6th International Forum of Design as a Process

SYSTEMS & DESIGN

BEYOND PROCESSES AND THINKING

2016

Electronic book

PROCEEDINGS

June 22nd – 24th, 2016

EDITORIAL UNIVERTITAT POLITÈCNICA DE VALÈNCIA

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Bernabé Hernandis Ortuño

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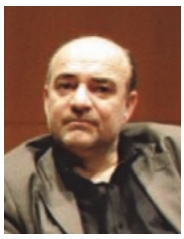

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Associate Professor at the University of Paris, France.

INTRODUCTION

"Systems and Design" aims to provide a global view from the perspective of systems in general, and how they have contributed to a new vision of design. Since ancient times we can observe how systems have participated in thought, customs and development of civilizations, and how this symbiosis (systems-design), has influenced the existence of those goods and products that currently surround us. The construction of our world and its future evolution is with no doubt largely influenced by systems and how they contribute to its formation and development.

In the last decades, the design is subject to a permanent renewal result of the multidisciplinary influence and the systems. The design of the intangible is an inexorably part that will be subsequently processed by transformation functions resulting products or services properly optimized.

Therefore, analyzing how the design is affected by the systems, and measuring their degree of participation and influence today, it has been one of the objectives of this Congress.

They have brought different perspectives, from the contribution of researchers from different universities and continents. And with this vision and in this context, we have tried to cover the different considerations about Systems and Design provided by SD2016 participants.

Bernabé Hernandis

POSITIONING PAPER

Systems and Design: Beyond Processes and Thinking

Celaschi, Flaviano; Celi, Manuela; Formia, Elena; Franzato, Carlo; Imbesi, Lorenzo; Peruccio, Pier Paolo & Hernandis, Bernabé.

Scientific committee

Abstract

A contemporary vision of design needs to be encompassed in the actual mutation of the productive and cultural contexts facing different systems of change. Conceived as a collective work, this introductory paper looks at these changes in the design field by identifying six possible perspectives that, albeit laying on parallel dimensions, present many interrelated aspects: productive, professional, creative, cultural, sustainable, prospective. The conclusive paragraph brings forwards an in depth analisys that offers an engineering vision of design cultures.

Keywords*: Industry 4.0, productive, knowledge, creative, cultural, sustainable, prospective systems*

1. Productive system. Awaiting the "digital tsunami" of the revolution in production processes[1]

When we are in the middle of some phenomena, very close to them, indeed, when the phenomena are right on top of us, it is always very difficult to describe them. As described by Massimo Bergami (2016, 13), "Up until now we have witnessed the appearance of gradual innovations that have added new tools and means of communication to our everyday life. In reality, the impact of the new technologies on processes is greater than what is immediately visible. It is also likely that this trend will suddenly accelerate due to the conjunction of enabling factors that are rapidly converging. Among these we could

[1] Flaviano Celaschi, PhD, Full Professor at Alma Mater Studiorum, University of Bologna (Italy), Director of the First and Second cycle Design Degree Programmes at UNIBO, Founder and coordinator of the Latin Network for the Development of Design Processes, Founder of the Advanced Design Network at the University of Bologna.

mention the diffusion of networks and ultrafast connectivity services, new abilities to rapidly manage large volumes of variable and diverse data, breeding grounds of revolution in industrial systems due to manufacturing computerization, the immersion of simulation systems that flip planning logic, the diffusion of cognitive computing, the effects of virtual/augmented reality, and the democratization of innovation potential, all obviously in addition to the 4.9 billion connected things in 2015, destined to become 6.3 in 2016, and 20.7 in 2020 according to estimates by Gartner."

With disarming clarity, nations at the forefront of production systems like Germany and the USA call it "Industry 4.0," intending with this slogan to establish that what is about to engage, and in part has already engaged the global production system is a revolution comparable in scale to the previous revolution in industrial automation that was led by Japan in the 1980s (Celaschi, 1992), recognized as a "revolution" comparable to the industrial upheaval linked to Ford and Taylor in the early 1900s, both analogous to the industrial revolution associated with steam in England in the late 1700s.

Personally I agree with this vision that underlines the moment, defining it as "revolutionary". As with the production revolutions that preceded us I am convinced that we can clearly use such a strong adjective because that which happened already in the first of these great revolutions is happening again now: the systemic set of innovations regarding the production system (what we would call B2B in professional jargon) and the set of innovations that regard our personal lives and communities every day (the rooms, the homes, the cities, where we live, in other words B2C) will be integrated into a single system that is more complex than in the past.

The processes that govern our everyday lives: food shopping, fueling and urban movement, fun and entertainment, education, sport training, emotional or sexual encounters, medical treatments, financial wagers, preparation of food, buying and selling houses, performing religious ceremonies, etc. will be strongly influenced, for the first time in real time and in digital form, by what can happen in the other half of the world (B2B), up until now characterized by being separated, closed, secret, and intended only for authorized personnel.

Production processes are at the center of this fourth revolution, due to two different drivers:

- Because the manufacturing dimension of making products and providing services is heavily influenced by the digital revolution that permeates it, redefining the relationships between operator and machine (control interface), but also the relations among suppliers, information management, geographical localization of factories, and their own productive nature.
- Because all this rethinking of the B2B dimension of production systems opens up to and can/must cross over into the other half of the world represented by people's lives (singly and collectively), heavily influencing their effects, but also being themselves heavily influenced in real time by the changes that will be triggered in the consumer and life part of the world.

Bergami, summarizing an intense contemporary bibliography, briefly suggested some of these drivers, which we will try to list: additive production, power of computer networks, cloud computing, sensors and Internet of objects, internet of behaviours, neurosciences applied to cognitive behaviours and decisions, big data, open sources, continuous innovation, futures studies, extreme design, automation and artificial intelligence, augmented and immersive reality, digital modeling, rapid prototyping, cyber security, photonics, traceability of production, use, and decommissioning processes.

Manufacturing passes from being producer of objects to being producer of production services, industry mixes with the lives of people and follows and influences each choice, quickly and continuously drawing from them useful indications of how to redefine the production itself (Frison, 2016), transforming us, as an integrated system of ubiquitous actors and consumers in real time, from factors of linear growth into

factors of exponential growth. Just in the EU the directorate general of production activity estimates a need for 800,000 professionals by 2020 capable of operating in this new system of production and consumption, in a market that is estimated to be 27% of the global market, so 3 million new actors in the world[2].

From our point of view we must observe that even now we educate designers that in recent years are trained to work in a context in which the production system and the consumption system dialog amongst themselves. Since the first Maldonado (1972), the definition of designer has placed the accent on the need to mediate between production system and consumption system (Celaschi, 2008). However, the mediation that we find ourselves managing is no longer a soft action between two hard systems, but now has become the queen of the tableaux. The mediation system has taken over the scene, and herein lies the true transforming force of the production system of industry 4.0.

The framework that I suggest as matrix for reflecting on this document is therefore a system divided into four quadrants influenced by two worlds, one digital and one manufacturing, that come together, and by two systems, one production and the other consumption, that mix. Each of the four quadrants identified interacts continuously and in real time with the other, breaking down every door and resistance, systematically pervading the globe, without creating immediate dystopias but structurally modifying the model of life and production of billions of people.

Every aspect of the digital tsunami that awaits us is therefore soaked with design cultures, within the factory in the rethinking of production processes and products, outside of them in the rethinking of use processes and consumer and life models.

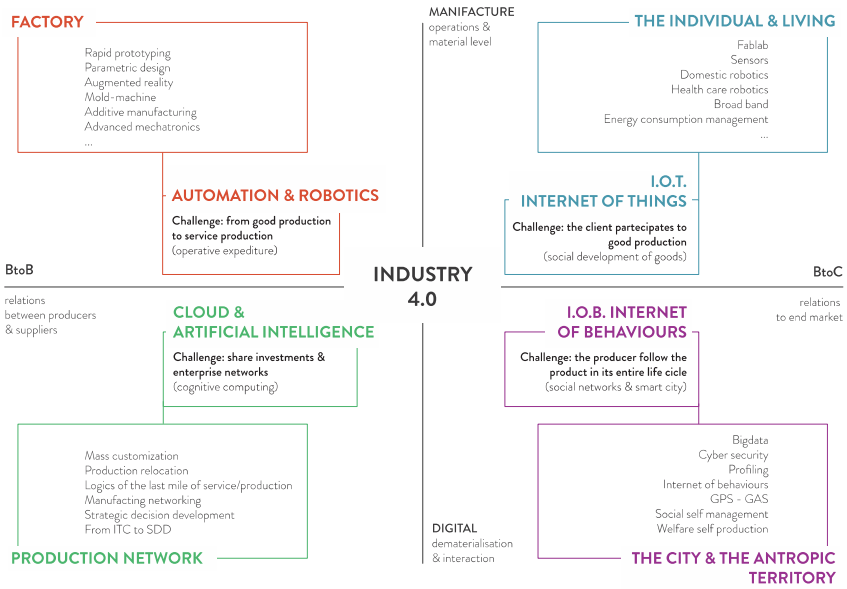

Fig. 1 Industry 4.0

[2] From the introduction speech by Khalil Rouhana, DG Connect, European Commission Component and System, conference Industry 4.0, Parma, 18/03/2016.

2. Knowledge system. Personal Factory, Design Cognitariat and Post-industrial Society: the design profession along with the transformation of the creative labour[3]

Along the crisis of industry, knowledge and the creative labour come to be the primary workforce capable of generating value and innovation. Industry is living an historical shift of its role within society and production through the admittance of the new technologies and the service sector.

The process of digitalization is leading to a transformation of the nature of the enterprises, while opening to new forms of micro-factories and "personal capitalism", in order to share locally and globally skills and knowledge, as well as resources and tools, to the accomplishment of projects and products.

The new generations of designers have come to terms with deindustrialization and, while their predecessors had a role in the assembly line with manufacturing processes, today's designers are aware of their service and strategic role concerning innovation.

Then, the young designer is experiencing a special space for self-organization, while incorporating all the productive aspects in his own office and even experimenting with self-branding, thereby revealing a spontaneous and alternative space to the official production.

Can we still speak of industrial design, while production seems to assume a completely new shape and organization, while delivering new outcomes? What are the characters of the post-industrial production in order to address design education and the role of the creative practitioner?

2.1 The Knowledge Cognitariat of Design

If the physical 'objects' are in the background of the creative activity of the project, design itself becomes a service in a collaborative network of players, where every segment is helping to finalise the end result. As property and goods were at the heart of the industrial capitalism and could be used for measuring the degree of innovation of production, the post-industrial era is investing in the immaterial assets of knowledge. The labour of the mind comes to be considered the primary workforce for generating value and design is an activity that can be located in-between 'doing' and 'knowing', material and immaterial.

In the knowledge society, the digitalisation process permeates every trait of the professional activity; it determines times and resources, and thereby reduces the entire design process to producing and processing data that has been re-elaborated by the knowledge and creativity that are put into play. The computer becomes the ultimate tool (Gorz, 2003), and unlike instruments requiring innate specialised skills and abilities, today's user-friendly software opens up the field to a vast, totally new group of young people, who would not have had access to design earlier.

In this way, the rate at which software is updated measures how quickly innovations are made to products, and design training becomes lifelong education and learning how to use updated technologies, thereby constantly redefining the rules of the game. In order to increase the value of their own cognitive 'fixed assets', the creative class needs to continually update and reinvest its knowledge through a constant training, in its daily grind producing and managing ideas, knowledge and techniques (Gorz, 2003). Even when off the job, they form and transform their knowledge and abilities: as a consequence, the continuous mobilisation of this live workforce through a constant creative effort occupies every moment of their life, so blurring the border between the time devoted to work and the time for leisure.

Everything in designers' daily lives - relationships, affective and emotional aspects, language and the ability to co-operate - is used as an investment to produce value. Thus, the anthropology of young

[3] Lorenzo Imbesi: Arch PhD, Associate Professor, Cumulus Executive Board, EAD Executive Committee, Design Unit Coordinator, Department of Planning, Design, Technology, Sapienza University of Rome.

designers is creating a ‘creative proletariat’ class, or to use a neologism, a ‘creative *cognitariat*’ (namely a cognitive proletariat of creativity) primarily through the imposition of new technologies (Imbesi, 2008).

In satisfying a broad demand of aesthetics, the ‘creative *cognitariat*’ is pushed to reinvent its own role every day, generating new products and services, as well as new markets and consumption models. The emergence of this new character with a bent for mobility and innovation, is spreading in our global cities, a bit as our 19th-century ancestors on the assembly lines created the *cité industrielle*.

2.2 Self-Capitalism

While observing the transformation of the nature of labour and enterprises in Italy, Bonomi and Rullani state the emergence of a new form of “personal capitalism”, where people may organize autonomously smaller entrepreneurships, while sharing locally and globally skills and knowledge, as well as resources and tools, to the accomplishment of projects and products. If the big Fordist corporation was self-sufficient with a pyramidal structure of organization, the model highlighted by the Italian industrial districts is made of a number of little and medium enterprises, networking each other horizontally and geographically positioned (Bonomi, Rullani, 2005).

At this end, the crisis of the big multinational companies seems to re-evaluate the experience and the organization of such ‘personal capitalists’, then leaving a special space for the self-organization of the individuals, with their unique trait and special contexts. Knowledge and creativity raise to be important levers with the support of the new technologies, to create innovation and value and to develop new autonomous experiences of production. At the same time, this is affecting also the way the young designers operate and manage their work. In a world where the number of designers are increasing and then the competition is more difficult - and without mentioning, at the same time the crisis of industry is restricting the spaces and the chances for them to work - the younger generations are trying to explore alternative professional approaches, also becoming themselves “personal capitalists”.

