The Nature of Design through the Lenses of the Sociological Imagination

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Abstract

The purpose of this paper is to shed light on the nature of design by positioning it as a major sociocultural phenomenon. The goals are to produce an understanding of design that is general enough to apply to most kinds of design endeavors; to highlight its essence and nature; and to provide a foundation for discussing the issue of boundaries between design and other sociocultural phenomena that are often related to it. A major objective is to conceptualize design at a very high level of abstraction that can inform general design studies. Methodologically, we start with analyzing the process of artification, progress to the project delivery process, and then focus on modeling the core design act. Design is about organizing materiality or substrate and creating configurations (material or social) that have never existed before. We can conceptualize these configurations as models of artifacts that are submitted to the production facilities for manufacturing. The paper contributes a new vision about the essence of design; about its relationships with related social institutions; and proposes a methodological platform for approaching certain traditional issues of the design specialty disciplines in a new way.

1. Introduction

The definition of design might seem ubiquitous. We expect it in every article or textbook of design, in any lecture course or seminar. It might seem like a problem that design researchers have resolved long ago and now there is a consensus about what design is. For many scholars, it might seem this way; others might

disagree and point to the diversity of perspectives on this topic and a huge variety of conceptualizations and definitions. We are joining the second group.

We have conceptualized a problem situation regarding the nature of design. The conceptualization of a problem situation might emerge in many ways: from practice, from the state of the literature, from intensive discussions in the research community, and so forth. We have monitored the posts on a major design research discussion list for over twenty years. It is quite surprising that periodically there have been intensive discussions on what design is, how to define design, and how design is different from science. In most cases, the discussions show huge differences, and in many cases, the discussions end without consensus. Considering the various positions and perspectives voiced in the discussion, the disagreements, and the emerging conflicts, we can conceptualize a problem situation that calls for a study on the nature and boundaries of design. In this process, we have found that the demarcation of the boundaries of design is an issue that is important for getting to the nature or core of design. And tracing the boundaries of design informs us how design is different from other social institutions. This leads to a better understanding of the nature of design.

There is a vast body of literature discussing what design is, what the steps in the design process are, and how design is different or similar to a number of other intellectual phenomena. While reviewing the literature, our major intent was not "to search and destroy". In this case, we don't see much value in highlighting the shortcomings of thousands of definitions of design (although they can be classified in a much smaller number of categories). Our objective was to find concepts and definitions that can satisfy our understanding of design, its essence, and its boundaries. Our attitude was to find useful ideas, rather than to prove that there was a need for one more definition of design.

Many articles on design make a reference to or tacitly use a particular concept of design. This contributes to thousands of conceptualizations and definitions, presented explicitly or implicitly. They are distributed over hundreds of design specialty fields and their corresponding journals. The types of definitions and models of design that are at a very high level of abstraction are not numerous, but the deluge comes from the specialty fields when they try to very precisely define what design is in their domains. At the specialty level, the variety of definitions is enormous, contaminating the "field of vision," and even confusing both academics and practitioners. Many of the conceptualizations have been developed by focusing on different aspects or adding and recombining different components. Most of these definitions contain only small differences depending on the typical materiality and social purposes of the specialty field.

We can find a treasure throve of information in the works of prominent design theorists like Nigel Cross, John Gero, Ken Friedman, and a number of other established design scholars. We have learned an enormous amount from their perspectives on design, design problems, and the design processes. The magnitude of information and the variety of ideas is tremendous. We are aware of the requirements of the traditional approach to a formal literature review. This can

lead to a lengthy treatise, longer than a separate paper or a book chapter. In this paper, we prefer to make a reverence to the contributions of the design scholars and to use our publication space for presenting our ideas about the nature and boundaries of design. Besides, there is a substantial difference in emphasizing and highlighting ideas about the nature of design in papers and books that discuss many aspects of design, versus a paper dedicated exclusively to the nature and boundaries of design.

