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Transdisciplinary Design: Tamed complexity through new collaboration

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ABSTRACT

The following essay aims to expose the characteristics of Transdisciplinary Design and its relationship with design thinking, applying both as complex problem-solving strategies. In order to achieve this, we must briefly explore the characteristics of design thinking and non-uni-disciplinary strategies and subsequently describe the reasons why design can be considered as a privileged platform for problem-solving strategies for the more complex problematics of our contemporary society; ranging from transdisciplinary design as well as the differences with regard to design thinking model.

Keywords: transdisciplinarity, design, complexity, design thinking, non-disciplinary approaches.

Introduction

Nowadays, it does not take much effort to understand that the world we live in is complex. Uncertainty is more and more present these days; change and continuous novelty, social and cultural plurality, as well as chaos in our environments affect our daily lives in diverse ways. However, the recognition of our environment as complex and the study of the relationships between the systems that conforms it (physical or human), construct and transform our knowledge and the way we behave individually and collectively. This is something new in contemporary thinking. A complex system according to Morin, "is the whole of events, actions, interactions, feedbacks, determinations and risks involved, that constitute our phenomenal world. So, complexity presents itself with the disturbing features of the tangled, the inextricable, the disorder, the ambiguity, and the uncertainty" (1994, p. 32, authors' translation). However, complex systems present some things in common: first, a complex collective behavior; complex systems are formed of individual components, like cells, ants, neurons, consumers or network users, is the collective actions of a vast number of components which generates complexity. Second, they are similar in the way they process information; all complex systems produce and use information from both internal and external environments. Finally, all complex systems are self-adapted through learning or evolutionary processes (Mitchell, 2009, p. 14).

Today, looks like design disciplines has been increase their tasks and responsibilities, not only in the creation of new and innovative artifacts, but also as an agent of social change, that seek the solution to phenomena that were previously distant from their work. Making design, more comprehensive in the search of solutions for problem solving.

In volume 5 of the *Journal of Design Strategies* (2012), published to commemorate the founding of the Master's degree for transdisciplinary design at Parsons University in New York, designer Jamer Hunt exposes some of the reasons that gave birth to the degree:

> *From the vexing challenges of sustainable growth to the disintegration of the United States nineteenth-century infrastructure; from the intractable complications of risky human settlement patterns to the perverse co-presence of obesity and hunger epidemics in developed and developing countries; and from problems in our own backyard to those of global span: the world is on fire and many of us believe that design can play a role in extinguishing some of the blazes. Or at least that it is time for practitioners of design to move on from projects that privilege stylistic novelty to ones that grapple with meaningful social change role, designers must refocus their gaze from the object or artifact of the design process to the complex systems that contextualize it. This shift—from artifacts to systems—mirrors the global shift in industrialized countries from manufacturing and goods based economies to ones built upon services, information, and innovation. When designers are no longer shaping objects, buildings, and letterforms but processes of innovation and change, the rules of the game and the terms of engagement must evolve as well (Hunt, 2012, p. 6).*

Hunt explains that even months after the first twenty students had started the Master's degree in transdisciplinary

design, the question "So what is transdisciplinary design?" was still largely unanswered, and he believes it possible that it will never be fully answered, so he proposes that there must be set conditions for designers to work in a transdisciplinary environment, without yielding to the temptation of making it into a new separate discipline (2012, p. 6).

The present article aims to contribute to the debate by highlighting traits present in transdisciplinary design in relation to other forms of collaborative design that are included in what we recognize as design thinking.

From what we learn from Hunt we can sustain that nowadays we live in a complex world, to understand it, we must approach it from various angles of the human experience in a multifaceted approach. For the socio-cultural areas, now more than ever, we require a broader scope, one capable of integrate diverse knowledge, in proof a better life quality, social integration, and the cultural enrichment of the contemporary societies. In lieu of these changes, the new non-disciplinary approaches contribute more seamlessly to the understanding and problem-solving of the more complex problematics. These approaches involve the participation of more than one discipline, with the interaction between them as a key factor, which in some occasions may even surpass the frontiers of their existing work frames. Among these types, transdisciplinary approaches presented as the most inclusive and the best alternative for the integration of various concepts available to the numerous stakeholders that constitute and form the human environment.