In the knowledge society, if it is true that the computer has become the tool of production *par excellence*, also its liberated accessibility is bringing closer the worker and his product, then opening up to new economies and new design experiences. This *'homo flexibilis'* of project often becomes an entrepreneur himself, building new biographical and production scenarios by experimenting with new forms of self-production that develops new critical keys beyond the immediate marketability (Imbesi, 2008).

With the help of information technology and the advancement of rapid prototyping and its related accessibility, for the first time the designer is in the position to close the circle of production, playing on his own every segment, ranging from design, to production, distribution, communication and even sales. The young designer - who has now learned to exploit his abilities to individually connect to a collaborative network of peers - can integrate every productive segment in his office, as a real entrepreneur, and even his name appears be used as a real brand.

The design studio happens to be renewed in a design office management; the prototyping workshop becomes a factory that produces small series of products; the tasks of the agent for distribution can be executed through Internet portals and e-commerce, just as every aspect connected with communication, such as designing the packaging, processing the corporate identity and all strategic aspects of product marketing may be handled by the same design office. The work of the designer may be extended even to curating the exhibition design of the points of sale and the selling itself, as it often happens in many international design fairs, where young designer are often self-promoting them.

Thus, the creative “cognitariat” of design discovers new capabilities for experimenting new experiences of self-organization and self-brand, while releasing a spontaneous and alternative space beside the official production, which may still be intertwined with, and then disseminating power for design.

3. Creative systems. Facing the tension between Authorial Creativity and Creative ecosystems[4]

In the prologue to his *The rise of the network society,* Manuel Castells affirms: "our societies are increasingly structured around a bipolar opposition between the Net and the self" (2012, 3). Very effective global networks are connecting individuals, groups, regions or even countries towards the fulfillment of the multiple goals that they search for achieving, with the same ease they could switch off them the next day. The ever-changing scenario gives multiple, temporary and weak opportunities to discuss, criticize, elaborate ethical positions and reasons for action. Individuals, grouped into several and frequently contradictory movements, go back to comforting primary identities, such as religious, ethnic or national ones, as today European vicissitudes demonstrate. While networks are shaping the world, we search for our identity to signify our social position and role.

Professionals, including design ones, are living this bipolar opposition. Designers design within powerful networks, frequently without being the protagonists of the design process. Many other actors, already involved in the design process (such as specialists of other area or the same entrepreneurs) or recently summed up (such as stakeholders or final users), could become equally or even more important for designing.

Adrian Forty (1992) already challenged the myth of the designer's omnipotence, stressing that, even if the literature have represented design as an act of pure creativity of the individual, society is a fundamental factor for inspiring the design process and creatively interpreting its results: thus, they are essential for the design success. However, today networks are taking on specific design potentials, becoming designing networks.

New information and communication technologies let many actors collaboratively interact in design processes, even if they are not designers, and web-platforms of design crowdsourcing, with commercial purposes or social ones, are making it even easier. Large design processes are being developed in real time, by actors distributed all over the world, without need of pivotal actors. Even the last winner of the Pritzker Architecture Prize, Alejandro Aravena, is well known for the development of wide participatory design processes, besides for his masterpieces.

Moreover, the design process continues within the use of the resulting devices. As foreseen by Pierre Lévy in 1990, in the knowledge ecology of the cyber culture, there are not clear limits that separate technical development and use: "no technical advance is determinate a priori, before to be tested by the heterogeneous collective, by the complex network in which it has to circulate and that eventually it should be able to reorganize someday" (1992, 204, authors' translation). As it was explained at the beginning of our positioning paper, industry 4.0 fades away the boundaries between production and consumption systems.

Instead, we should consider the ecosystems of creation as a whole. As other types of cultural ecosystems, creative ecosystems host countless, diverse, articulated connections that incubate creative processes aimed at interpreting, criticizing, rethinking and transforming the world, including design processes.

[4] Doctorate in Design from Politecnico di Milano (2008) and Bachelor in Industrial Design from the same University (2004), he is Professor in Design and Dean of the Shool of Creative Industries at Unisinos University (Porto Alegre, Brazil). His research focuses on complex collaborative design networks developed by designers, other professionals, organizations and institutions, users and citizens.

From an ecosystemic point of view, the design process is considered within those creative relations that it contribute to weave. Thus, the design focus shifts from the development of products, services, product-service systems or any other type of artifacts, to the practice of the creative relations. This way, the designer could aspire to be one of the most important actors of the designing networks, since his or her technical skills could serve as a platform for the cross-disciplinary convergence of the various actors of the creative ecosystem.

This way, the design process results in a method for the creation, the practice and the evolution of the strategies that organize the various actors for collaboratively designing. Through the design action, it becomes possible to lead with the instability of the ecosystem. In this direction, the designer's aptitude of reading the signals emitted by the ecosystem, allied to scenario-based design methodologies, come to be the core of design process, since they permit to consider the regular and the evident, the possible and even the deviation and the unpredictable, the chance and the error.

In the described context, even if design emerges as a very important process among the processes of the creative ecosystems, even if the designer – as we affirmed – remains immanently an important actor, which is the role of a most authorial design? We can highlight at least three possibilities of this form of expression that is so important for the design history:

- Critical design. Designers can use the design process to criticize our relationships with the natural and social environment, and, through their artefacts, propose alternative scenarios that discuss contemporary lifestyles and open to the democratic discussion of our future (see Dunne, 2008);
- Adversarial design. In this direction, designers can go on using the design process with political purposes, defying the status quo, the network society as well (see Disalvo, 2012);
- Advanced design. The previous possibilities are related to our present, but looking to a next future that we can socially construct. Anyway, designers can use evolved design processes to imagine a faraway future and design towards it (see Celi, 2010).

Interestingly, these possibilities for authorial design match the previous processes of designing within creative ecosystem in the metadesign level, in which it is possible to critically reflect upon the design process, in order to evolve it. In fact, as presented in the 5th international forum of design as process (Franzato, 2014), metadesign allows the speculative design processes that support critical, adversarial and advanced design, besides to allow the opening of design processes to designing networks. In this sense, metadesign is a crux for contemporary design processes.

4. Cultural systems. The role of design in the new system of cultures[5]

The infra-ordinariness of design is a distinctive feature. In the model of Design as Mediation Between Areas of Knowledge, Flaviano Celaschi affirms that "The design that we study appears to us today as a form of knowledge that creates relationships between other forms of knowledge. A discipline that would appear to take shape around the sensitivity of not producing an independent knowledge of its own (or at least one that has not yet succeeded in doing so) in competition with the capacity for analysis and with the levels of knowledge gained by other, historic lines of study in modern science. If anything, it is precisely by respecting the rules and the sets of analytical knowledge used up by other disciplines that it takes hold

[5] Elena Formia, PhD, is a Fixed-term Senior Assistant Professor at the Alma Mater Studiorum, University of Bologna, where she is member of the Advanced Design Network. Since 2008 she has been Scientific Secretary of the Latin Network for the Development of Design Processes, taking part in the organization, promotion and spreading of its various initiatives. Her research interests cover the concept of design cultures and the relationships between humanistic knowledge and design sciences.

of them as input and as a basis for bringing about an organised transformation of the world of goods that surrounds us." (Celaschi, 2008, 21)

The systemic model proposed by Celaschi was on some level a continuation of a previous thread of debate that first saw the light more than 40 years ago, when it then became apparent that design had to be recognized as a subject in its own right - a necessity based on objectivity and rationality. An example of this is the historical definition given by Tomàs Maldonado (1972), who spoke about design as the process of coordinating, directing and guiding different factors belonging to different spheres of knowledge that interact within a complex system: the functional factors, alongside those concerned with production and with socio-cultural and economic aspects, are the four elements that influence design. A few years later, John Haskett (1980) coined the non-definition of design, seen as an expansive and confusing discipline, full of incongruities, with many manifestations and whose boundaries are uncertain and polarized by different driving forces ("Design is to design a design to produce a design"). More recently, with the idea of "multi-faceted design", Ezio Manzini (2007) highlighted the fact that design can interact with and connect different spheres and fields of knowledge. Together, these all contribute towards expressing a new kind of innovation which is, at the same time, technical, social, cultural and esthetical. According to Alessandro Deserti (2009), if we place design on a hypothetical map, its development can be described in terms of a progressive expansion from a "solid centre" – which can be described as the link to the traditional interest in giving shape to new products – to much softer peripheral areas, that overlaps extensively with other disciplines. From here comes the idea of a "product-system", as a complex combination of material and immaterial factors and qualities, all of which have to be addressed with a new strategic mind-set.

These definitions have maintained a certain continuity over time and are strictly tied to the essence of design as a discipline, in being a subject that, historically, has cut across culture and science, art and technology, culture and technology (Mumford, 1952; Maldonado, 1979). The philosopher Vilem Flusser (2003) spoke about design as a "bridge" between the two forms of knowledge (scientific and artistic) or between what is termed the "two cultures". The direct reference to Charles P. Snow is evident and can be taken as granted. Between 1959 and 1963, the British scientist and novelist set out his theory whereby it is possible to create connections between disciplinary boundaries, between sciences and humanities, and between scientists and intellectuals, optimistically to introduce a mediating "third culture", defined by John Brockman in *The Third Culture: Beyond the Scientific Revolution*, published in 1995. While the purpose of this rapid overview is not to bring up the theory proposed by Snow more than 50 years ago, it is clear that scientific literature on design has progressively recognized and rationalized its capacity to be commonplace, disruptive, dynamic, open and relational; that it can work in a complex and not linear way; and that it can use an abductive model of reasoning when being generated.

The system of knowledge around design has progressively grown, consolidating its relationships with other subjects. British professor Guy Julier introduced the idea of a *Culture of Design* (1st ed. 2000, 2nd ed. 2007, 3rd ed. 2014) as a possible lens through which to analyse the ubiquitous role of design in contemporary society (both as an object of study and as an academic subject). The idea of a "cultural turn" has penetrated many humanistic disciplines since the early 2000s - from history, to anthropology, human geography and sociology (Nash, 2001; Barnett, 2002) - posing interesting questions about how to interpret the world around us or, in other words, our material culture. This change has progressively influenced the fields of design. In recent studies, the definition of culture itself has been closely examined, i.e. "which culture(s) should we refer to as scholars in the field of design?" (Penati, 2013). One of the most solid models remains the concept of production-consumption-mediation as a form of interpreting and studying design artefacts, processes and activities (Lees Maffei, 2009). The culture of the designer (education, ideological factors, historical influences, professional status and market perception),

together with that of production (materials and technology, manufacturing systems, marketing, advertising, product positioning and distribution channels) and consumption (demography, social relations, taste, cultural geography, ethnography and psychological response) are the domains in which to study the culture of design. They inform each other in an endless cycle of exchange and can be nurtured through the integration of many disciplinary skills. The emphasis on mediation has, naturally, acquired more significance, and mediating channels are now increasingly the focus of attention.

This discourse is highly complex and has been interpreted from many perspectives. Within the concept of the Industry 4.0 introduced at the beginning of the paper by Celaschi, we can examine whether this interpretative model still remain central and valid. Facing the challenges of the "new industrial revolution", we are asking further questions: Is it the network/system of knowledge already in place sufficient? Are there any other forms of culture that we should take into consideration when approaching and interpreting these new frontiers?

The French scholar Yves Citton has recently come up with an interesting proposition. In bringing up the importance of interpretation, he notes that the interpretative gesture offers a privileged condition for the encounter and synthesis between intuition (aesthetics) and order (scientific), between the immediate evidence of the textual data and the critical autonomy of the subject (Citton, 2012). Faced with the challenge posed by the new 4.0 Industry, the value of the designer, in a hermeneutic perspective, could, once again, play a key role in mediation.

5. Ecosystems. Against a throwaway culture[6]

Time has passed since "industrial design has put murder on a mass-production basis" as in the words of Victor Papanek (Papanek, 1970). Quite apart from any ethical judgements about this kind of behavior, it is nevertheless obvious that the designer is still an "accelerator" of events, a force he shares with the consumer. Even more today in the 4.0 Industry era: together they are capable of influencing market dynamics and therefore the production of goods and services. In one way or another, the choices a designer makes have a global fallout. His destiny is to play a crucial role in society.

In a 4.0 Industry scenario, sustainable design paradigms have to change. As production processes, logistics and resources modify their roles and even new players (e.g. Internet of Things, Big Data, Augmented Reality, etc.) enter the system, a product-centered environmental process to design seems to be ineffective in tackling contemporary issues.

An ecodesign approach, based on reducing, reusing, recycling, dematerializing, using renewable energy, disassembly and other strategic efforts to minimize the impact of products and services, only partially faces urgent sustainable challenges. It is necessary a shift in design methods and even more important, a behavior change. Rapid prototyping, sensing, clouding computing, IoT, Artificial Intelligence and other drivers of 4.0 Industry are powerful means by which we can modify our culture and, by extension, our Planet. "We have to accept that technological products are not neutral - Pope Francis clearly says -, for they create a framework which ends up conditioning lifestyles and shaping social possibilities along the lines dictated by the interests of certain powerful groups. Decisions which may seem purely instrumental are in reality decisions about the kind of society we want to build" (Francis, 2015).

