are beginning to see significant changes, which correlate with the diffusion of digital technologies and their

[1] "he or she accepts digital enhancement as an integral fact of human existence, and he or she is digitally wise, both in the considered way he or she accesses the power of digital enhancements to complement innate abilities and in the way in which he or she uses enhancements to facilitate wiser decision making" (Prensky, 2009, p. 4).

[2] For example, electronic storage enhances memory. Digital data-gathering and decision-making tools enhance judgment by allowing us to gather more data than we could on our own, helping us perform more complex analyses than we could unaided.

widespread use (Loh and Kanai, 2016). Some researchers are questioning the impact of ICTs on human cognition, especially in terms of brain modification and changes in cognitive processes. Others are studying the social behavioural changes and the shift in mindset that led to the creation of new social phenomenon, initiatives and communities (e.g., open source, peer-to-peer, etc.) emerging with the aim of contributing to a more community-oriented society (Florida, 2014).

In this digital transition, **creativity** has been recognized as one of the most distinctive human skills to nurture and develop in order to manage at best the powerful collaboration between human and machine. Indeed, creativity helps people conceive novel and useful ideas (Amabile, 1988), and get the benefit of the opportunities offered by digital technologies in any field. It also represents the intangible substrate for innovation (Kozbelt *et al.*, 2010) and is, therefore, a key to economic growth and social transformation (Florida, 2014).

Human existence will be related one-to-one with our ability to generate ideas to successfully exploit the opportunities that technology is offering us. Hence the responsibility of studying, understanding and developing creativity skills, and defining how digital technology and human evolution influence those abilities and how to exploit the new opportunities to digitally enhance them, becomes a sort of multidisciplinary mission.

Focus of the research

Starting from the observation of this scenario, research questions have been formulated from general aspects to specific ones, highlighting rationale:

- How to empower the human creativity of the digitally enhanced people to generate new and original ideas?
- How to enhance human creativity exploiting the potential and opportunities provided by the digital transition?
- And more specifically:
- What are the factors underlying human creativity?
- What are the changes of the current scenario of transition that could have positive and negative influences on human creativity?
- How is the creative design process influenced?

Given the complexity and the multitude of approaches that can be adopted to study creativity, it is essential to frame a clear definition and above all to choose which aspects to investigate.

Drawing on the 7 C's creativity framework (Lubart, 2017), the research aims at investigating creativity by studying the integration and interconnection of three of its different facets (fig. 1), which are:

- **creator**, referring to the digitally enhanced, the research adopts an individual perspective, considering the cognitive, personality, motivational and emotional characteristics of the actors that engage in creative activities;
- **creating**, referring to *Stage and Componential Process* theories (Kozbelt, Beghetto and Runco, 2010) that study the creative process from the macro perspective as a form of activity or action (Dewey, 1934);
- **context**, referring to the actual scenario of digital transition that influences several aspects of the human being.

The general aim is, therefore, to study how the aspects of the context of digital transition positively and negatively influence the creator and the creative process, which is a first attempt of this kind and contributes to the originality of the present investigation.

Therefore, I adopted a more extended and elaborated definition of creativity offered by Plucker, Beghetto and Dow (2004), which claim: "Creativity is the interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context" (p. 90, orig. emphasis).

The research aims at structuring a scientific approach to draw on the knowledge produced in the emerging domain named "Digital Creativity"[3], which is a wide and rapidly evolving realm that is being constantly redefined, where multiple disciplines – psychology, sociology, computer science, HCI, etc... – already investigate the influence of and relationship between creativity and digital technology from several and fragmented perspectives.

This exploration results in a method designed to deeply understand the main positive and negative influences that the current scenario of digital transition is bringing to multiple levels of human creativity to inform and empower the creative design process for innovation.

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[3] "As digital innovation has permeated our daily lives, creativity has started to take a new shape: **digital creativity**" (Lee and Chen, 2015). A first analysis of the state of the art brought me to discover this recent emerging domain of study which collect different Lee (2015) provided one of the first definition of digital creativity as "all forms of creativity driven by digital technologies". In other words, digital creativity occurs when any kind of digital devices or digital technologies are used for various creative activities.
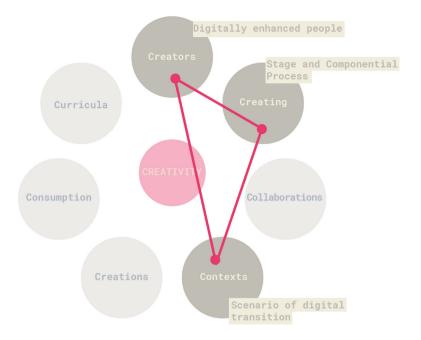
Fig 1 – The diagram shows the intersection of the three aspects of the 7 C's creativity frame-work on which the research is settled, thus drawing on their related theories and sources.

What is needed to be creative? Components and factors of creativity

Two major beliefs underly this research: the first one is that everyone can be creative, all persons of normal intelligence possess some ability to think creatively and to engage themselves in imaginative and innovative efforts (Roth, 1973). The second one is that creativity can be trained and learnt and that it relies on personal attitudes, cognitive skills, motivations and environmental factors. Psychology literature reports a category of theories called componential approaches (Amabile, 1983; Sternberg and Lubart, 1995; Botella *et al.*, 2013) that explains creativity taking into account the interaction between the individual inner level and the surrounding social and cultural environment. They focus on the ingredients, in terms of attributes, abilities, and circumstances, necessary for creativity to emerge.

One of the leading theories is the Componential Model of Creativity (Amabile, 1983; Amabile and Pratt, 2016) that identifies the major components necessary for individual or small group creativity in any particular do-

main, considering also how each component might enter into the creative process. According to the model, creativity is influenced by three main individual components (i.e., constituents or building blocks necessary for an individual to produce a creative outcome) each one including different factors (i.e. various elements that define the component and allow to put it into practice). These are: *knowledge&skills* that include factors such as domain knowledge, technical skills, special talents*; creativity-relevant processes,* including factors related to both personal attitudes and cognitive processes; *motivation* that includes the inner motivation and the external factors that influence it. The fourth component of the model is the surrounding *environment*, which can extremely influence the individual components and includes social and material factors, such as access to knowledge resources, space set up, technical and social support from others.

The Amabile model has been taken as a scientific reference for this research since it supports a holistic view of creativity merging both the individualistic and the socio-cultural perspectives (Sawyer, 2012) and factors, which are crucial to explain and study creativity in this era. Amabile (1983) also argued that "Although it is proposed that the three main components constitute a complete set of the general factors necessary for creativity, the listing of elements within each component can only be completed gradually, as progress is made in creativity research" (p. 362). Therefore, each component has been integrated with the factors identified by reviewing the main waves of creativity studies (Sawyer, 2012) adopted by psychologists to study creativity scientifically – only if explicitly demonstrate its relationship with the component. This allowed to add a fifth component, which is *emotion,* and to collect a wider and more precise overview of factors. Fig. 2 shows the overall components and factors that could influence human creative potential.

In recent decades, with the advent of ICTs, people and society have started a process of transformation, changing their behavior and becoming increasingly interconnected. Fischer, Rohde and Wulf (2007) defined the term social creativity as working together to solve a problem with the help of computer media and technologies. Digital technologies are indeed bringing new opportunities to empower the creative potential. Therefore, the need emerges to define a new model of creativity that could explain the multiple shades of creativity in this era and which could include the interaction between the three main aspects defined in the previous section (e.g., creator, creating and context).

This new model should also allow to effectively understand how the digital transition is positively or negatively influencing or transforming the ingredients that contribute to make a person more creative and their effect on the creative process.
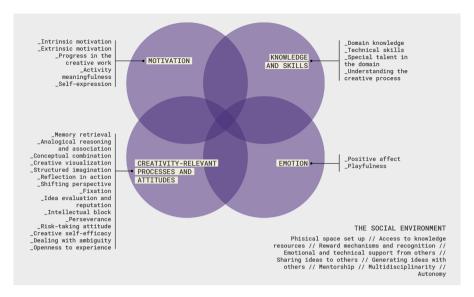
Fig 2 – Integrated componential theory of creativity.

The Creativity 4.0 model. Representing creativity in the digital age

An in-depth study of the literature reveals that the digital transition is radically impacting the human being in profound ways. A Human-centred approach has been adopted as a basic principle of the research placing the human being at the centre of the analysis and understanding how the changes wrought by the digital transition can somehow influence the human creative potential.

The human-being has, therefore, been broken into the three levels that belong to each individual (Huitt, 2012) and that influence the way in which a creative activity is performed, precisely:

- the **cognitive level** that includes mental functions that deal with logic and the way in which we process information;
- the **individual level** that includes the physical and the emotional dimensions of the human-being involved in his ability to carry out actions;
- the **social level intended** as the dimension of the human being involved in communicating and collaborating with other individuals in creating an outcome.

The analysis of the current scenario of transition enabled to build a model to understand the multiple dimensions and the crucial factors that affect creativity in this era.

The Creativity 4.0 Model (fig. 3) is structured through three main elements: the *digital transition*, that is the ground on which the model is growing and feeding; the *human being* analysed according to the three levels on which the digital transition has an impact (cognitive, individual, social) and, finally, the *creative process*, namely human ability, which is transversal to all levels of the human-being.

These three elements also correspond to the three aspects of the 7 C's creativity framework on which the research is settled – context, creators and creating.

HUMAN BEING   CREATIVE PROCESS

creativity as
social process
social level

creativity as
individual pactice
individual level

creativity as
mental process
cognitive level

DIGITAL TRANSITION

Fig. 3 – Creativity 4.0 model.

The Creativity 4.0 model built enables to include the many dimensions and factors of creativity identified that intervene within the human-being on the three different levels, which include:

- **creativity as a mental process** from problem definition to evaluation and implementation, supported by specific cognitive processes (Finke *et al.*, 1995, Ward, 2001);
- **creativity as an individual practice** requiring activity, things and tools, states of emotion and motivational knowledge as well as creative attitude (Amabile, 2012; Sanders, 2008);

- **creativity as a social process** that unfolds with others (Csikszentmi-halyi, 1996; Fischer, 2004; Literat and Glăveanu, 2016).

The intersection of those three levels provides a comprehensive understanding of the complexity and multifarious aspects of the creative process comprising several steps, activities as well as the motivational, cognitive, attitudinal, technical constituents and the social and environmental components influencing these constituents during the process. The three levels also influence each other as they are part of the same person.

The Creativity 4.0 model is not static, but it represents a tool that allows to observe the impacts of the digital transition on the three levels of the human-being understanding how they influence the creativity factors. This paragraph presented the overview of the main elements composing the model in order to help readers go through it easily and gain a better understanding of the overall structure. The following section focuses on explaining how the model can support the analysis of the factors of creativity identified.

Factor analysis. Objectives and methodologies

The model guided three main investigations and several steps of iteration and refinement on how the digital transition is impacting on the cognitive process unfolding during a creative activity, the competences, motivation and tools needed, besides the interaction with other stakeholders for the enhancement of its creative potential.

In the first investigation, based on an extensive literature review in the digital creativity domain, the factors were related to the positive and negative impact the digital transition has brought on the human-being on each level, to understand how they can be influenced. The second investigation, based on case studies analysis, aimed at identifying researches that explored the potential of specific digital technologies in the enhancement and stimulation of certain factors, verifying their influence on the creative process. The third investigation, based on expert interviews, focused on confirming the crucial factors highlighted from the previous investigations and on understanding where and how the digital transition is shaping human capacity to generate original and effective ideas. The analysis results in the definition of a set of positive and negative influences brought by the digital transition to the factors of creativity and in the identification of trends in the use of digital technology adopted to support the creative potential within the creative process.

Example

Observing the impact on the cognitive level. Managing the abundance of information. The Internet and Web browsing technologies have made a huge amount of information easily accessible. The extensive digital stimulation on developing minds has taught a digitally enhanced generation to respond faster, encoding information differently (Small and Vorgan, 2008). Altering our neural networks and synaptic connections through activities, such as emails, video games, search engines, or other technological experiences sharpens some cognitive abilities. Therefore, in the digital era it has become increasingly important to develop the ability to manage the abundance of information and learn where to find the most useful and reliable knowledge.

Understanding the influences on the factors of creativity. Neuroscience studies report that the increased presence of hypertext environment reduces the cognitive resources required for deep processing, and the ease of online information retrieval reduces the need for deep processing to commit information to memory. This combination can augment the cognitive overload of information that exponentially decreases the human decision-making ability. The resulting information overload blows up the divergent phase of the creative process, weakening the *conceptual combination* process in the convergent phase, thus creating **difficulties in combining and integrating the information** when attempting to form new ideas (Huber, 1990) **as well as in isolating the problem.** Creativity does not require a big amount of information to generate breakthrough ideas (Corazza and Agnoli, 2015). Too much information can lead to the availability of too many ideas and perspectives to effectively screen, process and integrate, increasing the **inability to select the most interesting and appropriate information**.

Tab. 1 shows the impacts observed, the factors involved and the relative influences.

Tab. 1 – Relationship between the impact observed and relevant influenced factors.

IMPACT	FACTORS INVOLVED	NEGATIVE INFLUENCE
Managing the abundance of information	Intellectual block	Inability to select the most interesting and appropriate information
	Conceptual combination	Difficulties in integrating the information when forming new ideas

Creativity 4.0 Framework. Mapping the impacts on the design process.

For design research and practice, this analysis becomes strategic if it is structured within a theoretical framework that associates the impact identified and the influenced factors with the design process. The framework thus becomes a tool to analyze the influence of the digital transition on the multiple aspects of the design process as well as to define design actions and tools to empower it. On the one hand, the framework integrates the factors of creativity which are mostly shaped by the digital transition and that consequently influence the components responsible for generating new and innovative ideas throughout a design process. On the other hand, it can be considered an analytical framework that maps the state of the art of the positive and negative influences of the digital transition, also identifying how digital technologies can facilitate the creative design process.

Fig 4 – Overview of the framework layers corresponding to the impacts identified.

A total of 13 impacts (fig. 4) and their positive and negative influences on some factors of creativity have been mapped on the creative design process, highlighting opportunities and threats brought by the digital transition.

The Creativity 4.0 framework has indeed been developed to properly understand how the digital transition is influencing the cognitive, emotional and social factors of the digitally enhanced generation that intervene in the production of new, original and useful ideas.

The framework strength lies in having systematized the knowledge on creativity from different disciplines, e.g., design, psychology, sociology and computer science, providing an overview of the main creativity factors on

Fig. 5 – Mapping the impacts on the creative design process structure.

which the digital transition has an influence. That is not all of it. The framework informs how the numerous factors intervene in the creative design process, also highlighting how the changes brought by the digital trans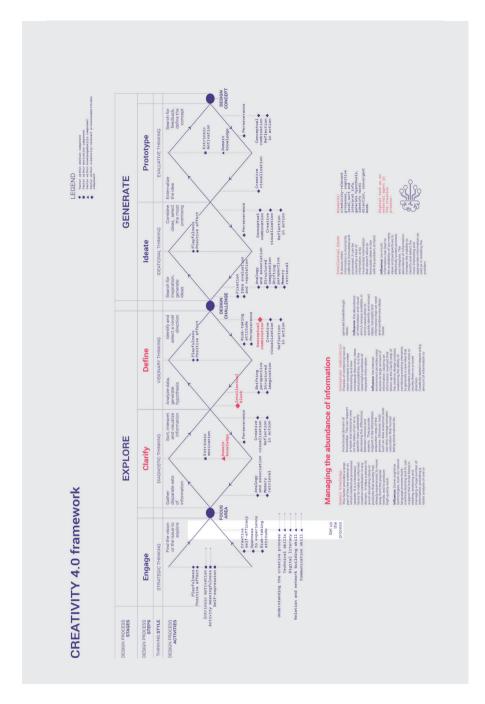ition can influence them. Fig. 5 shows the impact previously mentioned mapped on the framework highlighting the step of the process influenced, highlighting relations in order to define actions to enhance it.

Conclusions

The results of this research are crucial for the development of a Human-Centred method aimed at generating innovation by exploiting the emerging digital technologies. The method allows to study the human changes brought by this scenario of transition, in order to augment creativity both by empowering the factors on a specific step of the process and by transferring a design process to learn a strategic approach to technological development.

The method, through the application of the Model and the Framework, aims to facilitate and support the emotional, motivational, cognitive and social components of the human-being at the basement of the creative design process. These components are the levers to be activated and enhanced through technology. They allow the human being to express his maximum creative potential. Moreover, one of the aims of this research is also to contribute in updating and implementing the design vision about creativity in order to better understand and adopt digital technology to train and increase the development of the human creative potential.

The research and the framework allow to organize the fragmented data collected within the literature from different fields and disciplines and give them a new interpretation and a new meaning, providing members of different research disciplines with a common language and a frame of reference to define the boundaries of a complex phenomenon, such as creativity in the digital age.

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Toward a Yacht Design 4.0
How the new manufacturing models and digital technologies [could] affect yacht design practices

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Abstract

In the field of design, Industry 4.0, Internet of Things and intelligent products are profoundly transforming not only the representation of a design project but also formal references, input data, communication strategy and the design process itself. In this scene, the doctoral research estimates the role of the new digital technologies of Industry 4.0 and the new manufacturing models in the transformation of yacht design practices. The main research results – the Yachting 4.0 Forecasting Framework and the Yacht Design 4.0 Roadmaps – came from a systematic and comprehensive study of future alternatives to answer the research questions: How could Industry 4.0 digitally-enabled technologies be better implemented in a Yacht Industry 4.0 scenario? How could these scenarios modify disciplinary approaches to the yacht design project?

The study results contain a reflection on novel yacht design practices – in particular on data input, design processes, design tools, and communication media – positioning the study achievement on a conceptual level that still needs to be pragmatically tested and verified by applied research projects both in shipyards and in design studios.

Research Framework

Toward a Yacht Design 4.0 is the result of a doctoral research process that is mainly theoretical, supported by field investigations and participatory action researches. It explores Industry 4.0 to understand its role in manufacturing transformation and in introducing challenges to the field of yacht

design. The choice of focusing on this research topic does not derive from a recognized field of study – indeed, the Yachting 4.0 topic is almost absent in the literature review[1] and in industrial practice[2] – but rather from an intuition about the need to foresee the role of new digital technologies and new manufacturing models in the transformation of the yacht design sector, in order to understand and guide the digital transformation in progress.

In the field of design, Industry 4.0, Internet of Things and intelligent products are profoundly transforming not only the representation of a design project but also formal references, input data, communication strategy and the design process itself. In the contemporary scene, a designer needs to face design requirements, which are strongly influenced by an advanced technological system characterized by connected, computational, and open-sourced digital manufacturing (Giaccardi, 2015). Manufacturing shifts from producer of objects to producer of services, and industry mixes with the lives of people, rapidly and continuously drawing useful indications from them to redefine the production itself (Frison, 2016).

However, the impact of the discussion on Industry 4.0 on the design sector is still immature, with few papers discussing the topics only from 2016. As argued by Celaschi, Di Lucchio and Imbesi (2017), looking at the impact of 4.0, "the discipline of Design seems to be absent and, therefore exempt, from taking into consideration the transition to this fourth industrial revolution as a paradigmatic change of one's role and purpose. The research on Design and Industry 4.0 is often limited to listing the challenges in terms of new technological availability without really asking the question whether and how Design itself will have to change in order to adapt, in evolutionary terms, to this near future which implies productive as well as economic and social issues."

On the other hand, yacht design is a highly complex applied sector of industrial design. Scientific fields of engineering, design, architecture, ergo-

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[1] A systematic literature review was carried out during all the phases of the doctoral study to monitor the evolution of the Yacht Industry 4.0 concept in academic research. In March 2019, based on about 5,800 papers (journals and conferences) published in the field of Industry 4.0, over 480 articles include researches or applications in the maritime sector, while only thirteen are focused on the yacht industry.

[2] An international online survey was carried out between March and May 2018 with the aim of gathering information on knowledge of Industry 4.0 in the nautical field, and on the current use of digital technologies in the Yachting industry in relation to the level of end product customization. The survey results show a general lack of awareness of Industry 4.0 opportunities. In 92% of the sample, both 4.0 manufacturing models and 4.0 enabling technologies are unexplored in a systemic way, and the integration of digital data in the yacht design and production process is considerably low.

nomics and materials, with their specialized disciplinary articulations, are involved in a boat project. Besides, a marine product must have characteristics halfway between a passenger compartment and a living space that "moves even when it is still" (Spadolini, 1987). Hence, every project has to manage the diversified system of limitations imposed by the user and by the overall efficiency of the boat-system, including manufacturing techniques and process.