For its part, design understood as "a cognitive-project oriented activity in charge of the visualization to produce artefacts, images, environments, and locations, to simplify what we denominate as the construction of an area" (Gonzalez and Torres, 2012, p. 69, authors' translation). On this order, the design has positioned itself as essential to our contemporary culture, as an economic driving force and an essential piece of the cultural identity of the individuals in the 21st century.

Design thinking

At the turn of the century, design began to be recognized as an economic generator *per se*, going beyond the cosmetic finish of a product and a tool for commercialization, to become a key factor in the construction of our contemporary age, led by globalization and neoliberal economies.

This recognition is in part owed to its application in diverse areas of the economy through what we today know as design thinking, a concept that is generally used to describe the cognitive process by which designers apply creative thinking or lateral thinking alongside critical or rational thinking for the achievement of an objective.

Its origins can be traced back to 1969 when Herbert Simon in his book *The Science of the Artificial*, exposes a new way of thinking for design, much in the same way that Robert McKim later explains in his work titled *Visual Thinking* published in 1973. Both refer to the different forms of thought involved in design to approach and solve problems in contrast to other disciplines. However, the first to coin the term was Peter Rowe in his book *Design Thinking* published in 1987, in which he provides a more systematic approach to the design process involved in architecture and urban planning, something which Rowe claims every designer is capable of apply.

Its conceptualization and mass use is owed to Tim Brown, a professor from the engineering school at Stanford University and creator of the consultant *Ideo.com*, he described with profound detail this new concept in his article "Design thinking" (2008), in his work Brown states that innovation is driven by a solid comprehension, which is only attainable through observation of what people want, and need in their lives, what they like and dislike about the way a product is fabricated, packaged, sold and their support of various products. For Brown design thinking is "a discipline that uses the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity" (Brown, 2008, p. 86). He adds that design thinking is a creative, iterative and practical user-centered approach (2008, p. 92).

In other words, design thinking looks to find definitive solutions to necessities or problems through the application of a systematic perspective centered on the user and geared towards generating an economic gain for the client and a competitive advantage in the markets, in contrast with other business models, where it is understood as a processes that describe the way in which an organization produces, distributes and captures value, some examples of these are: the subscription model, the lure and hook, the pyramid or multilevel to name a few.

To achieve this, Brown (2008) explains that a designer who works with the concepts of design thinking must meet certain criteria, as Figure 1 illustrates. The first is empathy, they must be capable of analyze the world from different perspectives, which will allow them to imagine solutions that are inherently desirable and are capable of meeting explicit or implicit needs. Secondly, they must develop an inclusive thought process; they must be capable of appreciate all aspects of a complex problem (from a broader perspective than that offered by the analytical process, even though it is seen from the designer's point of view) and create novel solutions beyond those already available. They must also be optimistic, and be aware that even though there are multiple challenges ahead there is at least one solution that is better than the already existing ones. Another characteristic is to possess a liking for experimentation, which will propel them to explore beyond the limits of a perceived phenomenon and formulate questions that will lead them to find a novel solution in previously unchartered directions. Lastly, they must be collaborative, that is, they must have the ability to interact with other knowledge beyond their own area, given the ever-growing complexity of the products, services, and experiences available today (p. 86-87).

Since then design thinking has become such a relevant business tool that the magazine *Business Week* dedicated an article to it, titled "How business is adopting design thinking" (Wong, 2009) in which it describes how some of the larger brands such as General Electric, Procter & Gamble, and Phillips Electronics use it as a tool to promote innovation.

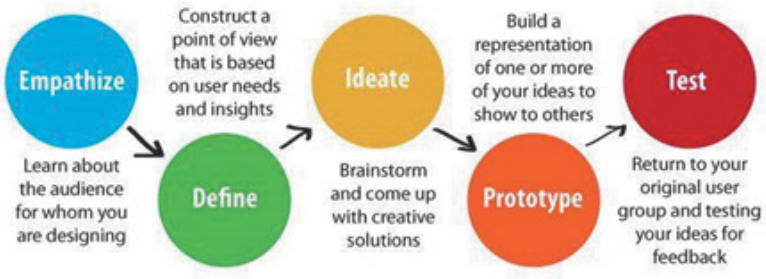

Figure 1. The illustration shows the principal steps in the design process from the design thinking perspective (Chen and Alladi, 2013).