As "industry mixes to life" (Celaschi, infra) we cannot ignore anymore the complex relationship between action and reaction in natural and artificial systems. From the smallest units to the largest entities, we are

[6] Pier Paolo Peruccio, PhD, is a Design historian, Architect and Associate Professor of Design at Politecnico di Torino. He is Vice-Coordinator and responsible for International Relations of the Design School at the DAD – Department of Architecture and Design of Politecnico di Torino. He is currently working on several research projects concerning history of sustainable design, systems thinking and innovation in design education.

all part of a complex system as described in the milestone documentary film “The Power of Ten” (1968) by Charles and Ray Eames.

Designers and architects were already aware of this in the 1950s when they realized how complex and difficult design actually was. Too many variables became involved and an interdisciplinary approach was needed with inputs by experts from more than one field of knowledge. The process that gradually developed and grew during that period helped to break down disciplinary barriers and moved in the opposite direction to the monodisciplinary and specialist approach of the first half of the nineteenth century. In particular, architectural projects and design met with the culture of complexity at the Ulm School with the introduction of new “design” disciplines such as cybernetics, theory of systems, information theory, semiotics, and ergonomics. Nonetheless system is not a real object: it is a simulacrum, a tool used to simulate reality and “exists only as we thought it. It is an arbitrary concept and also its limits are fixed arbitrarily by the observer in relation to cognitive ends he pursues it” (Bologna, 2008).

Sustainability is not a private issue. It is a common value shared by the entire community.

In a 4.0 Industry era, designers are asked to design open industrial systems to avoid production waste, and create ecologically sustainable communities. The focus moves on the design of an entire system located in a precise social, political, economic, and cultural context. Designers establish relationships with the natural world and even replicate some of its more virtuous processes, rather than entering into conflict with it. “After 3.8 billion years of evolution – Janine Benyus writes in Biomimicry - nature has learned: what works, what is appropriate, what lasts”.

This confirms a shift in the idea of industry, away from linear models in which waste is considered the norm, to integrated systems where both digital techologies and traditional manufacturing play an important role, in which everything has a use because it is converted into value-added input for other processes.

In such a cultural scenario we can recognize a strong interest on the organization of autonomous forms of enterprise. It means self-production in a design context: from do it yourself to digital manufacturing. Some of these activies are part of the so-called informal economy: "if we call formal economy the processes of production and exchange of goods and services regulated by the market and typically carried out by industrial and commercial profit-oriented enterprises, operating under the rules of business law, tax, labor - Arnaldo Bagnasco recently explains - than we could call informal economy all those processes of production and exchange that tend to escape one or more aspects of these distinctive characteristics (Bagnasco, 1999).

In an interesting pamphlet of 1978, Ivan Illich investigates the keen issue of unemployment and flanks the word creative, highlighting the potential of vernacular activities - for instance, the assistance offered to children and the elderly, bricolage or other household chores - as a historic opportunity to break the dominance of conceptual pair capital-labor which, from the time of Adam Smith onwards, makes up the corner stone of Western economy.

The informal economy makes way in the interstices of economic processes by enabling new projects from the bottom. If the traditional literature describes the two economies as in opposition to each other, nowadays it is necessary to think of a unique production system consisting of at least two souls. The definition of this model requires the presence of an official economy, formal, recognized, which is accompanied by an informal economy - also called submerged, underground, hidden, shadow or gray – unregulated, because it is outer of accounting of GDP per capita of a nation.

The interdependence of ecological and social issues as well as the re-growing phenomena such as informal economy and social capital (network of relations) are the basis of the concept of "integral ecology" (or "systemic approach" by Fritjof Capra[7]) outlined in chapter four of Pope's Encyclical (Francis, 2015). From this point of view also new technologies, on one side, and designers, on the other, could play active roles in fighting the throwaway culture, which is the result of the irrational belief in infinite growth. Not more production but better production in which the waste products of a production cycle become a resource for another production process. This is one of the most interesting challenges we need to face in order to activate virtuous growth processes in a territory.

6. Prospective Systems. Strategic Design & Anticipatory Design: different approaches to systemic change[8]

Design, as a driver of innovation and change, is a complex discipline characterized by unique ways of learning, abductive thinking and often untranslatable processes. Since Design discipline has grown its borders from material products and artifacts to the immaterial side of the project, many adjective have been used to define the design ability to shape, influence and determine the pathway to change.

Strategic and anticipatory nature represents different ways of facing future perspective in design activity.

Both of them aspire to a wider aim of design, not only connected with the solidity of the products world and the connected markets, but with the immaterial side of goods (meaning, ethics, social aims), both of them have the aim of planning and designing not only for the immediate tomorrow and nevertheless they show different attitude.

6.1 Strategy: the art of planning

The term Strategic design and its culture were born around a strong emphasis on the "company" as the main subject of the strategic design culture. Since Peter Beherens, whose first works for AEG have been defined a first contribution to design management (Burdek, 2005), emerged the first tendencies to valorise the design competences in the wider context of the entire company. Michael Farr, in particular, was the first one to intertwine knowledge from system theory, design and management defining a design path inside companies: "Design management is the function of defining a design problem, finding the most suitable designer, and making it possible for him to solve it on time and within a budget. This is a consciously managed exercise which can apply to all the areas where designers work." (Farr, 1965)

Further reasoning in the seventies focalized two main issues dealing with design management: the necessity to foster corporate strategy and the need of develop methodology for information processing. The influence of the operation area was at that moment justified by the necessity of growing a continuous practice of product development and of the companies' inadequacies in including design practice into the process of product development. In the eighties the design management had a great impulse thanks to the acknowledgment of its capability of increasing the product value on the market: companies have soon learned that the product, when bringing a semantic value, can be better or differently placed in the market

[7] The systems view of life, integrating life's biological, cognitive, social, and ecological dimensions, is implicit in the conceptual framework of Laudato Si'. The Pope states explicitly that that solving our global problems requires a new way of thinking, and he makes clear that what he has in mind is thinking in terms of connectedness and relationships — in other words, systemic thinking" (Capra, 2015).

[8] Manuela Celi, PhD in Industrial Design, is Assistant professor at the Design Department of the Politecnico di Milano. Since1999 she has cooperated with the School of Design. Since 2009 she has been working on Advanced Design topic being interested in methodology, process design and design for futures.

acquiring new customer's segment. But it is in the nineties that the idea of a Strategic Design takes place: a more holistic approach, the central role assumed by many designer in the product development process and the grow of a corporate culture and image were calling for a designer profile with mixed competences between project, economy and culture. In particular there has been a strong emphasis on a systemic interpretation of the project connected to the so called Product Service System (PSSD) dimension: emerges an orientation toward different kinds of social and market actors, a clear intention to produce innovation, and an emphasis on a systemic interpretation of sustainable development (Meroni, 2008). Francesco Zurlo in his definition of the term Strategic Design describes the strategic adjective as a hat that covers more approaches (operations, tools and knowledge building models) and is involved in theoretical and practical aspects (design leadership, design thinking, design direction, business design, research, etc.). In a wider sense when design is involved in the decision making process its role becomes strategic. Strategic Design is the activity able to plan or design to impact favourably the key factors on which the desired outcome of an organization depends. Another definition of strategy refers to methods or plan to bring about a desired future, such as achievement of a goal or solution to a problem. This openness toward future is connected to the design ability to foster change inside organization but, dew to the origin of such practice –as we have seen- and to the context primarily limited to enterprise (commercial or social) this change is normally connected to a predetermined objective. An horizon toward which the designer look designing scenarios, producing visions and then prototypes and artefacts able to catalyse and exploit the present resources to produce a certain range of results.

If we consider the literature coming from the Future Studies area and the contribution of Voros (2003) in particular it is soon clear that this perspective encompass only a limited vision of the futures. To foster a process toward what we "want to" happen, means to consider only the perspective of the preferable futures. In other words futures that are more emotional than cognitive, futures that derive from value judgments and for this reason are more subjective depending on who is doing the preferring.

6.2 Anticipation: the art of reacting

Paradoxically the only time in which we can act is the future and Design is an activity heavily projected in to the future. Even if the consciousness of the centrality of the futures study within our discipline is slow to grow the actual strength of the international scientific debate about the study of the future - and Anticipation Studies in particular - allows us to meet this important area of concern together with other human and social science (sociology, psychology, anthropology, technology, economy, art) involved in the dimension of time yet to come. The future awareness or better what Miller (2007) calls future literacy, is crucial in the design profession for many reason: its huge responsibility in shaping goods, its ability in planning products longevity or life cycle, its contribution to service design and social design, but most of all for its unique capacity of imagining, shaping and communicating new values and perspective.

According to Poli, Miller and Rossel (2013) "all efforts to "know the future" in the sense of thinking about and using the future are forms of anticipation. Equally the future is incorporated into all phenomena, conscious or unconscious, physical or ideational, as anticipation".

One important motivation the conscious use of the future is the statement that perfect anticipation of change is both practically and theoretically not achievable in our universe.

Our incapability of predicting - but also determining the future - is connected from one side to the lack or unavailability of both the data and models but, most of all, the consciousness that our universe is "creative" in the sense that novelty happens – provided that suitable enabling pre-conditions are given (Poli, Miller & Rossel, 2013). The certainty that characterises scientific disciplines and underpins the repeatability of scientific experiments does not belong to those of the project; this is precluded also to the disciplines of anticipation. Starting from this assumption the pretention of designing the future is an

oxymoron nevertheless we can recognize that design, constantly dealing with uncertainty is a discipline able to deal with the future dimension. The world of design is constantly subject to a state of continuous emergency; the product is increasingly temporary and precarious and takes on increasingly ephemeral connotations. In this condition of accelerated obsolescence that causes distress, some high-value technology products are promoted through the "future-proof" expression to emphasise their permanence in time and their adaptability to subsequent developments. When establishing new ways of future-oriented projects, there are no future-proof methods, however, as this means being able to predict today what will happen tomorrow with certainty, while the project of the future requires the unconditional acceptance of uncertainty (Celi & Celaschi, 2015). The capacity to understand context constraints, strong and polymorphous reframing capabilities and mediation skills are the knowledge areas that Design, and Advanced Design field in particular, can offer to anticipation. Zamenopoulos and Alexiou (2007), who already explore the possibility of an anticipatory view of design, also suggest another capability: "More importantly, design also involves the capacity to anticipate the correspondence between theories and models, which can only be verified by experimentation or the actual realisation of the design artefact" (Zamenopoulos & Alexiou, 2007, 431).

The design of the future must move on the ground of the possibility and its many never unique expressions. This approach, this ability can be recognized as an anticipatory attitude of design able to leave the orizon open to different possibilities, able to interact with several different actors and to produce multiple scenarios and solutions.

7. What is Systemic Design?[9]

Systems, existing from the beginning of creation, have evolved since ancient times generating a scientific and academic discipline through which the complexity of living beings, nature and even the evolution itself of current science is explained to a large extent.

The study of systems through modeling and subsequent simulation has enabled us to gain new knowledge and thus explain the behavior of countless phenomena. Their Identification and later classification, according to their origin, type or intangibility, have allowed us to represent, understand and study their past, present and future development, on the basis their expected behaviors.

Open, closed, adaptive, emergent, and other systems are defined according to their structure, behavior and evolution. In the field of design, taking the existing knowledge about system into account inevitably generates new approaches inherent in current design processes, suggesting new strategies that allow us to improve the management of the intangible in order to optimize the design of the tangible.

The social and business environments, the territory and the products are common areas, where knowledge management optimization is sought as to observe the largest possible number of factors affecting the decisions underlying the design of new products or services.

The challenges posed by the complexity of our times requires observation and study to be carried out with different approaches and research lines able of interpreting many complex relationships, considering their behavior and involvement in the design process from a multidisciplinary point of view.

[10] Full time professor, Founder of the *Grupo de Investigación y Gestión del Diseño* of the *Universitat Politècnica de València and* Director of the *Red Internacional en Diseño Sistémico, rDis.* Director of the *international journal, rdis*. Bernabé Hernandis Ortuño graduated from organizational industrial engineering and diplomated in Investigación Operativa y Sistemas and holds a PhD in Design. His specialization research areas are the systems theory, complex systems, design methodologies and systemic modelling for product-service innovation.

Therefore, systems deserve our greatest attention, in the light of their permanent existence as a constitutive element of our reality able to represent, in any discipline, the complexity of our world.

Furthermore, within the design field, it will be necessary to study, consider and analyze how systems are part of the academic and scientific domains to which we, as researchers, devote most our time.

Perhaps, as they evoke our not too distant past, today systems constitute an indivisible whole underpinning the behavior of many of the processes we base our work on both in the field of education and in that of research. And, probably, in a not so distant future, they will be studied for their structural uniqueness. We must not forget that since ancient times there has existed a continued interest in analyzing the tangible and intangible aspects that constitute reality.

However, the synergy process stems from a complexity which requires the existence of added elements to justify its balance. Perhaps systems are indispensable elements constituting the necessary blocks to stabilize continuous change.

What can we learn from the study of systems in order to optimize the design process? This will be a key issue to deal with in the next decade. Perhaps, System Design is currently able to provide a way to address the issue of what approach we should use to tackle the complexity of design without losing its inherent creativity power. This complexity should investigate the social and economic aspects of the territory, the companies and the products, considering both the tangible and the intangible, so as to provide sustainable solutions that envisage a future beyond processes(HERNANDIS, 2015).