Nowadays, the nautical sector is facing several challenges linked to the world economic, environmental, and societal context. Furthermore, the global Yacht Industry, led by Italian production, is projected to grow by up to 11% by 2022, considering both yacht length and number of vessels under production. However, the sector is experiencing technological backwardness and is recovering from a downturn that began in 2010. The recent economic crisis has highlighted both a need for significant changes in production systems led by an afterthought of the entire yacht design process (Pollicardo, 2017). Hence, the Industry 4.0 scenario could have a disrupting impact on current yacht design processes, which are still mainly described as a process of iterative engineering refinement and incremental optimization called "yacht design spiral" (Larsson *et al.*, 1994).

Design for the Future

If future scenarios and challenges cannot be predicted with an unquestionable level of uncertainty, they can be estimated and understood to inform present actors. Due to the freshness and the "unexplored complexity" (Magruk, 2016) of the Industry 4.0 topic, and the lack of references in literature, strategic thinking to explore alternative futures – Future Studies (Bell, 1997) – is prioritized. The beginning of all industrial revolutions took place in the industry and caused a massive change in society. The opposite is true in the current industrial revolution. The beginning of the transformation process is not driven directly by the industry itself (Schuh *et al.*, 2014) but is triggered by a hyper-connected society. For the first time in history, the industrial revolution is predicted, providing opportunities to shape the future actively.

According to these considerations, the main research questions of the doctoral research are:
- How could the Industry 4.0 digitally-enabled technologies be better implemented in a Yacht Industry 4.0 scenario?
- How could the Industry 4.0 digitally-enabled technologies modify disciplinary approaches to the yacht design project? So, what are the alternative yacht design processes and tools?

The theoretical framework of the research is placed in the broader conversation on relations between the Discipline of Anticipation and Design. In this framework, the research methodology aims at pushing the boundaries of yacht design toward a possible evolution driven by digital and interconnected technologies. This vast and unexplored context of investigation compels the research to continuously shift from phenomenological exploration and interpretation (surveys and case studies) and forecasting activity (participatory scenario-building workshop), opening it up to several tangents or critical matters that may be considered for future research work.

Research Methodology

The research approach[3] is placed across the two main categories of the design research, namely Research through Design and Research for Design (Jonas, 2007). While Research for Design mainly refers to the aim of the present study, the nature of this research is close to the actual design practice. Consequently, according to Volontè *et al.*, 2015, the research output has a twofold nature: problem framing – the Yachting 4.0 Forecasting Framework – and a series of artifacts – the Yacht Design 4.0 Roadmaps – to drive the study reflection and computational strategies in Yacht Design.

The research strategy comes directly from the literature review on Future Studies, and is organized into the 6-ing phases of the *Strategic Foresight* by Hines and Bishop (2006): framing, scanning, forecasting, visioning, planning and acting. Accordingly, the research adopts methods and tools generally used in design research mixed with management research ones.

Framing and *scanning* aimed at building a robust forecasting framework through desk research and case studies analyses. The scenario-building workshop (*forecasting* and *visioning* phases) was selected as a forecasting method based on the nature of the uncertainty involved in the activity and referring to the Future Studies framework proposed by Courtney (2003). While the case study analysis was conducted with an expert mindset, the forecasting phase had a participatory mindset, involving stakeholders as co-researchers. Finally, *planning* and *acting* referred to the activity of roadmap design and retrospective analysis to ground the workshop's results in an understanding of novel yacht design approaches, processes, and tools driven by the yachting 4.0 forecasting framework.

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[3] The study refers to the logical hierarchical taxonomy identified by Rampino and Colombo (2012) to give structural consistency to the term used in the research methodology.

Foresight with insight

A Case Study analysis on 4.0-enabling technologies applied in the yachting industry was carried out to reveal opportunities and trends for the scenario-building phase. Cases were identified by consulting with stakeholders – academics, naval and nautical shipyards, suppliers, yacht designers and nautical industrial associations – during international boat shows and in the yacht trade in 2017-2018. Forty projects and practices were selected within the nautical, maritime, and transportation sectors.

Case mapping mainly focused on understanding relations between industry 4.0 design principles (Herman *et al.*, 2015) and 4.0 enabling technologies, including the possible impact of the use of digital technology on yacht design and manufacturing and, more in general, to investigate the potential to scale up experiences in supporting the scenario-building activity.

After completing the desk research, cases were grouped by levels of consciousness in Industry 4.0 integration and by their influence on the disciplinary approach to the yacht design project. The resulting clusters were labelled and explored in relation to Industry 4.0 scenarios by PWC (2016)[4]. According to the PWC scenario, the forecasting framework backdrop was built as a scheme of four concentric circles divided into four sectors by the vertical and the horizontal axes. The horizontal axis separates focus on the product from focus on production, while the vertical axis marks the temporal division between before launch and after launch phases.

The resulting case study groups are labelled and described.
- Digital data gathering: projects integrating IoT and AHMI with the primary purpose of monitoring yacht assets.
- Environmental digital data analysis: projects integrating IoT, big data, simulation, and AHMI with the main purpose of gathering and analyzing field data to inform (in perspective) the design process. Vessel and marine environmental data gathering from the IoT structure are mainly used in this cluster for maintenance purposes.
- Data simulation for communication purposes: projects not informed (or partially informed) by field data integrating big data, simulation,

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[4] The PWC Industry 4.0 scenario framework identifies four steps in moving from a product-oriented to a platform-focused approach: (1) Core Product, the traditional base offering, (2) Digital Augmentation, digital interfaces and channels to augment the experience and to allow a variety of interaction models, (3) Digital Service, in which digitally enabled services are added to the physical core product providing an end-to-end solution to a broader customer need, and (4) Digital ecosystem, the product is embedded in an ecosystem for co-creation and additional value capture.

VR, and AHMI. The main examples are the virtual reality in marketing strategic communication and virtual sailing testers.
- Simulation analysis and optimization: projects not informed by field data in a non-integrated ecosystem. This group encompasses simulation software to predict real world performance and tools for manufacturing process optimization.
- Optimization through integration: collaborative projects developed for the marine and yachting industry to manage design phases, value chain or offshore and sailing operation.
- Optimization through generative processes: projects involving generative design tools to optimize and self-configure the product's shape according to the manufacturing process. In this cluster, we can also find collaborative platforms for both design and additive and collaborative manufacturing.

Fig. 1 – Map of case studies.

Case study mapping highlights a general lack of systemic vision of Industry 4.0 technologies. Digital data from field and user engagement are not yet employed in the design phase and are only partially used in the maintenance stage. This results in a disconnection between the after launch and before launch phases at the expense of input data design quality and quantity.

Looking at the purposes in the use of 4.0 enabling technologies, low consciousness cases are generally implemented in communication strategies, while collaborative strategies lead projects with a higher level of systemic integration and self-configuring processes. In particular, new communication media are emerging in relationships within companies and the yacht's end user, besides faster and easier access to information through digital platform and self-devices. Furthermore, these new media could embed digitally-enabled services to provide an end-to-end solution to a broader customer need. In terms of design and manufacturing, horizontal integration of digital data

Fig. 2 – Yachting Industry 4.0 Forecasting Framework.

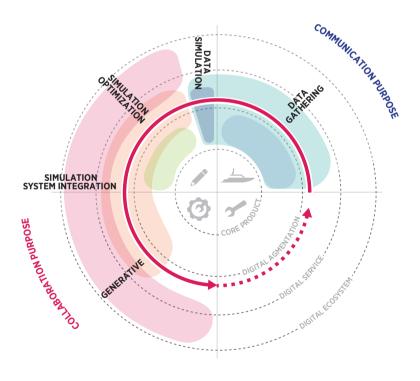for simulation, optimization, and self-configuration (generative) process are arising. However, as shown in the map of case studies, the implementation in the use of collaborative platforms for optimization and generative design process does not make use of field data through the entire value chain.

The case study analysis highlights numerous unexplored opportunities in the yachting sector, and confirms the high potential of digital enabling technology in improving consciousness and interoperability during all steps of yacht design and manufacturing processes. The drivers and challenges explored for case study mapping are then summarized in the forecasting framework. The Yachting 4.0 Forecasting Framework (fig. 2, previous page) is the first research result. As a guiding backdrop for yachting 4.0 foresight activities, it is conceived as an open tool for future activities.

Yacht Industry 4.0 scenarios building workshop

A co-design scenario building workshop, the YI4.0sws, was organized and run by the Author with the aim of covering the two phases of Strategic foresight, namely *forecasting* and *visioning*. It had three objectives: (i) discuss and validate the scenario framework; (ii) explore and build alternative scenarios on yacht design 4.0, outlining drivers and criticalities; (iii) involve the specific industrial community and make it aware of the opportunities of digital technologies.

To achieve the intended research objectives, the workshop involved experts in the yacht design field. Specifically, participants in the scenario-building workshop were yacht designers and draftsmen in the yard and shipyard project, and production managers, yacht industrial association managers, experts in digital transformation and policymakers. A specific set of tools, the YI4.0sws Toolkit, was created to support the strategic conversation among participants, and to assist the development in progress of alternative scenarios.

The workshop was focused on Yacht Design practices, but a systemic view of the whole yachting sector was fostered. The activity was divided into four main phases: a general introduction on purpose and forecasting framework, structured brainstorming, a free envisioning session, and a scenario-building session exploring the gap between current and future technology. Though free envisioning and scenario exploration activities were described as a consecutive sequence, the two stages were often conducted in parallel in an iterative conversation among challenges and opportunities.

The workshop resulted in the creation of three visions and three Roadmaps towards Yacht Design 4.0.

Roadmaps to Yacht Design 4.0

The roadmaps were developed according to the three clusters of yacht product and production (Pollicardo, 2017): top of the line – encompassing a high level of product customization and looking toward the larger segment of super- and mega-yachts –, model-based – product with a lower value in terms of customization and an engineered production process – and semi-custom – model-based production with a high level of flexibility and customization of the core product. Furthermore, the roadmaps created in the YI4.0sws take into account contemporary challenges in the yachting sector as described by Camper & Nicholsons and Wealth-X (2017) and explored in the *framing* phase of this study. These challenges are recognized when creating a product-service value system and when enhancing customization and product flexibility.

Top of the line roadmap to digital product-service ecosystem

The first roadmap takes the peculiarity of the specific cluster's sector into account and proposes a journey toward a digital product-service ecosystem in which field data are transmitted seamlessly and in two ways between the yacht and its digital twin. Furthermore, personalized service and yacht components are designed based on field data gathered on a knowledge management platform. The first roadmap step is the digital augmentation of both the design project, i.e., 3D model of the yacht, and the product, i.e., the yacht itself. Yacht design modelling becomes parametric[5], while sensors and remote control networks are placed onboard, transforming the vessel into a connected object. User experience data are recorded on a knowledge management platform. Coupled with the use of big data analysis, the digital platform allows the development of onboard personalized service, including optimized and automated routing, maintenance and marina service, and legal insurance services, component and digital assets optimization and customization.

In this scenario, yacht design processes maintain their character of an iterative cycle of refinement steps. With the use of parametric design tools, which allow to generate a living digital model according to a predefined

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[5] The relations between project dimensions are not directly drafted on a digital continuum space anymore (as in a CAD direct modelling tool) but depend on various parameters. This process is generally described as predictive modelling, as opposed to direct modelling, in which the descriptive modelling process converges manufacturing rationale and material proprieties (Oxman, 2006).

relational structure, the sequence of simulation and optimization steps are integrated into a unique analytical process on geometrical models.

In this contest, the living digital twin is managed by parametric design technologies and optimized by the result of the digital experience platform analysis. This scenario provides an integrated tool powered by real-time field data in which the designer can define the generic properties of a geometrical structure within a user-defined framework. Moreover, the design platform could allow multiple evaluative analyses and support collaboration among the various design and engineering teams involved in the yacht design process.

Finally, the digital twin, enriched by field data gathered on the digital platform, could be visualized through virtual reality digital devices both for augmented customer experience and manufacturing/maintenance purposes. The representation highlights not only the yacht feature and control gateways but also information on how the yacht, the systems, and the components operate throughout the whole life cycle.

Model-based roadmap to co-modular digital ecosystem

The second roadmap reflects on the recent debate on mass production and on the challenging shift to mass personalization. The move from mass production to mass personalization has been struggling worldwide in the industrial sector since the early '90s, and is extensively discussed in theory and applications. However, the integrated use of Industry 4.0-enabling technologies seems to offer a solution to the dilemma between the economies of scale and scope triggered by the concept of mass customization (Brettel *et al.*, 2014).

In this context, the model-based roadmap envisions a journey toward an integrated modular digital ecosystem, in which the yacht product, design, and production processes consist of integrated (design-production-product) subsystems with few interdependent aspects serving as module links. Subsystems are then grouped in a unique platform by flexible combinations. In the future scenario, field data and customer needs could optimize the single modules via the virtual management platform.

A sequence of four steps divides the design process of the co-modular digital ecosystem scenario. (i) Definition of a pre-set of general conditions and parameters mirroring the first cycle of the yacht design spiral aiming at establishing the interdependent logical structure of the yacht based on configuration variables and on yacht design principle and constraints. (ii) Variant-based generation of subsystems according to market and trend research. This step also involves the definition of module links and the rational cor-

relation of subsystems. (iii) Variant optimization by field data from product performance (sailing and user experience), from the production process and from supply chain management. (iv) Variant selection, final product visualization, and evaluation by customers through virtual reality. In this case, the collaborative design process involves customers in flexible customization.

In this scenario, the design process is supported by a parametric tool involving generation and management of digital representations of physical, functional, and production proprieties of subsystems and of their rational/construction links.

Semi-custom roadmap to generative-integrated ecosystem

The third roadmap proposes a journey in which virtual data from user experience and field measurements could inform the design phase during generative processes for higher optimization and personalization of project development. Indeed, the semi-custom sector features model-based products with a high level of flexibility and customization, in some cases already coupled with digital technology in design and production processes. The roadmap focuses on the generative design process. As argued by Kolarevic (2004), in the generative process, computational analytical techniques based on the finite element method are used to explore formal complexity and to accurately drive shape-forming processes. In this process, designers interact with the generative structures, their limits, and input, defining the grammar of shapes.

In this scenario, the previous parametric design process is shifting toward a computational process model of digital design (Oxman, 2006) under the impact of a new generation of associative algorithms. The linked and iterative cycles of design, analysis, simulation and optimization of the yacht design spiral do not describe the new paradigm of the yacht design process anymore. Furthermore, generative processes could take into account the "making level" of 4.0, enabling technology additive manufacturing and collaborative robotics.

Computational strategies in the yacht design process

The definition of the Yacht Design 4.0 Roadmaps was, in itself, a design matter. Underpinned by all the qualitative data and knowledge collected from case studies and by the co-design visioning activity, roadmaps are a synthesis of research results.

In the roadmaps, the journey toward a computational morphology system affects not only the design practice with the use of novel design tools but also the input data, the design process, and the communication media between designers and customers, and designers and manufacturing site.

As also suggested by the yachting 4.0 forecasting framework, 4.0-enabling technologies are driving the yacht design process toward a more digitally conscious and virtually collaborative environment.

The roadmaps highlight three different approaches to the yacht design process driven by digital and computational modeling tools: Digital yacht design spiral, Digital yacht module optimization cycle, and Generative yacht design tangle. At first, in the roadmap toward a digital product-service ecosystem, the yacht design process maintains its characteristic of an iterative cycle of refinement steps fed by real-time digital data. In the digital yacht module optimization cycle, the digital focus shifts to the logical structure in relations between elements and junction constraints.

Fig. 3 – Approaches to the yacht design process driven by digital and computational modelling tools: (a) Digital yacht design spiral, (b) Digital yacht module optimization cycle, (c) Generative yacht design tangle.

Although the parametric and modular approach has increased the interoperability of systems and flexibility among geometrical relations, the exploration of yacht design alternatives is still limited by the manual operation of designers in varying individual parameters. In the generative yacht design tangle, instead, digital focus is on the creative process itself. An artificial intelligence is asked to explore the design space semi-autonomously to disclose options based on predefined generative rules, relations, and principles. In this journey, the designer enters the generative structures of the yacht

model, defines the project requirements and the grammar of shapes and, finally, evaluates the generative results.

Research evidence highlights three central possible and future shifts in yacht design practices.

- Input data are moving from analogue to digital, reframing the focus of the designer practice from measured data to inferred data. The Internet of Things will enable access to more extensive data. In parallel to analogue data, yacht designers could make use of a large amount of direct data measured by sensors and smart devices. In the roadmaps, digital data from production processes and intelligent vessels become the new fuel for design empowerment and customer involvement only if they can be fully understood within a qualitative context framework of previous analogue yacht design knowledge.
- The use of parametric and generative design tools is shifting "digital doing" from digital drafting to digital logic. When focusing on the design process, moving from direct modelling to parametric design and, then, to generative yacht design could fragment the dichotomy between creative thinking and the digital draft of vessel shapes. This focus on the reasoning level of the design process is highlighted in the purposes of generative and computational design processes (Rossi and Buratti, 2018): "creating responsive objects able to react to external stimuli by modifying the formal shapes while conserving the morphogenesis logic".
- The digital twin is modifying the approach to communication media toward a more collaborative media strategy. In the journey depicted in the roadmaps, it acts as a medium by virtually replacing the paper draft and drawing and project renders. As a shadow of projects embedding all physical and digital assets, the digital twin could also be used as a co-design tool between yacht designers and engineers, as well to involve customers or manufacturing teams and supply chains in project definition.

Conclusions and criticalities

Toward a Yacht Design 4.0 is an exploratory study of the topic of Industry 4.0 in the yachting field. Strategic thinking to explore alternative futures was prioritized, due to the freshness and the unexplored complexity of the Industry 4.0 topic in yacht design practices. For this reason, the research outcome

was placed at a conceptual level. Hence, the results of the doctoral study still need to be pragmatically tested and verified by applied research projects both in shipyards and in design studios.

Although the research achieved its objectives, there are some limitations and criticalities, which should be discussed. First of all, the research focused on the level of yacht design processes, also exploring the manufacturing and sailing process as directly connected with the digital integration of 4.0, and not on the product level and its aesthetics. Second, though a case study analysis was carried out with an international point of view, the co-design workshop was conducted with a focus on the Italian Yacht Industry. The specific characteristics of semi-custom and custom production of Italian yacht craftsmanship fit a journey toward more personalized products but lacked a vision of the opportunity of mass market production. Furthermore, the co-design workshop was a unique experience that could only be reiterated to get more informed results.

Finally, workshop discussions point out numerous criticalities at different levels that should be considered for future study in the field: (i) the emerging role of digital yacht designers and the new skills necessary to face the digital transformation; (ii) the design of specific tools for yacht design co-creation; (iii) the release of data used and data protection; (iii) the challenges on cybersecurity in maritime sectors.

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Displaying open cultural collections. Interface characteristics for effective cultural content aggregators

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Abstract

In recent years, cultural heritage institutions, such as museums and libraries, are introducing several strategies to enhance access to their collections. The digitization of extensive cultural collections and their release under open licences are fostering the creation of cultural content aggregators, namely Web platforms funded by non-profit organizations to converge digitized cultural collections from multiple cultural institutions. Cultural content aggregators, such as Europeana and Wikimedia Commons, aim to support scholars, writers and artists in their research, dissemination, and artistic activities.

Although cultural content aggregators are adopting performative technologies and rigorous sharing methods, their user interfaces have several usability issues. Thus, part of the digitized heritage seems invisible to the end-user, as if it were a sort of digital depot.

This paper adopts a research through design approach to investigate interface solutions that may foster access, navigation and use of digitized cultural objects within cultural content aggregators.

Introduction

Galleries, libraries, archives and museums (GLAMs) have been digitizing and providing access to their collections for years. This digital transformation is primarily due to the physical limitation of exhibition spaces and the request for remote access to digitized collections by users. Several information systems have been developed in this context to allow users to search and access the catalogue of cultural collections. Recently, cultural institutions

are also releasing part of the digitized cultural objects under open licences to increase usage and awareness of cultural collections.