The non-disciplinary approaches

We must clarify before proceeding, that this essay does not deny the importance of work discipline, nor does it proclaim their extinction or replacement; the various subject areas by themselves have solved a number of problems and figured out how a lot of phenomena happens (social, cultural, natural, geological, biological, etc.), however, we argue that the disciplinary approach has a limited view of the objects that it studies and is no longer enough to solve some of the problems of contemporary complex societies.

Although the various disciplines, including the design disciplines, are able to respond to certain issues in a more individual character, when we are faced with a complex problem, the set of variables (if we look at the problem in its full context) and the relationships between them can be so large, it is impossible to address them and answer them from a uni-disciplinary perspective, therefore a new lens is required to address the complexities of today's world, one with greater amplitude, but also better oriented in its problem-solving capacities.

This new vision is described by many as multidisciplinary, interdisciplinary or transdisciplinary approaches, among others. They share a commonality in that they are defined from what is considered normal, i.e., disciplinary knowledge.

While the methods mentioned here deal with complex problems from different approaches across disciplines, the kind of problems they address, how they interact across disciplines and the resulting products are all different. It is also important to note that we should not consider such approaches as opposites, or as disciplines in themselves, but rather as a succession of levels of interaction between disciplines.

What we know as discipline or uni-disciplinary approach is an approach to practice and research that recognizes one discipline as responsible for studying or solving the problems of a society, which is the normal or traditional way of solving problems.

Michael Gibbons refers to this approach as *mode 1* to refer to science discipline whose academic interest is mostly oriented towards knowledge production. That is, its primary objective is to produce theoretical knowledge about physical and human nature. His organization model is normally found in universities, by areas and departments, their quality control systems are developed from peer review and the results of their research are published in journals (Gibbons *et al.*, 1997, p. 13).

Thus, a disciplinary field can be defined as a group of people working with the same object of study, trying to answer a specific set of research questions and sharing the same paradigms, methodologies, concepts, techniques and common theories (Kuhn, 1962; Boradkar, 2010).

Contrary to the disciplinary approaches, the non-uni-disciplinary approach involves the participation of more than one discipline and its goal is mostly the application of knowledge in solving complex problems. These approaches are described by Gibbons as *Mode 2* and are characterized by being practice-oriented so its objective is not so much to discover the laws and principles of nature but the study of the complex systems themselves.

Mode 2 is heterogeneous in terms of the actors involved in these approaches; they are diverse in their origins and not exclusively found in universities. Moreover, since they are oriented to specific problems, non-uni-disciplinary fields are in constant flux.

Also, these areas are less likely to have peer review and they tend to include citations from other disciplines beyond that pertaining to the researcher, quality control systems include various actions such as usability and social analysis (Gibbons *et al.*, 1997, p. 17-18).

Practitioners of this type of approach, as expressed by John Robinson:

> *[…] do not find themselves at the margins between disciplines, but in the sometimes uncomfortable borderlands between the academy and the larger world. They tend to start from real world issues and move from there into the arena of scholarly knowledge. This means that the criteria with which they select from among the various forms and types of knowledge differ from those that would be suggested if the starting point was the problems and puzzles emerging from within the academic enterprise itself. Such practitioners, familiar with the fact that the real-world issues they are trying to address are not easily expressed in terms of disciplinary knowledge (life tends to present itself as a seamless whole) are often, but not necessarily, somewhat critical of disciplinarity itself, and are typically more interested in creating forms of knowledge that are inherently useful, rather than in creating new disciplines. That is, their interest lies more in reaching across disciplines for a particular purpose than in filling in the gaps between them (Robinson, 2008, p. 72).*

Because non-uni-disciplinary approaches are relatively new, there is often some confusion about their definition, characteristics, and scope. This is reflected in the tendency to encompass all non-uni-disciplinary approaches under the concept of *interdisciplinary*. However, there are very definite differences between the multi, inter and transdisciplinary approaches, so we really need to continue to define the characteristics of each.

To begin with, the term multi comes from the Latin adjective *Multus* referring too much, numerous, abundant, an example of its use is the word multicolor, meaning many colors (Estrada *et al.*, 2010, p. 21). The multidisciplinary approach involves a central discipline which makes use of various disciplines to study a complex phenomenon. To do this, each discipline addresses the phenomenon from its own perspective and using its own methods of analysis.