We also want to mention several publications that are not always at the top of the reading list, but they bring an abundance of definitions, models, and ideas about design (Clarkson & Eckert, 2005; De Lessio, Wynn, & Clarkson, 2019; Wynn & Clarkson, 2018). Many of them are from engineering design, but the authors have completed an extensive search, categorization, and organization, which can contribute to various other fields. Engineering design theoreticians have the benefit of communicating with a large number of different design specialty scholars, ranging from industrial design (with an emphasis on aesthetical issues) to ergonomic design (dealing with usability and social factors), and to mechanical engineering (working with materials and natural processes).

Our analysis of the literature and online discussions have led us to several conclusions: There is an enormous variety of conceptualizations and definitions of design, at different levels of abstractness, focusing on different aspects, coming from different design specialty traditions, using different terminological systems and professional jargon. The multitude of definitions and process models is not a shortcoming in itself. Each of the publications highlights different aspects, materialities and perceptions of their design specialties or domains. They all contribute in some way to the progress of design studies.

On the other hand, this variety creates quite a lot of complexity and tempts scholars to engage in clarifying, organizing, and presenting all these developments in matrices, frameworks, and classifications. In this respect, we will abstain from critiquing and adding to the multitude of definitions by modifying or rearranging existing phraseology. Our intent is to remove ourselves from this mind-boggling Tower of Babel and search for a productive approach to understanding the nature and boundaries of design. We will talk more about this approach in the methodological section below.

The purpose of this paper is to shed light on the nature of design by positioning it as a major sociocultural phenomenon. The goals are to produce an understanding of design that is general enough to apply to most kinds of design endeavors; to highlight its essence and nature; and to provide a foundation for discussing the issue of boundaries between design and other sociocultural phenomena that are often related. A major objective is to conceptualize design at a very high level of abstraction that can inform general design studies. To achieve this, in the process of our study, we will go to the core of design, the design act and differentiate it from other activities and acts in the design process. Although in our study we use various models of the design process, we do not intend to develop a new process model.

Considering the differences stemming from various materialities, ontological pictures, levels of methodological development, and professional reflections, it is no wonder that every time people look at the phenomenon of design from the perspective of their design specialty, they use their conceptual matrix or lenses and expect to see a confirmation for their understandings. This is the reason why so many discussions on the nature of design end with dissatisfaction, disillusionment, and sometimes disenfranchisement. The problem lies with the perspective, the disciplinary preconceptions, and often with personal bias.

If we, as a field, want to create a general understanding of design, we have to rise to the top of the problem and enter the realms of philosophy and general theory. In order to abstract the common core and the essential, we need to ignore the peculiarities that obscure the big picture. We believe that such a high level of abstraction will allow us to better see the essence of design. The present study can be considered as a philosophical and methodological exploration of the nature of design. This investigation is conducted at the level of general design studies or a general theory of design.

Bearing in mind that these issues dwell in the realm of philosophy and theory, we can afford to abstract, as well as to "trim" a multitude of dimensions, aspects, and traits. We want to engage in exploring and probing rather than proposing a definitive answer. This approach offers the liberty to experiment with new visions in order to chart a new proposal in a very, very fuzzy field.

Throughout this paper, we use implicit and explicit models of design, which are not the primary objective of this study. The use of design models is only a methodological move intended for exploring the nature and boundaries of design. If we mention models of design and design processes, we do so only as an ontological substrate needed for developing perspectives, conceptualizations, and new visions.

The conceptualizations presented in this paper are intended to work at a very general level of abstractness, envisioning design as both a human activity and as a social institution. Considering the enormous variety of design specialties, the general conceptualizations that are proposed here aim only at abstracting the essence of design. They are not proposed for structuring the empirical material of a particular design specialty or for surveying design definitions in the literature. In order to apply them in a specific domain, it is necessary to pass through several steps of operationalization, adaptation, and adjustments, which is another topic.