The availability of open cultural collections – together with richer metadata – is fostering the development of Web-based applications providing digital access to resources that are physically disconnected. These cultural content aggregators, such as Europeana and Wikimedia Commons, mainly address students, scholars and writers (journalists and bloggers) who need digitized artworks for educational, research, artistic or dissemination purposes. Unfortunately, the existing cultural content aggregators have several usability issues. Hence, access to digitized collections is limited.

This paper explores interface characteristics that may foster access, navigation and use of digitized cultural objects – in particular, images – on cultural content aggregators. The aim is to provide guidelines for the design of cultural aggregators. The research question is the following: which interface characteristics can foster access, navigation and use of open digital collections? I conducted a detailed review of the literature, and related studies have been carried out, alongside stakeholders and end-user research, to answer this question.

Open collections and cultural content aggregators

Nowadays, one of the primary responsibilities of a cultural heritage institution is to promote scientific research and education. Several GLAMs are digitizing part of their collections and releasing the related digital surrogates with open licences[1].

The use of open licences – even for a small percentage of digital surrogates – brings several opportunities, such as increased visibility of the cultural institution – as both a resource for a specific cultural sector and distinctive brand identity – and an increase in possible collaborations with other partners using open licences.

The release of digitized collections is also fostering their use by organizations and ordinary people. In addition to common uses – such as reproduction on digital and paper supports – there is the remix, precisely the graphical elaboration of one or more digital surrogates to endow them with new meaning and value. The "remix culture" dominates the 2000s. It is present over multiple cultural sectors, and uses fusions, collages and mashups (Manovich, 2007).

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[1] Most of the cultural institutions releasing digital surrogates adopt Creative Commons (CC) and Public Domain (PD) licences.

Finally, the release of digitized collections is fostering the development of cultural content aggregators. A cultural content aggregator is a repository that stores multiple digitized collections contributed by cultural institutions and by the user community. Content aggregators were conceived – by initiatives of non-profit organizations – to facilitate the discoverability of collections. A content aggregator aims to promote crowdsourcing, education and entertainment across multiple collections.

A survey conducted by me among users of cultural content aggregators indicates that the primary audience is made up of journalists, Web writers, bloggers, scholars and volunteers of online communities. The final goal of the users of content aggregators is to find high quality images provided with relevant information and few usage restrictions. The content aggregator audience not only visualizes and shares digitized objects but also uses digital copies to make derivative artworks.

A study of the digitized Tropenmuseum collection on Wikipedia shows that only 10% of the images from the cultural collection is used within Wikipedia articles (Borowiecki and Navarrete, 2016). The other images are ignored. The usage pattern of digitized surrogates presents a long tail where few items are most popular, and the majority of the content remains obscure (fig. 1). Thus, popular items drive the attention of end-users towards certain content, despite others.

Wikipedia articles containing Tropenmuseum digital surrogates

Number of
cultural objects

Cultural collection
Tropenmuseum (category Images from the Tropenmuseum)

Aggregator
Wikimedia Commons

Period
April 2015

Number of Wikipedia articles
(0.3% of the total)*

*articles with less than 5 digital
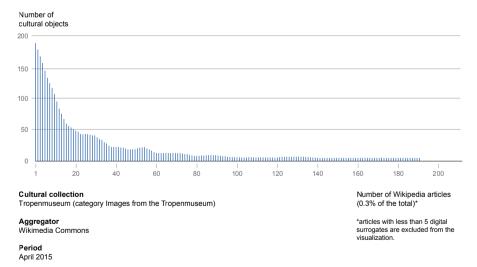surrogates are excluded from the
visualization.

Fig. 1 – Usage pattern of the Tropenmuseum collection on Wikipedia articles (redesigned by the author).

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An in-depth analysis of the literature and of the existing cultural content aggregators reveals that most of them have several usability issues. These reduce the possibility of accessing digitized collections. In this context, design can play an essential role in facilitating access and use of the digitized collections.

Methodology

The thesis defines guidelines to design cultural content aggregators that foster access and usage of digital surrogates. I adopted a research-through-design approach to achieve this goal.

Analysis

The analysis consists of the literature review, stakeholders' interviews and case study analysis. The literature investigates two domains: Information Science (IS) and Digital Humanities (DH). To develop the design project, I also reviewed papers related to the use of cultural content and the building of online communities.

After gathering a theoretical background from the literature review, I interviewed several people working for cultural institutions, including librarians, curators and a digital archive manager. I also interviewed people working and volunteering for Wikipedia. The aim was to gather general information on the cultural heritage system and stakeholders' needs.

The case study analysis aims to identify the features of existing European cultural content aggregators. Every case study is selected according to the following requirements: collect digital images and provide users with a graphic user interface. Fourteen case studies were selected based on these requirements (tab. 1). The goal of the case study analysis is to identify the fundamental interface features of cultural content aggregators.

I investigated three fundamental aspects of the selected cultural content aggregators: access, navigation and use. First, in the access modes analysis, I analyzed interactive tools to access digital surrogates. Then, in the navigation analysis, I used methods from the literature review (Kreiseler *et al.*, 2017) to examine connections among pages of content aggregators and all the navigation tools. Finally, in the usage analysis, I analyzed all the interface tools to organize, edit and share digital surrogates.

Tab. 1 – List of the European cultural content aggregators examined.

Name	Website
Archives Portal Europe	www.archivesportaleurope.net/
Culture Grid	www.culturegrid.org.uk/
Deutsche Digitale Bibliothek	www.deutsche-digitale-bibliothek.de/
The European Film Gateway	www.europeanfilmgateway.eu/
EUscreen	www.euscreen.eu/
Europeana	www.europeana.eu/portal/en
Hispana	hispana.mcu.es/es/inicio/inicio.do
Kultur Pool	www.kulturpool.at
Moteur Collections	www.culture.fr/Ressources/Moteur-Collections
SearchCulture	www.searchculture.gr/aggregator/portal
Swiss National Library	www.helveticarchives.ch
The European Library	www.theeuropeanlibrary.org
The National Library of Finland	www.kansalliskirjasto.fi/en
Wikimedia Commons	commons.wikimedia.org/wiki/Main_Page

User research

The user research consists of a survey of cultural content aggregator end-users and the design of a cultural content aggregator.

I conducted the survey to investigate reasons and methods to access content among people who often use cultural content aggregators. The survey is an ethnographic study consisting of a list of questions about the user experience. It is based on literature about Web usability (Krug, 2000) and the System Usability Scale (SUS) (Bangor *et al.*, 2008), a set of questions to measure the usability of an interactive system. I used the survey and the previous analysis to draft a set of design guidelines that may foster access, navigation and usage of digitized collections.

The design of a cultural content aggregator interface is based on a high quality prototype. The design project aims at validating the draft of design guidelines. I used an online survey to gather feedback on the design project. The survey includes open and closed questions about the user's personal information, interface features and other usability aspects.

Synthesis

I defined a set of guidelines for the design of cultural content aggregators. They synthesize the knowledge acquired through research in three main aspects (regarding access, navigation and use). The goal of the design guidelines is to provide designers with instructions on how to encourage access and use of cultural content within cultural content aggregators.

User interfaces for open digitized collections

A cultural content aggregator must provide end-users with tools to access, navigate and use digital surrogates. The following paragraphs show all the tools adopted by European cultural content aggregators.

Accessing collections

The growing volume of content combined with the pressure of time and money makes the need to improve findability of digital surrogates a critical issue (Morville, 2005). Content aggregator user interfaces generally provide end-users with tools to access the collection – on the homepage – and tools to narrow and expand the search in terms of results and single item pages. Literature review and the analysis of cultural content aggregators reveal that access tools belong to three access modes: search, browse and explore (fig. 2). Search mode refers to a search engine that allows users to ask for information by submitting a query. Browse mode refers to several labelled tools that allow users to navigate among content. Explore mode refers to interactive visual representations of metadata collections, such as all authors, places and dates. The main issue related to the access tools is the lack of "generous interfaces", interactive tools that provide users with rich overviews and foster serendipity (Whitelaw, 2012; Whitelaw, 2015).

Tools for searching content were introduced in the '80s as a way to help users answer questions (Bates, 2002) and support decision-making (Fidel, 2012). They consist of both simple and advanced search boxes. Search tools require basic knowledge of the collections and best suit end-users who already know what to look for. Since the search process generates several results, it requires further filtering operations.

Tools for browsing content were also introduced in the '80s. However, the browsing strategy was identified several years before computers began

to be used for information retrieval (Fidel, 2012). Browsing tools consist of several interactive elements, including the list of categories (usually presented through image thumbnails), tag cloud and index of content. These tools require a certain amount of time to reach the content of interest. Hence, they are more suitable for users who do not have a specific goal to accomplish.

Tools to explore content were introduced in the '90s as a set of visual displays to facilitate the visual search mode. At the core of the exploration tools, we find the idea of engaging users (Stiller, 2014) by first providing an overview of the collection, and then presenting the items in detail (Shneiderman, 1996). Exploring tools are mainly 2D or 3D visualizations and visual filters to display and access collection metadata. Visualizations can use both temporal visual models (such as timelines) and non-temporal visual models (including maps, networks and plots) (Windhager *et al.*, 2019).

Since one single visualization of the collection might not be enough to explore every collection's dimension, content aggregators usually make use of multiple views (Dörk *et al.*, 2017; Drucker, 2013; Andrienko *et al.*, 2007).
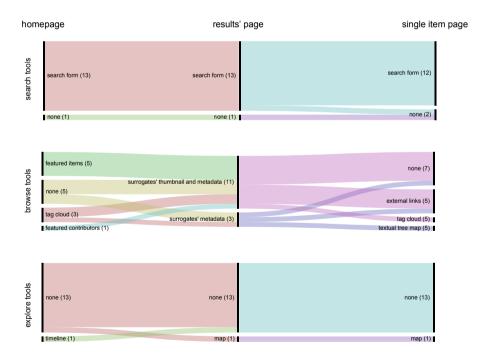

Fig. 2 – Sankey diagrams showing the access tools of a selection of European cultural content aggregators.

Navigating collections

One of the main goals of cultural content is to allow the user to easily navigate among collections. Cultural content aggregators adopt very simple information architecture. This consists of three main pages: the homepage, featuring some digital surrogates, the page with the list of results requested by the user, and the details page. The homepage generally provides all the tools required to explore the collection. The results' page provides the tool to narrow the exploration, and the details page provides the tools to continue the exploration. From the benchmark of European cultural content aggregators, we can identify four typologies of navigation tools. They help end-users to navigate among pages, within a page, within collections and among related content (fig. 3). The main issue related to the access tools is the lack of tools to navigate among digital surrogates.

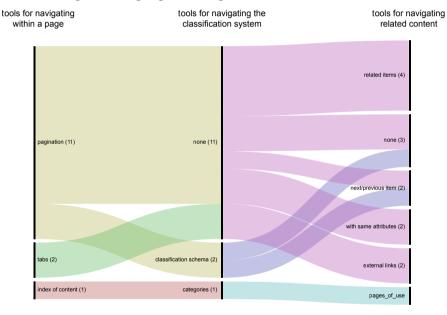*Fig. 3 – Sankey diagram showing the navigation tools of a selection of European cultural content aggregators.*

Tools to navigate among pages are the conventional Web navigation tools, which include the menu, the arrow to go back to the previous page, and the breadcrumbs[2].

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[2] Breadcrumbs are a navigation tool indicating the navigation path from the homepage to a specific internal page.

Tools to navigate within a page are used in the results page. They allow end-users to rearrange digital surrogates. These tools include page layout – an interface element that splits the retrieved surrogates into discrete pages – and the list/grid dropdown menu – an element that allows end-users to choose the visual layout.

Tools to navigate the collections are interactive elements that allow the end-user to visually navigate the collections' categories. These tools mainly consist of the classification tree and the list of categories.

Tools to navigate related content allow end-users to continue the exploration of similar items. These tools include the panel with related surrogates.

Using collections

The final aim of cultural content aggregators is to provide end-users with meaningful, high quality images to be used in their studies and publications, and related tools to manage them. From the benchmark of cultural content aggregators, we can identify four typologies of tools, which allow usage of digital surrogates: editing, organizing, generating and sharing tools (fig. 4). The user mainly accesses these tools on the page containing the single image. Unfortunately, most of the content aggregators do not provide enough tools.

Tools to edit content enable users to edit metadata of items or to propose an edit. They consist of online forms, which users can fill in with more accurate or new information. The use of these tools allows ongoing collective improvement of the content.

Tools to organize content allow users to either group or save items. These tools can serve as classification tools or as a bookmarking tool. Classification tools refer to interactive elements that allow the creation of a folksonomy. Bookmark tools refer to interactive elements that allow the creation of personal collections of items. Aggregators use these tools in the form of bookmarks, favourites, watchlists and collections.

Tools to generate content refer to the opportunity to generate, within content aggregators, articles based on the digitized collections. User-generated content not only enhances access to cultural collections but also fosters the discovery and the investigation of new topics.

Tools to share and download content consist of panels containing links to share an item on social networks or other external websites and to download it. Aggregators also containing bibliographic items may provide users with information for citations and with the text-based file format.
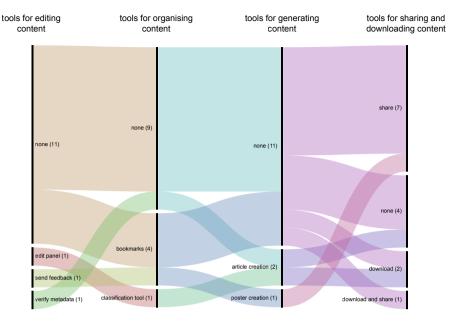
Fig. 4 – Sankey diagram showing the tools to use collections of a selection of European cultural content aggregators.

Designing a cultural content aggregator

I designed a cultural content aggregator to evaluate interface characteristics that might foster access, navigation and use of digital surrogates. Called GLAM Culture Hub (GCH), it is a high fidelity interactive mockup[3] featuring content from both Wikimedia Commons (the ETH-Library collection) and Europeana (fig. 5). It aims at providing users with useful tools for access, navigation and use of digital surrogates. In particular, by applying a draft of design guidelines that erase the previous analysis, it attempts to fix some of the issues of the existing cultural content aggregators.

Regarding the current access issues, due to the lack of rich overviews, GCH coherently integrates tools belonging to three access modes: search, browse and explore. The search box is available on the top of every page. A chart combining two visual models appears in the entire catalogue, on the homepage, and in the individual collections on the GLAM pages. Interactive browsing elements are present on every page.

[3] GLAM Culture Hub is an interactive mockup made with Invision, a prototyping Web application.
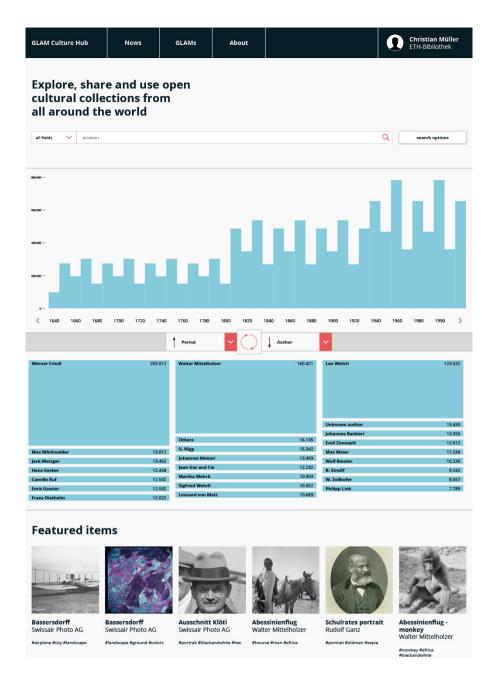
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Fig. 5 – Detail of the GLAM Culture Hub homepage.

Regarding the current lack of navigation tools, GCH adopts several types of tools, including panels to navigate the various types of related content.

Finally, regarding the current lack of tools to use the collections, GCH introduces a form to propose edits, and adopts a bookmark system.

GCH also adopts some interface features that have already been introduced on other generic content aggregators, digital archives and Web applications. These features include the horizontal bar containing filters to provide more space to the surrogates (existing cultural content aggregator display filters in a column) and several types of featured items.

A set of 18 people interacted with GCH and answered an online survey about their user experience. Subjects were aged 25-64 years, and all of them had attained a Master's Degree. They were professionals working for cultural institutions (33%), designers (33%), photographers (11%) and other professionals (11%). Questions that included textual responses were converted into a range of values ranging from 1 (not useful/disagree) to 5 (extremely useful/strongly agree) to facilitate result analysis.

The GCH survey detected a general appreciation of design by users. The access tool considered the most useful is the search form. It was deemed extremely useful by 43% of respondents (with an average of 3.1/5). Browsing tools recorded an average of 2.4/5, while explorer tools recorded an average of 2.3/5. Regarding features that allow users to navigate content, it emerges that it is particularly important for content aggregator end-users to navigate among similar items. The navigation tool considered most useful was the adoption of favourite items (2.2/5).

The survey detected that content aggregator users need easy-to-use tools to organise, edit and download collections. The respondents of the survey liked the downloading panel (3.1/5), the forms for suggestions (2/5) and editing, and the form to add tags to the picture (2/5).

Design guidelines

A set of design guidelines has been defined, following the GLAM Culture Hub design and the collection of feedback from end-users. Guidelines are a tool to support the design of cultural content aggregators. In particular, they aim to foster access, navigation and use of digital surrogates.

Guidelines are meant to suggest design strategies to be adopted to meet end-user needs. Their implementation can positively impact on the activities of cultural institutions, communities and end-users.

Providing several access points

The research shows that only one access mode for collections is not suf-ficient. This is because end-users have a different level of knowledge of the platform and goals. Thus, a cultural content aggregator should allow users to access digitized collections, from distinct and maybe unfamiliar viewpoints (Thudt et al, 2012), through an integrated model consisting of search, browse and explore tools (fig. 6). Information architecture should be based on three main interconnected page templates: the homepage, the list page and the sur-rogate page. The homepage must provide access tools belonging to the three modes. The list page features the results according to a user request. Thus, it should provide direct access tools to narrow the user's search (search tools). The surrogate page features a single item, and it should provide access tools to expand the search (explore and browse tools).

Since search tools provide direct access to content, they must be placed in a prominent position. Explorer tools can remain on a secondary level, but they may require a vast space. Tools to browse the content can have a secondary role as well, and be spread over the user interface. Both tools be-longing to the search and explore mode may need textual or visual filters to narrow the search. These filters may be shared among the two modes.

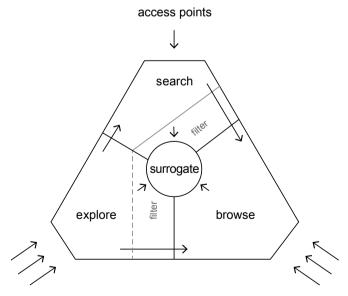In the proposed integrated model, tools belonging to different access modes can coexist within a unique access tool.

Fig. 6 – Diagram of a proposal for an integrated access model.

Making connections among content

The GCH survey shows that content aggregator end-users need to navigate among similar items while rapidly looking for surrogates. Thus, navigation tools may cope with this requirement by visualizing relations among items. Due to the complexity of relationships (fig. 7), there are several ways to display their connections. We can split the strategies into two levels: the general level – related to the overall set of surrogates – and the detail level – related to a single item. The aim of both levels is to foster the collection's exploitability.

In the general level, the design should reveal relationships among all contents. Interactive tools should allow the creation of sets of surrogates according to their attributes, such as sets of items grouped by place, author, date and subject. The homepage should feature a network as a visual model to show the connections among surrogates. The interface might also provide end-users with tools capable of generating new connections among surrogates.

In the detail level, the user interface should encourage pivoting. Interactive elements should allow users to move between sets of items, which share the same attributes. For instance, metadata values can become a query for a new search. The "related items" are some of the most common interactive elements to continue exploring the collection. Looking into the details, other possible design solutions to foster pivoting might be the use of surrogates over multiple pages through the creation of user-generated content, and the integration of content from other related and relevant online sources.
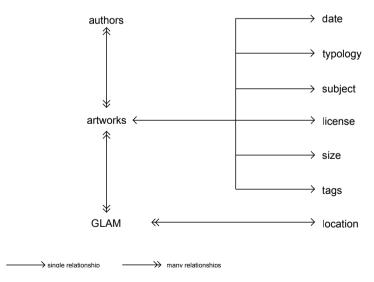

Fig. 7 – Diagram of relationships among surrogate metadata.