The multidisciplinary approach brings the participant disciplines close together momentarily, but the boundaries between each are clear and they do not mix. Therefore, although many perspectives are shared during the multidisciplinary interaction, the goal is to serve the discipline that initiated the collaboration, so once the problem has been solved, each discipline returns to their area of study and none of them loses its specificity.

Thus, although there is the contribution of various disciplines when a problem arises, they do not necessarily work together on a solution and collaboration amongst participants is not entirely required (Mobjökj, 2009, p. 21). Also, since in this approach there is no integration of results at the end of the work or a development of new theoretical perspectives, the multidisciplinary approach is way beyond the boundaries of disciplinarity, but its goal is limited to the framework of disciplinary research (Nicolescu, 1996, p. 19).

On the above, Manfred Max-Neef (2005, p. 1) argues that from this approach:

> *A person may have studied, simultaneously or in sequence, more than one area of knowledge, without making any connections between them. One may, for example, become competent in Chemistry, Sociology and Linguistics, without generating any cooperation between the disciplines. Multidisciplinary teams of researchers or technicians are common and frequent nowadays. In them, the members carry out their analyses separately, as seen from the perspective of their individual disciplines, the final result being a series of reports pasted together, without any integrating synthesis.*

Unlike the multidisciplinary approach, the interdisciplinary approach *-inter* (a preposition) meaning between, amongst, between one thing and another implies a higher level of interaction between disciplines involved. While in the multidisciplinary approach each discipline is maintained within its framework, in the interdisciplinary approach there is sharing from one discipline to another: methods, theories, tools and models (Thompson, 2010, p. 15), and sometimes it's even likely that a new discipline or sub-discipline arises, such as neurobiology, astrophysics or bio-art.

Furthermore, the results obtained through interdisciplinary approaches tend to have greater coherence and integration than those of the multidisciplinary approach, due to the increase in information that the participating disciplines share. Therefore, participation in this type of study produces an extensive range of learning opportunities for those involved, mainly because interdisciplinary approaches are focusing on issues and problems of the real world. This creates connections between different disciplinary fields, integrating knowledge and improving critical thinking and collaboration between teams. It is worth mentioning that although this approach allows us to create a new synergy to transfer knowledge between different disciplines in order to deepen and solve problems of a complex nature, the interdisciplinary approach does not assume to understand the complexity of the context, but only solve a specific problem within that context.

Therefore, to solve or study even more complex problems that involve various issues at the same time such as poverty, discrimination, sustainability, exploitation, oppression, globalization, capitalist ideology and the free market, it is necessary that we reach a deeper level of discipline interaction, a level that goes beyond the lens of the multidisciplinary and the interactions of interdisciplinary, it is this cooperation of disciplinary frameworks we refer to as transdisciplinary.

Basarab Nicolescu argues that transdisciplinary – the *trans* prefix meaning through, between and beyond disciplines, is a relatively new perspective in the history of human knowledge, and he explains that although the word transdisciplinary may have been used previously, this term applied to the need to consider a new field of knowledge was raised by Piaget in 1970 at the international workshop *Interdisciplinarity-problems of teaching and research in universities.*

In 1985, Nicolescu proposes the inclusion of the definition beyond disciplines; the same term he developed in several articles and books. A key date in the development of transdisciplinarity was the adoption in 1994 of the Transdisciplinarity letter by participants in the *First World Congress of Transdisciplinarity* in the convent of Arrábida, Portugal.

In it, Nicolescu poses a unifying and diverse development of transdisciplinarity; unifying, not in the sense of a total science but of the unification of different disciplinary knowledge to solve complex problems; and different, because the relationship between diversity and unity is inherent in transdisciplinarity (Nicolescu, 2006a, p. 21).

We can say, following Gibbons, that unlike other approaches, the transdisciplinary approach is characterized in part by not only the use of disciplines (systematized knowledge) as actors in solving complex problems, but by also involving actors who are outside of the disciplines (incorporation of non-systematized knowledge): institutions, universities, laboratories, governments, social groups and individuals, to name a few.