The conference “SYSTEMS and DESIGN: Beyond Processes and Thinking” aims to present some of these new approaches leveraging this forum to pool new thoughts, voices and insights that pursue any of the objectives described above. Although it may seem that everything has been invented and designed already, multiple inspiring visions still arise that suggest new approaches in the traditional disciplines. Mankind continually reinvents itself, coming up with new ways of working and turning new methods into future proposals. Studying systems from a design perspective with a view to improving the reality as much as possible, as well as bringing a new distinguishing visions to design, might pose a challenge worth solving.

Through knowledge management we are able to transform the intangible aspects associated with different sociocultural, business, territorial and technological dimensions by using design as a transforming function capable of converting intangible knowledge into tangible solutions (i.e. products and services demanded by society).

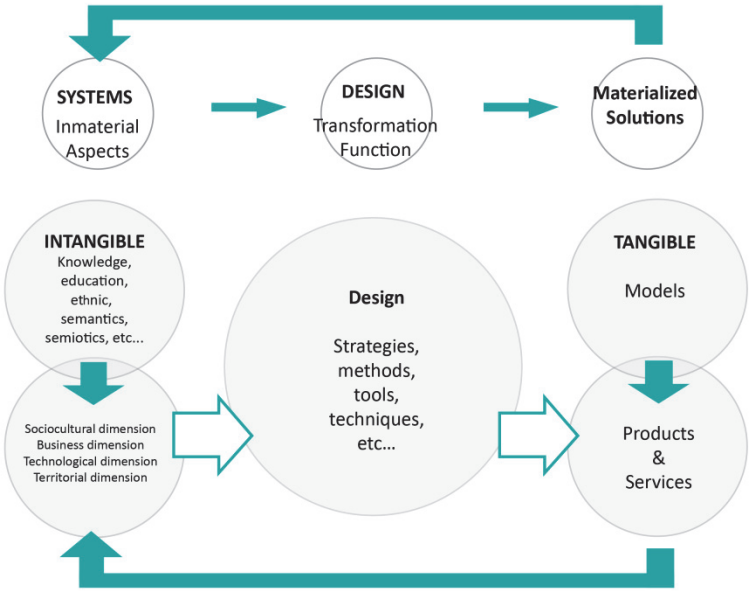

Fig.2 Management of the intangible in order to optimize the design of the tangible. Hernandis, B. (2015)

This stands for a conceptual model expressing that the function of the intangible is susceptible of being transformed into tangible through the intervention of the transformative role of Design. The design of intangibility, i.e. the knowledge necessary to represent systems, generates tangible subsystems, namely products or services, through the design transformative function (1).

$$[D(I)_k] \times \Phi(D) \equiv [D(T)_{p/s}] \quad (1)$$

One may say that the designer uses knowledge management consciously or unconsciously as a starting point for the ideation of the product. The handling of the intangible becomes more and more relevant over time as different methods emerge for knowledge extraction and subsequent organization. This calls upon the designer to have a broad knowledge about the possibilities offered by new methods based on innovation and creativity.

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INTANGIBLE ASPECTS

Smart specialization strategy: model innovation systems

Fernández-De Lucio, Ignacio.
Ad honorem professor at Universtitat Politècnica de València, Spain.
Keynote Speaker

Abstract

We are in the knowledge and network society which are the factors generating growth of society. But the combination of these two factors does not make other factors essential to achieve that growth? In this global world where we are increasingly more often companies, institutions, cities and territories establish their development strategies to achieve leadership. Strategies, as it can't be otherwise, must be intelligent and because of that we speak of smart cities and territories. Every intelligent design requires the establishment of adequate representation of this in order to, with the influence of the past, imagine scenarios of future success. This representation must be systemic by the number of agents, relationships and committed knowledge, but the practical management of these systems need to devise models that simplify reality but take into account the main features of the system they represent. In the case of innovation I will show you how the complexity of the system need to innovate can be modeled in order to understand the initial situation and to establish, with relevant information, smart specialization strategy system.

Keywords: *Knowledge, systemics, strategy, smart specialization.*

Design after Design: Creating a wisdom economy through Generative and Collaborative Design practice.

Ferrara, Luigi.
Dean of the Centre of Arts, Design and Information Technology, Canada.
Keynote Speaker

Abstract

In this information age what becomes most critical is our capacity to sift through data, recognize patterns and synthesize knowledge into actions that will improve the quality of life on our planet for all citizens and species. The capacity to make wise choices and to foster wisdom at the broadest level in society will be critical to addressing the global challenges we are facing all the way from income inequity to climate change. Industrial Design has had a critical role in advancing our standard of living and at the same time exacerbating our current environmental malaise by enabling hyper-productivity. Can we re-imagine a Design after Design that will power a new paradigm for creation and sharing in this next century characterized by balance and moderation? By examining new generative models for design and new inter-disciplinary ways of collaborating we can begin to imagine a new systems design philosophy that fosters co-creation returning to people the fundamental act of creativity enriching their lives with continuous learning.

Keywords*: Knowledge, prospective systems, industrial design,*

The Series Lies within the Object

Bihanic, David
University of Paris I Pantheon-Sorbonne, France.
Keynote Speaker

Abstract

The new industrial and digital craft objects shall not be considered as finished products, so in other words 'ready-to-use' and closed in on themselves. They are not the ultimate outcome of expert anticipatory (or predictive) studies (i.e. future sensing), and even less the material support of prescribed/predefined uses. In fact, these new objects are inherently unfinished, and therefore spur both designers and users into action (in favor of manifold design and development proposals). As their shape and function (amongst others) continuously change, the object acquires a new status, a new nature: it becomes a genuine system that provides an infinite number of possible object. The series3 would thus be lying within the object — the first occurrence of the object-system allows establishing the foundations of his ad hoc combinational logic (leading to countless generations of object states). In my speech, I will strive to highlight the main challenges and opportunities brought by what appears to be a new systemic revolution of product design. To do so, I will focus on two key strategic axes: (1) from the object improvement to his 'parametric mutation'; (2) from the customization4/adaptation5 of object to a new type of innovative use (towards an innovation through practice).

Keywords: *Object systems, series, parametric, custom.*

Learning systems within the design praxis

Íñiguez-Flores, Roberto.
Tecnológico de Monterrey. Mexico.
Keynote Speaker

Abstract

During the second half of the last century the General Systems Theory (GST) received much attention, not just because of its promise regards offering a "unified science" as Checkland mentioned, but also because in its becoming it demonstrates to the world a completely different way to observe the reality. In a third stage (after theoretical and bio-systemic) the GST demonstrate a capability of application, particularly in the management and engineering field that have had a huge impact.

Nowadays, the systemic thinking offers an alternative to complexity management, precisely in application fields where design is getting present more and more, complexity brings more uncertainty so that the meeting points between systemics and design are required: from methods to visualization (or modelization) design has been nurtured from applied systemics. An important key to understand the overlap phenomenon between systems and design (mainly inside organizations) is learning; at the systemic tradition, methods suggest "learning" as the element that connects the real world problematic situations with change and the improvement that and organization may want to perform. ¿How to deal with learning inside complex processes?, ¿which are the characteristics of the convergence at the design processes? ¿how the organizations face or lead the learning processes to cope with change?

Keywords: *Design. systemic thinking. innovation management*

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Diseño inmaterial - Hacia la desmaterialización y digitalización de productos y servicios como herramienta de sostenibilidad

Rivera-Pedroza, Julio Cesar[a] y Hernandis-Ortuño, Bernabé[b]

[a]PhD candidate at Universitat Politècnica de València, Spain. – Investigador y diseñador industrial de la Universidad Nacional de Colombia. juriped@doctor.upv.es; juceriv@hotmail.com.

[b]PhD. Full Professor. Universitat Politècnica de València, Spain. bhernand@.upv.es

Resumen

La crisis ambiental es también un problema de comportamiento, y no está limitado sólamente a tecnología, producción y volumen. Por lo tanto, con la evolución y los avances en la tecnología, los procesos y métodos de producción para desarrar nuevos productos y servicios, es necesario analizar el nuevo papel del diseño en la sociedad actual. El objetivo propuesto de este estudio es el de describir la relación entre dinámicas de desmaterialización y digitalización (o informacionalización) de productos y servicios y la sostenibilidad.

La investigación se lleva a cabo a partir de un estudio de caso con un enfoque cualitativo y un énfasis analítico-descriptivo, sobre la manera en que factores tales como los avances tecnológicos, junto con los comportamientos y las emociones de los usuarios influyen en la configuración de productos y servicios y su relación con la sostenibilidad. Es importante resaltar hasta qué punto se puede sentir amenazado el "know how" del diseñador con la aparición, cada vez más frecuente, de productos y servicios desmaterializados y/o digitalizados. En este sentido, se plantea que, más que una amenaza, puede ser una oportunidad para evolucionar, considerando enfoques sistémicos desde una perspectiva multi-objetivo, multidimensional y multidisciplinaria. El presente análisis podría proporcionar pistas en el campo del diseño, teniendo en cuenta el contexto inmaterial para desarrollar productos y servicios desmaterializados y digitalizados, comprometidos con una sociedad más sostenible.

Palabras clave: *Diseño, inmaterial, desmaterialización, digitalización, sostenibilidad.*

Abstract

The environmental crisis is also a behavioral issue, and not one simply of technology, production, and volume. Thus, with the evolution and advances in technology, processes and production methods for development of new products, it is necessary to analyze the new role of design in today´s society. The proposed aim of this paper is to describe the relationship between dematerialization and digitalization (or informationalization) of products and services into sustainability.

The research is carried out from a case study with a qualitative approach and an analytical-descriptive emphasis, how factors such as technological advances along with behavior and emotions of users influence the configuration of products and services and its relationship to sustainability. It is important to stress to what extent the "know how" from the Designer can feel threatened with the appearance of increasingly frequent dematerialized and/or digitalized products and services. And in this sense, it might be stated that rather than a threat, it could be an opportunity to evolve, considering systemic approaches from a multi-objective, multidimensional and multidisciplinary perspective. This analysis could provide clues to field of knowledge taking into account the immaterial context, to develop dematerialized and/or digitalized products and services committed with a more sustainable society.

Keywords: *Design, immaterial, dematerialization, digitalization, sustainability.*

1. Introducción

La actividad del Diseño tiene una gran responsabilidad del actual estado del medio ambiente, además de un papel fundamental en la búsqueda de la sostenibilidad. En el contexto actual, enfocado hacia una sociedad sostenible, es conveniente reflexionar sobre la influencia que tiene el diseño sobre productos y servicios, a modo de lograr un planteamiento, desarrollo y puesta en funcionamiento -o uso- de los mismos de manera sostenible. Del mismo modo, es necesario reflexionar sobre la forma de abordar los problemas de la sostenibilidad, pues se considera que aunque ya se han logrado algunos avances, es un campo aún por explorar. De hecho, hasta hace poco, las metodologías de diseño sostenible raramente estaban comprometidas con las cuestiones más fundamentales como el sentido y el lugar de los productos y servicios en nuestras vidas, y la contribución de los bienes materiales a lo que podría ser definido ampliamente como el esfuerzo humano (Chapman, 2009). Aunque las cuatro décadas y media de actividades del diseño sostenible, según y cómo lo afirma Chapman, *"han hecho este desperdicio e ineficiencia ligeramente menos derrochadora e ineficiente"* (2009, pág. 30), es una perspectiva de sostenibilidad limitada e insuficiente desde un punto de vista evolutivo y de proyección en el tiempo, por lo que se hace indispensable un abordaje desde otras perspectivas, en términos de proponer alternativas y medios que permitan alcanzar una sociedad sostenible en todos los niveles.

La sostenibilidad está evolucionando, actualmente su naturaleza va más allá de los tres pilares básicos con que era concebida (ecológico, económico y social), por lo que es conveniente analizar si hay una nueva visión de la sostenibilidad, en la cual a través de una perspectiva holística y sistémica de las alteraciones ambientales, sea posible encontrar soluciones que incluyan elementos *materiales* e *inmateriales* relacionados con el comportamiento humano y las dimensiones culturales. Planteamientos propuestos por autores como Walker (2006), Wahl & Baxter (2008), González (2013) o Wigum (2004), destacan la importancia de las motivaciones esenciales de los individuos, como una la fuerza dinámica que permita un cambio en productos y servicios, a través de las demandas y aspiraciones reales, que no pueden llevarse a cabo y definirse sólo a través de hechos físicos.

Autores como Mugge, Schoormans, & Schifferstein (2007) se cuestionan sobre el porqué las personas desarrollan relaciones sólidas hacia determinados productos y cómo los diseñadores pueden influir en el grado de apego a través del diseño de productos. Aunque lo anterior se refiere a productos tangibles, se

plantea que también se puede presentar en productos y servicios intangibles. Lo cual es una gran oportunidad para que, diseñadores y desarrolladores de productos y servicios, lo enfoquen hacia su área de estudio, y en éste caso en especial hacia "la sostenibilidad".

Por otro lado, también es importante tener en cuenta al usuario o consumidor y su percepción sobre la sostenibilidad, a modo de identificar cuales son los rasgos, aspectos o atributos que deben poseer productos y servicios sostenibles, según sus criterios. Esto puede servir para identificar, cómo se le puede dar un nuevo enfoque a la sostenibilidad -en caso de ser necesario- o comprobar si el modelo actual es el adecuado; con el fin de ratificar o replantear el concepto que la sociedad tiene de la sostenibilidad. Para ello se debe ir más allá de la caracterización del fenómeno. Es decir, saber si el fenómeno de la sostenibilidad hoy en día se caracteriza por reparación, reuso, uso secundario, mínimo consumo de recursos, recuperación, reciclaje, compostaje, etc., o si se está caracterizando por otros aspectos basados en actualización, cambio de formato (producto a servicio), desmaterialización, sustitución, virtualización, multifuncionalidad, optimización de la vida útil, uso compartido, creación de experiencias, vinculo emocional y otros elementos que podrían hacer parte de ese *contexto inmaterial*, relacionado con las emociones y los valores, y que posiblemente no sean considerados en la actualidad como impulsores de la sostenibilidad.