Support the use of surrogates

The user research shows that the end-users of content aggregators need easy-to-use tools to organise, edit and download items. Cultural content aggregators should be considered as working tools. Thus, the design of the content aggregator should provide users with tools that both allow and guide the use of digital surrogates (fig. 8). Regarding the individual item, the interface must feature elements that allow users to rapidly understand, share and download the surrogate. Related information may include where the artwork was used, such as temporary or permanent exhibitions and author biographies. Concerning the collection, the interface must provide users with bookmarking tools that allow the management of sets of surrogates. These tools aim to allow users to organize content for future usage. Bookmarking tools should make it easy to add personal notes to single or multiple surrogates, add labels to multiple sets of items, aggregate elements and eventually provide batch download options.

high-level of
involvement

individual generation
of content

collective generation
of content

content edit

individual
action

collective
action

generation of a
private collection

generation of a public
collection

classification of items
(through tags)

rating of items

low-level of
involvement

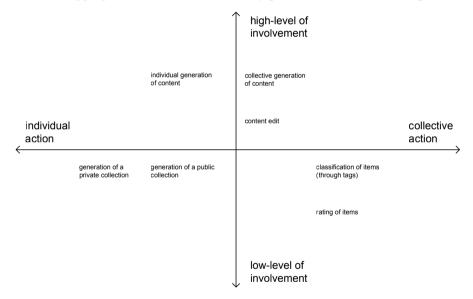*Fig. 8 – Diagram of the possible actions users can perform within a cultural content aggregator.*

Conclusions

The research showed that providing users with multiple access points and visual models showing the connections among surrogates may increase the use of digitized collections within cultural content aggregators. The proposed

guidelines provide designers with design strategies to facilitate surrogate access and encourage the use of content. They can also provide designers with useful tips to redesign current cultural aggregators. The design guidelines are not meant to be the final outcome of the research on cultural content aggregators but, instead, an open document that can be further developed.

A limitation of the guidelines is that they have not been validated through a redesign of the cultural content aggregator. However, each guideline is based on multiple evidence that emerged from the literature review and from in-depth empirical research.

Future works related to the research include validation of the design guidelines through a new design project and dissemination within the design and GLAMs communities. Furthermore, I intend to expand the research on design practices to foster spreading and usage of open cultural collections.

In conclusion, opening cultural collections and technological advancement is leading to reconceptualization of cultural content aggregators. The design of these platforms should be based on real end-user needs. Cultural content aggregators should not be considered static searchable databases but dynamic research and dissemination tools.

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From Adriano Olivetti's project:
Eduardo Vittoria. Research, drawing and design.
New methods of representation to enhance
modern architecture

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Abstract

The research develops in the disciplinary field of drawing and representation. The workflow experiments the use of info-graphic BIM-oriented software and parametric models as a tool to preserve, communicate and enhance modern architecture and its historical documents in the museum and archival sector. The main objective is the integrated digitization of an architecture and its archive documents from the executive drawings, making the three-dimensional parametric model an interface for heterogeneous data. At the same time the model allows the virtual reunification of archived documents and facilitates the research, providing an overview of the design process, strengthening the system of document collections and introducing possible new archiving methodologies. Specifically, the thesis proposes the enhancement of the cultural heritage left by Adriano Olivetti and his company to the city of Ivrea through the work of Eduardo Vittoria, one of the most representative designers employed by Olivetti but less popular than other authors. The subject of the digitalization project is one of his most symbolic buildings designed for the company: the 'Centro Studi ed Esperienze' built in 1954.

Theoretical and critical background, design context and research objectives

The thesis, which develops in the disciplinary field of design and representation, focuses on the study of the Information and Communication Technology (ICT) tools and their relationship with design process. These tools can be defined as all the technologies that allow to process and communicate

information through digital media. They intervene methodologically in the construction and representation of the project. Specifically, the research investigates the possibility of using the info-representative Building Information Modelling (BIM) systems, created for the design and construction of new buildings but which have already been used in the field of restoration as a tool for the conservation, consultation and communication of architecture and its materials in the museum and archival field.

The BIM-oriented applications are one of the most interesting technologies developed in the field of computer-aided design. They are based on three-dimensional parametric modelling, which uses a relational database combined with a three-dimensional geometric model to process and represent information about buildings. These software connect different types of information and documents to the geometry of every building and real parts of an architecture, and allow the construction of three-dimensional informative models or visual databases in continuous updating. The virtual models that have already been produced become navigable and queryable hypertexts, potentially able to relate the architecture to its iconographic materials. The opportunity for testing with this methodological approach in the conservative, expositive and communicative logic of modern architecture and its documentation was offered by the need to enhance the cultural and building heritage left by Adriano Olivetti and his company to the city of Ivrea.

To fully understand the importance of the Olivetti company in the development of the modern project, we should start from its foundation, when the basis was provided for what will be recognized in the world as 'Olivetti style' and to become an ethical enterprise capable of generating social, cultural and human development. Since 1908 the Eporedian company, the first Italian factory of typewriters, led by its founder, Engineer Camillo Olivetti, has been characterized by constant attention to research and innovation, not only applied to the field of industrial production. The company gradually gained national and international credibility and success with its policy of relentless technological and aesthetic product development on a commercial network of monobrand stores, and by relying on avant-garde art forms for the transmission of the advertising message. From the onset, these factors, which were innovative at the time, remained constants during all the development phases of the company, and were combined with actions and protective tools in order to support and facilitate human work and lifestyle. These *social welfare* aspects were systematically applied under the factory management of Camillo's son, Adriano Olivetti.

It was under Adriano's leadership that the role of design as a fundamental tool for the transformation of reality was concretized within the industrial

setting. Starting from the 1930s, he became so interested in E. Persico's idea of architecture with a moral purpose that he said, in the article *Architettura al servizio del sociale* published in the magazine *Casabella,* "sia compito degli imprenditori e dei progettisti affrontare il tema delle relazioni tra industria, lavoratori e luoghi che vengono a modificarsi con il consolidamento della società industriale. Questo atteggiamento deve quindi dar forma a un'architettura pensata come un servizio sociale atto a trasformare un processo economico in uno sociale"[1] (Olivetti, 1936, pp. 4-5 orig. ed.). According to the entrepreneur, "il tentativo continuo e permanente di vedere più avanti del momento che si sta vivendo"[2] (Vittoria, 1988, p. 162 orig. ed.) in the field of architecture and urban planning must follow continuous research and innovation in the field of product. This led the company to have no rivals on the market in the Fifties. These characteristics combined with industrial theories, liberal and social thoughts developed by the entrepreneur during his life, established an ethical industry, capable of generating not only profit but also economic and cultural value for the territory and the community in which it is located.

This translates concretely both in designing innovative products that facilitate human work and in projects and architectures that improve the quality of life. In order to achieve this goal, Adriano Olivetti did not rely on a single designer but invited sociologists, artists, philosophers, young architects, designers and urban planners to Ivrea, asking them for "strutture architettoniche, organizzazione degli ambienti e del territorio capaci di far coesistere bellezza formale e funzionalità, miglioramento delle condizioni di lavoro nell'impresa e della qualità di vita fuori dall'impresa"[3] (Olivetti, 2015). Between the 1930s and the late 1950s, the entrepreneur implemented a global design process based on the relationship between industry, man and territory. It led to the construction of new districts and modern residential and social buildings, to the development of research on modern living and to the construction of productive buildings, which respond to the new work organization systems proposed by the company. These are places that recognize human dignity at work and enhance individual protection. Starting

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[1] It is the task of entrepreneurs and designers to address the issue of relationships between industry, workers and places that change with the consolidation of the industrial society. This attitude must, therefore, give shape to an architecture designed as a social service capable of transforming an economic process into a social one.

[2] A continuous and constant effort to think beyond the living moment.

[3] Architectural structures, organization of the environment and the territory capable of ensuring the coexistence of formal beauty and functionality, improving working conditions in the company and quality of life outside the company.

from 1932 a series of productive buildings, functional to the life of the industry, joined the original red brick building designed by the founder Camillo in 1895, the historical headquarters of the company. These buildings made in different styles by different authors but showing a modern rationalist efficiency marked the renewal of the Olivetti image. Four extensions of the *ICO* plant implemented by Luigi Figini and Gino Pollini, the *Falegnameria* by Ottavio Cascio, the *Centro Studi e Esperienze*, the *Officina H* and the *Centrale Termica* by Eduardo Vittoria, are just some of the buildings that still characterize the road and productive axis *Viale Jervis*. As mentioned, renovation works were not limited to the design of industrial buildings in this area. Social structures afferent to the factory but open and functional to the community were built, such as the *Mensa-Dopo Lavoro* of Ignazio Gardella, the building *Servizi Sociali* by Figini and Pollini, in addition to the first two residential districts. Then the socio-residential experiments were extended to the whole area of Ivrea and Canavese, where the development of the company and its choices designed a large urban and industrial territory, to all locations of corporate branches situated in other parts of Italy and in the world, and to places which are the object of the political and urban initiatives conducted by Adriano himself as President of the INU[4].

In the latter half of the 1980s, after the death of the entrepreneur in 1960 and during a time of corporate reorganization, the need arose to preserve and enhance the cultural heritage of both the company and the family, which was about to be lost due to the slow decline of productive activities. The *Associazione Archivio Storico Olivetti*, *AASO*, was established with this purpose, and since its foundation promoted a series of initiatives starting from the systematic collection of the documentary material produced by the industry during the years of activity and that related to it. Together with the documentation cataloguing the AASO, in collaboration with a research group, a programme developed in two phases for the preservation and enhancement of the buildings constructed by the company began in 1996 (Bonifazio, Giacopelli, 2007). They are a collection of the architectural solutions implemented in Ivrea, and faithfully represent the uniqueness and values of Olivetti's project, and the complexity of Italian architecture during that period. The preliminary aim was to quantify the existing building stock, attribute the design, verify the conditions and start a preservation and restoration process. The research led to the cataloguing of nearly 237 buildings in Ivrea and its surroundings, and to the opening, in 2001, of *Museo a cielo Aperto dell'Ar-*

[4] Adriano Olivetti has been President of the INU since 1950, and Director of IRUR and UNRRA-Casas since 1954. These positions were maintained until his untimely death in 1960.

chitettura Moderna, the MAAM: a medium to spread the knowledge, the enhancement and the communication of the Eporedian heritage (Bonifazio and Scrivano, 2001). After a long process, Olivetti's works linked by the museum and the thought, which underpinned their creation, were recognized by UNESCO, and the site was added to the World Heritage List as "Industrial City of the 20th Century" on July 1, 2018.

The proposed research focuses on the heritage protected by *MAAM*, and today also by *UNESCO*, which consists of both a material part, all those architectures that characterize the city of Ivrea, and also the relative documentation preserved in the company's historical archive (fig. 1).

Fig. 1 – Location of the architectures that from 1 July 2018 are UNESCO heritage: "Ivrea, industrial city of the twentieth century".

The architectural heritage in its material condition is the most evident but at the same time most fragile object of the design process and of the cultural and social system that led to its implementation. The buildings narrate their present and the place where they are located, often revealing complex situations and contexts. Especially in the framework of modern and contemporary architecture, buildings are conditioned by the events of their properties, the dynamics of technological development and the economic and urban developments of the territory in which they are located. Despite

the rules[5] developed during the definition of the MAAM, even in the Ivrea case the disposal of most of the productive and organizational activities of the company have caused the heaviest transformations in the architectural heritage. Many buildings have been transformed to adapt them to new and more limited functions, others have been surrendered and reconverted, and yet others, long since abandoned, are in a poor state of conservation. Most of the works are inaccessible and the exhibition path of the museum reveals some criticalities caused by traditional infographic media that do not support the interaction between the user and the building, and do not allow personalization of the visit.

Fig. 2 – In order from the left: views of the museum itinerary, the site to diffuse news about the heritage of Ivrea, "Archivi Digitali" site that through a nominal search and temporal filters allows access to some digital content. These enhancement methods are not mutually connected.

The documentary part and in particular the drawings, place of the conceptual and design process of a building, and the documentation of the archive instead tell about the past of a building. Preparatory sketches, maquettes, executive drawings, photographs, correspondence between clients and designers, and personal diaries testify through fragments the contents and meanings of the work itself. This documentation, which finds an initial form of enhancement in academic research and publishing, is protected and preserved in Italy, unlike in other countries, by small entities and institutions spread over the territory. Despite the shortcomings caused by a late recovery, Olivetti's material has a remarkable quantitative and qualitative consistency,

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[5] "Normativa per gli interventi sugli edifici e le aree pertinenziali dei beni tipologici costruttivi e decorativi della città d'Ivrea" is drafted to Article 2.4 of Regional Law 35/95, and was completed and approved in 2000. This identifies the intervention criteria on each building or category of building, and represents the first stage of protection and safeguarding for the recorded and listed heritage in the area of Ivrea. Today this legislation is adopted as Building Construction Regulation.

and represents an irreplaceable tool of investigation of the complex architectural heritage. The archive, preserved in Villa Casana, Ivrea, comprises many collections, such as the Olivetti company, family and many associations of former employees, and has different mediums and typologies. Not all the documentation relating to these works is kept in the company's archive. Sketches, design hypotheses and study models are, however, collected in the author's personal archive, thus promoting the preservation of the unified designer's archive, not the building's. We find such an example in Figini and Pollini's work, whose documents are filed in the *Archivio del Novecento* at Mart Museum in Rovereto. Today's framework of the archival system, the fragmentation of the preserved documentary heritage which, in fact, determines the present order of the Italian archival system, and the lack of use of consistent organizational standards among them involve a series of critical issues that hinder the integrated reading of the architectural work and its documentation (fig. 2).

In recent years, the introduction of computer methodologies to the archival and museum sector has been mainly involved in simplifying interaction between the work and the user, often making it easier to immediately access data, and allowing the user to customize the visit depending on his level of interest or expertise. In a scenario that witnesses the increasing use of ICT in the museum and archival fields, in addition to being a tool in the design area, the research proposes the use of BIM-oriented applications and parametric models generated with them as a document archiving system and as a tool for communication and enhancement of modern architecture. The main objective is integrated digitization of the architecture and its documents produced from the project drawings, making the three-dimensional parametric model a container and interface for heterogeneous data. At the same time the model, capable of bringing together virtually archived documents, which are physically preserved in places even distant from each other, can become the content of traditional or virtual museums in an attempt to overcome the inherent difficulties in the exposition of architecture on the one hand, and in the transmission process of the underlying cultural contents of architecture to heterogeneous users on the other.

Methodology and focus of the research

The dual field project developed within the research, the info-representative BIM-oriented system and Olivetti design process, were analysed using the register methodology that led to the creation of databases, thanks to

which parameters have been identified in order to compare different data types with a cross-reading system. The main applications were recorded and studied within the BIM-oriented system field, introducing the technical features as discriminating parameters with the aim of identifying the most suitable one for the experiment. Some of the key features are compatibility with existing digital two-dimensional drawing and three-dimensional modelling applications, the possibility of use with multiple operating systems, ability to connect different types of computer data, the existence of proprietary applications for intuitive navigation of the model and the predisposition to augmented or immersive reality.

At first the extreme variety of Olivetti's design process made it necessary to catalogue the production with the primary objective of identifying a time-frame to limit the area for the research of the case study suitable for experimentation. The preliminary action was a thematic subdivision of activities, which resulted in the identification of five sectors: design, architecture, urban planning, publishing and promotional activities, graphics and advertising. This first classification evidenced relationships between the different design fields, identifying as meaningful for the register[6] only the sectors of design, architecture and urban planning, in view of the subject matter and the specific subject of the research. A classification system was established for the different sectors, taking into account the specific factors of each of them and the common ones to allow a comparison. This operation led to the creation of different typological databases later visualized through temporal lines. The design sectors of architecture and urban planning were brought together in a single register, subdivided later into two distinct schemes for better readability of data: the first one gathers Olivetti's presence in the world, the second Olivetti's presence in Italy.

The cross-reading between the database dedicated to the products produced by the company and that of the architecture, narrowed typologically to the only Italian and worldwide industrial building, highlighted a period of intense development delimited by two discontinuities: the first one in 1950, which identifies a productive change within the company, and the second one in 1964, which identifies an administrative-corporate one (fig. 3).

The selection of this timeframe, defined as the period of corporate expansion, and a further geographical selection, carried out through the architecture and urban planning sectors' register, allowed to circumscribe the focus

[6] The general register takes into account from the establishment of the company in 1908 until the definitive change of ownership in 1999.

of research. Then, a systematic analysis of the designers and their projects was performed, identifying in the Neapolitan architect and designer Eduardo Vittoria the most representative author of Olivetti's design activity and the main interlocutor for Adriano Olivetti's architecture in the period considered.

During this period the author designed twenty-nine projects for Olivetti, including detached villas, residential buildings, a community centre, two thermal power plants, experimental and agricultural laboratories, the company's first branch in San Bernardo d'Ivrea and then, together with Marco Zanuso, the main Olivetti production campus in Italy. He is the main protagonist, with Ludovico Quaroni, of the experience of *Comunità* in the relationship between landscape and architecture. He designed flexible structures for the company, which required a continuous transformability of its production sites, integrating in his work technology and interpretation of the surrounding environment. He was the one who, better than any other, gave a visible and working form to the entrepreneur's thought by experimenting with innovative solutions and forms, consistently with the construction process.

To define the case study within Vittoria's design activity, the building's belonging to the industrial typology, the *MAAM* museum area and the construction process used to design it were introduced as key parameters. This allowed to identify the first project for Olivetti as a trial, implemented when Vittoria was still very young and possessed the relative experience for which he was called by Adriano himself to Ivrea.
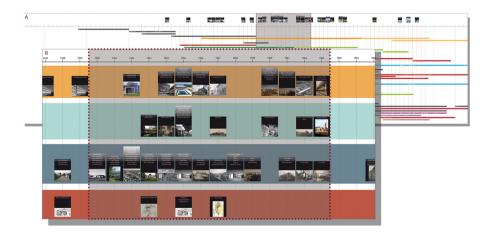

Fig. 3 – Register of Olivetti products compared to all the company's branches (A) highlights a range of time between 1950 and 1964, the period of expansion of the company. The buildings built in Ivrea (B) in this timeframe were analyzed and the case study was found.

Fig. 4 – From the left, view of one of the 4 wings of the building, comparison between the photo-rectification and the executive drawing of the type c module.

The *Centro Studi ed Esperienze* of 1952-1954 was the first building built in a perspective of functional decentralization of the company, and had a high symbolic value for company. It mirrored the corporate image in the world as the place of design and prototyping of all future Olivetti products. With this building and by experimenting with shape and colour, Vittoria broke the rationalist scheme of buildings built up until then in Ivrea. It introduced an organic spatial articulation and expressed the author's architectural poetry of continuous research and rejection of previously established patterns. The building was not far from the *Officine Ico*, and was expanded for the first time in 1965 by Ottavio Cascio. In the 2000s, the interior spaces and the curtain wall were renovated by studio Sottsass to host the Interaction Design Institut d'Ivrea. Today it is an integral part of the *MAAM* museum itinerary, and is protected by UNESCO, although it is not accessible (fig. 4).