This allows us to search for solutions from a wider perspective, capable of integrating diverse knowledge in a series of results that may ultimately be of no use to all actors -disciplinary or not, involved in its solution. Also, the complex problems that can be solved by this approach are generally unique in their context, so that the results applied in a particular context can hardly apply in the same way elsewhere.

Table 1. Main differences between levels of interaction discipline.

	Main objectives	Outstanding characteristics	Evaluation method
Disciplinary	Generate knowledge	• Objective • Homogeneous • Paradigmatic • Subject/object • Mark common research	• Peer review • Publication in journals of the same discipline.
Multidisciplinary	Generate knowledge	The combination of various disciplines without overstepping their boundaries. Example: Social studies combine various disciplines such as geography, political science, sociology, and psychology, without them necessarily sharing their disciplinary frameworks.	• Review by specialists in the area who initiated the investigation. • Publication in journals of the discipline that initiated the investigation.
Interdisciplinary	Generate knowledge	• The combination of disciplinary frameworks. • Can lead to new disciplines or sub-disciplines. • Example: biochemistry, social or environmental psychology, etc.	• Review by specialists from different disciplines • Publication In magazines from different disciplines from the author.
Transdisciplinary	Problem solving	• Approximation from various knowledge fields, disciplinary and non-disciplinary. • Heterogeneous • There is no method, it is constructed according to the development of the problem. • Subjective • The need to develop tools for the interaction of various actors. • Involvement of the observer.	• Contextual-truths, based on interpretation. • Dissemination at the same time as the project develops.

Source: Moreno (2015).

In addition, projects have initially no methodology to follow, but rather it is created as the project develops. This generally makes for new methods of integration among participants needed in a project of this kind. Another interesting feature of transdisciplinarity is that an approach from this perspective is not possible from an individual standpoint[1], which may be possible in other disciplinary approaches, thus this introduces the team to highly complex dynamics.

In addition, unlike the *Mode 1* (discipline), where the results are given through institutional channels, in *Mode 2* (non-uni-disciplinary), the results are communicated to those who participated in the project and thereby the dissemination of results is initially achieved, in a sense, within the same production process. Finally, transdisciplinarity "is the dynamic that a particular solution can become the cognitive site from which you can make further advances, but predicting where that knowledge will be applied and developed is as difficult as determining their possible applications" (Gibbons *et al.*, 1997, p. 17, authors' translation).

In addition to the above, since the production of knowledge from this approach is heterogeneous, transdisciplinarity gives us a lot of places where it is possible to generate knowledge, in other words, that knowledge is no longer produced only in universities, but it brings forth diverse places such as companies, research centers, government institutions and even public spaces. Therefore, the transdisciplinary way of work involves generating strategies that allow the correct interaction between the project stakeholders.

Nicolescu says transdisciplinarity is fully developed and ready to be applied, and he explains that in the past "[...] our actions were concentrated in the field of education, a fact that is natural because of the central role of it in individual and social life. But now we have an ethical obligation to extend our activities to the scientific, social, political and spiritual sectors" (2006b, p. 20, authors' translation).

As Moreno details in Table 1, each level of discipline involves a level of complexity which includes particularities of the study. Moreno establishes, that generating knowledge is not the main goal of transdisciplinarity, but instead is responsible for solving complex problems. It also does not follow an established method. So, it becomes subjective, constructing its own method depending on the problem and the various actors involved in it.

Potential of transdisciplinary applied in design

As mentioned, the design has positioned itself as part of the culture of contemporary cities, not only as a producer of objects of material culture but as an essential part of the culture in the 21st century. Also, the design has proven through its history, have the ability to solve very differ-

[1] The multidisciplinary subject is able by itself to master varying knowledge and address an issue on these (e.g. people with various degrees or graduate degrees). The interdisciplinary subject is able to master one or more knowledge fields and have the ability to adopt theories, concepts and techniques from other areas to solve a problem; however, the transdisciplinary subject does not necessarily require more knowledge – because as there is no integration of all the sciences in the subject, the subject is unable to know everything – but he does require special communication skills that allow for working with other social actors, by discussing and negotiating solutions to help solve complex problems, which means in principle that it cannot be achieved by the individual itself.

ent problems. Joel Towers (2012) in introducing the issue dedicated to the transdisciplinary design published in the *Journal of Design Strategies* exposes the following manner:

> *In fields as diverse as education and disaster relief, designers are contributing not just to the conception and development of innovative new products, scenarios, and systems, but also to the effective planning and management of the development processes themselves. Indeed, an emerging hallmark of designers today is precisely their ability to engage productively with a wide range of other sources of knowledge and expertise. In a world beset by intractable problems whose complexity defies resolution within the terms of any single professional perspective, collaboration across disciplines is itself becoming a sine qua non of effective action (Towers, 2012, p. 3).*

However, the change proposed one design that can expand its boundaries to complex problems and it requires a deeper explanation. Why is design essential to address the complexity? And what makes it conducive to work from the transdisciplinary approach?

Most of the things we do require at least interaction with an object and actions, such as shopping requires (consciously or not) of the interaction of the person with various artifacts (products, shelves, carts, etc.) that intertwine in turn with the surroundings (corridors, signs, etc.). These interactions generate complex situations. Take, for example, urban public space. In many systems, we interact with very different levels. If we start only with the material level: the first of which are the objects of public space (buildings, furniture, and signage), the second of them are the objects outside the public space that bring the user. In the third place are those outside the user objects (which bring with other users); relations generated between subject-object these three levels we have a whole complex, which is further mixed with concepts such as identity, ideology, tastes, customs and power relations, to name a few. Understanding how these relationships are being built is the first step in solving this kind of problems. Therefore, we must accept in principle the existence of the complex and its influence on certain aspects of our daily lives, from this design can help us master the complexity, through the design of artifacts. These should be comprehensible, must contain logic that allows those who use them (once understand that logic) handle quite easily "[…] the major issue is understanding: things we understand are no longer complicated, no longer confusing" (Norman, 2011, p. 4). An example of this are the controls on an airplane; they are complex but are arranged so that a pilot understands its complexity, at least for him. However, some seemingly simple things (such as urban space) are highly complex because to understand them properly, it is necessary to have knowledge about the culture, customs and behavior and human interaction.

One of the ways in which design in partnership with other disciplines such as Psychology can help you understand the complex is through the construction of conceptual models. Norman (2011, p. 35) defined it as "a conceptual model is the structure underlying beliefs that a person has about how something works (artifacts, customs, social life, etc.)". When we move files from one folder to another on the interface of our computer, we are using the mental model that designers carefully selected to facilitate this action. The conceptual model, also called mental models[2] (Martínez-Val, 2004, p. 217), exist in the minds of people and allow us to transform complex realities in mind easy to understand concepts. That's why they are important tools to organize and understand the complexity. Mental models manifest themselves as knowledge structures or media devices and how to make sense of conduct and action. For example, our mental model of what is a beach, allows us to be surrounded by people in beachwear with tranquility. We would not have this if the situation were to occur in the office or on the streets of the city. According to Donald Norman "the designer's job is to provide people with appropriate conceptual models", and adds that "conceptual models apply to almost everything we do in life, the more complex the activity, the more important the conceptual model" (2011, p. 40). The conceptual models set the difference for an individual to declare if something is simple or complex. The better relationship between the individual and the conceptual model will be simpler for him/her, the development of the action, or the use of an object, space or interface (some conceptual models are schemes, mimesis, i.e., see what others do and customs).

According to the previously stated, Norman concludes that "complexity can be tamed, but it requires considerable effort to do it well. Decreasing the number of buttons and displays is not the solution. The solution is to understand the total system, to design it in a way that allows all the pieces fit nicely together" (2011, p. 46). Clearly, this raises the idea that we may sometimes use not one, but many mindsets that must interact with each other [often at the same time] so that the subject understands them as a whole, i.e., in relation to the context in which they are registered and used. Therefore, managing complexity is not as simple as developing and connecting a series of conceptual models. Larry Tesler, vice president of Apple says "make one part of the system simpler and the rest of the system will get more complex" (Norman, 2011). This principle is known today as, the *law of the conservation of complexity* or, Tesler's law which states that "one cannot reduce the complexity of a task beyond a certain point. Having reached this point, it is only possible to move the complexity from place to place" (Norman, 2011, p. 46). An example would be the transmission of an automobile, which allows the driver to move easily; however, transmission as a set of mechanical gears, hydraulic fluids, sensors and electronic controls is extremely complex; by simplifying one part of the system (the driver) the other (transmission) becomes more complex. Tesler's

