



Chair:
Prof. Paola Bertola

DOCTORAL PROGRAM IN DESIGN

Field of study

The Politecnico di Milano was among the first universities in Italy to start a PhD programme in the field of design in 1990. Based on this tradition, the PhD programme in Design was established in 2008, as the result of a process of substantial rethinking of the way design was taught at PhD level.

In its current configuration, the PhD programme in Design aims to develop academic and professional skills to carry out high quality research in terms of design as a complete scientific field. In this respect, its main topics are: to reflect on the nature of design, with its aesthetic, formal, performance and meaning values, as well as its capability of being an agent of social change towards more sustainable systems; to strengthen the disciplinary core of design; to develop and share a common body of knowledge and methodologies, as well as a complete set of tools able to distinguish the designer from other researcher/professional figures involved in design activity.

The PhD programme in Design is structured into various **research fields**, which correspond to specific research teams within the Department of Design.

In order to coordinate research activity over a wide range of topics, teams cluster around three Sections, which are:

- Design and Cultures
- Products, Strategies and Services
- Design for Environments, Landscape and Mobility

The PhD programme in Design carries out research on specific topics emerging from the research initiatives of the research labs of the department.

The programme aims at educating researcher-designers who will contribute original knowledge to the field of design by tackling the problems and identifying the potential of contemporary society.

Their contribution may be brought to bear in:

- creating designs, visions, and proposals (research through design);
- developing tools and methods for putting these into practice (research for design);
- developing critical analysis of design and its application domain

(research on design).

The Programme develops project and analytical abilities, proposes different methodologies of research, promotes the attitude to collaborate, and offers professional opportunities in universities and research centres, design enterprises and public corporate bodies.

Mission and goals

The courses offered aim at training the candidates for the skills needed to carry out high quality research for companies, universities, research centres and other institutions. The scientific field is Design. Other fields partially covered are Science and Philosophy, Language Theory, Sociology of Cultural Processes and Communication, History of Art, Science and Technology of Materials, Industrial Engineering, Operations Research, Computer Science.

The programme offers doctoral candidates the following **opportunities**:

- to develop an original theme of research, becoming an effective member of a research team;
- to attend courses and seminars on design, on design research and on research in general, developing skills concerning the discipline of the design, and the profession of the researcher;
- to attend courses and seminars referred to a specific field of research, developing high-level specialist skills and acquiring knowledge and tools for the development of their own research theme;
- to be an active part of a teaching programme and, in this way, to understand the relationship between research and teaching, and to develop the ability to clearly and effectively present the contents of their own work;
- to develop expertise in an international research centre to verify the hypotheses, the methodologies and the results of their own work and to consolidate the network of international relationships within which it is situated.

The achievement of the PhD qualification in Design requires a study and research activity equivalent to at least three years of full time study, research and development of PhD thesis. During this period, both

educational and research activities are provided.

The programme develops design skills and analytical abilities, proposes various research methodologies and promotes a collaborative disposition.

At the beginning of the programme, candidates become effective members of a **research team**, within which they develop an original research topic (PhD thesis); this activity is the fundamental core of the learning process.

Parallel to this main activity, candidates are involved in several other educational processes, divided into training and specialist activities.

Training activities are those, such as courses and seminars, related to the discipline of design and research methodologies and practices, viewed in their entirety. Specifically: common activities are proposed to consolidate the cultural and operational background, which is common to all areas of design research.

Specialist activities are those educational activities specifically regarding the areas of research in which the PhD programme as well as the Departments are articulated.

Moreover, the activities of the PhD in Design include participation in projects taking place within the research team; participation in conferences (as listeners or speakers); writing of scientific papers; participation - as tutors - in teaching activities, from the viewpoint of an ongoing synergy between teaching and research activities.

Professional qualifications

The Designer-Researcher, which the PhD program in Design intends to educate is a flexible professional figure: a designer who knows how to carry out research and a researcher who uses design tools. At the same time, s/he is also an expert in knowledge management, in constructive interaction among different actors and in the communication of ideas and proposals.

The combination of these skills is useful in a variety of work environments. Specifically: in institutions expressly dedicated to the development of design research, such as universities and research centres;

in design agencies and in the most innovative and design-oriented companies; also in public corporate bodies, in service companies and in organizations for territorial development which, increasingly, are faced with complex design problems, which the Designer-Researcher can effectively address, analyse and contribute to resolve.

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SUSTAINABLE PRODUCT-SERVICE SYSTEM APPLIED TO DISTRIBUTED RENEWABLE ENERGY

Elisa Bacchetti - Supervisor: Carlo Vezzoli

Nowadays, around 1.2 billion people still lack access to electricity, and most of them are in rural areas of emerging countries. This condition hampers the provision of basic services such as health care and education, and reduces opportunities to achieve a sustainable development. In this challenging scenario, Distributed Renewable Energy (DRE), meaning locally-based and small-scale energy systems based on renewable resources (e.g. sunlight and wind), is considered a possible solution to bring sustainable energy access to All¹.

This research aimed to explore and characterize the adoption of Sustainable Product-Service System (S.PSS) approach to DRE solutions, aiming at increasing their diffusion (even) where DRE products (e.g. solar panel) are not affordable, or where their management lack of local expertise or unaffordability of local repair, maintenance etc.. To deal with S.PSS applied to DRE solutions, this research defined a role (with knowledge-base and know-how) for the designer, both as designer and facilitator of such innovation.

First stage of the research, explored both S.PSS and DRE models, as well as their coupling, to characterize their win-win (socio-ethical, environmental, economic) potential towards sustainable development. A literature review together with a case studies research on DRE solutions adopting a S.PSS approach, were conducted on this purpose. What observed from literature review and case studies, was discussed and refined in an open process with the LeNSes project community as scientific context of this research.

Sustainable Product-Service System applied to Distributed Renewable Energy.

The adoption of S.PSS approach to DRE solutions, it means to move from selling DRE product ownership (e.g. solar panel) to provide the satisfaction of a specific (energy) need (e.g. local communities to access their (energy) satisfaction) through a mix of products and services based on innovative stakeholders' interactions. This entails a systemic configuration, where the provider (or alliance of providers and/or manufacturers) owns or has some responsibilities on the DRE product included in the offer,

thus avoiding to the customer the (often unaffordable) initial cost for to buy the DRE product, as well as its life-cycle costs e.g. operation & maintenance (often cause of drop-off) which are retained by the provider.

Socio-ethical benefits. When DRE solutions adopt a S.PSS approach, customers can access their (energy) satisfaction through customized (affordable) payments e.g. pay-per-month or pay-per-use. This moves the initial cost to buy the DRE products included in the offer and their life-cycle costs to the provider who owns or have some responsibilities on them, thus avoiding the (unaffordable) initial cost and life-cycle costs (cause of drop-off) for the customers. In the case of small businesses/local entrepreneurs' businesses as customers, the adoption of S.PSS approach based on customized payments, increases the reliability of the (energy) provision as well as the reliability of their own businesses. Such S.PSS applied to DRE offers can be extended to Energy Using Products and Equipment e.g. lantern is a product, sewing machine is an equipment, thus increasing the accessibility of the offer both for final customers

and/or small businesses/local entrepreneurs' businesses. Finally, as S.PSS and DRE are both labor and relationship-intensive solutions, their coupling can favor the involvement of local stakeholders with a consequent development of skills and potential employment opportunities.