The analysis of bibliographical sources referred to the author and the archival search at the Olivetti archive initially allowed to collect and study only the executive drawings related to the building and some historical images. Research and publication activities carried out during the doctoral years helped to re-discover Vittoria's unpublished drawings, projects, photographs and writings from two separate collections preserved at the *Dipartimento di Architettura Univerisità Federico II*, Naples, since late 2017. The first collection, preserved for a long time by Prof. Giovanni Guazzo, former Dean of the *Facoltà di Architettura e Disegno industriale* of Ascoli Piceno founded by Vittoria and his historical collaborator, collects projects implemented

I FASE

BIBLIOGRAFIA
- Comunità, n.69
- L'architettura. Cronache e storia, n.4
- L'architettura. Cronache e storia, n.39
- L'architecture d'aujourd'hui, n.69
- Zodiac, n.5
- Eduardo Vittoria. L'utopia come laboratorio sperimentale

ARCHIVIO OLIVETTI IVREA
- 90 disegni esecutivi, su microfilm dal 1988
- 10 fotografie esterni, stampa, bianco e nero
- 15 fotografie interni, stampa, bianco e nero

CATALOGAZIONE/DATI

II FASE

VERIFICA
- Restituzione bidimensionale
- Analisi planimetrica
- Rilievo qualitativo
- No rilievo strumentale, indisponibilità edificio
- Pianificazione della modellazione parametrica

III FASE

MODELLAZIONE
- Scelta software
- Scelta dei disegni d'archivio
- Modellazione parametrica Modulo C
- Configurazione Cloud
- Collegamento ai disegni

IV FASE

ARCHIVIO VITTORIA NAPOLI
- 90 disegni esecutivi, eliocopie
- 6 disegni progetto I versione, prospetti e piante, matita su lucido
- 2 assonometrie, matita su lucido
- 5 prospettive interni, matita su lucido
- 8 prospettive esterni, matita su lucido
- 15 schemi di progetto, matita e china su carta

CATALOGAZIONE/DATI

V FASE

CONDIVISIONE
- Esportazione attraverso BimX
- Utilizzo portable device
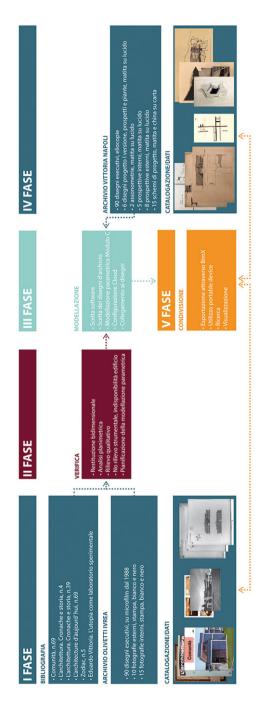- Ricerca
- Visualizzazione

Fig. 5 – The testing phase.

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during the years of training and of partnership with Olivetti, and those from professional studies in Milan and Rome in the 1960s and 1970s. The second collection comes from the architect's private studios in Rome and Capri, and collects, in addition to writings and annotations, a series of sketches related to his architectures and to architectures considered exemplary by him. Above all, these collections comprehensively relate the architect's cultural context and design process; in particular, the drawings concerning the Centro Studi ed Esperienze, mostly unpublished, highlight the design and construction process split into its architectural elements, and are essential sources to understand Vittoria's production in the Olivetti period and in the subsequent ones.

The research activity has brought to light a vast and significant documental heritage present throughout Italy and hard to converge, unless virtually.

The trial process was divided into five phases, which can be grouped into an analytical-cognitive macro-phase and a simulation one (fig. 5). In the first phase, all the information, derived from the rare bibliography available on the building, and drawings and images, kept at AASO, were collected and catalogued. The trial continued with a check of the data collected, through a two-dimensional drawing of the plan, which allowed to study the building's spatial composition and to compare it against the existing building only with a qualitative survey, given the partial accessibility of the building.

Fig. 6 – The relationship between the model and analogue design is bidirectional. It allows to make the model accessible from the catalogue cards and the reverse, for a quicker and more immediate archival research.

The third phase deals with the process of reconstruction and insertion of catalogued data of a curtain-wall module of the building, to verify the correctness of the methodological process, and then extended to the entire building. In addition to standard information, such as dimensions, positions, function

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and material, the information sheets of each construction element within the model were integrated with the archival classification and the digital location of iconographic documents related to the elements; furthermore, sheets were customized with other external contents, such as links connecting the object to the Web (fig. 6). This made it possible to connect every virtual element to the corresponding archive documentation previously digitized and stored in the cloud. The process can be implemented with possible documentation from other archives or users.

The fourth phase, which coincides with the re-discovery of Vittoria's archives, provided for a new data collection and cataloguing process, with the aim of also linking these documents with the relative geometry. The accessibility of the model created was finally tested in the archival and museum sector with the BIMX application that allows virtual navigation of the building through a simple and intuitive interface, to access archive data from their virtual image and vice versa. It has also experienced the predisposition to virtual and augmented reality, which makes these virtual models a useful tool to enhance and communicate the architecture both in the real and virtual museum exhibition (fig.7).

Fig. 7 –Example of use of the 3D model in portable devices.

Research findings and possible outcomes

The research shows how parametric modelling, applied in archival and museum sectors, can help to communicate the architecture to users with different skills. The characteristic of being a three-dimensional database favours reunification into a digital *unicum* of archival data related to an architectural work, making the virtual collection continuously expandable. This enhances the meanings of the archival collections and amplifies the possibilities of accessing them by introducing the concept of the archival unit related to the architecture and not to the designer who designed it. In addition, as a

result of the immediacy of the three-dimensional representation, the model allows innovative, different and easier access to the archival research, adding a visual one to the traditional one. The intuitive virtual representation, the pictures and audiovisual document facilitate interaction between visitor and architecture, and become an important tool to recognize inaccessible or transformed place.

The virtual reality, conveyed by the parametric model, makes the coexistence and the integration of the digital and analogue medium possible, allowing to customize a museum itinerary, either physical or virtual, according to the skills and the degree of experience or interest of the users.

The model thus acquires the double value of container of archival documents and of content of a museum collection, overcoming the dichotomy that exists between the representation and the object of the representation. The model becomes a tool potentially able to relate architecture museums and design archives, solving some critical issues associated with the complexity of the architecture. In this specific case, the Olivetti heritage in its entirety, a tangible example of experimentation carried out in the '30s and the' 60s by leading Italian and non-Italian architects on the theme of residential, social and work places, can become the object of a new experience conveyed by ICT through a more direct relationship between the reality of architecture and the virtual nature of the project.

The typological registers of the Olivetti design process, one of the first results of the research and, particularly, their graphical representations, lay the foundations for a future project of reordering and visualization of data, remaining open to the introduction of possible new information from various bodies and of new forms of communication.

The Vittoria archive and the drawings preserved there, which are another outcome of the research, enabled to validate the use of BIM-oriented systems as a tool capable of virtually reunifying material related to an architectural work and kept in mutually distant archives.

Mostly, the study of these unpublished collections, made possible by Prof. Massimo Perriccioli and Prof. Pietro Nunziante, has allowed to develop important initial considerations on the meaning of the drawing in Vittoria's design process, and on the sequence of his production during the early years in Ivrea (Conte and Rossi, 2019). The study has also allowed to spread the work of one of the most important designers in the Italian scene, one who is still little valued to date.

This opens new possible research scenarios focused on completing the analysis of the author's design activity carried out for Olivetti, cataloguing the entire Vittoria archive and enhancing it in the future.

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Ethics and social awareness

Personal Interaction Design. Introducing into the Design Process the Discussion on the Consequences of the Use of Personal Information

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Abstract

Sensors and devices which gather personal data have become pervasive, and so have the digital solutions which use these data to tailor and improve services for users. The collection, storing, use and sharing of these data, however, raise concerns about possible future consequences. Thus, management of personal data has become a critical task for the design practice. This chapter illustrates the basic knowledge and tools that brought about the definition of the Impact Anticipation Method as an outcome of the PhD research. It helps designers consider the impact of the use of personal information that goes beyond the broadly considered problem of privacy. It aims to elicit awareness in designers about the data implied and data flows of the designed solution, about the involved and possible actors that acquire value through the use of personal data, and the possible positive and negative consequences of its use. It considers impacts on the aspects of self-awareness, action performance, interpersonal relationships, and social agency.

Personal data as a source of value within services

Many products on the market rely on personal data to provide various services with different purposes, such as security and safety, medical monitoring, fitness tracking and intelligent personal agents (Neff and Nafus, 2016). Personal data can be considered as a by-product of digital devices (Schneier, 2016) and information on the web. Digital devices create data about the individual and provide much information regarding body parameters and body behaviours, actions performed in space, interactions with digital interfaces

and with surrounding people, and so forth. Personal information extracted from data is creating value not only for individuals, but also for companies that use the information to provide meaningful services. The collection and use of data even enable the creation of innovative new services and systems, and of new modalities for interaction (Balsalobre-Fernández *et al.*, 2017; Rashidi and Cook, 2009; Pillan and Colombo, 2017). Furthermore, the interactions among networks allow the user to search and investigate about other people through their information. The connection to the Internet enables the creation of data about actions performed on the web and communication with others through portals, websites, apps and messaging. Computers surround people's daily activities acting as enablers, facilitators, and companions. The creation of services that rely on the use of personal information is a complex chain of value creation that starts from the human element. People are surrounded by technologies that are capable of gathering information about them, such as cameras, scanners and a huge amount of other different sensors. People are giving away data that belong to them to receive services and insights. The same data are so not only collected, but also processes, stored, sent to the cloud and other services. Providing their data to these services that convert it to information, people are consciously and, often, unconsciously exposing themselves. In this context, the objective of the research is to understand how it is possible to elicit critical thinking in design processes, raising awareness about opportunities and problems related to the use of personal information in interactive digital solutions.

Awareness and Function

The practice of tracking personal data is able to increase self-knowledge through the analysis of personal traces (tracked data) and the derived information (Ferraris, 2009; Buckland, 2017). Reading visualization of personal information, the user increases his/her knowledge about activities performed, about personal preferences and trends, and about body behaviours. Digital technologies and precise sensors are now able to detect and make explicit even very precise and detailed information that was not previously available. Self-tracking is also able to promote behaviour change in a goal-oriented approach (Lupton, 2016; Young, 2013), also through the comparison and sharing of personal data with other people, which improves personal knowledge of the individual, alone and among other people, engaging them in a goal-oriented community. Current service solutions use personal data not only to provide awareness on the extracted information and knowledge, but

also often provide an additional service value through functions shaped to fit the analysis of the user's information (Bogers, Frens, van Kollenburg, Deckers and Hummels, 2016). Private and public companies, governments, and other actors have the power to collect data and use it to enable service functions, to personalize the user experience, to create legitimacy through identity verification, to provide access and authentication, to create new services and to improve already existing services (Joinson *et al.*, 2010). Modern connected home appliances allow remote control, use behaviour analysis, and collect users' preferences to enable service proactivity (Pillan and Colombo, 2017). Connected wearables, portable devices and integrated services provide information every time and everywhere about everything and, more importantly, about everybody. Consumer electronic devices can create service value through the use of personal information for personal purposes (reaching personal goals, monitoring health parameters, and so on; Purpura *et al.*, 2011; Balsalobre-Fernández *et al.*, 2017). Devices and the environment are providing services that lower effort, as well as insights, suggestions and help to manage daily life tasks. The digital solution becomes an everyday companion for the user; the proactive system is a digital symbiont that knows its owner, and acts and reacts accordingly.

A revised DIKW model

Considering data as "symbols that represent the properties of objects and events and their environment" (Ackoff, 1989; in this research, the person is considered as a carrier of properties), we know that data "are useless until they are in a usable (i.e. relevant) form" (Ackoff, 1989). Data is provided by the user or automatically gathered from the system, which collects it mostly in real time. Data is created, collected, and then processed to be useful. Information represents the properties of objects and events, but in their processed and more useful form. The difference between data and information is functional. The added function of information is in its being interpreted from raw material to something that is filtered, elaborated, and selected so as to be understandable and analysable by an analytical processor. The processing of data is the elaboration that creates the signifier for the elements in the form of information. When data is processed and merged to create information, it becomes valuable and has meaning (Boyd and Crawford, 2011; Rowley, 2007). Then, the application of the information though analysis leads to knowledge and understanding as interpreted information according to statistics, rules and reference knowledge (such as research findings and

results). Wisdom is a type of knowledge that includes a deep understanding for its proper applications to a given situation, which results in the evaluation and judgment of how to act. Wisdom is recognized as a virtue (Jifa, 2012). Humans create wisdom when they evaluate knowledge according to personal ethics, values and culture. Consistency with elements and definitions from the DIKW model (Ackoff, 1989) is a conventional reference for information organization, and Fig 1 proposes the linear reshape of the model that consider Frické's critique to the pyramidal model (Frické, 2009). Furthermore, the revised model considers the whole process as open to both a build-up approach and a design-down approach. In a build-up approach, the creation of wisdom derives from inferences that extract opportunities from the roots (properties). This approach is consistent with current trends in the regulation of data protection, such as the European GDPR (IT Governance Privacy Team, 2017). The purpose of the data use is the element that determines the inferences of the steps. Although this approach is compatible with a higher level of control by the user upon data sharing and management, the principle of "data minimization" reduces the possibilities of discovering opportunities through the embrace of complexity of phenomena. With a design-down approach, the inferences start from the given situation and lead to the discovery of opportunities through the seeking of answers from the top (Frické, 2009) which is extended to the whole process and focuses on the start from the need of a clear understanding of tactical objectives (Marr, 2015). The revised model generally frames the process of the DIKW model offered by the combination of technologies (devices, algorithms, AI) and human processing (reading and interpreting information, evaluating and judging knowledge).
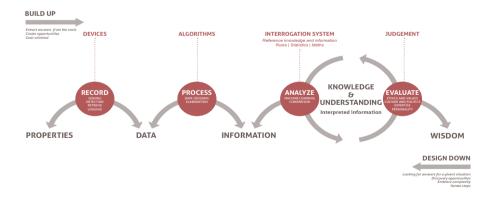

Fig. 1 – Revised DIKW model.

Impacts of the use of personal information

Active and passive, aware and unaware tracking and use of data has impacts on different layers of the individual identity and everyday life.
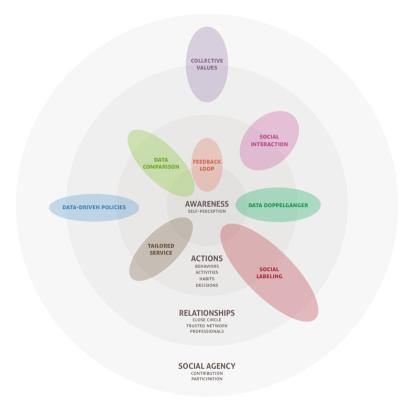

Fig. 2 – Impact layers.

Fig. 2 shows the four impact layers which emerged from the research, and on which the use of personal information has an impact. First, it impacts awareness and perception of the self. This impact layer belongs to the very personal sphere of interaction with the self. The return of information from a system to users in the form of visualization, feedback and insight, impacts on individual self-perception and self-reflection. The second impact layer concerns the dimension of actions and behaviours. The proactivity of services, their suggestions, alerts, and tailored experiences based on profiling, impact the action that the user performs in specific occasions and in daily life activities. The third impact layer relates to interpersonal relationships

and roles within them. Social interaction based on data, the comparison with data from other people and tailored experiences offered by services impact relationships and roles that users have within their personal and professional networks. The fourth impact layer refers to social agency in the political, cultural and public domains. Participation and contribution to society through sharing and providing data for research, data-driven policies, in collective values, and even contributing to social labelling mechanisms: user's information has an impact on how society shapes itself.

Personal information as a matter of design

While scientific literature mainly addresses the topic of the impacts of the use of personal information on privacy concerns and technical solutions to that (Joinson *et al.*, 2010), a significant contribution to the discussion that goes beyond the problem of privacy can be found throughout scientific communication for the masses. Focusing on the use of personal information in digital solutions, it is possible to report several cases of misuse (even while promoting bottom-up innovation) related not only to privacy violations, but also to issues related to surveillance, fraud, and persuasion through social engineering. Among several examples, such as the various allegations brought against Facebook for violations of the privacy of its users and the related permission of data usage for social engineering and persuasion for political purposes (Young-Joon, 2017; Hewes, 2018; Geib, 2018), we can also identify misuse (or unintended use) of data and information by users themselves. Currently, it is easy to have indirect access to private information through expert use of technologies that make it possible to gather, combine and relate information and extract useful knowledge in a completely legal way. One example is the case of Angelina Jolie's fans who were able to use Google Maps to identify and visualize the exact position of the geo-referenced information written in pictures of a tattoo posted on Instagram by the actress, which reports "the latitude/longitude of the places where she adopted her four kids" (Sui, 2008). It represents a use of the information contained in social media that was not intended by the actress when she posted the pictures of her new tattoo. Furthermore, the use of personal information can arouse concern about the reliability of data and of the interpreted information (Hughes, Joshi and Wareham, 2008), which can even cause severe problems, such as unreliable information in the field of Medicine 2.0. The research identifies several contemporary issues related to consequences of the use of personal information and clarifies the need for ethical criticism when designing solutions that

imply the use of personal data and information. During the design process, the creation of innovative connected services must consider the reliability and safety of the final solutions. New services and innovative solutions bring changes that can be perceived as utopian to some people, and completely dystopian to others. When creating such innovative services, designers are faced with a multiplicity of different perspectives about wellbeing, sustainability, and social justice. They should orient design choices to embrace the contradictions implied by the changes they can produce, and to deal with the complex issues that go beyond utility.

Facing the problem through design that considers impacts

While designing digital services, we deal with the inconsistency, variability and variety of the human perception. We should clarify and focus on the tangle of issues involved in the use of personal information, so as to better understand what is at stake in order to face the complexity of the issues involved in ubiquitous computing. Technologies should be developed to help people in their life, to improve and enhance life conditions, and to allow new activities. They should be meant as active contributions for creating a better future, but the directions of progress and the meanings of the future utopia is not such a contribution, nor is it common to everybody (Diener, 2009). We have started advocating the need to move toward the use of distributed cognition as a theoretical foundation for designing new communication and interaction technologies so as to maintain a human-centered focus. The design of human-computer interaction requires a comprehensive understanding of the cognitive processes and considering the relationships between all elements participating in the process (Hollan *et al.*, 2000). Some scholars developed approaches that aim to introduce social sustainability into the creation of technologically advanced artefacts (Khodzhaeva *et al.*, 2015; Friedman, 1996). Critical thinking has to be introduced in the design process, among designers and involved companies and stakeholders in order to: 1) improve services thanks to the possibilities personal information offers, and 2) to avoid negative consequences through the anticipation of possible issues related to the designed solution. Therefore, it is essential for designers to understand how technological solutions can imply the use of personal data to provide meaningful new services or improve existing ones. First of all, it is necessary to provide definitions of personal data and personal information, then we have to understand how the creation of value from personal data works in technological solutions.

The Impact Anticipation Method and Data Impact Toolkits

A possible approach to this challenge is the use of tools and knowledge within the design phases to raise awareness in designers and other professionals involved in the process. The Impact Anticipation Method has the purpose of helping designers who deal with innovative products and services to create robust, reliable solutions. It can improve the design process by foreseeing what the potential user will perceive about the solution with respect to several issues. It can also help in understanding if and how the solution will be socially and ethically accepted, and this can also influence its success on the market and its long-term adoption. The method is applied in different ways and using different tools according to the process phase and the design approach used. It is added to the already used UX tools, such as stakeholders' maps and user journeys, and it has the double purpose of: i) potentiating the values provided in the service; and ii) anticipating possible criticalities related to it. Furthermore, the dissemination of knowledge and tools can advocate and contribute to the discussion of the topic among the design community. By involving the identification of issues in their positive and negative aspects into the design process, the method aims to help designers in different phases anticipate points in question and carefully envision detailed innovative contexts. The Impact Anticipation method consists in the application of different tools specifically created in the form of toolkits that address different design phases and depths of analysis of the use of personal information. Regardless of whether the method is used for preliminary analysis of case studies and context, or to assess a designed solution in the creative or assessment phase, both the in-depth and the light versions of the Data Impact Toolkits contain tools that address two main objectives: raising awareness in designers about data and actors involved (understanding of data flows), and the identification of possible consequences related to the solution (exploration of impacts).

Understanding data flows

The part of the Data Impact Toolkit that addresses understanding and raises awareness of how and for what purpose personal data are used in a designed solution consists of two different templates. Both the templates include directions and explanations of how to use them in the bottom part. The first one (fig. 3) visually represents the flows of information from the data sources (sensors, devices, self-logging), which become information and then knowledge, to the specific features that add value within the service.

PERSONAL INFORMATION FLOWS

Fig. 3 – Personal Information Flows template.

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OTHER ACTORS

Identify other possible actors that can benefit from the use of personal information in the service specifying the value and if is awareness or function (for the actor)

DIRECT STAKEHOLDERS

Identify the stakeholders currently involved in the designed solution (including the service provider) specifying the value derived from the use of personal information and if is awareness or function (for the actor).