[2] A mental model, understood from psychology, is a representation of a state of affairs of the outside world. It is a form of knowledge representation recognized by many researchers in cognitive sciences, being the natural way by which the human mind constructs reality, conceived alternatives and verifies hypothesis when it enters a mental simulation process. The term mental models used to refer to sets of skills or knowledge that is homomorphic (or isomorphic) with a certain system of the external world; such knowledge can be represented by a set of propositions or a set of images (Johnson-Laird, 1983, p. 1-5).

law establishes the search for balance in a complex system and in turn raises the impossibility of achieving something ideal. For this reason, it is advisable not to focus on finding the best solution possible, but to develop initial solutions and from there work on their improvement, in this way we can achieve better control the efforts and focus them on what the user really needs.

Therefore, regarding the subject-object interaction, we can establish the following, according to Llovet:

> *A design problem needs not be more complex by the simple fact, that the design of the object or signal be more laborious [...] a design problem becomes more complex as the network of contextual relationships in which it is or can be found becomes more intricate. In this sense to design an engine can be more laborious but no more complex than designing a house; an engine must simply be able to pull a train, while housing must hold one of the social structures most critical and full of variables that exist in our society [family] and mark the center of their operation and progress in many aspects: labor, parental, idle, educational, sexual, aesthetic, psychological, and so on (1981, p. 19, authors' translation).*

We must assume the nature of the systems, meaning that changes made in one part have consequences on a whole. And that this whole can affect the systems overlap. "The design then (in conjunction with other disciplines such as sociology and communication among others) could be part of the solution if customers, the public and governments raise strategies to address the problems effectively" (Heskett, 2005, p. 62, authors' translation). However, to achieve this it can only be done through dialogue between social partners and not through disciplinary monologs as is done nowadays. We must understand that

> *the objects are the result of various social practices developed by a large number of actors [designers, engineers, marketers, journalists, consumers, etc.], and theories that seek to explain their cultural meanings cannot do without using a lens wide enough to include diverse perspectives (Boradkar, 2010, p. 21).*

Interest in transdisciplinary design is just developing, but already it's begun to present some approaches on the subject, like Fernando Martín Juez, who in his book *Contributions to an Anthropology of Design* states that:

> *Design problems, like those of anthropology -its issues, work programs, and strategies, proposals and solutions are transdisciplinary problems linking fields of varying complexity, which change their appearance and limits each time and always include, correlated, physical, biological and mind phenomena (2002, p. 128, authors' translation).*

While Martín Juez, in his book mostly develops the idea of the complex over transdisciplinary and concludes that:

> *The complex thought and transdisciplinarity with its wealth and potential commitments and implications will be the way it is design exercises anthropology: the way the design and anthropology, together, build objects of men and women; how, together, inquire to fully understand women and men who use such objects (2002, p. 135, authors' translation).*

It does not present much information about how to do it. Other papers posed similarly transdisciplinary approach without approach it beyond the bases presented by Martín Juez[3]. However, the most significant example of this interest can be found in the recent creation of the Master in transdisciplinary design at Parsons University in New York in 2012.

On the latter Jamer Hunt explains that "among other things, then, a transdisciplinary design is a connective, collaborative practice", and therefore "designers cannot go it alone when navigating issues in public health or disaster relief, for instance. These challenges defy a solitary approach" (2012, p. 7). If we consider this as true, the model of the heroic, lonely and omnipotent designer, is outlined insufficiently in complex conditions.

In addition, we must consider that collaboration is itself a complex process that requires experience and preparation. And in this sense, designers can contribute greatly to innovation due to the ease in handling arguments both critical and creative and experience in the use of various tools for creating ideas, as well as collection and analysis information. But also, designers who venture into such projects as decision makers need experience in collaborative methods, due to the need to coordinate multiple stakeholders to discover new methods and unique approaches to problems, not derived from a disciplinary approach but are validated by collective agreement among the participants. Therefore, we are convinced that the design is in a unique position to participate in finding solutions for certain complex issues from perspectives as transdisciplinarity. This thought would enhance designers interested in participating in this type of approach, enabling them to expand their scope and opportunities, both in theory and in practice.