El propósito del actual estudio es, desde una perspectiva sistémica, reflexionar sobre unas dimensiones material (*contexto material*) e inmaterial (*contexto inmaterial*), que se creen presentes en el planteamiento, desarrollo y puesta en funcionamiento -o uso- de productos y servicios, a modo de identificar un *diseño inmaterial* que relacione las actuales dinámicas de *desmaterialización y digitalización -o informacionalización-* de productos y servicios con la sostenibilidad. Con base en lo mencionado, se plantea el análisis de un estudio de caso en el que se consideren enfoques y estudios basados en las necesidades de los seres humanos, así como las emociones y sistemas de valores, que permitan reconocer puntos clave pertenecientes a esa *dimensión inmaterial*, los cuales a menudo se pasan por alto en la configuración de un producto o servicio y que se cree son relevantes al momento de generar una solución de diseño sostenible.

2. Marco conceptual

2.1. El modelo de diseño concurrente

El presente estudio se basa en el *Modelo de Diseño Concurrente* (MDC) de Hernandis, B. (2003). El modelo consta principalmente de un *sistema exterior* y de un *sistema de referencia* o sistema en estudio. En el *sistema exterior* se consideran tanto los aspectos relacionados con la *dimensión más tangible* del diseño del producto/servicio (materias primas, procesos, tecnologías, funcionalidad, distribución, proveedores, infraestructuras, entre otros), así como los aspectos más próximos a una *dimensión intangible* (cultura, sociedad, emociones y valores de los usuarios, percepción y motivaciones de las personas, entre otros) y demás aspectos que aportan consideraciones y restricciones que influyen sobre el problema de diseño.

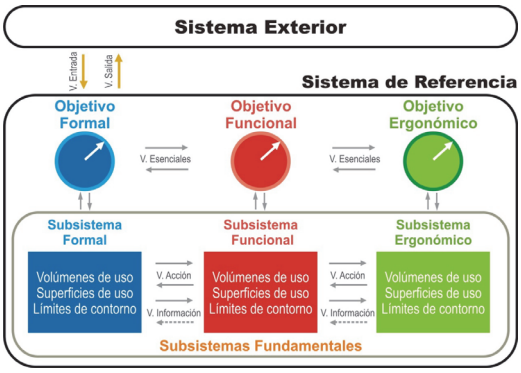

Fig. 1 Modelado teórico. Fuente: adaptado de Hernandis (2003)

Se parte de la idea de que en el *sistema exterior* se encuentran los *suprasistemas* (o subsistemas del *sistema exterior*), que abarcan la realidad que nos rodea y pueden definir las variables que permiten la configuración de un producto, sistema o proceso; y es en ésta fase del diseño conceptual en la que se deben aplicar los criterios para generar una respuesta sostenible a un problema planteado. Desde esta perspectiva, Vezzoli & Manzini (2008, pág. 238) afirman que, "mejorar el impacto de productos es más probable durante las primeras fases de desarrollo, cuando la innovación tiene una mayor magnitud".

2.2. Derivación del sistema exterior

Cualquier problema de diseño, abordado desde la sistémica, se debe asumir como un sistema que se compone de subsistemas en donde la respuesta, acertada o no, depende de las interacciones y relaciones de estos subsistemas o componentes, en donde, según Wahl & Baxter (2008), es pertinente abarcar otra dimensión, además de la física, para obtener respuestas acertadas. En este sentido, existen dos extremos específicos: el primero, a partir de artefactos culturales, instituciones, patrones de producción y consumo, que expresan la *intencionalidad material*; y el segundo, en la *dimensión inmaterial*, el "metadiseño" de nuestro conocimiento consciente, sistemas de valores, cosmovisiones y aspiraciones que definen la intencionalidad detrás del diseño materializado.

Se propone una perspectiva de sostenibilidad apoyada en una vision holistica y sistémica, que abarque varias disciplinas, panoramas y enfoques, que permitan y faciliten una acertada toma de decisiones. Para ello Rivera et al (2013), plantean dos contextos como componentes del *sistema exterior*, el *contexto material* y el *contexto inmaterial,* a manera de reconocer criterios que validen los supuestos o conocimientos sobre los conceptos identificados de la realidad percibida.

Fig. 2 Esquema de derivación del Sistema Exterior. Fuente: adaptado de Rivera et al (2013)

Resultado de estos análisis se ha identificado, que además de las variables de entrada, relacionadas con el *contexto material* de un problema de diseño, hay otras asociadas con un *contexto inmaterial* en el que se consideran aspectos emocionales y valores, como factores psicológicos y psicosociales, que satisfacen necesidades no materiales de los usuarios/consumidores.

2.2.1. Contexto material

En el *contexto material*, se suponen aspectos ligados a los conceptos físicos de productos y servicios, en donde son analizadas las características, materiales, producción, energía, etc., además de las relaciones e interacciones de elementos ya desarrollados y el medio en que se utilizan. A este respecto, Wahl & Baxter (2008), indican que la intencionalidad que hay materialmente detrás del diseño, "se expresa a través de las interacciones y relaciones formadas por productos de consumo, sistemas de transporte, economías, sistemas de gobierno, patrones de asentamiento, y los recursos y la energía utilizados, con la complejidad de los procesos sociales y ecológicos (pág. 74). Bajo esta perspectiva, se propone que durante el planteamiento y desarrollo de una solución a un problema de diseño se debe realizar un *"análisis físico"* en el que se consideren aspectos relacionados con el componente tangible o *contexto material* del proyecto.

2.2.2. Contexto inmaterial

En este contexto, se formulan analisis relacionados con conceptos psicológicos y sociológicos que estén ligados a las diversas cosmovisiones, ideas, sistemas de valores y aspiraciones de la sociedad. Wahl & Baxter (2008), señalan que, inmaterialmente nuestras ideas de organización, cosmovisiones y sistemas de valores, expresan cómo damos sentido a nuestra experiencia de la realidad a través del metadiseño (pág. 74). Aquí esta formación del sentido por medio del metadiseño, va más allá de los aspectos tangibles del *contexto material*, para lograr una relación con conceptos y supuestos psicológicos y sociológicos. En esa dirección, Stegall (2006) afirma, que el nuevo objetivo es diseñar productos que sean más que simplemente no tóxicos o reciclables, en realidad sirvan como herramientas para formar personas, vidas y valores, para lo cual es necesario examinar los rasgos, valores y comportamientos que las personas deben tener en una sociedad sostenible (pág. 58). Para ello, es necesario un enfoque holístico en el que se incluyan diversas disciplinas académicas y profesionales, visiones y enfoques diferentes.

Lo que se pretende con la derivación del *sistema exterior*, es observar en el *contexto inmaterial*, si algunos de sus componentes -necesidades, emociones y valores-, que a menudo son ignorados en la configuración de un producto o servicio, pueden ser relevantes al generar soluciones de diseño sostenible. A partir de este planteamiento, se analizan los anteriores contextos, para identificar elementos que estén en línea con la sostenibilidad, considerando teorías relacionadas con las necesidades humanas, las emociones y los valores, desde lo que se ha denominado *diseño inmaterial*, mediante dinámicas sostenibles emergentes de *desmaterialización* y *digitalización* de productos y servicios.

2.3. Dinámicas sostenibles emergentes

El diseño sostenible está madurando, se cree que hay un cambio hacia una nueva dimensión, en donde una serie de motivaciones (necesidades, emociones y valores) traen consigo una nueva visión de la sostenibilidad que pasa por la *desmaterialización* y *digitalización* de productos y servicios. En el *Atlas del Diseñador de Sostenibilidad*, Thorpe (2010) se refiere a esta mayoría de edad como la segunda etapa en un debate en el cual el rol del diseño en aspectos económicos y sociales de la sostenibilidad está más plenamente explorado, además de la atención ya establecidos en materia de energía y materiales (Thorpe, 2010, pág. 5). Para Chapman (2009), la crisis de la sostenibilidad es un problema de conducta, y no simplemente de tecnología, producción y volumen. Las condiciones de comportamiento que ambos

manejan y los patrones de la influencia del consumo de materiales son complejos, pero fundamentales para un compromiso efectivo con una agenda contemporánea de diseño sostenible.

Afirmaciones como las anteriores hacen que emerjan interrogantes sobre las perspectivas de la sostenibilidad y los roles de cada uno de los actores involucrados en alcanzarla, así como del surgimiento de dinámicas sostenibles emergentes como la *desmaterialización y la digitalización* de productos y servicios que consoliden una nueva dimensión de sostenibilidad, en donde, y siguiendo a Robèrt et al (2002), se genere una transformación cultural que cambie el foco en los productos y servicios, a fin de encontrar completamente nuevas formas de satisfacer las mismas necesidades en los usuarios/consumidores, sean estas necesidades básicas o de autorealización.

2.3.1. Desmaterialización

En primer lugar, se harán algunas aclaraciones sobre el concepto de *"desmaterialización"* utilizado en el presente estudio, debido a que este término tiene varias interpretaciones. En este caso en particular, el termino *desmaterialización* es tomado como una estratégia que apoya a la sostenibilidad, con antecedentes asociados desde la *Rueda de LiDs* (Lifecycle Design Strategies) de Brezet & van Hemel (1997) hasta enfoques más conteporaneos que podrían estar asociados al bienestar humano; tal como sugieren Beuren, Ferreira, & Miguel (2013), quienes citando a *Baines et al.,* (2007)*,* indican que la desmaterialización de productos, además de haber sido discutida en la literatura por autores como Mont (2001), Ehrenfeld (2001), Manzini & Vezzoli (2003), Wong (2004) y Tomiyama (2001), también ha sido utilizada como un objetivo para los *sistemas producto-servicio* (PSS en inglés product service-systems).

Li, Zhang, Li, & Tong (2010), afirman que la *desmaterialización* se ha convertido en un concepto importante en la ecología industrial, el cual ha penetrado en todas las fases del ciclo de vida del producto. A lo que Beuren et al (2013) interpretan, que consecuencia de ello, un producto puede ser desmaterializado mediante la inclusión de servicios que reducen la cantidad de materiales consumidos en el ciclo de vida de un producto, no sólo en su creación sino también en su uso, reutilización y reciclaje; en ese sentido Kestemont & Kerkhove (2010) aseveran, que la idea es tender hacia un desarrollo más sostenible y eficiente para "producir más bienestar humano utilizando menos recursos naturales", es decir, desvinculando el crecimiento económico del uso de material, mediante la utilización de menos "cosas", o en su defecto de productos y servicios más eficientes, proyectados y desarrollados desde la *desmaterialización*. En este caso, no se trataría solamente de la *desmaterialización* a través de la cantidad de material consumido, sino y como afirma Cleary (2010), con posibles escenarios de gestión de residuos, incluyendo la prevención de residuos, mediante la ampliación de los límites del sistema. Lo cual podría ser la prevención de residuos a razón de la desmaterialización, en donde los propios usuarios/consumidores tomaran conciencia de algún tipo de bienestar humano, logrado a raíz de la utilización de menos recuros naturales o la reutilización de productos.

Para el desarrollo del presente estudio, y siguiendo a Beuren et al (2013), se toma como principal objetivo de la *desmaterialización*, el de mejorar el bienestar de la sociedad, mediante el desarrollo más eficiente y sostenible, en donde, y coincidiendo con *Baines et al.,* (2007)*,* la *desmaterialización* sea una oportunidad para que sistemas producto-servicio, rompan el vínculo entre el valor entregado al cliente/usuario y la cantidad de material físico necesario para crear ese valor.

2.3.2. Digitalización o informacionalización (de átomos a bits)

El principio que se expone a continuación, pueden ser reconocido por otros nombres como *Transmaterialización* y *Servicing* (prestación de servicios), pero se ha considerado que los conceptos de *"digitalización"* e *"informacionalización"*, son los que se aproximan más al principio que se propone, a efectos del presente estudio, para ello se ha partido de diferentes aproximaciones teóricas.

Singh (2002) afirma, que en la era industrial, la atención estaba enfocada en los bienes tangibles, pero que en la era postindustrial, la atención se centra en la producción y el uso de bienes intangibles, relacionados con la información y el conocimiento. Del mismo modo, sostiene que en la era industrial la persona promedio estaba más preocupada por los bienes materiales, pero que en la emergente *sociedad de la información*, la persona promedio está más interesada en aspectos psicológicos y espirituales de la existencia, afirmando que de esta manera, mediante la digitalización se ha pasado *"de átomos a bits"*.

Shedroff (2009) por su parte propone, que con la informacionalización se pueda replantear un problema y su contexto, en donde por medio de la reducción de recursos se logre convertir *"algo en casi nada"*, a modo de buscar como objetivo principal el tratar de enviar mensajes, recetas, datos, etc. cuando sea y donde sea, para que ese algo en sí mismo -material o inmaterial-, pueda ser replicado en el destino.

En el contexto del diseño de productos y de acuerdo a planteamientos como los propuestos por Vezzoli & Manzini (2008), referentes a la digitalización de productos o algunos de sus componentes; Garetti, Rosa, & Terzi (2012), proponen una optimización general para alcanzar una condición más sostenible, la cual sólo puede obtenerse mediante la acumulación y la eficiente gestión de un profundo conocimiento de todo el ciclo de vida del sistema, y la implementación de herramientas avanzadas.