Environmental benefits. When a DRE solution adopts a S.PSS approach, this fosters the interest of the provider (or alliance of providers and/or manufacturers), who owns or has some responsibilities on the DRE products included, to provide high quality and efficient DRE products, i.e. lower costs for products to be replaced, and lower energy consumption in use. In fact, higher quality and efficiency of DRE products can reduce the costs for the provider. This and other strategies such as use intensification or products reuse, re-manufacturing, can reduce the environmental impact of energy provision.

Economic benefits. A S.PSS approach to DRE, can increase competitiveness of the offer as more customized on customer needs, and can open new market opportunities towards unexplored targets i.e. those unable to pay a DRE product in one instalment. Finally, as S.PSS applied to DRE solutions require to be managed at local level, this can offer opportunities to strengthen the local economy.

The win-win values of the S.PSS adoption for DRE solutions, brought to the development of a design role to contribute in the design of such innovation. To support the practice, a design approach, with a design process

and related tools were developed.

System Design for Sustainable energy for All.

The adoption of S.PSS approach to DRE solutions, requires the designer to: design (socio-ethical, environmental, economic) sustainable products and services together to fulfil the (energy) satisfaction of customers; design and facilitate new configurations (interactions/partnership) between stakeholders to achieve their convergence of economic and environmental interests in relation to the energy solution; operate/facilitate the participatory process to design new S.PSS applied to DRE concepts among entrepreneurs, users, NGOs, etc. So forth, the so-called *System Design for Sustainable Energy for All*, is a new role for designers, which derives from S.PSS Design and is declined to design DRE with its characteristics.

This research (within the LeNSes project), to support the new design role, developed the following tools: the *Sustainability Design Orienting Scenario for S.PSS & DRE* aimed to give inspiration on S.PSS applied to DRE innovations; the *Sustainable Energy for All Tables & Cards* aimed to support the generation of ideas of DRE solutions adopting S.PSS approach; *Innovation diagram for S.PSS & DRE* aimed to design new concepts of S.PSS applied to DRE; *Concept Description form for S.PSS & DRE and Stakeholder Motivation and Sustainability Table* aimed to detail S.PSS applied to DRE concepts. To test, verify and refine the design role and its potential operational contribution, as well as the design approach, design

process and tools, they have been adopted and assessed within two *vocational training courses* in Botswana and Uganda involving more than 15 SMEs for energy, two *workshops* on S.PSS and DRE for cooperatives and associations in Italy, as well as a *design exercise* for design students conducted by the author of the research. Furthermore, the whole resources have been presented in Brazil and Mexico, opening rooms for discussion in new countries and contexts, and contributing to the current way of presenting S.PSS for innovative perspectives.

To make the developed resources more accessible, this research built an *open course on System Design for Sustainable Energy for All* aimed to equip the designers with a first knowledge-base and know-how towards sustainable energy for All. The resources adapted in the open course, were developed all along the LeNSes project, as open production of knowledge, so forth they are not finite products, but they can be updated with new resources, findings, etc. to come. All resources are available free of charge, in open source and copy-left ethos at www.lenses.polimi.it.

Scientific context of the research.

This research was developed within the scientific context of the Learning Network on Sustainable energy system - LeNSes project (2013-16 - www.lenses.polimi.it) funded by the Edulink II, coordinated by Politecnico di Milano and where the author had a role in the research development and project management.

1. All refers to: everyone, both a single entity, company, community or people, for whom economic difficulties limit access to sustainable energy, and which can be found both in emerging and industrialized countries

DESIGN IN A COLLABORATIVE MULTI-STAKEHOLDER ECOSYSTEM

GROWING SOCIAL INNOVATION THROUGH CROSS-SECTOR PARTNERSHIPS

Marta Corubolo - Supervisor: Anna Meroni

This doctoral thesis moves from the observation that complex social needs, as the ones tackled by social innovation, require integrated and innovative processes able to combine and manage the contributions of different actors. The main hypothesis is that a new systemic approach is needed to allow every actor and stakeholder to gain a common perspective on strategies, methods and tools to tackle shared societal issues, and to be empowered towards a more collaborative and structured way of operating. In this framework the design discipline, and more specifically design for social innovation, could bring a crucial contribution.

The background knowledge investigates three main domains: social innovation, the role of private sector and the form of partnerships with stakeholders, and the contribution of design for social innovation in growing and sustaining such practices. As regards the first domain, the phenomenon of social innovation is investigated mainly through scaling and growing routes of social innovation and the role of incubation and support processes. The complexity of societal issues tackled by social innovation requires the adoption of processes able to include various

stakeholders, especially those who have competences and resources to turn commitments into long-term concrete practices able to generate change. Among the social innovation ecosystem, the private sector is called on to take a more active role. Within this domain the research explored the approaches to CSR as the traditional for profit companies way to address societal issues. It highlights how the evolution towards strategic and relational-based approaches may be the way to innovate how business can enable social changes through new forms of collaboration with stakeholders, and especially with third sectors organization, as mediators between small and large scale problems. Moreover, the research identified in cross sector partnerships as the organizational device with which to structure a collaboration oriented towards the generation of collective benefits. Finally, investigating the role of design, this work focused on the role of which design for social innovation plays in supporting and reinforcing social innovation practices. In particular the contribution of design for service applied to social innovation incubation, the participatory and co-design approaches and the methodologies and tools of strategic design are crucial in

empowering people in taking an active role. This theoretical background allowed me to frame a series of preliminary questions: How to tackle complex societal issues by establishing collaboration between multiple stakeholders? How to identify social innovation opportunities in the potential synergies between the players of the social innovation ecosystem? How the partnerships between the private and the third sector can be oriented towards the generation and support of social innovation? And a set of more specific questions related to the design discipline: How design could contribute in activating and sustaining such forms of collaboration? How to raise awareness and interest around social needs and challenges, while managing the collaborative process towards the expected social impact? How to set up a participative, accessible and open (also to communities) process able to generate social innovation outcomes? The methodology adopted is based on the combination of case studies and participatory action research, and leveraged on a learning by doing way to connect theory and practice. The discussion is grounded in a series of experimentations that

involve local communities, social enterprises and big companies. More specifically I carried on desk research for the case study collection analysing existing processes of generative CSR practices within the more established businesses, sharing economy platforms exploring collaborative models to generate social benefits, crowd sourcing approaches to establish collaborations and framework projects acting as platforms for collaboration. As regards the participatory action research, I activated several experimentations in different contexts according to the main stakeholders at the centre of this research: business and the social enterprises. The first set of experimentations were developed to enter the social enterprise world and to deepen the understanding of existing dynamics in establishing forms of collaboration with stakeholders of their network. The second set is carried on in hybrid context, where multiple stakeholders meet to activate exchanges, discuss and collaborate. These are mainly events related to the topics of this work, where I could explore how to organize the encounter between private and 3rd sector. The third set of experimentation is a multi-stakeholder project,

exploring forms of communitarian and cross-sectorial welfare. Here I had the opportunity to activate and test a process that moved from the detection of societal issues to the co-design of social innovation solution, within a multi-stakeholder environment. The results of this doctoral dissertation can be divided in two main parts: the first is the identification of a Collaborative Multi-stakeholder Ecosystem described through members and specific features that define it as capable to generate social innovation through collaboration. The second is a design driven model for activating and sustaining collaboration within the Collaborative Multi-stakeholder Ecosystem with the purpose of generating scenarios, strategies and services that enable stakeholders to be empowered to take action and to make things happen, collaboratively.