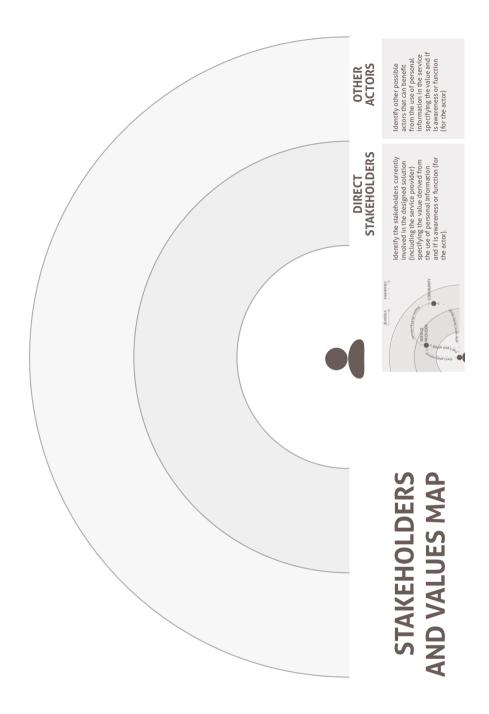**STAKEHOLDERS AND VALUES MAP**

Fig. 4 – Stakeholders and Value Map template.

The second template (fig. 4) shows which actors are directly involved in the service and invites readers to consider other possible actors and stakeholders that could gain some value from the knowledge acquired by the solution. The use of these templates by design students during courses at Politecnico di Milano demonstrated that the representing information flows and value provided by services through the use of personal information is a useful tool to raise awareness and bridge possible gaps that designers may have about which data and information are used in the analysed solution. Designers also learn specifically how data adds value to the service, and they can then envision possible improvement for the solution in terms of value provided for direct stakeholders and other actors.

Exploration of impacts

An analysis of two different sources brought to the identification of numerous issues referring to the use of personal information in digital and interactive solutions and services. The sources analysed are futuristic scenarios from sci-fi narratives and a selection of news articles from online magazines that refer to the use of personal information. The future scenarios described by science fiction authors are seen here as the representation of hopes and fears of our society with respect to the evolution of technologies (Shapiro, 2016). Furthermore, linking communication and the technological advancement of the masses actualizes those hopes and fears, and makes them useful for understanding current worries and wishes related to the future of technologies and technological services. The huge amount and variety of the emerging issues highlighted the need for a way to conveniently explore them. The Potential Issues Database is an interactive explorable collection of these issues. There are two explorable visualizations of the same database (the Light and the In-depth Potential Issues Databases) which refer to the depth needed for the analysis. The In-depth Potential Issues Database is divided into the eight Ethic-Oriented reference scenarios which emerged from the analysis of the sci-fi narratives (Varisco, Pillan and Bertolo, 2017), and then the information within each of the scenarios is organized into issues (belonging to a specific impact layer) that contain the single magazine's quotes. Tto use the database, designers follow three steps: first, they identify and then select the ERS that are relevant for the concept they're analysing; second, they navigate across the issues related to the selected ERS and identify the relevant ones; lastly, they cluster the issues in critical themes according to their sensitivity. The outcomes of the process are the resulting critical themes related

to the concept in analysis. This step of creating the critical themes is crucial, not only to inform the following assessment of a solution's features, but also to enter data into the Light Potential Issues Database. When time and effort available for the application is limited, the light version of the tool allows a quicker but meaningful analysis. The information in the Light Potential Issues database is clustered into the Critical Themes, so as to be used quickly through the possibility of selecting only the Critical Themes that resonate with the features of the solution under analysis. The Light version of the database is directly dependent on the In-depth one.

Critical Themes

The Critical Themes that emerge from the use of the In-depth Potential Issues Database can be considered as clusters of issues that refer to specific contemporary themes. The description (below) points out how the use of personal information in connected services creates a complex system of real and possible ethical and social consequences.

Consent or denial of service access: Personalization of services and tailoring of experiences are the results of the processing of user's data. The consequence of this personalization is the granting or denial of access to the user with regard to specific services or features. The right to access is decided based on information about the individual, and the result is a reduction of time and effort spent on professional tasks. The goal of automation to reduce time and effort does has some critical points: i) users have to provide data to allow services to check their right to access; if users refuse to provide data, the service access could be denied; ii) automatic data collection could result in totalitarian surveillance mechanisms. Data can also be used by third parties without giving the user the power to refuse; iii) the accuracy of the provided data and its interpretation are critical points. A misinterpretation of data can lead to serious errors in granting or denying access.

Awareness of data tracking, sharing and use: Services that detect and track people's data can return the information gained, and/or use this information for specific purposes, share it and even sell it according to the terms and condition that the user agreed to. Although most of the time the user is well aware of the tracked data, it is also true that some issues arise when the individual is not completely conscious of when tracking occurs, which data is collected, with whom it is shared or sold, who is using it and what kind of profit they make. It can happen that users not be totally aware of hidden tracking and, moreover, of what kind of information and knowl-

edge is extracted from their data. The user's unawareness of tracking, and the related impossibility of hiding from it, cause lack of individual power with regard to controlling the exposure of personal and intimate information to the external world. Service providers and third parties could gain profit from users' data without involving users in the trading process, and even without letting them be aware of the use of their information for a specific purpose, such as marketing and social labelling. Furthermore, the user could perceive hidden tracking even if it's not occurring, and so have the wrong sensation of being spied on.

Rights of data access management: The critical elements of data ownership and control of access are related to the user's right to decide who can see and/or use their information, which kind of information is used, the granularity of the information and the level of personalization. Access management affects the services received by the user and the individual impacts influencing the balance between individual freedom and privacy regarding policies, health and safety. While providing more and more personalized services, IoTs and ubiquitous sensors are collecting data on everyday actions and behaviours of people. The increasing tailoring and optimization of tasks and services requires much data, and its use by third parties and the related power of the user in denying said access is not always clear. Hidden tracking, as well as the pervasive availability of data thanks to its sharing on the web, make the control of the use of information difficult.

Automation of actions and services: The use of personal data makes it possible to create proactive services and automatic task management processes to save time and effort. This automation is modifying both how the service is provided and the user experience. Tailoring and proactivity are changing the paradigms of services as in the case of healthcare services that shift the focus from curing illness to self-care and prevention. The automation of analysis of personal data, however, brings up doubts on how technologies such as Artificial Intelligence can be used. Persuasion and decision-making based on personal data analysis is nothing new, and the perfection of gathering and collection as well as the automation of the analysis, thanks to technological advancement, raise issues especially when services imply Artificial Intelligence, such as Machine Learning algorithms, to automate procedures and manage complexity: i) algorithms have been labelled as biased against people of colour (Corbett-Davies *et al.*, 2016); ii) biases and prejudices in learning algorithms (Crawford, 2013) become particularly critical when Machine Learning is applied to the field of justice and law-making because of its socio-political implications; iii) even programmers do not always understand clearly how algorithms make decisions. The suggestions and filtering options

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provided by services through the use of algorithms that analyse personal data can create selective exposure to content and information (Liao and Fu, 2013).

Alteration of cognitive load: the use of Artificial Intelligence allows human focus to shift from the tasks to the user experience. The cognitive load on decision-making and task completion can be lowered or raised due to automation: proactive services can lower cognitive load and allow the user to focus on less repetitive tasks and on the experience. However, the use of the technology itself can increase the cognitive load due to higher expectations from the user. Also, the return of information and knowledge in the form of visual feedback or insights and suggestions can raise the cognitive load related to burdens on new issues, such as the exposure of individuals to the external world. New problems can also be created by the invasiveness of the service or the return of too many details due to the granularity of gathered information, which in turn creates issues related to psychological effects (Mućko, Kokoszka and Skłodowska, 2005).

Alteration of risk of judgment: automatic detection and analysis are moving the burden of task completion from humans to machines, and analysis is performed mostly on automatically detected data instead of data that is actively provided the human. While automating processes through AI makes choices and task completion easier, it also removes the effort for judgment from humans, raising risks of inattentiveness in decision-making processes: i) the 'automation paradox' refers to systems making decisions while humans mentally 'switch off' (Greengard, 2015); ii) decision-making tasks based on personal information, as well as judgments made by machines through the use of algorithms, could open new perspectives of discrimination. In the USA, employers can require employees to submit to genetic testing ("H. Rep. No. 115-459," 2017). This change in the law inevitably affects relationships between subjects. The employer is now entitled to gather employees' information not related to current health issues, but related to future possible diseases. The discrimination can be based on something that could never happen; iii) The interaction with bots and AI changes the attitude of users during their experience. They can feel less judged than if interacting with another human being.

Self-mirroring in data: the use of personal data has many possibilities of creating knowledge for the individual. Users' self-perception changes and relates to the self-knowledge they acquire while understanding their own data (Arda, 2014). When the user receives information back from the service, feedback can be returned in the form of information visualization or through the analysis of the information, in the form of insights, suggestions and tailored proactivity. This return of information about mechanisms such

as inner body functions and behavioural patterns renders visible something that is usually hidden to the individual. The knowledge acquired from data changes the perception users have about their own body, actions, behaviours and the returned information has to be relevant, accountable and understandable. It is possible that the received knowledge changes the way the user will act in the future (Ancker *et al.*, 2015). Self-tracking can be seen as a way to deeply connect the self to the body, but also as a distractor from life: i) people tend to pay more attention to tracking their lives than living them (Young, 2013); ii) when individuals analyse the received feedback, they experience disembodiment: knowing themselves through data creates disconnection between the knowledge and the physical (Young, 2013); iii) personal information can be used in digital life as a representation of the individual in virtual environments and users can reflect themselves in their data doppelganger, as well as being misrepresented by their digital identity.

Information overload: details and granularity of data gathered by advanced sensors increase the precision of the information and the knowledge extracted from it. However, it is important to consider the psychological impact the information has when is received by the user. Self-knowledge can be negatively influenced by overload of information (Swar, Hameed, and Reychav, 2017) that is irrelevant or has too many details: i) overexposure to information for users could be misleading, or even make them worry about irrelevant knowledge leading to further consequences such as control addiction (Mućko *et al.*, 2005); ii) increasing amount of available data is raising questions about its usefulness, possibilities of extracting valuable knowledge from it, and even concerns about privacy and surveillance.

Alteration of attitude and quality of life: digital services are providing value in services both for users and stakeholders. Although tailoring and automation make it possible to improve already existing services, as well as to create new ones for specific purposes, the use of personal information brings consequences in terms of alteration of users' attitude toward actions and behaviours and with regard to quality of life: i) the increasing availability and pervasive use of sensors to detect people's data alter their attitude toward everyday life behaviours due to the "observer effect" (McCarney *et al.*, 2007) that brings people to behave in a different way when they know (or think) they're being observed (services can also take advantage of the "observer effect" for the user's good, aiming to change a bad behaviour according to the user's goal settings); ii) the ubiquitous and pervasive connectivity that allows users to be "always present" in their digital representations raises the issue of the impossibility of hiding and disconnecting, which can change in approaches toward everyday activities.

Data use for public benefit: a utilitarian ethical approach applied to the use of personal information, as a benefit for large groups of people or even in the whole of society, can produce by-products in the form of problematic effects for individuals and for society itself: i) the gathered data can be used for public services and for increasing public knowledge to encourage better decision making, such as for creating policies or energy saving strategies (Marr, 2015); ii) massive amounts of data about people can make them become targets for massive surveillance and deny access to services according to their and other people's data.

Creation and management of communities of value: the interaction of people through their data often creates an actual community, thanks to the sharing of values connected to the purpose of data tracking common to community members. However, it is important to consider that: i) the exposure of data in the community has to be voluntary; ii) even if the amount of data is big enough to make a decision, only the collected data contributes to the decision-making process, while the "voice" of non-tracked people is cut out and not represented in the results.

Democratization of services: the use of personal data to enable remote interaction makes it possible to provide affordable or even free services and features for lower income people, as well as increasing the plateau of users. The democratization of services is granted for people who can provide their data (those who do not have access to an Internet connection or cannot afford the necessary devices are not considered). Users' intentions to share data can be obstructed by: i) not being part of a specific interest group or community; ii) unawareness about the availability of the service; iii) doubts about unknown uses of the data collected.

Changes in design choices

Among the possible applications of the method in the design processes for interactive innovative products, we can reflect on the use of critical themes and issues as assessment and discussion elements to: i) frame the state of the art in terms of current solutions in the preliminary context analysis and foster reasoning in the preliminary user analysis; ii) identify possible impacts of a solution concept so as to make more aware design choices during the creative phase; iii) assess proofs of concept and the related scenarios of use to verify the solution and support the definition of user tests. The use of these discussion elements in different design processes can help to identify user's rights, generate design guidelines, assess concept features, and

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identify possible improvements. The application of the method performed in design activities helped not only designers to develop awareness on the consequences of their actions and outcomes, but also researchers to assess and improve the method itself and its findings. The results from the application of the Impact Anticipation Method in design processes shows that the method can support the design process thanks to different applications and tools for the analytic, definition and assessment phases (Varisco, Colombo and Casalegno, 2019; Varisco, Pavlovic and Pillan, 2019; Varisco, Pillan and Marti, 2019). It helped designers create robust, consistent and resilient solutions supporting the design through the introduction of critical thinking in the whole process – from preliminary phases to the assessment of the solution. The designers involved in the application of the method demonstrate increased personal awareness on the topic by changing and improving the outputs of the design processes through more thoughtful design choices with respect to: i) the use of personal data in terms of collection, storage and elaboration; ii) the derived information and knowledge; iii) the possibilities that this knowledge opens in adding value to the services; iv) and the possible impacts that the use of personal information could have on individuals and society. Furthermore, while exploring case studies, designers have the sensitivity to understand and identify valuable user's rights and design principles that go beyond the topic of privacy, using a critical thinking approach that embraces the complexity of the various impacts looking toward design choices as possible solutions.

The role of design in the discussion on the consequences of the use of personal information

As the research pointed out, the design of solutions that implies the use of personal information is a critical concern. The need of critical thinking for the design of such solutions emerged not only from the literature and the critical themes which were identified during the application of the Impact Anticipation Method. It was also underscored by the difficulty of designers and students in figuring out and becoming aware of both how and when personal information is implied in their designed solutions, and the potential impacts that the use of such information and the derived knowledge could have. The Critical Themes clarify the need for thoughtful design choices which take into account the user's rights regarding privacy and security, but also regarding less evident impacts such as: i) perturbations in self-perception and self-awareness due to self-mirroring into data and feedback received

from services; ii) the automation of the extraction of knowledge about individuals that changes people's cognitive load, actions and behaviours; iii) the alteration of people's quality of life, freedom and access to services thanks to increasing availability of services that imply personal data as a matter from which to extract knowledge; iv) the alteration of the individuals' participation in society and the community, and the changes in their interpersonal relationships and roles. The outcomes of the design processes in which the method has been applied clarified that designers have the sensitivity and capability to identify and interpret user's needs. They can mediate between companies and users and also help define best practices. Designers have an active role in designing innovative solutions and their aware design choices can produce an active contribution to the identification and interpretation of user's needs and rights with regard to management of their data.

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Delaying Obsolescence in Digital Products. Interdisciplinary Research through Emotionally Durable Design and Well-Being in the Z Generation

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Abstract

Does planned obsolescence of products affect people's happiness? Does having a long-term relationship with things improve our wellbeing?

This study positions itself in the Life Cycle Design literature, addressing the human environmental footprint, from the Psychological point of view. Focusing on electronic goods, particularly smartphones, as a case study, it investigates whether longer lasting emotions towards objects, can improve the psychological well-being of people. In doing so, it supports those Circular Economy strategies and Business models, aimed at slowing down the frantic loop of production and consumption of material goods.

This chapter presents the main principles of Emotionally Durable Design theory by relating it to Positive Psychology – a discipline focused on the pursuit of well-being. It seeks to synthesise a broader, empirical study based on a sample of about 1.300 young people, mostly belonging to the Z generation. The chapter briefly shows the original methodology designed for this study, previews the huge amount of data, and provides just the main results – the interpretation of which deserves to be deepened during future years of study.

Introduction

This chapter is an overview of a wider three-year theoretical research program which culminated in an experimental investigation.

The exploration covers areas which are apparently distant, including environmental sustainability design and research on Psychological well-being, which are then compared.

The research supports the theory of Emotionally Durable Design (Chapman, 2005). It takes as a model a milestone of psychological studies on the "meaning of objects" (Csikszentmihalyi and Halton, 1981), and embraces theories and methods of Positive Psychology (Csikszentmihalyi and Seligman, 2000), and adapts them to their purposes during empirical research. The study supports the reasons for a slower and more balanced idea of development, in harmony with the cycles of nature and humanity, to the benefit of the environment and people. The most important challenge is ensuring that this change of pace considers the legitimate economic interests of producers.

Smartphones as WEEE

The study focuses on WEEE[1], waste electrical and electronic equipment, which by its nature undergoes ever-faster technological obsolescence, using the smartphone, a symbol of our age, as a case study.

The 2002 directive governs the disposal of this type of waste, encouraging the collection and recycling of components. The regulation covers large and small household appliances, from washing machines to toasters and products such as TVs and computers in addition to all those products that use electricity and electronic components. The production, use and disposal of such components have a negative impact on the environment. The new WEEE directive (19/EU of 2012) applies to other types of previously excluded equipment, such as smartphones, which at the time of the first regulation did not exist. Therefore, we need to consider the speed with which the electronics market creates and discontinues new products.

Since 14 August 2018, products that use technologies related to electricity and electronics, including future products, will be subject to the regulation, regardless of their type, but excluding certain categories of professional items used by public utilities.

The WEEE debate concerns more and more not only large household appliances, but also small devices such as smartphones, which by their nature undergo rapid obsolescence more than others. This can be driven by market interests or unstoppable and increasingly pressing technological innovation.

Extending the life cycle of a smartphone, even for a few months, has an enormously positive impact on the environment (Chapman, 2014).

[1] The acronym WEEE stands for Waste Electrical and Electronic Equipment.

In a Skype interview granted to me on 04/04/2019, Prof. J. Chapman[2] stated:

> […] the aim is not to make products last forever! The aim is to design products that last longer! So, if you have a smartphone that lasts 12 months, then you can find a way to make it last 18 months. That would be a very significant change!

It is estimated that seven billion mobile phones have been sold worldwide in 10 years; in China 95 percent of people own one, in America and Europe the figure is 91 percent (Kantar Worldpanel, 2017; Greenpeace, Jardim, 2017). Not everyone knows the devastating effect of the rapid production and disposal of a smartphone.

A smartphone weighs a few grams, but the extraction of the precious materials it contains requires the excavation of at least 30 kg of rock.

A Remedia study[3] conducted in partnership with Politecnico di Milano (Masi, Cristiani, Dotelli, Iannicielli Zubiani, Sciuto, Azzone and Bengo, 2012) found that a single smartphone contains more than 60 valuable raw materials of which many are potentially poisonous.[4]

Multiplying by the seven billion smartphones sold worldwide in the last decade (more than 35 million sold in a year in Italy alone), we understand the extent of this huge source of pollution.

Emotionally Durable Design

In literature, many studies have focused on theories which support product life extension as a strategy for environmental sustainability, based on the product's physical, functional, performance, economic and technological duration (Sanderson and Uzumeri, 1997; Lounis *et al.*, 1998; Rose, 2000; Horie 2004; Sundin and Bras 2005; Rüdenauer and Gensch, 2005; Lindahl *et al.*, 2006; Cooper 1994-2005; VHK, 2011).

There are fewer and more recent studies which defined the goods' durability by observing the cultural, psychological and semantic aspects that lead

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[2] Formerly professor of design for sustainability at Brighton University (UK), Jonathan Chapman is now full professor in Transition Design at Carnegie Mellon University in Pittsburgh, Pennsylvania (US), where he is Director of Doctoral Studies in the School of Design.

[3] Consortium in charge of Italian WEEE disposal.

[4] On average: nine grams copper, 11 grams iron, 250 mg silver, 24 mg gold, nine mg palladium, a gram of rare earth (Praseodymium, Neodymium, Cerio, Lanthanum, Samarium, Terbium, Dysprosium) and other precious metals such as Cadmium, Cobalt and Ruthenium.

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the user to establish a more lasting bond with goods (van Hinte 1997; Kostecki 1998; Takada *et al.*, 1999; Lyndhurst, 2011; Gnanapragasam, Cooper, Cole and Oguchi 2017).

Prof. Chapman stands out as an author who, more than others, has put this principle into practice in design literature. He links the importance of products' psychological and emotional durability to the environmental issue, and has devoted much of his studies to defining the Emotionally Durable Design (2005, 2008, 2015) concept.