This paper brings a new vision about the essence of design and its boundaries. The boundary issues highlight the relationships of design and related social institutions. The paper also creates a foundation for approaching in a new way certain traditional issues in the design specialty disciplines. In order to produce these outcomes, we have designed a methodological platform that guides our exploration of design and provides directions for the next steps. On that basis, we have decided to use the concept of artification as the foundation for construing

several layers of processes that will progressively narrow down to the core of design. This will lead us to a new understanding of the essence of design. After that, we explore and demarcate the boundaries of design and the design specialty fields with the purpose of expanding our understanding of design and highlighting several important issues for future investigation. In the process of tracing the boundaries of design, we offer a proposal about the relationship between design and science, as well as incorporating a number of other social institutions.

2. Methodological Section

2.1. General Methodological Considerations

When working on a general concept of design, a number of problems arise because of the variety of activities included in the design process. These activities can range from the habitual and routine to the innovative and inventive. When there is little innovation and invention, the design activity looks very much like the activity for communicating a design to other people—usually drafting. And when the communication activity requires special skills and a particular level of proficiency like drafting and computer modeling, the design process is obscured by the communication process.

Several other aspects we consider are how explicit the core design component of any activity is, how much it is explicated and professionalized, and to what degree it is visible to researchers and designers. Also, there are many information and/or research activities that experts identify and place in the design realm. And there are managerial and logistic activities as in any other profession. This list can be expanded, but it is enough for this stage of our methodological process.

If we want to construe the essence of design, our best option is to reason at a very high level of abstraction. In this way, we will prevent numerous distractions by the peculiarities of each design specialty and would not be allured by the kaleidoscopic rearrangements of design components to stray in the wrong or secondary direction. This high level of abstraction helps to overcome tunnel vision and bias due to the complexity, fuzziness, and illusiveness of myriad of discipline-specific objects of design and definitions of design; the disciplinary traditions, thinking routines, and diverse discourses; and professional jingoism, to name just a few. Very often, these factors drive design theoreticians in the wrong direction and to wrong conclusions about design.

When theorizing about the nature of design at specialty discipline level or practice level, it is easier to focus and to understand the subject matter because we stay closer to the empirical. The narrow specialty has a "smaller" and clearer picture, which makes it easier to see the whole, to track its specific design process, and to set its boundaries. In such cases, we work with more specific and concrete concepts and terminology, which makes the process of conceptualization even easier. It is always easier to define something homogeneous than something very heterogeneous. Heterogeneity brings complexity, and complexity is a major chal-

lenge for our reasoning.

However, when working at the philosophical level, the empirical material from all those design specialties is so voluminous that it might be impossible to process and get anything out of it. In order to organize this voluminous information, we need to find a way to narrow the field of exploration and focus without losing the big picture. This is done with the help of first principles, very abstract frameworks, and conceptual structures that are so general that they can be imposed on almost every phenomenon with the intent to organize the information about it.

Very often the correct approach to a phenomenon is hindered by an untimely and unpractical goal to perfect all steps along the way. In this process, scholars get bogged down in minutia or at least in details that are not necessary at this time for reconstructing the big picture. And when we go to perfect the details, it can become a conundrum: how many phases and steps, which come first, which comes next, why we constantly see these steps in different orders, and so forth. This is natural, but at the same time in has to stop at a particular moment of time in order to introduce the big picture as a compass and a guide. Excessive engagement with the details, in particular in the design specialties, can distract from understanding design as a generic phenomenon. Excessive discussions and debates about certain issues might do more harm than good.

When exploring the nature of design in new ways, using unconventional approaches for this field, the problem with lack of adequate conceptualizations and terminology emerges very quickly. It becomes evident in the course of reviewing literature, in the process of writing, and when reflecting on novel ideas and suggestions. The conventional design discourses have a history; they are deeply imbedded in disciplinary and professional traditions; and they have the benefit in well-established conventions, shared conceptualizations, and terminological systems. The accepted terminology makes the discourse and mutual understanding immediate and effortless. Our approach to dealing with this terminological deficit is to use tentative conceptualizations as placeholders until better concepts and terms are developed (or designed). However, we are aware that such provisional terms may or may not work well for all readers.