ICONIC TEXTILES AND CULTURAL COORDINATES RELATIONSHIP BETWEEN ART AND DESIGN FOR THE VALORIZATION OF TRANSCULTURAL CHARACTERS IN THE TEXTILE FIELD.

Lucie Decker - Tutor: Raffaella Trocchianesi

Correlator: Federica Vacca

The study tackles the question of the valorization of dialogic relations between specific cultural languages and particularly through the studies of iconic textiles, that are characterized by a set of biographic elements, some innate other acquired over time. These elements are intending in this research as transcultural characters. Principally, it intends to valuate particular processes of valorization actuated by artistic and design's interpretations, focusing in this way on the role and the importance of this two approaches in the evolution of cultures, thoughts, and expressivity. Methodologically, the research develops a theoretical model of interpretation of the case studies appropriate to analyzed the selection of artistic and design's interpretations. At the design level, attempts have been made to tackle theoretical issues through the systematization of data within a kind of digital tool and its activation through artistic and design intervention. The interest for transcultural characters conducts to focalize the attention on determined technics, materials, iconographic imprint from textile field, that were subject

to migratory flow, colonialism and consequently to processes of cultural translation, transformation, appropriation, protection and innovations. The research it focuses on example of singular textiles as the Batik, the Madras, the Denim, the Paisley and the Jute, respectively become representative elements and symbols of the African, Caribbean, North American, Britannic and global culture over time. These textiles are the result of a complex and not always visible transcultural process that has sometimes become perceptible through interpretations of different points of view. In fact, when it deals with a meaningful object, the understanding is not always immediate and presumes an intermediary act of interpretation, which is relevant in the field of art and design. Therefore, it was activated an "interception process" of different interpretative acts, focusing on the interrelations generated between different actors, competences, institutions coming from different territories and cultures. Along these lines, the study

places an emphasis on interpretations that, on the one hand have shown how this textile can bear witnesses becoming symbols of cultural "plurality": entities constituted and crossed by multiple cultural influences. On the other hand, those that generate transdisciplinary and transcultural paradigm in the field of art and design implicating more or less concretely artisanal/ traditional elements into their creations. In other words, the research aims to individuate and verify processes of valorization that include both analytical - interpretative approaches (about constitutive elements and facts related to the transcultural characters of the textile), as much as artistic and design points of view that activate co-creative and trans-disciplinary approaches between distinct disciplines and cultures. To reach this goal, the research focus primarily on the transversal question of the migration, inherent at the globalization that consist generally in a process of relationship and connection between different *world*, and at the same time in a process of reinvention of differences. In this sense, the migration is intended more as

cultural resources than as a recent problem with which we have to faced today. In fact, the continents have been constituted by immigration, emigration and transit. The stories of migration are giant interlacement of circulations, transports, passages of persons, of things (and of textiles in the research framework) and is intended as cultural and territorial constituent. In view of the topic density, this research tries to tackle different issues:

What are the effects of migratory flows on the textile technics of batik and on each singular relevant culture?

How conceive cultural processes regarding the textile sphere (for example: the formation of technics, symbol, social group, tradition, ritual, etc.), considering that they have been develop in a plural set of contexts, territories, spaces and times?

It is possible that there are invariable cultural transversality? In which way do art and design create new references, and new sense, expanding the space of knowledge and of action, specifically regarding to these individuated iconic textiles?

The research is structured in five parts linked to each other's. Starting from the transversal questions of migration inherent to the history of the textiles, the first part analyzes widely relevant notion such as Tradition, Identity, Authenticity, Otherness and relatively processes of Translation, Innovation, and Transculturation. In the second part, realizing the need to tighten

the field of action, the attention is concentrated on just one singular textile. The aim was to analyze more in detail and specifically those general thematic and the complex dynamics that cross them, creating with one type of textile a king of model of analyze. Considering the attractiveness manifested nowadays for artistic and design productions related to the African continent, the choice was directed towards the famous textile technique Batik become over time symbol of African visual identity. With the aim of documents in a relevant way different aspect of the history of Batik, a four-dimensional reading was undertaken, broadly based on historical, geographical, artistic and design interpretations. These first two part represent the theoretical basis on which has been developed both the fourth and the fifth part, respectively the phase of the *meta-progetto* and the experimental activity. The third part take on the methodology of case studies by the way of collection and selection processes, and setting up a system of interpretation of singular artistic and design artefact related to the iconic textile Batik. Starting from the interest of relational properties among cultures, approaches, and particularly in-between art, design and craftsmanship, it was tried to highlight various logic of interpretation actuated in the formation of the selected works of art and projects of design. In other words, attempts were made to point out not only the respective specificity of these three approaches but also the existence of interaction within approaches,

territory, and cultures. In order to facing, from a design driven approach, the issues analyzed in the previous parte, and considering the multiplicity of data collected and collectible, the idea of designing a digital tool\archive has been triggered. The fourth part is based on the idea that this archive would allow to transmit a knowledge, to understand a certain past (in this case relatively to the batik. Focalizing not so much on the object itself but rather on the sense that it can have in various context, and therefore on the discourse that can be communicated through the archive. In other words, it was tried to design an "active" and extensible digital archive, working on the theming of selected data, with the primary aim of creating narrative paths, that can describe through their configurations experiences and transformations of the textile. The last but not the least part concern the experimental phase of verification and valuation of the research. Principally, the assessment was carried out through artistic and design intervention to evaluate the functionality of the archive and the relevance of the issues addressed in the course of the thesis. Therefore, experimental artistic-design actions have been activated, basing on the organization and the theming of the data in the archive. This strategy is based on the process of valorization through documentation, transmission, communication with the aim of stimulating a process of interpretation and re-elaboration of the transmitted knowledge.

PRAGMATISM WITHIN DESIGN PRACTICES: A PROPOSAL OF PARADIGM SHIFT IN DESIGN SEMIOTICS RESEARCH

Felipe Domingues - Supervisor: Salvatore Zingale

Co-Supervisor: Dijon De Moraes

The thesis, developed in the scope of a broader investigation within Design Semiotics and Design Management, aims at building a method of analysis of the pragmatistic dimension of artifacts. This dimension relates to emerging senses and plausible design consequences that emerge from the stakeholders' or design-agents' rationale. The objective is to provide theoretical and technical support to the analytical stages of product and service development by introducing such a dimension into design practices. The focus lies on gaining insight into *mediation processes* and their outcomes from the perspective of Peirce's notion of *sense* and Eco's understanding of *functions*. Mediation processes are subjective and embedded in the relationship established among customers, industrial goods and services providers. As such, according to Peirce, "our idea of anything is our idea of its *sensible effects*", i.e., the senses/functions of any industrial good or service are associated with *all possible interpretative answers* and *practical consequences* derived from the social and individual responses they produce or could produce. Consequently, as stated by Eco, "seeing functions from the semiotic point of view might permit one to understand

and define them better [...] and thereby to discover other types of functionality, which [...] a straight functionalist interpretation keeps one from perceiving". Hence, they should be investigated in contexts of use, in *non-controlled* environments (e.g. focus groups), and under behavioral circumstances through the employment of specific research techniques. But how to precisely access, identify and analyze pragmatistic features—interpretative answers and practical consequences—that emerge when artifacts and services are launched worldwide? And then how to bring such features into design practices? Even though design practices inherently attempt to cope with symbolic and cultural features, the *applied* use of semiotics within design practices has remained incipient. However, the use of design semiotics as a foundation to enhance design practices that aim at developing reasonable solutions to social and customer issues seems to be neglected or misused, especially when one considers that design semiotics copes with our world of *signs*, which are strongly associated with the ways users make and negotiate meanings [senses] of objects [artifacts]. Hence,