Landfills are full of physically intact and functional products, especially electronics. Their obsolescence is induced by logics of incremental technological innovation, which do not add substantial value to the user experience, prompting them to replace still efficient products before their time. This replacement is due to a market logic, based on the planned obsolescence business model (London, 1932) – a worn out and uncivilised system which is fatal for humans and the environment. Although this model was legitimately created to remedy the socio-economic damage of the 1929 economic crisis, it cannot and must not represent a dominant economic model today.

According to Chapman's theoretical framework, the product life extension must take into account the design of emotions. Therefore, it is a concept of durability that is independent from the product's physical resistance and function, and therefore its technical or technological capacity to last over time. According to Chapman, product durability must focus more on the emotional point of view, and the degree of long-term user attachment. Chapman summarises this theory into a "Six Point Experiential Framework", subsequently reworked (Haines-Gadd *et al.*, 2018). It originally represented (2005) an attempt to provide an operational tool, which makes the concept of emotional durability applicable through six types of interaction between user and object:

Narrative, Detachment, Surface, Attachment, Fiction, Consciousness.

Such a theoretical construct represents not only an academic study subject, but has also been used to draw up the British government waste management policies. It has become the subject of attention and research by important companies in different sectors, such as Puma, Philips, and Sony, just to mention three well-known brand names.

Chapman's thesis on Emotionally Durable Design reinterprets and expands, in an original and unprecedented way, some concepts already expressed by other authors (Papanek, 1992; van Hinte, 1997; Desmet, 2002; van Krieken, Desmet and Mason 2012; Kwan, 2012; Weidman and Dunn, 2016).

The originality of this theoretical construct lies in its ability to relate (fig. 1) design for sustainability, and life cycle design (LCD) to emotional design (Norman, 2003;). The emotional design theme by itself could potential-

ly conflict with the principle of sustainability, stimulating compulsive and insignificant purchases dictated by enthusiasm, due to temporary emotions, exploited by marketing. This happens especially today, where the market of emotions, which are reduced to commodities (Cabanas and Illouz, 2019), exploits the internet immediacy, encouraging "easy" click-enabled purchases (Pani and Biolcati, 2006).
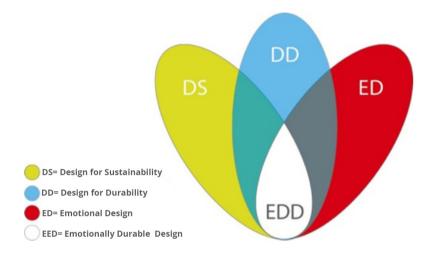

DS= Design for Sustainability
DD= Design for Durability
ED= Emotional Design
EED= Emotionally Durable Design

Fig. 1 – Positioning Emotionally Durable Design.

Making Product Durability Economically Desirable

Many companies do not take kindly to the idea of extending products' useful life, as they fear losing sales volumes. Mistrust and prejudice towards more durable products are also shown by some consumers, which are fearful of forsaking the latest technological product.

The design books contain legendary objects and status symbols that are not always a commercial success. This has reinforced a prejudice among manufacturers, who do not necessarily associate the idea of a durable and well-designed product with one which is economically viable. Several economics studies prove the opposite and investigate the effectiveness, and commercial success, of durable design products. These include "Business Classics" (Sanderson and Uzumeri, 1997) which are aesthetically durable products that are style icons, but last on the market and generate profits for a long time. A typical case in the automotive industry was the Fiat Panda designed by Giugiaro (Marchesi, 2005; Verganti, 2009).

A speed-based production and organisational model is not necessarily a gain for the company. Preferring continuous product replacement, can sometimes prove disastrous, and not only for society or the environment, but manufacturers' economic and financial interests. This phenomenon is well known in economic literature as an "acceleration trap" (Von Braun, 1990) and shows that competition based on a faster time-to-market damages the market itself. Production acceleration leads to a short-term gain, thanks to the sale of more goods, but ends up irremediably weighing on the organisational processes to the point of becoming unmanageable and unprofitable. In the medium-long term it risks direct negative effects on the company's turnover (Bruch and Menges, 2010).

The product life extension attractiveness from the consumer's point of view, and the business potential for manufacturers of durable goods, is supported by research (Eurobarometer, 2014), which shows that 77 percent of European citizens would rather repair their products than buy new ones, if they could choose. Ninety percent of respondents would like stores to put an expiry date on non-food products, such as computers or appliances.

According to the same statistical surveys, young people seem more inclined to use refurbished or second-hand products. Here are some figures: 84 percent of young people between 15 and 24, against 54 percent of adults.

The environmental cost of products with an ever-shorter life cycle is high, for the environment, consumers and companies. Consumers are forced to increasingly replace their devices, at ever higher prices, to meet the producers' interests. Companies are forced by governments to comply with updated environmental standards, which are increasingly stringent and vexatious (Chapman, 2005). These costs end up weighing on the consumer.

Making a circular economy, which is financially sustainable for companies, means activating a systemic design strategy, using complementary design solutions that work together, such as design for long lasting products (or design for durability), disassembling, reparability, upgradability, modularity and so on. These should be combined with legislative incentives, servitisation strategies and business models, capable of transforming profit logic (traditionally based on the sale of products) into the sale and management of new services related to longer-lasting products (which are more repairable, upgradeable and customisable). In this case, product and components' end of life would also follow a more controlled, efficient disposal process, reducing the environmental impact.

The product life extension in a traditional and linear economy based on product sale probably does not work but, used in a service-based system, it can represent a strong strategic and competitive value for companies and also a

new business opportunity. Such a logic, which is based on more durable products and service provision, would give consumers greater savings and choice. It would give them more customisable products, which can provide a more individual, lasting and exclusive emotional user relationship, despite commodification that makes products, especially electronics, identical to each other.

Well-being in Developed Countries

Investigating the effects of product life extension on user well-being was fundamental to understanding what well-being really was in industrially advanced countries, and how to measure it. We could summarise this by saying that happiness, even before material wealth, is 50 percent ascribed to genetic factors and, 50 percent to environmental factors, mostly linked to our behaviour (40 percent) and only a small part (10 percent) to accidental events and factors beyond our control (fig. 2).

To back these theses, there are known and accredited psychological studies (Seligman, 2011) which were supported by previous scientific evidence (Iacono and McGue, 2002).
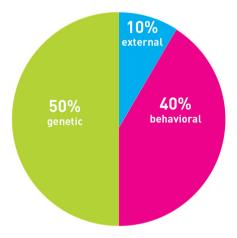

Fig. 2 – Diagram summarising the data cited by M. Seligman (2011), attributable to the same data published by the Minnesota Twin Family Study (2002).

Today, we still insist on measuring countries' well-being based on their degree of technological advancement and their ability to produce and consume, using a one-dimensional development logic – as if industrialisation and technology were a guarantee of happiness and well-being.
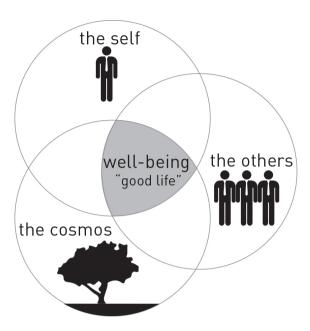
Fig. 3 – Author's illustration "The good life Beyond the self."

Although several recent alternative indicators have been suggested[5] almost 90 years after its introduction, the measurement of the well-being of nations is still sadly done through GDP calculation (Kuznet, 1934). This means we use a quantitative indicator to measure a qualitative aspect such as "well-being." Well-being is a holistic, polymorphic, systemic and complex entity, just like the environmental sustainability issue. It is due to the interaction of several factors, which are not always material or related to a single reason. Individual well-being cannot practically exist, except in connection to natural and social well-being.

The investigation of many psychological studies, particularly those about how objects and materialism affect our well-being (Csikszentmihalyi and Halton, 1981; Inghilleri, 2003) confirm that the life quality of the individual transcends the self's egoistic dimension. There can be no self-happiness without a good relationship between the person's social, environmental and broader cosmic interactions (fig. 3).

The experience economy (Pine and Gilmore, 1999) and Maslow's hier-

[5] For example, the OECD Life Index, or BES in Italy by CNEL/ISTAT, ISEW, HDI (Human Development Index) used by the UN, GNH or FIL, HPI and many others. For further information see Rinaldi and Zelli (2014). *Misurare il benessere. La sfida degli indicatori alternativi al PIL*. Roma: Donzelli Ed.

archy of needs (1954), show how much the industrially advanced countries have already met their primary needs. This shifts the search for well-being to a more metaphysical and "superstructural" dimension – the psychological. The search for well-being today works in the sphere of mental needs, linked to a meaningful, cognitive and emotional dimension, rather than a purely material dimension.

Well-being as good relations with others

Well-being is now linked to intangible and behavioural factors and was highlighted in the well-known *Grant Study* (1948-2018), of the Massachusetts General Hospital in Boston, which lasted about 80 years. This study proved that life quality, or well-being, was inextricably linked to interpersonal relationship quality, rather than other material factors. The emotions that come from love and friendship help us live longer, healthier and happier.

According to another study (Sandstrom and Dunn, 2014), this evidence is not only about strong ties with our friends, relatives, parents or partners, but includes "weaker" ties, such as impromptu relationships established with unknown transient people. These behavioural and environmental factors linked to relational life, seem stronger than genetic factors, in influencing the life quality and duration of surveyed subjects.

According to the *Grant Study*, loneliness kills more than alcohol, cigarettes or any other disease.

A mental issue

According to the World Health Organisation (2017), anxiety is the worst disease of our century; 3.6 percent of the world's population, in the so-called rich countries, suffer from anxiety disorders, and this percentage increases dramatically every year. Depression is expected to be the second biggest cause of disability in 2020.

It has long been known that "[...] the depression rate is related to modernisation [...]" (Nesse and Williams, 1994).

Treatment of psychological well-being is a crucial issue in the so-called "rich" countries. This is economically relevant to State budgets, since 340 million people suffer from depression worldwide and its cost, in Europe, is about 92 billion Euro annually (Epidemiology of Mental Disorders [ESEMeD], 2004).

Material Well-being and Wealth

Money won't bring you happiness is a cliché which is sometimes mocked in its apparent naivety, but it is now scientifically proven.

The American economist Irving Fisher (1906) already realised that economic well-being depends mainly on the psychological enjoyment of life, and not only on available goods.

Another economist (Easterlin, 1974) explained a similar idea when he described the relationship between happiness and wealth as a paradox. An inverted "U" (fig. 4) where wealth – a source of well-being at its first stage, often ends up becoming a source of discomfort when it exceeds a certain limit.
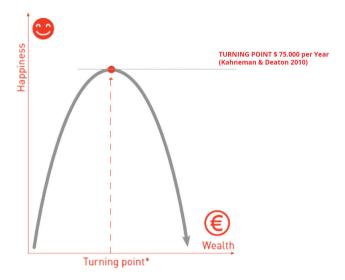

Fig. 4 – Easterlin paradox.

Some scholars (Kahneman and Deaton, 2010) have recently engaged in experimental research to asses the exact economic threshold of this limit. They rate at $ 75,000 per year of revenue the figure beyond which material wealth would start becoming a threat, and no longer a well-being functional tool.

Even if we do not want to believe such an extreme theory, we must admit that a life built only around material wealth often generates unease and complexity that cannot be reconciled with an idea of complete well-being. Wealth can trigger interpersonal relationships which are not always genuine, and often entails a burden of responsibility and anxiety linked to the management of assets and related interests.

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While not harmful in itself, materialism can become destructive based on the mistaken meaning we give it.

This thesis does not demonise, but rather exalts, the materialist value and meaning in our lives, according to a principle of "instrumental materialism" (Csikszentmihalyi and Halton, 1981). A materialism that is functional to well-being, contributing to a use and consumption of goods that are more "meaningful".

Material objects can be symbols that unite (e.g. religious symbols), or diabolical[6] tools, that separate people, creating conflicts. Wars over possessions are one example.

Methodology

Fig. 5 shows the research's extreme thematic synthesis and how it evolved into a more experimental phase in the field.
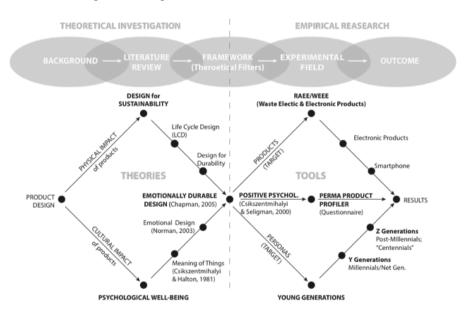

Fig. 5 – Research methodology.

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[6] See the etymology of the Greek words: "Symbolic" from σύμ – (sym-), "together" plus the verb βάλλω (ballo) "throw", which means "to unite", and "diabolic", διαβάλλω (diabàllo) from which the modern term «devil», the one who «divides» par excellence.
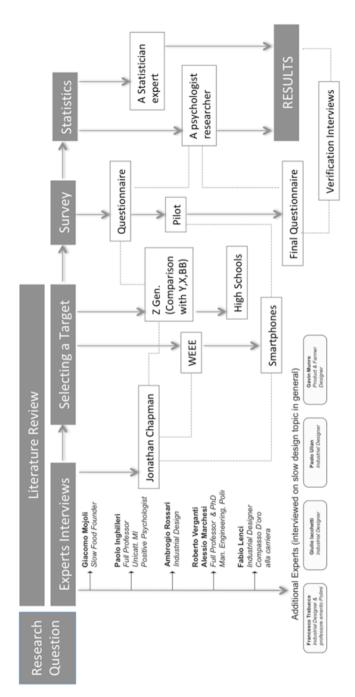
Fig. 6 – The research's experimental phase and the tools used.

Referring more specifically to the tools, a second diagram (fig. 6) details the research's experimental phase and the tools used. It included expert interviews, which were fundamental to the formulation of the final survey on the enlarged user sample.

After a phase of investigation through pilot tests, empirical research was condensed into a survey of 1338 people, of which 676 were in Lombardy and 662 throughout Italy. Excluding 41 unreliable answers, 1297 subjects were analysed using a statistical method, about 80 percent were school aged, between 14 and 26 years old. The survey's objective was to study the relationship between the duration of the user-object bond, and the well-being that derives from it for the individual. It looked at the connections and the effects that this duration has, or could have, on the user psychology.

After a careful examination of the psychometric scales[7] historically used by psychology to measure well-being, the research chose the Martin Seligman PERMA model (2011), as an interpretative filter. This was adjusted and interpreted for research purposes, by creating a tool dubbed Perma Product Profiler (PPP), for the measurement of object-induced well-being.

Seligman's PERMA model does not really represent a scale of measurement immediately applicable in field research, but it is a broader theory, developed as part of Positive Psychology, of which Seligman is one of the founders with Mihaly Csikszentmihalyi (2000).

This thesis is added to the work of other authors (Kern, 2014; Butler and Kern, 2016; Kun, Balogh, Krasz, 2017) who used the PERMA model to obtain independent scales of measurement, which are applicable at an experimental level, in a specific context.

PPP provides 30 questions (items) divided into five modules, corresponding to the five variables of Seligman's theoretical construct which include: *Positive Emotion (P), Engagement (E), Relationship (R), Meaning (M) and Accomplishment (A)*. For Seligman, these variables constitute the five ingredients of the "good life" (Inghilleri, 2003) and psychological well-being that our society needs. PPP is structured according to the Likert method (1932), subjecting the respondent to six degrees of agreement or disagreement for each item/question.

The survey does not end with PPP, but includes interviews and other questions to collect information about the socio-demographics, family relation-

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[7] We only mention the main ones here: State Trait Anxiety Inventory (Spielberger, Gorsuch and Lushene, 1964) and related distinction between state and trait anxiety (Cattle, 1966); Manifest Anxiety Scale (Taylor, 1953), Hamilton's Rating Scale for Anxiety (HRSA or HAM-A)(1959); Zuckerman's Multiple Affect Adjective Check List (1960); Ryff (Ryff, 1998; Ruini *et al.* 2003) better known as Psychological Well-being Scales (PWS).

ships, the sample's objects of affection, intensity of the bond with the object, its duration, meaning/reason and type of relationship with the smartphone.

The questionnaires were provided using Google Form, and the answers were entered in spreadsheets (Excel).

The amount of data resulting from the approximately 1300 questionnaires was subsequently processed through the main statistical analysis standards and led to mostly unpublished and unexpected results.

Fourteen product categories were identified among the products preferred by the sample. These and the other answers were numerically interpreted to aid calculation. This involved the help of two expert statistics researchers to give the data collected the most reliable interpretation.

Microsoft SPSS version 23 software processed the data. The data analysis was expressed as an average value ± SEM or as median and interquartile, where necessary.

The relationship and comparison between two data groups were carried out using contingency tables and evaluated using Spearman's non-parametric test. The relationship and comparison between several data groups was then carried out with ANOVA. The correlation between groups of variables was evaluated by calculating Pearson's correlation index.

Where necessary, the questions' predictive value was carried out using Cronbach's Alpha test.

Results and Discussion

This paragraph does not report the full research data. The amount of data collected is so large that it cannot be easily summarised in the space granted by this publication. Many of the results deserve a more in-depth analysis and further interpretation before they are published. We will provide only a summary to give an idea of the nature and potential of the work.

What are the most popular objects for the younger generations?

The smartphone was absolutely the most voted object in the sample, with 499 people out of 1297, but it was young people who voted for it the most. As age increases, the value drops, until it occupies the penultimate place for the Baby Boomers (the oldest group of the interviewed sample).

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What is the duration of this bond?

The bond with the smartphone is the most frequently stated but also the least lasting. The sample possessed it for less time and didn't plan to keep it as long as other objects. The preservation over time of objects increased with age and women bonded to their objects longer than men.

What is the meaning of this bond?

It is interesting to note that the function that makes the smartphone the object preferred by the sample, changed profoundly based on age. The reason, and the meaning, for using a smartphone was almost the opposite between young people and adults. Young people said they used it mostly for games and social media, while adults for information, study, work and knowledge.

Ratio between product durability and well-being: the longer you keep your objects, the more well-being you get

The sample was asked, without explaining the reasons, how long they owned their favourite object, and for how long they were planning to keep it, if they could choose. The aim was then to relate the duration to the well-being induced by the product. The answers confirmed the initial assumption that there was a strong correlation between well-being and duration of the emotional relationship with the object.

This correlation, in the statistical analysis, was measured by the Pearson coefficient (R), and proved to be significant and causal. The longer the user-object relationship lasted, the more well-being it created and vice versa. The well-being score (measured using PPP) was significantly higher in durable objects. This is true for the possession duration ($R=0.07$; $P=0.009$) as well as for the estimated duration ($R=0.32$; $P=0.0001$).

Of the 14 object categories, those which induced the most well-being on average percentage value are objects related to sport, play and leisure. Video-photo cameras were in second place and then other objects related to memory – which confirms the importance of objects as a memory tool. The products that induce less well-being (lower PPP) are smartphones, followed by consoles and video games.

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Conclusions

The research results confirmed that a link established by users with digital technology products was weak and had little meaning. Despite the smartphone being the Z generation's preferred object in the survey, its emotional aspect is minimal. The link with this type of object seems to be motivated by temporary and functional factors, to the detriment of other emotional reasons. The technological-digital product does not seem to generate user-affection nor acquire meanings that are comparable in duration, intensity and meaning to those embodied by other "analogical" objects identified by the survey. The link with the physical, material, and aesthetic dimension of the electronic product seems to disappear and was confined to the initial phases, i.e. the product purchase and first use.

If these results may appear obvious, the blind test data shows that the link is not only temporary but brings the lowest user well-being and psychological satisfaction. Strong signs are evident from the research. One of these is the identification of mobile phone covers (fig. 7) as an important emotional compensation tool for young people. This is a sort of remedy that compensates for the emotional shortcomings of cold digital technology and humanises it. It gives the phone more meaning and new missing psychological functions that allow a more emotionally meaningful and individualised relationship with the object.

Fig. 7 – Mobile phone covers: an important emotional compensation tool for young people.

Research Contribution

This research is a contribution to the studies on the meaning of objects, using unpublished results on the relationship between young people and material objects. Using experimental data, a strong correlation between the bond duration with objects and the user's psychological well-being was demonstrated. The study confirmed the centrality of product durability among the new circular economy's strategies. In demonstrating the positive effects of long lasting products on the user experience, it makes them more attractive for consumers and also for companies oriented towards customer satisfaction.

The thesis provided a methodological contribution by suggesting and testing a new psychometric scale (PPP), which was specifically designed to measure the relationship between product durability and well-being.