En esta misma dirección, Stevels (2007) afirma que mediante los avances en las tecnologías y la *digitalización,* se fortalece la entrega de más funciones por unidad de carga ambiental. Lo cual puede ser aprovechado a nivel de producto y servicio, con el fin de sustituir la *Tecnología Mecánica* (TM) por *Tecnologías de la Información* (TI) y *Tecnología Óptica* (TO) o combinar TM, TI y TO de manera inteligente. Esto ya está sucediendo con los actuales *Smartphones* y *Tablets*, así como con la transformación de productos en servicios, lo cual, además de haber generado una revolución frente al diseño clásico, disminuye notablemente las cargas ambientales, y va en línea con el aumento de satisfacción emocional del usuario/consumidor.

Desde esta perspectiva, y con base en los anteriores planteamientos, a continuación se nombrarán algunos ejemplos del principio de *digitalización -informacionalización-,* en donde algunos productos y servicios están desapareciendo y otros han cambiado su estado en bits a partir de átomos. En la música, por ejemplo, lo que anteriormente eran medios fisicos como, discos, casetes, discos compactos, han sido desplazados por la música digital, y en la misma línea se pueden nombrar:

- El video digital, como tecnología de grabacion de imágenes
- El correo electrónico, como servicio de envío y recepción de mensajes y archivos digitales (documentos, imágenes, audios, videos, etc.)
- Los libros digitales (eBooks), como versión electrónica o digital de un libro
- La fotografía digital, como reemplazo a la fotografía química
- Los documentos digitales, que ganan terreno sobre los impresos
- Las herramientas de diseño asistido por ordenador (CAD, CAE, CAM)[10], que permiten la simulación y pruebas virtuales, de productos modelados digitalmente.

Aunque en estos ejemplos, se ha cambiado el estado de los elementos de atomos a bits, para que haya una interfaz entre el usuario/consumidor y el elemento se necesita de un medio que lo permita, sea este: un ordenador, reproductor de música, teléfono móvil, tablet, televisor, etc.; tamnién es importante resaltar,

[10] Por sus siglas en Inglés, Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), Computer Aided Engineering (CAE)

que puede haber oportunidades en donde estos elementos, se conviertan en material físico por acciones como una impresión, un revelado o una grabación.

2.4. Relación de las necesidades complementarias y las emociones con la sostenibilidad

Debido al enfoque del presente estudio, se reconocen otro tipo de necesidades complementarias de las personas como usuarios/ consumidores de productos y servicios, para indagar cómo diversas motivaciones y aspiraciones, que no son sólo necesidades básicas -como el beber alguna marca en especial de bebida en lugar de solamente agua-, son aspiraciones o motivaciones que se pueden dar en función de la sostenibilidad. Para analizarlo se recurre a los planteamientos de Maslow (1966), Max-Neef (1992) y Jackson & Marks (1999) sobre las necesidades, las formas de satisfacerlas y sus escalas o jerarquías.

Wigum (2004), basada en las nueve necesidades humanas fundamentales propuestas por Max-Neef (1992), afirma que estas se pueden dividir en *materiales* (subsistencia y protección) y *no materiales* (afecto, entendimiento, participación, ocio, creación, identidad y libertad), y que al menos en parte, pueden estar satisfechas por tanto satisfactores[11] materiales como no materiales.

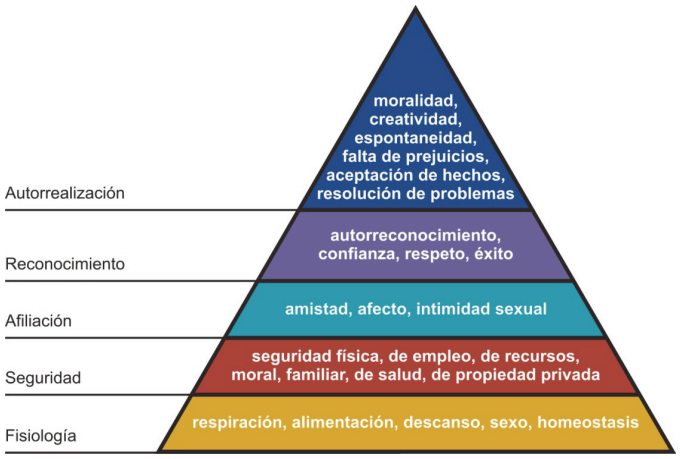

Fig. 3 Pirámide de Maslow – jerarquía de necesidades. Fuente: adaptado de Bartiaux et al (2011)

Por otro lado, se ha tomado como referencia la clasificación de necesidades de Maslow (1943), derivando que, gran parte de los componentes del *contexto inmaterial* que se relacionan con la sostenibilidad, se encontrarían en la parte superior de la jerarquía de necesidades. Estas necesidades de reconocimiento, pertenencia y autorrealización pueden estar relacionadas con aspectos emocionales, afectivos, espirituales y valores pertenecientes a la *dimensión inmaterial* en búsqueda de la sostenibilidad.

Para analizar la dimensión emocional, se toma el concepto de *"la experiencia del producto"* de Desmet & Hekkert (2007), el cual emplean para referirse a todas las posibles experiencias afectivas involucradas en la interacción producto-humano. Ellos afirman que la interacción producto-humano no sólo se refiere a la interacción instrumental, sino también a la no instrumental, e incluso la interacción no-física. En ese mismo sentido, Nagamachi (1995) afirma, que los consumidores son exigentes en la elección de los productos en términos de su demanda y preferencias. En la actualidad los consumidores son más sofisticados y desean que los productos se ajusten a sus propios sentimientos de diseño, funcionalidad y precio. Un ejemplo de ello ocurre en Japón, donde basados en el *"Valor KANSEI"* (2007), se pregunta a

[11] Los *satisfactores,* son formas de ser, tener, hacer y estar, de carácter individual y colectivo, conducentes a la actualización de necesidades.

usuarios/consumidores comunes, sobre sus necesidades y recomendaciones para desarrollar productos o servicios que despierten emociones, empatía o resonancia simpática. En este sentido, Vezzoli & Manzini (2008) afirman, que al tener en cuenta la demanda de satisfacción en nuevos sistemas producto-servicio, se ofrecen diferentes -y más sostenibles- formas de obtener resultados, que podrían convertirse en socialmente apreciados y al mismo tiempo radicalmente favorables para el medio ambiente.

Planteamientos como los anteriores, sobre la relación de algunas necesidades humanas y emociones con la sostenibilidad, apoyan el enfoque que se propone sobre aspectos pertenecientes a un *contexto inmaterial*, del *sistema exterior* del MDC, abordados desde una perspectiva sistémica.

3. Metodología – Planteamiento metodológico

El presente estudio es realizado de forma descriptiva para analizar, si dinámicas de *desmaterialización y digitalización* o *informacionalización* de productos y servicios están relacionadas con la satisfacción de las actuales motivaciones (necesidades, emociones y valores) en los usuarios/consumidores. Con base en un trabajo anterior de los autores, y desde una perspectiva sistémica en la que se establecieron un *contexto material* y un *contexto inmaterial*, como derivaciones del *sistema exterior* del MDC; se pretende establecer si hay una conexión de estas dinámicas y las actuales motivaciones de los usuarios/consumidores con la sostenibilidad.

La investigación es descriptiva correlacional, para lo cual, basándose en investigaciones y teorías sobre actuales dinámicas de *desmaterialización y digitalización* de productos y servicios, así como en estudios sobre las necesidades del ser humano (Maslow 1966, Max-Neef 1992, Jackson & Marks 1999), las emociones y la relación usuario-producto (Desmet & Hekkert 2007, Mugge et al, 2007, Vezzoli & Manzini 2008), por medio del análisis de un estudio de caso, se logre establecer si estos factores pueden estar relacionados con la sostenibilidad, desde un *contexto inmaterial*, en el cual se busque llegar a productos cada vez más desmaterializados y digitalizados que afecten menos el medio ambiente.

4. Estudio de caso

En la actualidad, algunos productos han desaparecido (VHS, Betamax, casetes de música, máquinas de escribir, etc.), mientras que otros han sido reemplazados por un solo dispositivo (teléfonos, videograbadoras, reproductores de música, calculadoras, GPS, grabadoras, etc.). Aunque actualmente se siguen fabricando muchos de estos productos, se debe resaltar que algo ha cambiado en algunos de ellos; han evolucionado de cómo eran anteriormente en términos de volumen y peso. Los libros se siguen fabricando, a pesar de los ebooks o la enciclopedia británica, después de haber sido reconocida como algo icónico durante más de dos siglos, desaparece como -hecho- *medio material* y evoluciona hacia un *medio virtual e inmaterial*, disponible en la red como una nueva vía de acceder al conocimiento.

Con base en las anteriores teorías y planteamientos, como estudio de caso, se establece que el *contexto inmaterial* puede estar presente en la cotidianidad, sin ser percibido. Para ello, como ejemplo práctico se plantea el siguiente supuesto en el que:

> *Una persona puede estar retirada de la ciudad, por decir algo, a 50 kilómetros de la zona urbana en un entorno rural, y desde ahí acceder a una serie de servicios que le brindan las funciones y aplicaciones de su Smartphone.*

En tiempos pasados esto era muy difícil, por no decir imposible de lograr, debido a que en algunos dispositivos, su volumen, su peso o su conectividad eran un impedimento (teléfono, contestador,

ordenador, televisor, reproductor de música, radio, etc.), donde en el mejor de los casos, se debían elegir algunos de estos objetos/elementos para llevar consigo. Hoy en día, esta situación ha cambiado, ya que en algunas ocasiones con solamente un dispositivo es posible: hacer llamadas, tomar fotos, grabar videos, escuchar música, jugar, ver películas y programas de Tv, así como conocer las condiciones atmosféricas y la geolocalización del lugar en el que se está; todo esto sin contar, que con el desarrollo de nuevas aplicaciones se amplía el espectro de funciones de este tipo de dispositivos.

Fig. 4 Desmaterialización y digitalización de productos y servicios. Fuente: elaboración propia

Lo que se pretende con el anterior supuesto, es reafirmar que hay una *contexto inmaterial* que está presente y tiene una relación directa con la plenitud, las necesidades y las motivaciones reales de la gente, en donde la *desmaterialización* y la *digitalización o informacionalización* de productos y servicios contibuyen al desarrollo de todo este fenómeno. Esto se refuerza con el planteameinto de otro caso hipotético en el cual:

La misma persona, que se retira a 50 kilometros del entorno urbano, pero suponiendo que disponga del dinero y los medios de desplazarse con esos equipos físicos e independientes enrtre sí (teléfono, contestador, televisor, reproductor de música, reproductor de video, radio, calendario, etc.), podría generar aspectos negativos en relación con la plenitud de la experiencia y sus motivaciones, además del impacto negativo que causaría en el medioambiente.

Es importante en este punto, hablar de experiencia, satisfacción y bienestar, pues si se evalúa objetivamente a la persona que se desplaza los 50 kilometros de la ciudad, en estos términos, tendría que cargar con "X kilos de productos", para suplir las mismas necesidades/funciones con algo que pesa alrededor de 140 gramos. En el primer supuesto, no tiene lugar el evaluar la calidad de algunas de las funciones que suple un sólo dispositivo, porque es evidente que la calidad de un Tv plasma, es mucho mejor, al igual que las fotografías que se pueden lograr con una cámara réflex; aquí se trata de lo básico,

de las funciones básicas y cómo ellas en su conjunto pueden generar una mayor experiencia, satisfacción y bienestar en el usuario con un menor peso y volumen.

Fig.5 Caso de diseño – teléfono inteligente (iPhone 4). Fuente: (iMore, 2016)

Al respecto, Wahl & Baxter (2008), citando a Buchanan (1992) destacan el que el poder creativo detrás del pensamiento de diseño se encuentra en *"pasar a la modalidad de imposibilidad"*, y reconocer que lo imposible "realmente sólo puede ser una limitación de la imaginación que puede ser superada por el mejor pensamiento del diseño". Además, también sugiere que el pensamiento de diseño en este contexto es "no pensar dirigido hacia una "solución tecnológica rápida" en hardware, sino hacia nuevas integraciones de signos, cosas, acciones y el ambiente que aborden las necesidades concretas y los valores de los seres humanos en diversas circunstancias". Para ello, es necesario analizar la relación entre los aspectos motivacionales de las personas y lo que caracteriza a la sostenibilidad "hoy en día", para encontrar las verdaderas motivaciones en el uso de productos y servicios y "no" lo que las empresas suponen o sugieren. En este sentido, se podría seguir adelante y cambiar la perspectiva, olvidando el producto o servicio en sí mismo y pensar acerca de las funciones que los usuarios/consumidores necesitan.