collaborative intersections among design semioticians, design practitioners and researchers, industries and service providers may yield superior responses to design issues as well as to social and individual demands. As such, the development of a Full Methodological Research Framework aiming both at empirical and experimental studies in Design Semiotics and at introducing the pragmatistic approach into design practices, especially into ones which take into consideration the engagement of users [design-agents] (e.g., co-design and bottom-up practices), may contribute to developing specialized design skills and culture as well as Design Semiotics and Design Management. However, due to the complexity of such a framework, which may be regarded as a paradigm shift within Design Semiotics, its investigation and development process was divided into three correlated stages: Theoretical (2006-2008, Master's Degree in Management), Empirical (2010-2012, Master's Degree in Design), and Theoretical-Empirical (2013-2017, PhD in Design). The *Theoretical Stage* consisted primarily of pinpointing gaps in design semiotics. A theoretical approach was taken to tap into

how individuals, design, culture, semiotics, and artifacts interplay with a view to understanding *how* such interplay may affect meaning [sense] contingency in projecting, adapting and localizing global products. The study showed that design is deemed as a relevant tool in managing artifacts overseas, but empirical contributions are incipient as only recently have scholars attempted to establish design as a scientific domain. In response to such absence of *systematic* contributions to design semiotics, two theoretical models were developed—*The Target Model* and *The Hanger Model*—before moving on to second stage. The *Empirical Stage* drew on an exploratory investigation funded by Whirlpool Latin America (Brazil) in partnership with the Minas Gerais State Agency for Research and Development (FAPEMIG/Brazil). Supported mainly by ethnographic techniques, the theoretical assumptions developed in the previous stage were empirically tested. The research process, which consisted of tapping into *habits* and *cultural codes*, critically improved the research methodology. The *Theoretical-Empirical Stage* aimed at concluding the FMRF. As outcomes, the previous investigations and results led to

theoretical advancements such as *The Propeller Model* and *The Trefoil Model* as well as to the development of such concepts as *design-agents* and *plausible consequences*. In conclusion, the entire investigation attempts to introduce *systematicity* into research processes within design semiotics in the long run. Its contributions are expected to assist processes of attribution of intangible features in both (co-) design practices and early stages of design of industrial goods and services.

FROM METALLIC POWDER TO THE OBJECT DIGITAL AESTHETIC OF NEW PRODUCTS OBTAINED BY SELECTIVE LASER MELTING PROCESS

Giorgia Galimberti

Supervisors: Prof. Mario Guagliano, Prof. Barbara Previtali

With the most recent technological developments, rapid prototyping technologies evolved into **Additive Manufacturing (AM)** technologies. AM, or three-dimensional Printing (3D Printing), is increasingly being applied as a means of production in consumer product manufacturing. AM is a set of technologies that produce products by adding materials, layer upon layer. Several methods have been developed allowing the production of functional components, leading from simple and creative prototypes to final products personalised with peculiar functions in an actual industrial production. Such manufacturing techniques allow achieving illusory shapes free from any geometrical and productive constraints, thus fostering a new conception of production based on the **digital aesthetic**. This revolution is expressed by the digitalization of the manufacturing process which thus opens the way to a direct production from a 3D model to the final object and therefore to a new way of thinking, designing and producing objects. Customized products, complex shapes, lattice structures, topology optimized part and use of new materials with interesting properties are some of the improvements the AM processes

introduced, but there's still much more to investigate, to test and to develop in this particular field, especially under an **aesthetic point of view**. The development of reliable technologies able to provide functional components with acceptable mechanical properties has polarized much interest on **metals**, due to their importance on many strategic fields as automotive, aerospace, medical/dental and energy.

The highly complex shapes and extreme precision of these new techniques lead to a widespread industrial support of powder bed-fusion processes, such as **Selective Laser Melting (SLM)**, which guarantees great details and acceptable surface finishing. SLM is based on a digital design and manufacturing environment, as all the AM technologies. The

perception of SLM objects by the users is still to be investigated. This work investigates also conventional post processes and the obtainable surface finishing. These surface variations provide an increased number of possibilities for designers to alter the users' perception of the finished objects.

A greater understanding about the perception of SLM produced components can be eventually useful at **predicting shape and surface variations in a digital environment**, that can be later considered during the design process (Figure 1). Accordingly, this PhD thesis aims to investigate the SLM character defined by shape and surface. To investigate the arising character the perception of shapes produced by SLM and finished

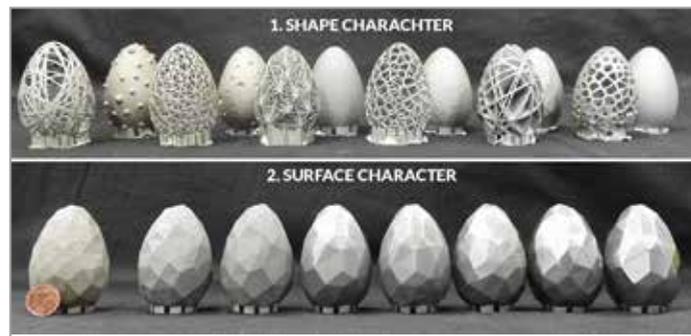


Fig. 1 - SLM Icons character: shape and surface

using conventional surface post processes a user judgment is investigated. This thesis provides a methodological overview to investigate the appearance of this new metallic components realized with the SLM technology. The project starts with a literature overview on printing process and conventional post processes. To investigate users' perception several **icons**, in terms of shape and surface, were designed and manufactured to test different appearance. How the icons provoke user experience should be the design in the concept phase. In particular, a basic shape was chosen as icon, namely the egg. The egg shape was selected because it is axial-symmetric, it avoids personal judgement and it is a self-supporting structure. In this way, the created product was not characterised by functional or mechanical aspects but only by formal aesthetic ones. Twelve different shapes were prototyped with the intent of investigating their different formal aspects, including continuous and discontinuous, full or empty surfaces. They were designed and modelled with a Rhinoceros 3D software Grasshopper plug-in. Four conventional post processes as shoot peening, tumbling, as build (or SLM) and sandblasting were chosen with a total of eight surface appearances, from matt to glossy. The eight appearances have been experimented on two representative icons one sparse and one massive for a total of sixteen icons.

Thanks to availability of the SLM system at AddMe.Lab of

Politecnico di Milano and to the open and long-standing collaborations with companies involved in post-processing, both leavers are experimented. These icons were produced using SLM Renishaw AM250 system and steel powders (18Ni300 Maraging steel). Moreover, the chosen post processes have been done with the supports of two companies: Peen Service and Rollwasch s.r.l.

Their perception was studied through a **specific questionnaire** designed and submitted at several exhibitions. To understand the users' judgment was designed a self-reporting questionnaire that used a Likert scale method. This method allows to score qualitative aspects and transform them into quantitative values usable for statistical analysis. Furthermore, 646 participants evaluated the perception of the shape variations and 158 participants judging the surface finishing variations. In these events the audience are considered expert and non-expert, that means the experts are aware of the technology. The analysis of the user's answers puts in evidence that few adjectives synthesize the character of the new aesthetics. A strong correlation between the attributes is present after the analysis.