2.2. Creating a Methodological Platform

Following the general methodological considerations, for the purpose of this paper, we have generated (or designed) a methodological platform to guide our explorations. The creation of the platform is influenced by sociological imagination, a term very popular in the sociological community. In effect, this is sociological thinking—the sociological counterpart of design thinking. In our case, the sociological thinking provides a methodological "umbrella" and amalgamates a composition of ontological entities, perspectives, and approaches that guide us to see design from several vantage points, yet keep us consistently focused on the nature of design and its localization in the universe of sociocultural processes.

In addition, there are several intellectual developments that shape our methodological reasoning: systems thinking, the notion of the artificial and a corresponding artification perspective, Activity Theory and the ensuing methodology, an institutional approach to social phenomena, and a genealogical approach to the emergence and institutionalization of activities. Systems thinking is coming back as a major approach to complex problems. The artification perspective drives us to see the things around us as products of human activities, designed and constructed by will. The institutional approach looks at social action to find recurring patterns that are codified, conventionalized, and reproduced. Activity Theory methodology is used to look at artification processes as purposeful actions and articulate them to focus on the core of design. The genealogical approach is used to understand phenomena by investigating the mechanisms of their emergence.

Systems Thinking (Banathy, 1996; Bedny & Karkowski, 2007; Luhmann, 2012) directs us to look at phenomena in their context and to approach them in iterative cycles from outside before delving into their inner structure. In this respect, system thinking works well with an artification perspective on our world. Both systems thinking and the notion of artification are very abstract and allow us to start the investigation from the highest levels of generality, covering a number of classes of phenomena under their umbrella. But they also can guide us to understand the essence of phenomena by demarcating them from outside and moving towards their core or essence. We are aware of the paradigmatic bias here, but at the same time our methodological reasoning guides us to take a "top-down" approach rather than to engage in generalizations from the empirical realm. Metaphorically stated, if we want to see the nature and boundaries of a phenomenon, we need to look from above and see the big picture.

The Artification Approach is a way to see the world as designed and manufactured rather than a constellation or ecology of naturally occurring objects in use. The book *The Sciences of the Artificial* (Simon, 1996) provides a general platform for thinking about the objects around us as products of social processes and activities. The artification perspective allows us to integrate and use Activity Theory methodology to create a particular way of interpreting and articulating the artification processes.

Activity Theory Approach (Bedny & Karwowski, 2007; Engeström, Miettinen, & Punamäki, 1999; Kaptelinin & Nardi, 2006; Lektorskii, 1990; Leont'ev, 1978) is popular in Human-Computer Interaction, although not well known in the rest of design fields. Our choice of an Activity Theory version is based on the need to see the artification processes in more concrete ways, as activities. The constant switching between the concepts of process and activity will facilitate the transitions between different levels of abstraction as needed, in order to understand better design as an activity with its particular object of action, process structure, and boundaries.

In this study, activity is conceptualized as a complex, multifaceted, hierarchi-

cally organized matrix (lattice). It is comprised of heterogeneous components, different in form and content; components that change, transform, complement, or are interchangeable. Each of them can at any moment become an organizing core and then, at the next stage, another element will take the lead position. The number and type of active components and the emergence of a central element are contingent on the specificity of the larger environment, the goals, resources, and policies. The "boundaries" of the activity system are set by the subjects/agents of activity: individual agents, groups, and organizations. The dynamic nature of the activity is manifested most openly in the change of the organizing elements, the shift in the significance of the components and the connections between them, that is to say, the shift in the importance of the different structures of the system (Lektorskii, 1990; Leont'ev, 1978).

From an Activity Theory perspective, the design process can be articulated in tasks (or steps). It can also be seen as a sheaf of processes, going on parallel in time, or starting and ending at different but coordinated points. Metaphorically, the sheaf can be interwoven, twisted, warped, etc., because of the complex interactions of different sub-processes and tasks. The coordination of different processes in time is complex because different tasks might have different durations. The sub-processes and the tasks feed their results into the subsequent tasks and processes. If we what to replicate and teach activity processes, we need to explicate and articulate them, thus producing a method to guide us in the replication.