5. Discusión

La *dimensión inmaterial* en productos y servicios, es una realidad y está presente en la actualidad. No se puede dar por sentado, a priori, que la gente conoce el concepto "*inmaterial*", se cree que la gente puede comprender que hay un *contexto material* y un *contexto inmaterial*, no solamente porque esté de acuerdo o no, sino porque efectivamente está ocurriendo. Hay un proceso de desmaterialización y de cubrir más necesidades con menos productos, lo cual puede ser evidente en los sistemas producto-servicio. Como ejemplo de ello están, Ascensores Schindler que cambian a vender servicios de transporte vertical en lugar de ascensores; o la empresa Rank Xerox, quienes ofrecen servicios de reproducción a la medida del cliente en vez de vender solamente fotocopiadoras (Stahel, 1998). Este fenomeno se presenta en la actualidad desde empresas que cambian de ofrecer y vender productos a ofrecer servicios, hasta los actuales smartphones y tablets, que integran varios elementos y productos, mediante sus aplicaciones en

uno solo. Esta nueva forma de interpretar el actual desarrollo de productos y servicios, está basado en anañlizar "*lo que la gente quiere y aspira"*, así como "*el por qué lo necesita"*. Aquí cuando se habla de aspiraciones, necesidades, motivaciones, se refiere a lo que motiva a la gente a adquirir algo, lo cual va en línea con esa *dimensión inmaterial*.

Volviendo al caso de Xerox, la marca no desarrolla su estrategia desde la óptica de la sostenibilidad, sino desde una perspectiva de negocio mediante la cual pudieran mejorar sus servicios, y que al mismo tiempo esto se viera reflejado en el aumento de sus ingresos; al parecer sin darse cuenta, que ese modelo al mismo tiempo favorece la sostenibilidad.

… ahora, según el actual desarrollo de las cosas/objetos/dispositivos, la relación de los usuarios, con base en sus aspiraciones, necesidades y motivaciones, y reconociendo la existencia de ese *contexto inmaterial* y su posible relación con la sostenibilidad, es necesario preguntar:

¿La generación de menos objetos pero con más funciones, realmente estaría relacionado con la sostenibilidad?

¿Tienen los procesos actuales de desmaterialización y digitalización o informacionalización de productos y servicios, una relación con una mayor sensación de plenitud de esas funciones?

¿Cuál es la tendencia de la sostenibilidad, en relación con esa valoración de lo inmaterial?

Desde el punto de vista de tendencias, se cree que hay una tendencia hacia la dismiución productos, pues anteriormente eran necesarios más productos que satisficieran -cubrieran- las necesidades de la gente, mientras que hoy en día, en algunos casos esta satisfacción se puede alcanzar con un solo producto (multifuncionales, smartphones, tablets, etc.). Lo anterior se puede traducir en que, hoy en día , "con menos productos, la experiencia individual aumenta, porque se pueden realizar muchas actividades, mediante las funciones y servicios integrados en un solo elemento". Muchas cosas cambian de formato y dejan de ser tangibles, para convertirse en intangibles.

6. Conclusiones

A través del desarrollo de los contenidos tratados, se asume que el aporte del presente estudio, además de reconocer la existencia de un *contexto material* y un *contexto inmaterial* desde una perspectiva sistémica, es el de identificar desde la *intangibilidad*, algunos puntos clave generadores de sostenibilidad. Para este propósito, se ha analizado cómo ésta realidad del *contexto inmaterial*, que además es tendencia, puede apoyar la sostenibilidad, por el "sólo hecho" de ser características, aspectos, rasgos a los que la gente le da valor; a modo de alcanzar las expectativas y motivaciones más profundas de los usuarios, lo cual puede coadyuvar a que se demande mucho más la sostenibilidad.

Anteriormente los usuarios experimentaban una fragmentación de la relación uso-función con los productos/cosas, esto significa que un producto realizaba "una y sólo una función" por lo que eran necesarios más productos que realizaran funciones específicas; esto si se toma desde la perspectiva de la sostenibilidad significaría la utilización de más materiales y por consiguiente, más volumen y más peso; lo cual a su vez, hacía que la experiencia individual fuera menor porque estaba más fragmentada. En la actualidad se presenta un fenómeno opuesto, en donde, con menos productos se puede alcanzar una mayor experiencia individual; ya que en algunos casos sólo un dispositivo, puede abarcar un mayor número de los dispositivos, productos o elementos que en otros tiempos se utilizaban; lo cual está directamente relacionado con la sostenibilidad. Resultado de lo anterior se concluye lo siguiente:

"Hay una relación directa de la desmaterialización y digitalización o informacionalización de productos y servicios con las motivaciones (necesidades, emociones y valores) de los usuarios; en donde, por medio de una reducción de materiales - volumen y peso-, un menor consumo de materias primas y energía en producción y uso, además de la optimización funcional –entre otros–, se favorece la sostenibilidad, y al mismo tiempo componen ese contexto inmaterial que involucra aspectos emocionales de satisfacción y bienestar de los usuarios".

Por último, aunque se reconoce una *dimensión inmaterial* que está relacionada con las necesidades, aspectos emocionales y/o valores de los usuarios/consumidores, en donde dinámicas de desmaterialización *y digitalización* o *informacionalización* han contribuido a la desaparición de algunos productos, mientras que otros, han evolucionado pasando de ser elementos materiales a ser elemenntos inmateriales o servicios, es probable que en algún momento de la interfaz PRODUCTO/SERVICIO-HUMANO, sea necesario tener en cuenta elementos materiales (p. ej. teléfono móvil, tablet, ordenador, televisor…) como medios que permitan la interacción entre el humano y el producto o servicio, así como otro tipo de conexiones (p. ej. energía, internet, datos, fibra…) que consoliden la plenitud de la experiencia y la satisfacción de las demandas, necesidades, emociones y valores de los usuarios/consumidores. Lo anterior refleja que desde un enfoque de *diseño inmaterial*, así como de dinámicas de *desmaterialización y digitalización* o *informacionalización* de productos y servicios, se contribuye a la redución del impacto ambiental causado por el consumo intensivo de elementos materiales.

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Opportunities and challenges in teaching Systemic Design

The evoluation of the Open Systems master courses at Politecnico di Torino

Barbero, Silvia

Department of Architecture and Design, Politecnico di Torino, Italy. silvia.barbero@polito.it

Abstract

The contamination between design and theory of systems as a field of development of new design processes is nowadays consolidated. However, the issue concerning the methodology to apply in teaching systemic design remains an open question.

The approach adopted in the Master Degree in Systemic Design at Politecnico di Torino is based on the assumption that the teaching method must itself be systemic. Alongside designers, the degree course has involved from the very beginning experts from different disciplines (i.e. chemistry, physics, mechanics, history, economy and management) as teachers, in order to create a multidisciplinary environment for the development of projects. Born as master degree in academic year 2002-03 at Politecnico di Torino (Italy) from the close collaboration with Gunter Pauli, the course has changed name and form but not the content, until it reached the current title (a.y. 2015-16): master degree "Aurelio Peccei" in Systemic Design.

The Open Systems course has enabled students, in early years, to experiment the design of production processes. This was the case of the systemic project done with NN Europe, a company engaged in manufacturing ball bearings, in which the output management allows a positive economic impact. Over the years the course has shifted its focus from the production process of a single product to the wider company context. In 2010, the approach has been applied to the agricultural enterprise Ortofruit: starting from agricultural production, the students have defined the production system and the relationships with the market. Systemic Design, during this course, has experienced the transition from the design of industrial processes that are closely linked to the territory, and then enhance local resources, to the design of the whole territorial system.

The work done by the students of the course in recent years has led to the definition of scenarios about fields usually distant from the traditional design world. For example, the definition of the economic model, the corporate model that is built around relationships on cooperation with different disciplines.

This transition, from the product to the entire territorial system, allows the exploration of new contexts, but it also puts the designer in a complex and challenging position in according with complex theories.

Keywords: *systemic design, education, sustainability*

1. Background

Teaching, and learning, is a complex process that involve many variables with non linear accumulative effects (Dhindsa et al., 2010). The complexity doesn't decrease with the higher level of education, neither when the content of the lectures is related to the the Complexity Theories. That is exactly the case that we are going to discuss in this paper, because we analize the educational model in teaching Systemic Design Theories and its relation with the other Complexity Theories at Master Degree level (Politecnico di Torino).

More studies bring the research-practice gap in education changing research methodologies that modify the teachers as collabborators (Krockover & Shepardson, 1995) or the teachers as researchers (Pekarek, Krockover, & Shepardson, 1996). Krockover & Shepardson, in their introduction of the Journal of Research in Science Teaching (1995) underlined the need of "a more holistic image of education in which researchers investigate the interplay among the learner, the teacher, and the nature of the curriculum, instruction, and assessment". The new figure of teacher has a systemic view of schools and community, in order to develop a collaborative relationship with students.

From the classical meaning of the word education, it derived from the Latin ex-ducere, so "draw forth from within". This concept emphasize the fact that the teacher should not put in information in students, but the learner build internal representations of new experiences in relation to past experiences (Anderson 1992). This kind of education was formally defined as Costructivist Learning Theory (Piaget, 1950), with its psycological applications, for axample with Bodner, 1986; Driver & Oldham, 1986; Novak & Gowin, 1984; Von-Glasersfeld, 1988. This theory is based on the active role of the learner in costructing interpretations of experience and in sharing with others common cultural experiences, in order to organize a set of informations. In that perspective, "the most important single factor influencing learning is 'what the learner already knows' " (Ausubel et al. 1978). Building a knowledge in memory is strictly connected with the ability of reasoning, understand concepts, and connect them with prior conceptions. Those kind of activities are crucial for effective learning, because they require a process of setting many information at a time, which is facilitated by the organisation of prior knowledge (Mitchell & Lawson, 1988). Hence, the teaching tecniques should help the students to organize their knowledge in memory and enhance learning of complex scientific ideas. The students should be actively involved in order to reconciliate disparate prior conceptions with more scientifically accepted new information in order to resolve inconsistencies, represent scientific content in a conceptual way, and build the knowledge organisation (Ebenezer and Gaskell 1995; Linder 1993; Nieswandt 2001; Smith et al. 1993). Therefore, in this process in which new information are built, the previous knowledge may be subjected to transformations, such as conceptual growth or, even, change because the learner actively attempt ways to merge new insights within existing frameworks.

The Constructivist Learning Theory comes from the same theroetical basis of the more recent Systemic Design Approach, that is the content of the lectures we are going to analyse and discuss. The use of Constructivist Learning Theory in theaching Systemic Design is coherent and effective.

The complexity theories evolved on the basis of the General Systems Theory by Karl Ludwig von Bertalanffy (1968), so some of the next rationales applied this theory on different artificial systems, such as the Generative Science. This trans-, inter-, and multi-disciplinary theory explores the natural world and its complex behaviours as a generative process (McCulloch et al., 1948; Wiener, 1948). From General Systems Theory have grown ideas within diversified areas, exemplified by the ecosystem ecology by Eugene Odum (1975), the living systems by Fritjof Capra (1997), the organizational theory by Peter Senge (1990), the financial research related to human resource development by Richard A. Swanson (1988), and so on.

The Systemic Design theory considers productive industrial organization as complex adaptive systems with the same behavoiur as the Nature has, where there is no waste because all the substances are used as resources by another natural reign. This approach comes from the Cluster Theory (Porter, 1990), the Industrial Ecology (Frosh & Gallopoulos, 1989) and the Industrial Symbiosis (Chertow, 2000).

The content of those theories are complex and need a large number of information already in the prior knowledge of the learner, so they were usually taught at Master of Science level of degree. At Politecnico di Torino, the academic curriculum in design has three levels, and in the first one (bachelor degree) just some theoretical basis on Systemic Design are taught, but in the second level (master degree) is totally focus on it, not by chance its name is "Systemic Design, titled to Aurelio Peccei", and in the third level (PhD corse) the research and the learning in that topic is mixed. In that paper we are going to go in deep with the teaching and learning of Systemic Design in the Master degree because it is the most crucial moment for learners.

2. Aims and Objectives

This study aims to examine the educational model used to teach complexity theories at university training and its benefit in the professional carriers of the students in different working activities. In additon, the specific analysis on the master degree courses in Systemic Design at Politecnico di Torino is used to answer the following research questions:

1- the use of teaching/learning theory close to complexity approach, like Costructivist Learning Theory, is beneficial in teaching/learning the complexity theories, like Systemic Design topic?

2- What are the competences needed for teachers and students?

3- What are the tools and the tecniques used by teachers in the process of new information acquisition by the learners?

2.1 Methodology

The subjects of this study were the students and professors of the Master Degree at Politecnico di Torino in Ecodesign, since academic year 2002-03, and then in Systemic Design, since academic year 2015-16. The students are about 100 per year (except for the first three years, where we can see an esponencial growing from 20 students to 80), and they are coming half from the other italian universities and half from the rest of the world with different academic and cultural background. Prior to being in the master classes, they had different academic curricula, not only in design but also in architecture and engineer. The lessons were in English despite it is the second or third language for both students and teachers. To have a complete documentation about the nature of the experimentation, we have collected data using observation instruments and students' visual mapping and reports.

The observation is made up of two components: the former is the historical evolution of the structure and content of the master courses in Open Systems at Master Degree in Ecodesign/Systemic Design (Politecnico di Torino), the latter is the actual learning model used in the lectures by different professors in the same course. The historical evolution analysis considers the wide changes in the organisation of the courses and the content of the project during the years (from academic year 2002-03 to 2015-16), in order to verify if there is an increasing of complexity also in the way to face the Systemic Design projects. The analysis on the actual learning model goes in deep on the taught methodology, in order to understand the convergence between the model and the content.

The limit related to these two observation is the absence of comparison with other courses in some other institution, but unfortunatly any other university in the world has an entire master degree course lasting two years in that topic with the contribution of many disciplines. Many other universities have singular course on Systemic Design and Complexity Theories that last one year, at maximum.