The participants of the events identify the most complex shape variations as the most representative of the feasibility of the SLM process. On the contrary, for the surface variations, the users are not ready to accept the SLM surface appearance.

Subsequently, is introduced an "aesthetic tool" concept. This ideal tool provides the designer with a **set of aesthetic rules**, recommending shape and surface finishes to convey a desired user perception as suggested by the statistical models acquired. The qualitative analysis, converted in a judgment points is done to understand which factors are mostly involved in the perception process. Indeed, the main purpose of the aesthetic tool is to predict and modify the product appearance according to the users' project requirements. The work ends with a brief project validation done by a small group of designers.

DEVELOPING DESIGN CAPABILITIES IN THIRD SECTOR

LEVERAGING SOCIAL TRANSFORMATION THROUGH DESIGNERLY ORGANISATIONAL DESIGN APPROACH

Xue Pei - Supervisor: Francesco Zurlo

The design capability has been considered as an essential and competitive resource to obtain for business companies. The contributions of design, especially the design thinking processes and methods, have been recognised, studied and distributed at operational, tactical and strategic levels in organisations (De Mozota, 1998; Best, 2006; Brown, 2009; Martin, 2009). These different roles of design correspond to the four-order of design (Buchanan, 1992; Golsby-Smith, 1996), which has categorised design activities according to the design subjects. And at the fourth level, in which design activities are dealing with organisational, social and cultural issues, the roles of designers are not limited in fostering organisational economic performance, instead, the human-centred and social-oriented aspects of design activities will impel design thinking in impacting new areas and emerging purposes that beyond the conventional business.

The third sector, an increasingly growing field - which aims at answering the social needs and challenges by delivering possible high-quality supports and offerings - has shown its potentialities in confronting the social and economic crisis.

However, the organisations in this sector, which has been called Third Sector Organisations (TSOs) in this research, have also encountered barriers to develop and grown. Design thinking has the potential to provide effective methods and to guide their practical activities to connect with their target communities and to establish new ways of operating and managing themselves.

This doctoral research has carried out a designerly organisational design (Boland & Collopy, 2004; Barry, 2016) approach to explore the design capability building processes in third sector organisations towards fulfilling their social missions and propositions. This research has followed an action research strategy - which connected the theories with practices from building basic theoretical knowledge, collecting and analysing success cases, conducting participatory design actions to formulating three organisational encounters as organisational design outcomes. The research primarily started by reviewing literature in two design fields: 1) organisation(al) design area: the research trends towards a more designerly approach in developing and managing the organisations; and

2) social impact design area: the practices of design intervention on social issues and social-oriented relations. Likewise, the literature review has also been conducted on third sector organisation (TSO), including its features, the motivations and opportunities to develop its design capabilities. Afterwards, the research has collected successful cases, in which designers have applied their ways of thinking and doing to different organisational activities. Analysis has been done to understand 1) what contributions design and design thinking have provided to third sector organisations observed from the organisational perspective; and 2) the design processes, which established different paradigms to involve different actors, of empowering third sector organisations towards developing the design capabilities. Meanwhile, three participatory design projects have also been used to answer the research question through reflecting on observation and produced results. The participatory design activities have strategically adopted a design-led approach in guiding third sectors organisations to build their design capabilities through different paths.

Eventually, two main findings have been generalised. Firstly, the

research has disclosed five main characteristics of the designerly organisational design approach. These five main characteristics are: 1) Enabling - it is a capability building and learning-by-doing process. This approach doesn't focus on generating concrete design objects but on proposing occasions and opportunities in which TSOs could understand themselves better, experience new way to manage resources and processes, and gain knowledge by practically doing and making. 2) Networked - this approach builds up new internal and external relations through collaboration. The engagement of different actors (stakeholders) in actively participating a design-led co-creation process is an effective way to open conversations on organisational issues and all participants are encouraged to provide their opinions. 3) Explorative: it is an explorative approach, which doesn't end up with a specific and concrete design solution. Instead, it has contributed mainly to the explorative capability in searching for new opportunities to innovate. However, this research doesn't deny the importance of exploitation in organisational management and development. 4) Suggestive: applying design-oriented paradigm to well-defined operation model. The designerly organisational design approach is suggesting to apply the alternative innovation model to modifying and shifting existing TSOs operational structures. 5) Transformative: leveraging design impacts through reframing design questions to leverage higher level of design

intervention in TSOs. Secondly, three diverse organisational encounters have also been identified and illustrated. They are acting as different types of platforms for TSOs to develop their offerings, to connect with internal and external actors, to (re)form their organisational behaviours, processes and also fundamental assumptions. These three organisational encounters (fig.1) are: 1) Establishing Social Enterprises as new TSO offerings; 2) Building Integrated Operational Paradigm; 3) Collaboratively Formulating TSO's Purpose/Assumption. In these organisational encounters, different design paradigms are established. Designers could make use of them as a way to leverage a design-led organisational changes for different needs and at different phases. Moreover, they could also be transformed from one to another. Afterwards, insights and suggestions are provided to designer collaborating with third sector organisations.

As a research initiative, the study contributes to several research areas. Firstly, it advanced the research in organisational design realm through conducting a design-led approach in challenging conventional organisational design logic. Secondly, the research has generated a top-down strategy(ies) in embedding design thinking in third sector organisations. Thirdly, the research has proposed different types of organisational encounters as effective outcomes for building design capabilities in the third sector. Moreover, the maps developed by analysing successful cases and design tools produced in practical projects are also parts of the research contributions.

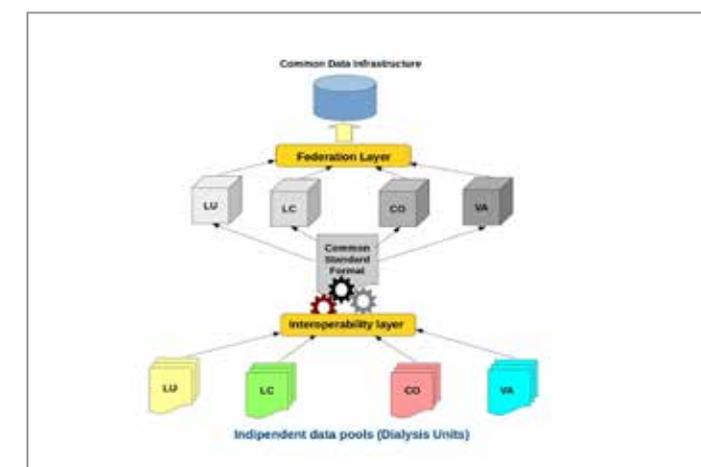


Fig. 1 - three organisational encounters

MATERIAL SELECTION IN THE PROFESSIONAL APPLIANCES INDUSTRY.