Generally, and despite its technical limitations, the thesis has the value of having experimented with a multidisciplinary approach which answered the research question and generated unexpected data and information worthy of further study, even in areas other than design.

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Design for Sustainability in Fashion

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Abstract

For many years, researchers and designers have focused on answering the question of how fashion can be more sustainable; however, the fact is that fashion has become one of the most polluting industries in the world. The purpose of this study is to investigate and develop a consolidated knowledge-base and know-how to support and equip fashion designers in the design process, with a focus on Accessory Design. To achieve this goal, three research phases have been conducted, including (1) the Preliminary Research phase, to explore and describe the dynamics and factors affecting the implementation and popularizing Sustainable Fashion; (2) the Prototyping and Assessment phase, to develop and systematize the consolidated knowledge-base and know-how to support the role of design in applying and spreading Design for Sustainability in Fashion (DfS.F); (3) the Reflection phase, to present a retrospective analysis, generalize the results of the research, and propose the potential path for future research. As a result, DfS.F design methods and tools were assessed through participatory research, and their effectiveness was evaluated through a series of pilot workshops and courses, as well as projects in collaboration with stakeholders.

Introduction

Fashion is "a powerful communicator", and it represents the diversity of cultures around the world, expressing individual or community identity (Black, 2008). Starting from the first Industrial Revolution, the fashion industry has become a mature industry, characterized by mass production and globalization

(Arvidsson *et al.*, 2010; Plank *et al.*, 2014). In parallel with the achievements of the fashion industry in economic terms, this industry worth trillions of dollars is also full of contradictions and paradoxes. It is also considered one of the most unsustainable and polluting industries in the world (Schor, 2005; Boström *et al.*, 2016; Cappellieri *et al.*, 2019; Rana *et al.*, 2015; Ricchetti and Fisa, 2012; Bertola *et al.*, 2018, Armstrong *et al.*, 2015; Joergens, 2006). In other words, fashion products have a negative impact on the environment and society at every stage of their life cycles from production, distribution, and use to disposal. However, over the past few decades, a new movement has emerged to counteract the existing problems of the fashion industry – that is, "Sustainable Fashion". The concept of sustainable fashion has received attention on a global scale; it is not only a trend, but has become one of the essential values of fashion designers and brands and deals with facing environmental and social challenges. Therefore, in this Ph.D. research, we have focused on the role of design in promoting Design for Sustainability in Fashion (DfS.F), presenting a set of knowledge-base and know-how for environmentally and socio-ethically fashion designs, with a focus on accessory design; at the same time, the results of the study have also pointed out the pioneering role of design in the journey to find alternative solutions for future fashion.

Fashion and Sustainability

In an era of consumerism, pragmatism has crept into every street, participating in the daily lives of people from urban to rural settings. Fashion with frequently changing characteristics, such as "trendy" and "obsolete", makes things happen quickly (Bhardwaj *et al.*, 2010). The feeling of "obsolete" leads to increased consumer desire; thus, it encourages the industry and consumers to look for new things in a continuous cycle of demand, production, consumption, and disposal. It can be seen that the challenges and negative impacts facing the fashion system are related to environmental, social, cultural, and economic impacts. The five key issues in the relationship between fashion and Sustainability that have been discussed are: (1) overuse of resources; (2) pollution problems taking place on a global scale; (3) working environment; (4) trade conditions and (5) excessive consumption. As such, existing problems of contemporary fashion show a contradiction with the definitions of Sustainability. How can these contradictions be resolved if we continue to produce and consume fashion? This is a big question for the entire fashion system in the process of finding a way to meet the transition towards Sustainability.

During the last decades, various definitions of Sustainable Fashion have been shown. In the original definitions, it was defined as fashion clothing combining the principles of fair trade, with fairly paid labor (no sweatshops) and the use of biodegradable organic cotton (which will not harm the environment or workers) (Joergens, 2006; Clark, 2008). Recently, the trend has shifted from clothing and textiles to a broader and more generic definition of fashion, which can now be defined as clothing, footwear, and other accessories manufactured, marketed, and used — in the most sustainable way possible, considering both environmental and socio-economic aspects[1]. However, another noticeable change of attention, especially in the entire Design for Sustainability process, is first focusing primarily on products, then moving on to focus on sustainable product-service systems (Fletcher, 2008; Vezzoli, 2010; Armstrong *et al.*, 2015; Stål *et al.*, 2017). Therefore, the main objective of DfS.F is not only to focus on products but also to consider other factors in the entire fashion system, as well as education on sustainable fashion design in higher education institutions.
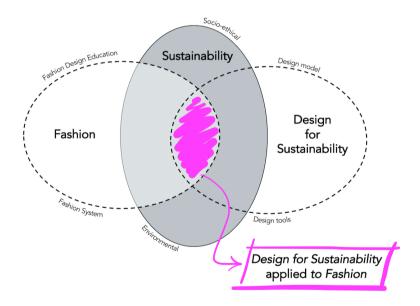

Fig. 1 – Research focus: Design for Sustainability (DfS) applied to fashion as great potential and win-win approaches

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[1] www.greenstrategy.se/sustainable-fashion/what-is-sustainable-fashion

Research Hypothesis

Based on the above-mentioned understanding and knowledge gap, the research assumes that providing potential knowledge-base and know-how of Design for Sustainability (DfS) innovations takes place in fashion design processes, which can be oriented and stimulated. Thus, the research has formulated the Research Hypothesis: "Design for Sustainability applied to fashion design processes can build up a proper set of knowledge-base and know-how as far as this is based on life cycle and functional approaches. This can support and equip fashion designers in designing and orienting the process of introduction and diffusion of Sustainability. Furthermore, designing and adopting Sustainable Fashion and offering a viable model might have great potential and win-win approaches, i.e., changing conscious knowledge of customers in consumption processes, and stimulating innovation in individual and social cognition."

Research Questions

To clarify the research hypothesis mentioned above, this research focused on exploring and answering the Research Questions:
1. **How can Design for Sustainability integrate into fashion as a promising approach for sustainability?**
   a. What are the dynamics and factors that facilitate DfS applied to fashion?
   b. If it is possible to manage and orient this process, how can it be done?
2. **Can the diffusion of Design for Sustainability in Fashion be stimulated?**
   a. If yes, what knowledge-base and capabilities are required by a fashion designer?
   a. What are the design methods and tools that can be used in practice and how can they spread them?

Research Objectives

DfS is a potential model to address the environmental and socio-ethical challenges that exist in the fashion system. However, the process of transforming to sustainable systems often encounters barriers in industrialization

and globalization because these systems have the main goal of producing a product faster at a cheaper cost to meet all the customers' needs, and which is continuously promoted by trends and obsessions with consumerism. Furthermore, although sustainable fashion has become a widely discussed topic in high-income countries, it is a new concept in the context of low-income countries; and the role of fashion designers has not really promoted the diffusion of sustainability.

General objective

The main goal of this research is to explore factors that affect the transformation of the fashion system towards sustainability, and to characterize the model of sustainable fashion. At the same time, we also intend to investigate potential strategies and approaches that can be applied to the design process and promote the role of design in this shift by understanding and building a set of knowledge-base and know-how, as well as establishing proper guidelines and tools for a fashion designer to approach sustainable fashion.

Specific objectives

The general objective can be broken down to three more specific objectives that would together achieve the overall goal of the project as follows:
1. to assess and verify DfS applied to fashion design processes;
2. to define the knowledge-base for a new design role in order to apply it to the creative and productive process of fashion as well as accessory design;
3. to define design know-how in terms of approaches, methods, and tools to support design practice, as well as to tailor the functionality of this framework so that it is suitable for the application of these systems in various study contexts.

Methodology

The main goal of this research is to explore the potential approaches of DfS applied to the Fashion system (a set of Research Question 1) and provide and equip a proper knowledge-base and know-how to support and enable designers to apply DfS to Fashion (a set of Research Question 2).

Design-based research (DBR) is a suitable type of research methodology applied in this PhD study. DBR is defined as a method that is built on the theory of the learning environment in order to create new theories and frameworks for conceptualizing learning processes. The focus is on simultaneously

developing a design and generating new theory (Barab, 2006) that includes the concepts of "design-research" and "development research" (Oha *et al.*, 2010). It seeks to increase the impact and transfer of educational research from a theoretical scope to improved practical application. In addition, DBR emphasizes the need to build theory and improve both practical application and research. These features of Design-based research have made it relevant to this study, with the aim of integrating and developing the DfS.F design principles, while testing and improving DfS.F. in an innovative learning environment (Reimann, 2011; Wang *et al.*, 2005; Anderson *et al.*, 2012). Thus, this is a method designed to solve complex problems in the actual context between educators in collaboration with students. Based on DBR, the research strategy followed three main stages, which are listed below.

1. *Research stage 1 – preliminary research:* needs and context analysis, review of literature, development of the conceptual framework of the study;
2. *Research stage 2 – prototyping and assessment stage:* design stage consisting of iterative research activities, with a series of pilot workshops and courses, as well as prototype projects with fashion companies, aiming to improve and refine the design approaches for DfS in Fashion;
3. *Research stage 3 – reflection stage:* this stage often includes a retrospective analysis, followed by the specification of design principles and refinement of the conceptual framework.

Preliminary research

This stage was based on the review of literature and research on case studies. It was aimed at providing an overview on the concept of sustainable fashion and how DfS applied to Fashion systems. Based on the results of the review of literature and case studies, a conceptual framework was developed, adjusted and refined during the study. Thus, it answers the set of Research Question 1.

Literature review

The literature review was focused on the Sustainable Fashion design field, and investigating the existing studies focused on how DfS applied to fashion products and services systems. In particular, the main issues were conducted to:

- explore the challenges and opportunities of DfS in the fashion system;
- review existing research on the relationship between Fashion and Sustainability as well as the role of fashion designers in this context;
- investigate exiting tools and methods of DfS that can be used to applied DfS in Fashion;
- examine the challenges and opportunities that fashion designers encounter in the design and production processes for sustainable fashion.

Case study research

Case study analysis, searching for DfS applied to fashion through desk research and semi-structured interviews, was conducted in order to:
- explore the phenomenon subjected to research through cases, and the challenges and opportunities of design for Sustainability on fashion;
- understand how DfS takes place, as well as what factors influence fashion design for Sustainability;
- assess the mechanism and dynamics in the development and diffusion of sustainable fashion models.

The objective of the case study research is to investigate the DfS.F journeys made by twenty-five fashion brands in introducing sustainable fashion on the market all over the world, both fashion clothing in general and fashion accessories in particular. The researcher wanted to understand how DfS takes place and what factors influence the companies' work, and thus validate and develop the conceptual framework as well as verify the hypothesis.

The case study format of each case was collected and described in a structured and similar format in order to cross-reference all cases with analysis and comparison.

Conceptual framework development

After the literature review and case study analysis research, the outcomes were used to build a conceptual framework in order to:
- clarify the concept of DfS and the relationship between Sustainability and Fashion.
- provide the context of DfS.F, which interprets the variables as well as the study findings.
- promote theory development that can be used to support an analytical strategy and efficient process.

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The results of the literature review provided an overview of the framework. The starting point of the framework was determined by the paradigm shift of the DfS.F model: from traditional fashion production to the Sustainable Fashion model with a developed DfS.F idea or strategy. This change is directed to the process of applying DfS to the fashion system with four innovation levels of DfS.F in which the study explores how these changes are promoted. The literature review also shows that in this transition, there are relative actors.

The second point of the conceptual framework is the limitations for the application of DfS.F. In fact, the way the contemporary fashion system operates is considered unsustainable and contains the paradox. From an environmental standpoint, the excessive use of resources by the fashion industry is polluting and depleting resources, destroying the environment by the amount of toxic waste that has adverse effects on the ecosystem, region, and planet. From a socio-ethical point of view, natural resources are exhausted and the habitat of ecosystems and local communities are destroyed. For example, textile factories use toxic chemicals that release toxic substances into the environment. Polluted water runoff leads to irreversible damage to ecosystems and communities in a large area. Thus, the researchers found in the existing literature the need to transform fashion design, production, and business models into sustainable models to reduce the pressure on the depleted planet, as green resources are continuously reduced and overloaded by pollutants. Therefore, implementing DfS.F can benefit the environment because it restricts the use of natural resources by reducing or replacing materials, such as using recycled materials or reusing leftover materials. DfS.F also enhances the use of environmentally friendly materials and local raw materials to help reduce pollution and ecological footprints in the industry's materials production and distribution. From a socio-ethical point of view, DfS.F recommends companies to be transparent about labor rights and the working environment of fashion industry workers; sustainable fashion companies use local labor and disadvantaged people and people with disabilities, thereby creating local employment opportunities and empowerment.

Application of the DfS.F model should be based on a combination of products and services. It has a complex supply chain involving stakeholders, e.g., raw material suppliers, manufacturers, raw materials manufacturers, product manufacturers, distributors, retailers, service providers, and customers and users alike. Indeed, the DfS.F configuration consists of four levels that require a long-term relationship between stakeholders in order to

achieve environmental sustainability goals and bring profits to stakeholders and benefits to customers, because customers are the decisive factor for the development and spread of Sustainability and this transition.

Prototyping and assessment stage

The prototyping and assessment stage was aimed at refining the potential approaches and strategies to apply DfS in Fashion and the needed capabilities of fashion designers to design and implement Sustainable Fashion in specific contexts. It was also to test the design knowledge-base and know-how to support design practice. Thus, this stage answers the set of Research Question 2.

Development of the design approach and tools

Based on the results of the first stage, existing approaches and tools were systemized. An analysis of the existing approaches and tools was undertaken in order to highlight strengths and weaknesses in the process of applying DfS in Fashion. This provides the ability to choose potential approaches adopted and adapted for the specific context (in design practice and design education in Vietnam).

Implementation and assessment in design education (pilot workshops and courses)

The design approach was adopted in five pilot workshops and three pilot courses aimed at applying proper methods and tools of DfS in Fashion, focusing on designing the strategy to facilitate the introduction of the concept of DfS and Sustainable Fashion and diffusing Sustainability in design education.

These consist of three pilot courses and five design workshops with undergraduate students from two universities (at Fashion Department, the University of Industrial and Fine Arts and Design Department, FPT University in Hanoi), and stakeholders in two cities located in the North (Hanoi) and South (Ho Chi Minh city) of Vietnam. The objectives of the trial were:
  • to diffuse and strengthen Design for Sustainability for young designers;
  • to apply design theory to practical application with the relevant environmental and socio-cultural context;

- to stimulate collaboration between universities/young designers and society;
- to enhance the role of design education towards sustainability in higher education institutions.

During the pilot workshops, students were asked to explore the DfS concept and design products/services by applying DfS principles and approaches to introduce and diffuse the concept of Sustainability. Thus, the approaches and the tools were adapted and tested to figure out the proper and potential design approaches in terms of effectiveness and practicality. Finally, a questionnaire was used to evaluate the design approach and test the strategy applied.

Pilot courses focusing on Sustainable Fashion were integrated into the Accessory Design course (the course was part of the Bachelor program in Fashion Design). Three courses were undertaken at the Fashion Department, University of Industrial and Fine Arts in collaboration with Gosto company and some local fashion companies. The goal of these courses was to design sustainable fashion accessories (shoes, bags and jewelry) by applying DfS approaches. Finally, a questionnaire was used to evaluate the design approach and test the strategy applied.

Implementation and assessment in design experiences

In parallel with implementation and assessment in design education, the design approach and tools were applied in the prototyping project focused on accessory design with Gosto company in Ho Chi Minh city, Vietnam. The author was directly involved in the projects, and took the roles of both the designer and the researcher, participating in the design activities as well as interacting with the other practitioners. The project aims to design fashion products by applying the principles of DfS and also testing the proper approaches focusing on shoe and bag design.

Refinement of design approaches and development of the design knowledge-base

In addition to assessing DfS applied to Fashion design experiences (pilot courses, workshops, and projects), an evaluation by experts and practitioners was carried out. The continuous application and evaluation of applying design approaches in design experiences enabled the researcher to evaluate the design intervention to figure out those strengths and weaknesses. Thus,

the continuous application and evaluation of the proper approaches and tools brought to reflect on the knowledge-base needed by designers to integrate DfS in the design process.

Reflection stage

The purpose of the third stage of the research was aimed at a retrospective analysis of the study. This stage focused on the main research findings, limits and generalizations of this research, and recommendations for further research programs. The research activities have reflected on the methodology applied and the research results as an operational tool capable of guiding and supporting designers, which can apply in both Vietnamese and other contexts, to engage and integrate DfS.F.

Core research contributions

This research focused on the promising models of DfS in Fashion that have been studied for the past several decades. The core contributions of this study include the key points listed below.

First, a framework describing and explaining how to innovate DfS.F has been developed. This framework described the paradigm shift of the DfS.F model: from traditional fashion production to the Sustainable Fashion model with a developed DfS.F idea or strategy. This change is directed to the process of applying DfS to the fashion system with four innovation levels of DfS.F in which the study explores how these changes are promoted. Then, the conceptual framework introduced the limitations for the application of DfS.F.

Second, the research has contributed to clarifying the challenges that the fashion industry is facing and the need to change. Based on an overview of the research and results of the first part, definitions related to DfS and SF were conceptualized and the boundaries of Sustainable Fashion were discovered. The research also identified factors that affect DfS.F, which can be used as a guide to identifying the elements needed to implement DfS.F.

Third, the research has summarized and systematized the Sustainable principles and Sustainable frameworks for Sustainable Fashion. These can be used as a guide to determine sustainable approaches in fashion.

Fourth, the research proposes a new role for fashion design in the process of converting the traditional model to the DfS.F model towards sustainable development.

Fifth, the study also proposes the necessary capabilities and skills to equip fashion designers to operate the DfS.F model at strategic levels based on new context analysis. This is the design knowledge base that designers need to develop.

Sixth, the research has developed a DfS.F model, and detailed guidelines and tools, to assist fashion designers in implementing and managing the design process.

Finally, the study summarized and proposed the development of an operating tool capable of guiding and assisting designers in their design work: a handbook intended to provide theoretical knowledge and practical methods and tools to help students and fashion designers to implement DfS.F.

Conclusions

Design for Sustainability in Fashion (DfS.F) is making significant strides towards Sustainability. It can have the ability to radically transform the fashion system and create constant changes, from transforming products to modifying and renewing the fashion industry (Fletcher and Grose, 2012). Thus, designers should be aware of their responsibilities in implementing ethical and sustainable activities. To support this transformation, and play their role successfully, designers need to be equipped with a comprehensive knowledge-base and know-how on fashion in general and DfS.F in the new context. It must be emphasized that to achieve sustainable goals, designers need to be equipped with a broad vision, capabilities and skills to deal with "wicked problems" and the ability to adopt sustainable design strategies during the time. In other words, the designer must understand the appropriate knowledge-base, aiming to provide a coherent view of fashion and sustainable thinking. Awareness about DfS.F, when applied to any production and business model with barriers and drivers, is also a requirement for designers in a series of new roles, in which designers focus on a specific fashion field and integrate their work with sustainable ideas. Also, awareness means we understand the different skills necessary for designers to positively contribute to the unprecedented transformation process taking place in fashion.

The doctoral research started with a review of literature and case study best practices, and defined a conceptual framework for DfS.F. These studies demonstrated the potential of applying DfS in the fashion system; thus, a new design model has been proposed with the creation and development of appropriate methods and tools to support this model. The study has also pro-

posed to expand the research area to improve and refine the research results and identify characteristics for other areas. Triggering a broader discussion and collaboration with researchers and experts in the fields of fashion and DfS can be valuable in establishing a network of professionals in multidisciplinary fields to work on and explore existing issues in the fashion field.

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We are in a time of deep transformations, led by digital revolutions following one another. Such transformations, that are impacting our daily life, are not just technological, but also social and cultural. As a consequence, trends transversal to different fields are advancing, requiring the design field to be aware, responsive and, above all, predictive.

This book proposes an overview of the researches initiated in 2015 in the Design PhD programme of Politecnico di Milano. All of them explore the implications of the ongoing transformations, from the specific perspective of design research. Throughout the book, the cultural, organisational, social, and managerial issues raised by digital technology and its applications, are debated. How and to what extent such issues call for a reframing of design processes, practices and models? This is debated in the first and second part of the book. The third part taps into a growing but still underexplored issue, the ethics and social awareness that comes along in today's smart and interconnected world.

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La passione per le conoscenze