The final considerations of these two observation are enriched with the Alma Laurea's data about the rate of satisfaction of students and their rate of employment after the degree, in order to understand the real benefit in their career and what kind of information pass through the long term memory. The Alma Laurea is an Italian consortium that groups 72 university in the Country, with the purposes of collect the evaluation from graduates and of publish their curricula to match with the job market. This data set is extremely interesting because it collects first hand information from the primary engaged actors and because it keeps track of time and its changes.

3. Results and discussion

The Master Degree in Ecodesign/Systemic Design at Politecnico di Torino has involved from the very beginning experts from different disciplines (i.e. chemistry, physics, mechanics, history, economy and management) as teachers, in order to create a multidisciplinary environment for the development of projects. Born as master degree in academic year 2002-03 at Politecnico di Torino (Italy) from the close collaboration with the economist Gunter Pauli, in the last year, the course has changed name and form in Systemic Design, titled to "Aurelio Peccei". This master degree was organized in 4 modules: Virtual Design, Innovation, Product Components, and Open Systems (in chronological order, once a semester). Those modules have an increased complexity in the taught contents, and especially the first one gives the basic also for the visual representation of multiform concepts. Each semester a single complex project should be designed by the students with the help of different disciplines, explained by different professors.

In the last years, one more modules was added (Atelier inside/outside) in collaboration with the master degree in Architecture, so students can freely choose between this one and Innovation. The enlargement in the academic offer it is a way for the students to define better their competences and curricula.

The Open Systems course is mandatory and it is the last course before the degree. It includes contributions in various disciplinary fields (see figure 1): Systemic Design (design), Environmental Sustainability Processes (engineering), History and theories of Systems (humanities), and Economical evaluation of projects (economics). The core teaching in this module is the configuration of a new development model (economic and social) in which the outputs of a system become input of another one (Bistagnino, 2009).

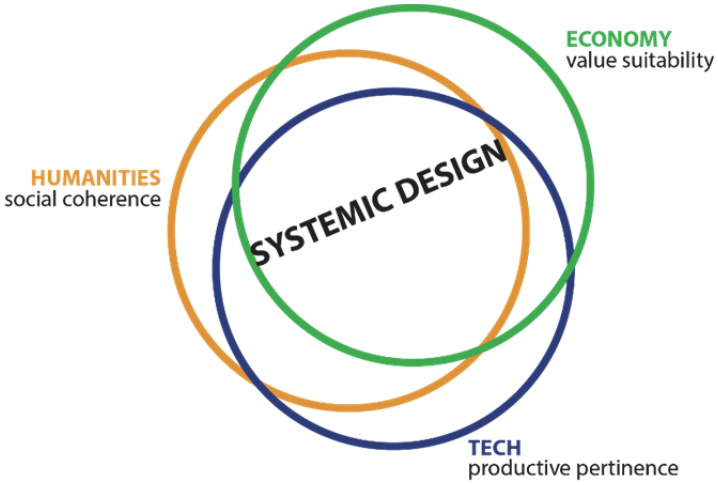

Fig. 1 Disciplines contribution to Systemic Design.

The projects developed in Open Systems module have seen an evolution in content: in early years, the students experimented the design of production processes related to single product, then of wider company context, and of industrial processes that are closely linked to the territory, and its local resources, and finally the design of the whole territorial system. The first step of this escalation was the case of the systemic project done with NN Europe, a company engaged in manufacturing ball bearings, in which the output management allows a positive economic impact. The second one, around year 2010, was the project with the agricultural enterprise Ortofruit, that has many different industrial processes and gives the chance to understand the relationships between local production and the market. The last step involves the students in the definition of scenarios about fields usually distant from the traditional design world; for example, the definition of economical model, the corporate model and other cultural paradigms (see figure 2). This transition, from the product to the entire territorial system, allows the exploration of new contexts, and puts the designers in a complex and challenging position in according with complex theories.

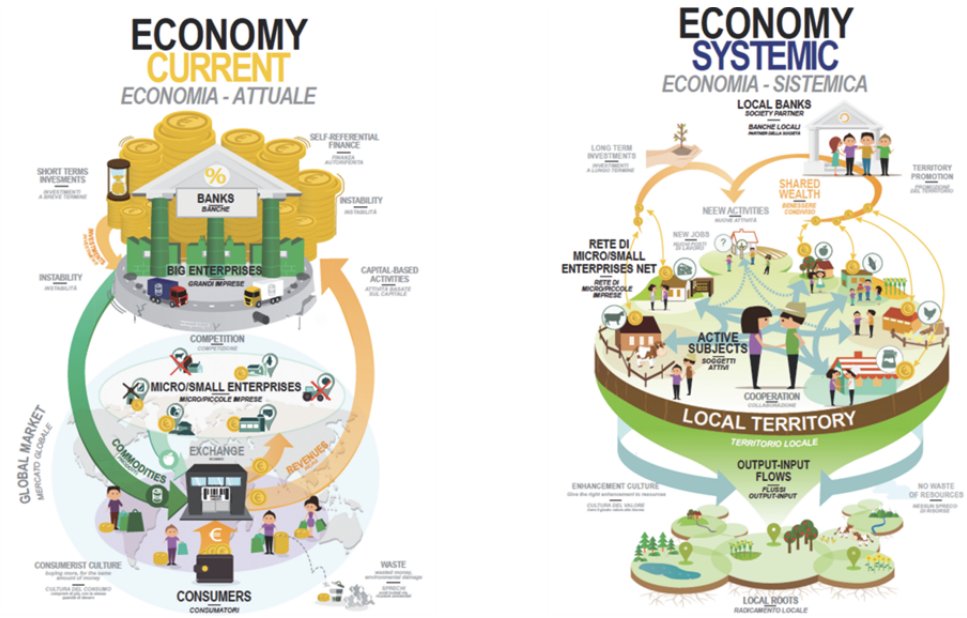

Fig. 2 Results of Open System module at academic year 2015-16 with different cultural paradigms.

The methodology taught and applied in Systemic Design project consists of a preliminary Holistic Diagnosis, the definition of design eco-guidelines, the systemic design project and its implementation. The Holistic Diagnosis considers natural, anthropic, social and economic aspects of a context and it is organised in three steps (see figure 3):

1- desk reseach on Exhisting information, with a mix of quantitative and qualitative data (from database, statistics, reports, case studies, scientific reviews, general readings, to social media);

2- field research to Integrate information, with a mix of quantitative and qualitative data (from data recording, mapping, case studies analysis, survey, perception, to emphaty);

3- research synthesis with Information Design Visualization, in order to have the data correlation and its visualisation, the list of criticalities (needs, problems, etc.) and the lists of potentialities (resources, etc.)

The first two steps derives from the theories of Celaschi and Deserti (2007) about the combination of desk and field research in design processes; especially the reiteration of these two steps is marked by the gap analysis and the visual framing in order to fulfill all the information needed to complete the holistic diagnosis. The crucial function of visualisation will be deeper faced later on in this paper.

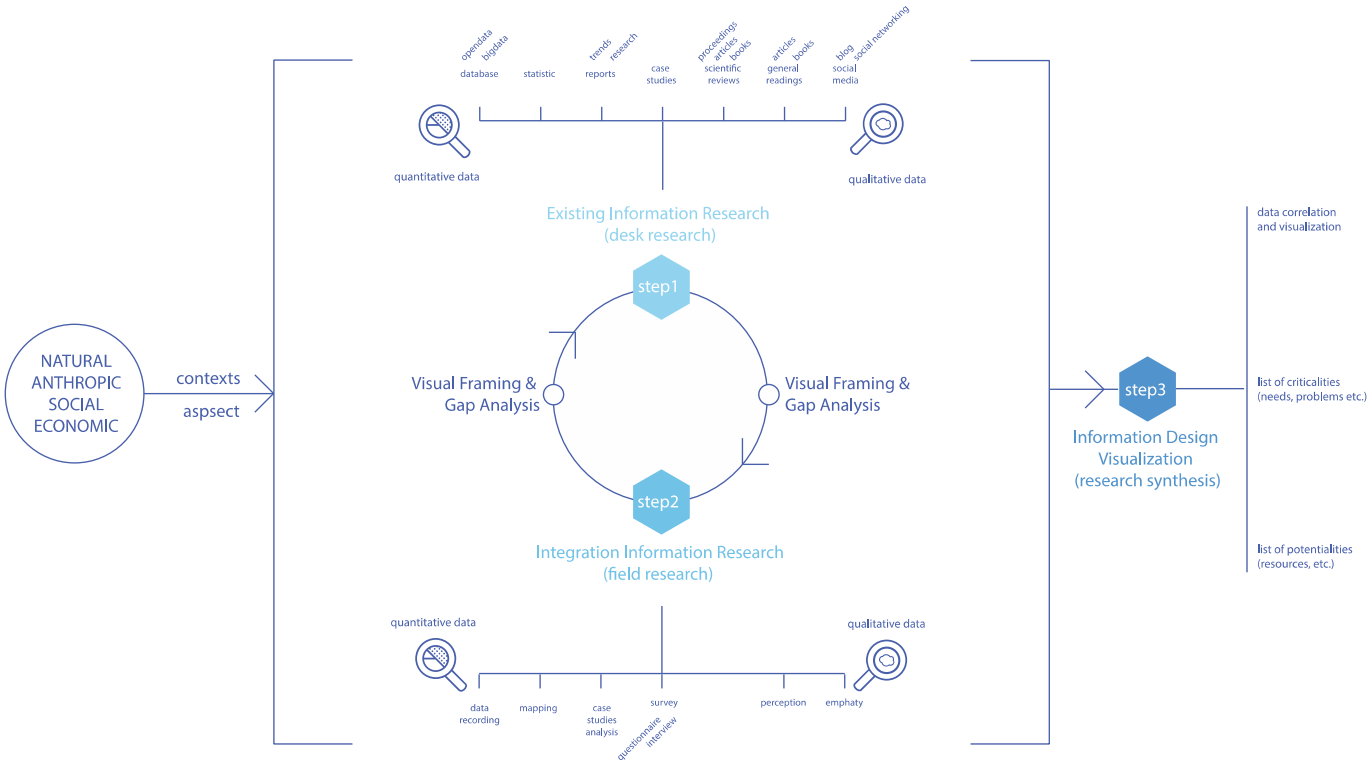

Fig. 3 Results of Open System module at academic year 2015-16 with different cultural paradigms.

With the complex data visualised in different maps and lists that underlines criticalities and potentialities, the designers can gather the design eco-guidelines in order to start the design of the entire system. The goal of the design phase is to optimize all the energy and material flows in the system and to valorize all the waste as resources, in order to obtain zero emissions. The last phase is the implementation of the system with the realization of the system in the specific context and the evaluation of the feasibility of

new business plan. The implementation of the project gives a lot of new input to improve the project and let it autopoietic (Maturana et al., 1972).

During the lectures, students are challenged by new experiences that require them to rethink their understanding based on scientific evidence from past experiences. The work is organised in small group in order to foster contrasting ideas, encourage reflection on experimental data, and motivate them to evaluate again and again prior ideas in relation to emerging evidence. In this way the students are forced in a conceptual change process where the brain actively interprets new experiences based on the mobilization of stored information in memory as a framework for the new knowledge construction (Anderson, 1992). One of the crucial aspect in the development of the lecture is the use of visual mind mapping by the students, every time new information and concepts come out. This is a technique of representing knowledge by organizing it as a network or other non-linear diagram incorporating verbal and symbolic elements. In general, this technique is consistent with modern constructivist approaches to learning, and emphasize the active involvement of the learners who utilizes existing knowledge structures to construct new knowledge by inter-relating new content with existing knowledge in memory. Longo, Anderson and Wicht (2002) demontrated how this tecnique helps the students to organize their knowledge and make it more salient in long-term memory, compared to the more traditional lecture-centered format of teaching. Mind mapping teaching techniques, compared to some traditional methods that emphasize ‘‘knowledge transmission from expert teacher to novice students,’’ are more student-centered and involve students’ active participation in the learning process. During discussion, students were encouraged to share ideas and reach an agreed-upon structure for the organisation of their ideas, and to fix them in visual maps. In such a student-centered learning environment, the students have a crucial role in the organisation of learning activities, in order to build a more effective and efficient set of new knowledge. However, a limited number of organised lecture presentations are included, assuming that the teacher has taken care to determine the prior status of the students’ learning and to engage them in multi-modal learning activities. The quality of information organised in students’ cognitive structures help them to reconstruct correct information quickly and to accurately answer questions during discussions and examinations. Thus the constructivist-visual mind map teaching approach may enhance more broadly students not only in academic performance, but, better, in solving problems in daily life.

Recovering the data from Alma Laurea, we can say that this Master of Science is dense of contents, so generally students take a little more time than the convential 2 year to reach their degree. However, the final score is high, on average: about 30% students gain the 110 with honors. Furthermore, the data shows a good interection between students-professors, with highest rates about the satisfaction of students in the availability of teachers (83%). A very positive rate is given to the general satisfaction of the degree course, with the 88% of positive answers and the 63% of the graduates that state their wish to sign up again in the same master degree. To confirm this data, we have done a cross-evaluation with the data collected in “Comitato Paritetico per la Didattica” (CPD) Questionnaires by Politecnico di Torino, supervisioned by the internal Joint Committee for Education. In those questionnaires the students reveals the high utility in attendance the educational activities for learning purposes (64%).

Reflection on learning outcomes and market demand is mirrored in the results of the consultation with the professional members of the Consulta, that confirmed the validity and effectiveness of the Master Degree as a whole. About the employment status, one year after the graduation, the 73% of graduates work in the systemic design field.

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