METHODS AND TOOLS FOR EVALUATING SENSORY CRITERIA AND AESTHETIC OBSOLESCENCE OF MATERIALS

Agnese Piselli – Supervisor: Barbara Del Curto

In new product development, one of the central step is represented by the choice of materials, finishes and manufacturing technologies. Developed in collaboration with Electrolux Professional Spa (Global R&D), this work serves the purpose of solving an actual industrial problem. In the product development process, engineers and industrial designers operate material selection at different steps, using diverse tools, languages and perspectives. Engineers and technicians usually compare and select materials referring to quantitative data, namely technical properties, and manufacturing and economic requirements. On the contrary, industrial designers typically deliberate on aesthetic decisions about materials, finishes and textures. In doing so, they mostly use qualitative tools, such as mood boards, trend reports and material samples, communicating their intentions in the project by expressive-sensorial adjectives. The industry of professional kitchen appliances is a representative case study to analyse such phenomenon. Several and different variables, indeed, need to be taken into consideration when evaluating material alternatives: technical properties, manufacturing and economic requirements, food

contact compliance, durability at specific service conditions, sensorial and intangible properties, etc. In this context, emerges the need to facilitate the decision-making process and to increase the agreement about material choices among the two professional figures who operate the selection. The first research question has been formulated: *“How to design a material selection method useful to manage both technical aspects and sensory criteria?”*. The design researcher recognizes the need for an integration of the different approaches and defines a new structured method of selection. It consists of multiple tools, both traditional and original structured in a two-step framework. The evaluation of sensorial and intangible properties in an objective way represents one of the most complex issues in material selection. By this, the second research question: *“Which tools could be used to measure, analyse and interpret the user-material perception?”*. Sensory analysis techniques, already used in many industrial fields, have been selected and integrated in the holistic process of selection. In this way, the first step of the method involves the application of established techniques to identify bulk solutions based on their

technical specifications. The second step employs sensory analysis to provide industrial designers with measurable data with the aim of supporting and explaining aesthetic decisions on finishes (SensoMAT protocols). During their lifetime, professional appliances face specific durability problems related to the daily use and the interaction with food and detergents. These factors frequently cause material degradation that potentially affects consumer’s perception about a product. The third question that motivates this thesis is the following: *“How to predict and integrate the evaluation of materials aesthetic obsolescence in order to improve quality perception of products since the material selection phase?”*. The systematic evaluation of materials “aesthetic obsolescence” by sensory analysis permitted to anticipate quality considerations, which are generally investigated in the last steps of new product development process. Three parts, each dedicated to one research question compose the thesis. > **Part I** provides a critical literature review on engineering and design-based selection methods and examines the industrial research context. Chapter 1 presents an overview on the most commonly

employed approaches to material selection: the advantages and limits of traditional approaches used in the academics and industry field, have been evidenced. Chapter 2 depicts the critical issues connected to material selection in professional kitchen appliances industry. By comparing traditional methods with the real industry requirements, emerges the need for a holistic approach and a unique language to evaluate the different materials properties.

> **Part II** describes the research hypothesis, objectives, methodology and focus. An in-depth analysis of different industrial case studies has been performed to set up the general framework of the research, which it is extensively illustrated in the Chapter 3. Looking at the case studies analysed, the focus of the project has been selected: metal-to-polymer replacement in aesthetic components of professional appliances. Chapter 4 is dedicated to picture the material selection written guidelines, testing procedures (SensoMAT protocols) and practical tools elaborated to meet the objectives of the research.

> **Part III** consists in the application of the developed method and tools for material selection in the professional industry. Chapter 5 describes and discusses the results of five metal replacement case studies, whose represent the validation of the research. Chapter 6 evidences limits and advantages of the research, highlighting possible implications of the holistic material selection method and tools in the professional appliances industry and in the design education. The last chapter of the dissertation (Chap. 7) underlines the original contribution of the research to the current knowledge in material selection and suggests future research paths to improve the study’s insights and assess their transferability and relevance to other industrial contexts.

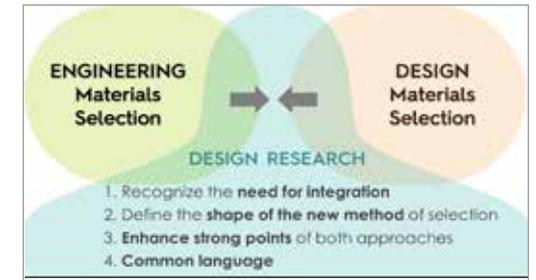


Fig. 1

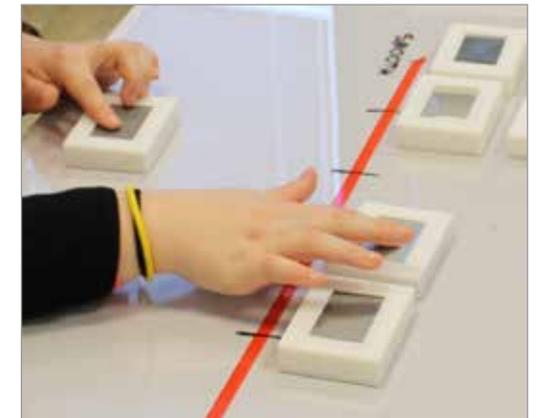


Fig. 2

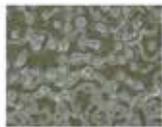
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Fig. 3

ENGAGED DESIGNERS & THE USE OF COMMUNICATION TOOLS TO BRING ABOUT SOCIAL & CULTURAL CHANGES

Andréa Poshar - Supervisor: Paolo Volonté

Protests all over Brazil have been going on since 2011, but they gained gigantic proportions in 2013. It all started with the increase of 20 cents in the public transportation fare. The “Não é só por 20 centavos” (It's not just for the 20 cents) movement took millions to the streets and became known as one of the greatest political manifestations in the country since the impeachment of President Fernando Collor de Mello, in 1992. And this political situation was not restricted to Brazil. During the second decade of the 2000s, one could already witness continuous demonstrations and protests all around the world like the anti-austerity demonstrations in Tunisia after the street vendor Mohamed Bovazizi, set fire to himself as a protest against the abusive authorities who had his wares confiscated. Disgusted with the event that led Bovazizi's to his self-immolation, citizens of Sidi Bouzid, began to protest stimulating an upheaval that within months arose in Egypt, Syria, Libya, and Yemen. The uprising in the Middle East was so great that it reached Europe. In 2011, anti-austerity demonstrations began to take place in Madrid, Spain. Right before the political dispute, an atmosphere of outrage arose through the Democracia Real YA! (Real Democracy NOW!), a political activist group revolted with

political corruption of the Spanish State. Months after Madrid's event, protests crossed borders and reached the US where a revolutionary shift took the main square of Manhattan's financial headquarter: 'Occupy Wall Street Movement'. Encouraged by a poster and a manifesto published in Adbusters Magazine, Occupy Wall Street spread over a hundred cities in the US and scattered to over a thousand cities throughout the world. This research started with our observations towards the graphic communication pieces developed by those movements. From that particular and traditional counterculture aesthetic of handmade, hand-painted, posters were being produced with a very well-considered and calculated aesthetic. These graphic pieces were being produced either locally and hand-delivered by local designers or were produced and exposed online, under open source and creative commons rights, for their download and print. For us, this was the initial characteristics of a particular engagement between designers and social movements. However, it is necessary to stress here that neither the engagement of designers with social movements is a new phenomenon nor our initial

observations. Thus, historically, designers do engage with activism. In the context of design, we consider engagement as the participation and involvement of the designer in social movements. The designer who gets engaged in social causes and movements differs from those designers who work in creative studios and advertising agencies. Identified by us as *engaged designer*, one is able to pinpoint 3 main different nuances. First, they stand out for being a cultural producer and an organizer; second, for being a cultural intermediary and thirdly, as a commuter. As a cultural producer and organizer, a *engaged designer* produces meanings, that is, every content he/she creates is capable of causing influence in society's structure and culture. What we mean is that, as a cultural producer and organizer, the *engaged designer* is capable of creating invisible rules that can drive society's behavior reflecting on social and cultural realms, positioning social spheres of society. In order to do that, the *designer* transforms, translates, distorts, and modifies the meaning of the elements they use, that is, our culture. Such actions led us to consider them as cultural intermediaries, meaning, the link between his/her production and their final destination, that is, the audience they are trying to reach.