We therefore believe that, speaking particularly of the design, it has evolved from being a discipline whose purpose was the development of products, – spaces, objects or communications – to a discipline able to understand the complexity of today's world and act with others social actors (disciplines, governments, society, etc.) in finding solutions for some of the problems facing our societies today.

Conclusion

So, on the understanding that theories related to key terms described here: complexity, design, and transdiscipli-

[3] The essay of Raúl Hernández Valdéz, The Sense of design, between the office and transdiscipline, published in the journal *Science and Society* in 2003, the articles of Olivia Fragoso Susunaga, Rotation of design: trans-disciplinarity and complexity, published in the magazine *Research Center* at the University La Salle in 2009 and The image of the design: the complex maze transdiscipline, published in 2011 in the same journal and diverse participation in forums such as Foroalfa are examples of approaches to the relationship between design and transdiscipline.

Table 2. Main characteristics between transdisciplinary design and design thinking.

Design thinking	Transdisciplinary design
It only involves the application of design thinking in solving a problem.	It implies the integration of design thoughts with other knowledge, for the resolution of a problem.
It can be applied to any problem.	Applies only to highly complex problems.
Users play a participatory role in any part of the project, but not necessarily in the identification and conceptualization of the problem.	All stakeholders are summoned for the identification and conceptualization of the problem.
Not necessarily involved with other disciplines.	Various social actors participate (disciplinary and non-disciplinary).
Design serves as a leader, it directs the actions.	Decisions are taken from the consensus of social actors, including design, and only if there is controversy design will have a dissenting vote.
Uses the discipline language.	Meta-language are created.
Proposes a unique solution.	It proposes evolutionary solutions, which consider emerging problems in the future.
The development of the project is established in the short and medium term.	The development of the project is established in the long term.

Source: Moreno (2015).

narity, are relatively new and therefore still in an ongoing process of discussion and construction; we must emphasize, at this point, some considerations about what we understand as transdisciplinary design here.

First, we must remember that transdisciplinarity is not the only existing approach to the interaction of knowledge, and therefore is not appropriate for the resolution of simple problems; disciplinary, multidisciplinary and interdisciplinary approaches are able to address and resolve a wide range of issues, some of them of some complexity. Similarly, the transdisciplinary design does not apply to simple problems where design intervenes, many of them can be addressed by different approaches.

Second, not all transdisciplinary projects can be addressed through design, so we must avoid thinking that the transdisciplinary design can address any phenomenon. In general, we propose that those complex projects involving many variables (e.g. insecurity, mobility, infrastructure, communication, etc.) and diverse needs (e.g. conceptualization, design and construction of spaces, environment, or visual communications devices) would be appropriate to be addressed by the transdisciplinary approach, one example is the urban environment and more particularly the public space. In this type of complex projects, design as a set of disciplines can serve as the decider. There are also another number of complex issues that include several topics such as poverty, insecurity, violence, etc., but do not have to do with the direct application of design. In these, the design may be involved as part of an interdisciplinary team, just like any other participant actor, and not as a decider. Similarly, there are other complex issues cutting transdisciplinary in which design would not be accommodated.

Third, when we talk about transdisciplinary design, we do not consider that the design can solve the problem by itself alone; as discussed, a problem of this nature requires the participation of various social actors involved according to the project, therefore, from here, when the concept of transdisciplinary design is used, we mean a set of diverse social actors, who are meeting to solve a complex problem, which involved considerably, design.

In this way, we could understand in the same way, the concepts of psychology, sociology, art or transdisciplinary engineering, as applicable.

The fourth characteristic of transdisciplinary design is the integration of actors from conceptualization of the problem and finally, the answers to the problems addressed from this approach will need to allow emergency, uncertainty, chaos, in other words, must be evolutionary.

As Moreno mentions in Table 2, all this generate many differences between what has been exposed as design thinking in contrast to the transdisciplinary design.

According to Moreno transdisciplinary design, as an innovative approach, can help build places of interaction, mobility, coexistence, and usefulness; where it can reduce and even marginalize the negative aspects that so far and invariably emerge in our cities. But to achieve this, we must first establish the necessary conditions – in academia, public policy and within society – so that various disciplines, design included amongst them, can work in a transdisciplinary way.

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