Within the context of social movements, as cultural intermediaries, designers might be considered as the bridge that connects mainstream culture to counterculture. However, this connection cannot be seen as an approximation and coexistence of both. On the contrary, this approximation is given towards influences brought and presented by the designer itself. And in order to make that connection and influence, a vehicle is necessary: the *designer* himself. This movement of coming and going between different fields of action makes the designer a commuter, a regular traveler that carries and produces symbolic meaning. Notwithstanding their engagement and image production, we wondered about the changes this engagement was bringing to the movement and if they in fact, were causing any change. And if they were catalyzing social and cultural changes, was there any possibility of identifying and analyzing them? At first glance, those changes were notorious and they were not happening only in the realm of the inner circle of the activist movement but also in their culture production and the way they used to produce their own communication material. In other words, for us, designers were producing cultural and social changes while commuting from their sphere of action to counterculture. With this research question in mind, we wanted to investigate and bring such changes into discussion. With more specific goals, we wanted to analyze the behavior of these designers through both fields of action and

then describe their practices, methods, and tools of actions in such fields. Because of the transdisciplinary nature of this research, this research is a research *into* design, according to the research methods presented by Frayling (1993). This means that this research needed to go beyond Design Study Theory to understand a phenomenon that happens within the Design field. Due to this, this research was carried out with qualitative research methods because of the need to understand the experiences and attitudes of individuals and its community/environment. We could see that the designer, even as an activist and engaged in social movements, he/she does not play a neutral role within social and cultural changes. On the contrary, their participation can bring about social and cultural changes since its first contact with the movement. Just by having a training/educational background within the hegemonic culture, and having the experience of having worked or still working for that particular sphere of action, and especially having (and being aware of having) specific technical knowledge about communication and design, turns them into key figures of such changes. With this, this research showed itself to be valid and necessary to exhibit the role and the participation of the communication designer in such current and important social topics/situation. This research presented us a glimpse of the relationship with activism and the role the designer occupies in such historical moment

of social crisis and struggle, be it in the past, present and predicting even its behavior in future actions as well. All explained and analyzed from a sociological, communicative and design perspective. This is why this research stands out. We believe this investigation contributes by showing how a designer can lead to such profound changes in the cultural production of a society by using, manipulating, and subverting the purpose of a medium of communication as a political tool and activist manifestation. To summarize, it is necessary to stress that it was not easy for us to find scientific and theoretical literature that would make a linking of data and evidence the role of the designer in such a position. It is true that there are many catalogs of political graphic design pieces, which makes it even more evident that there has always been a production and political engagement on the part of the designer. However, there are very few books, such as “Design Activism: beautiful strangeness for a sustainable world” written by Fuad-Luke (2009) and “Graphic Agitation” from McQuiston (2009), that analyze and explain such phenomenon. I hope to shed some light towards this direction and showing the importance of analyzing the activity of a designer through the lens of other disciplines such as Sociology and Communication. The same thing can be said in relation to the other disciplines. It is hoped that scholars of those areas can begin to understand the social role a communication designer possesses within society.

COMMUNICATION DESIGN FOR GENDER CULTURES. MODELS AND TOOLS TO EXPLORE GENDER ISSUES IN DESIGN EDUCATION.

Marta Isabella Reina - Supervisor: Valeria Bucchetti

Co-supervisor: Elena Caratti

Over recent years the attention on including a *gender dimension* in the design field increased as proved by institutional acts and programs that demonstrate the necessity of more sensible design practices and processes to foster equality, diversity, and inclusion in society. Design scholars started to debate on introducing gender issues in design research and teaching, and in a similar way to what happened to other social issues, gender equality will become a crucial problem to be addressed by design in the near-future. What could be the contribution of design to further equality? How can designers raise awareness of gender issues? What are the theoretical and practical tools they can use? These are some of the emerging questions of the area of studies recently defined '*gender design*' and focused on the historical, socio-cultural and economic impact of gender for the discipline.

In close conjunction with the objectives of the research network the thesis aims to improve a critical knowledge about the relations between gender, design, and representation. The first stage of the study identified the theoretical and practical tools for gender analysis on design artefacts and the best practices

where communication design has created steps towards gender equality by a case study research and literature review. This phase along with an inquiry to interrogate the design community on the topic was preparatory for the development and pilot test of models and tools for a gender-sensitive education of designers. The activities were conceived to acknowledge the responsibility of designers in the process of socio-cultural construction of gender identities through a participatory process which may be used to improve and inform successive activities.

Even if gender is a mutable concept always in the process of change, the contemporary societies reiterate an unequal and dichotomic relation between the sexes as consequence of the patriarchal system. This has implications for design because gender is often involved implicitly according to stereotyped and non-representative associations. The design of artefacts (such as objects, dresses, images, interfaces, etcetera) engage designers and their beliefs about the identity of the user (f/m). Also, the needs and the expectations of the user/consumer (f/m) affect the design. Consequently, considering more intentionally

a gender perspective requires understanding the relationship between designers and users. In this regard, the education of designers is crucial and was chosen as the way to explore the topic obtaining data from students and, at the same time, raising their awareness of the problem. Before of the development of the models and tools, was set up an inquiry to get to know the audience of design students from Politecnico di Milano, Scuola del Design (that were also the beta testers for the subsequent activities). The study was drawn up to investigate how they are aware of gender issues and precisely if they believe in occupational stereotypes in design and recognise different skills and attitudes between women and men. The tools of the investigation were semi-structured interviews, and a questionnaire aimed to provide quantitative data for longitudinal research. Moreover, a research toolkit (a visual survey) helped to understand how students interpret gender when they must connote artefacts (for her/him/all) by the formal-aesthetic languages. The inquiry confirms the research hypothesis about the belief in typical stereotypes regarding the professional development of

women and men and of the use of different formal-aesthetic codes to differentiate artefacts (for her/him).

Designers need to be aware of their role of amplifiers of the social conventions, and the observation of signs, images, that are part of daily experience can be decisive. The objects and especially gendered objects offer precisely representations of consumer practices that are significant indicators of the way in which people see their self and others. The study of language can be used to comprehend gender in society uncovering that is an artificial construct which may change modifying the "rules of playing". Exploratory research of how gender norms operate in design was set up by the analysis of the communicative dimension of a collection of consumer products. The formal-aesthetic codes of 'femininity' and 'masculinity' were identified revealing different values and meanings that distinguish the feminine from the masculine. There is a variety of visual codes for women while the men codes were closer to a neutral language as a standard to which the feminine is the exception.

The research stage was the basis for the development of the *DGD (Design/Gender/Design) Lab*. which shows similar findings. Each participant of the workshop created a repertoire of signs for her/him/all providing solutions to specific problems related to gender representation (individual). Successively, the own responses were combined into taxonomic tables following given guidelines

(group). To conclude, students discussed the results according to the instructions of the researcher/facilitator.

As the study reveals, gender analysis in design has an essential role in the self-understanding of society and the construction of its future. On the other hand, the diffusion of best practices, bold ideas, and compelling case studies may create a positive impact on the creative community enabling new initiatives to grow. More than 400 cases where designers have created steps towards gender equality were collected over the years 2015-2017 and analysed highlighting approaches, methods, and inspirational examples/outcomes. The data were archived on a website (www.dxcg.org/observatory) conceived as a resource for primary research: a tool for designers, researchers, high school instructors, and other educators for developing teaching and training activities. The workshop *AAGS (Actions Against Gender Stereotypes) Observatory Lab*. used the web archive to engage students in social activism on gender issues. The activity was set up in three phases: the exploration of the cases through the web archive following provided guidelines (individual); a group discussion on emerging topics (group); the design of a concept of an action of awareness raising on an identified problem (individual or group). The goals of each phase are: assess the efficacy of the tool in improving individuals' knowledge; prove the adequacy of a participatory process to

strengthen the reflective practice with students; activate the students' creativity and capacity to deal with design activism. The findings evidence that the tool can be useful to improve the knowledge of students on the issues; participants have great critical capacities for commenting the problems constructively and were enthusiastic to design actions to contrast gender stereotypes (some exciting proposal emerged). The research proved that communication design could be an agent for the pursuit of gender equality by what it may concern the visual and communicative languages of design artefacts. This regard both their *genderisation* (e.g. discussing and revising stereotypes to propose new models of representation) than their relevance in supporting gender issues (e.g. providing solutions for raising awareness and social campaigns). The discipline can play a crucial role in education opening new spaces of reflection, spreading forms of social criticism and imagining a respectful and comprehensive representation of gender. The implementation and internationalisation of models and tools is the prospect for this research which introduces an ethical perspective in design education.

IN THE INTERIOR OF INNOVATION: THE MAKERSPACE PARADIGM

Ricardo Saint-Clair - Supervisor: Alessandro Biamonti

Over the course of the last decade, Makerspaces and Fablabs have emerged from the realm of niche creative communities and their stakeholders to demand the attention of everyday citizens, the mass media, and their respective governments. Some cities have gone so far as to use them to define political policy, assigning ambitious targets relating to their economy and sustainability, where these spaces play a pivotal role in the achievement of real innovation and change. The success of such endeavours are yet to be substantiated. Whereas, the impressive growth of Makerspaces' physical facilities, all over the world, speaks to their impact and optimism: from the dawn of a third industrial revolution with the advent of mass customisation up to an entire redistribution of manufacturing, reconfiguring the mass production global map towards a more local and sustainable alternative. Substantial evidence of this expansion comes from the most notorious system of Makerspaces: the FabLab Network. Launched in 2002 at the MIT's Center for Bits & Atoms, the FabLab Program aimed to investigate the implications and applications of personal fabrication in other parts of the world, primarily in areas where technology was scarce. Presently,

there are more than 900 FabLabs in 77 countries, according to the FabLab Foundation. Even though this topic is associated with many areas of knowledge and research, from the social sciences and humanities to the ones directly related to digital technologies, the thesis focuses on the built environment of MakerSpaces and FabLabs. Using a comparative analysis of 18 locations in five major European cities (Milan, Paris, London, Barcelona and Amsterdam), it aims on the platforms, settings, and layouts that support and enable their collaborative and innovative practices. The bottom-up approach of these adaptive spaces, usually designed by the users and not by experts or outsiders, invites findings that are both novel, valid, and truly valuable. The general goal of this dissertation is summarised in the following comprehensive research questions: What extent does the design of a space enable people to be more collaborative and inventive? Which structures or platforms genuinely encourage human agency and innovation? The focus on the built environment reflects the intent to explore a hypothesis based on a core characteristic of Makerspaces' territories: their mixture of bits and atoms. The fact that their

virtual and physical spaces are not entirely distinct or defined by clear borderlines has led to a Conceptual Framework for analysing this synergistic quality, in order to map the digital and intangible aspects of the virtual domains being applied and transferred into the physical and tangible ones. Could Makerspaces give us a glimpse of the future of the workspace? There is a growing understanding that the establishment of an innovation culture is crucial to its progress, in many cases more pivotal than technological excellence. Considering culture as a complex body that encircles knowledge, routines, policies, art, and beliefs, transmitted via human behaviour and social interaction, it is logical to assume that it is inside the built environment of institutions and organisations where a significant proportion of these material and immaterial components condense and collide. The Maker Movement, through the dynamic ecology of Makerspaces and FabLabs, proposes a random synthesis of virtual and physical realms through a mix of tangible and intangible attributes: co-creation, socially shaped innovation, non-hierarchical routines, available resources, open knowledge, digital democracy, and loosely structured platforms.

Often restricted to the role of prototyping workshops, there is currently a proliferation of hybrid models that unite comaking and coworking services and facilities, where individuals – professionals and non-professionals – entrepreneurs, and start-ups interact in a shared relaxed work style, calling into question the boundaries of what might be considered a workspace. The patterns and congruencies of these adaptive areas reveal their influence on how people feel, behave, interact, and exchange experiences, reinforcing the maker ethos and producing innovative end results. An extensive participatory research was conducted using a Constructive Design approach, defined by the use of mixed methods and qualitative ethnographic probing. The overall research premise is that new knowledge should also emerge through the design practice. Hence, the Conceptual Framework is proposed based on the practical investigation of the hypothesis, which has sharpened the study focus. The ultimate outcome is the ideation and early prototyping of a digital research instrument – a mobile application – that embraces the complexity of these contextual-based socio-technical habitats, along with their comprehensive

ambiguity and ever-changing character. The Mobile App is a generative program, a reflection of participants' needs and desires able to adapt and evolve continuously through the co-participation of members and users, with the understanding that iteration and evolution of their built environment must be a continuous, co-designed and never-ending assignment. The thesis contributes to suppressing the lack of specific literature concerning the built environment of peer production

communities, through the examination of their rituals, protocols, topologies and layouts, and the impact on people's behaviour and social interaction. Last but not least, the thesis also proposes new practices and ways of working based on the hybridisation of digital and physical territories and its impact on human behaviour and social interaction, helping to better predict the future of contemporary workspaces.

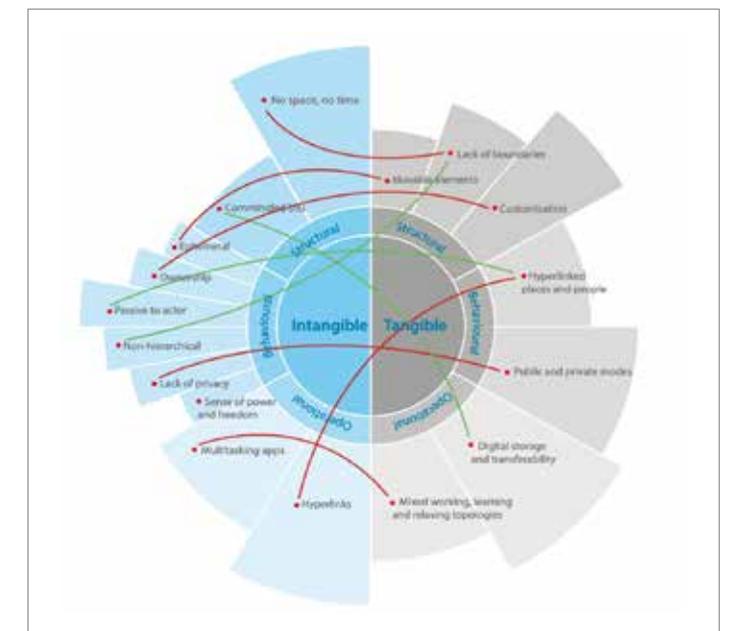


Fig. 1