The Social Institution Approach is interpreted, here, as a way to help position design as a social phenomenon. In the realm of social philosophy and sociology, authors agree that there is a wide variety of views and conceptualizations of the phenomenon of institution. Our interpretation of institution is based on, and derived from, Giddens (1984: p. 24) and Turner (1997: p. 6). Giddens offers a very wide and inclusive view, considering as institutions all phenomena with enduring features of social life, providing continuity, functioning as mechanisms of sociocultural maintenance and reproduction. This point of view allows us to see major and widely accepted social institutions, such as science, art, religion, myth and others, together with activity systems that are socially approved, supported, and maintained over time, like design. In fact, this view provides the opportunity to talk about institutionalization of every reoccurring human action as long as it is widely accepted, codified, and maintained over time. We would like to take the notion of codification as the major defining factor when we talk about design as an institution. The moment we start a discussion on design with the purpose to clarify what it is, how it has to be done, and how to reproduce it as a profession, design is institutionalized. Actually, the very fact that we talk about design as a profession indicates the institutionalization of design.

Looking at design as a social institution has several advantages when discussing its capacity to produce knowledge and its relationship with science. Exploring these relationships is important for seeing the connections with other social institutions and other entities in the artification processes in a complimentary way and consequently, for charting the boundaries of design. In turn, the issue

about the boundaries of design leads to a better understanding of the nature of design. We can see how the nature of design informs about the boundaries, and how the boundaries inform about the nature of design. The institutional approach will help us compare and contrast design with other major institutions in order to better understand their interconnections. We can better trace the inputs and outputs, the division of labor, and the cooperative system. We can see the overlaps and the "gray" areas with other institutions, as well as the boundary conditions.

The Genealogical Approach will allow us to understand better the nature of design by tracking its trajectory from its social emergence to its present situation. The genealogical approach also relates design to its larger context in a complimentary way compared to the systems, activity, and institutional perspectives, and allows us to triangulate the ideas about the boundaries of design.

Design has a long history, bridging centuries and epochs (Friedman, 2016). However, as a professionalized phenomenon, design emerged after the Industrial Revolution. Before that, design was ubiquitous, but "hidden" in the crafts mode of artification (Jones, 1992: Chapter 2). The crafts developed syncretic and holistic processes of artification. Product reproduction is based on an existing artifact serving as a model. This method allows for incremental changes, but nevertheless maintains product identity for a long time, even for centuries. This was possible in times of very low technological dynamics and progress. In such situations, the changes in the social functional environment of the artifact are minimal and the production process goes on by replication of existing exemplars/precedents, which function as models for replication.

However, after the Industrial Revolution, social and technological dynamics increased exponentially. The social and functional dynamic brought about new user needs and corresponding abrupt changes in the artifact (Friedman, 2012). Suddenly humankind faced a wave of novelty. The crafts could not respond in time to the increased demand for new products, driven in part by new inventions and in part by the increased purchasing power of societies. The creation of mass production processes required division of labor. This led to breaking down the syncretic craft processes. At this point, the old artifacts could no longer be used as models for guiding replication. The solution to this problem was to externalize and formalize of the ubiquitous hidden design processes. Thus design emerged as an autonomous professionalized phenomenon.

The industrial mode of artification split design from manufacturing by separating the creation of the model of the artifact from the materialization of the model. This approach created the need for a new profession that was preparing models intended to provide manufacturing with specific information about the various parameters of the artifact to be manufactured. The model of the artifact was transmitting "genetic" information. We are interested in the model as an output of the design process and as an input into the manufacturing process. So, the genealogical approach has led us to consider the contemporary separation

and integration, as well as the professionalization of design and manufacturing.

We have created an overall methodological platform. Next, we will start focusing on the artification universe to see design as a process and as an activity with its own structure and character, explicated and articulated. In this way, we will get to the core or essence of design. After that, we will look at design as a social institution in the universe of other institutions that participate in the artification processes, with the objective of discussing the demarcation of the boundaries of design.

3. Localizing Design in the Realm of the Artification Universe

A note of caution as we continue: the conceptual and terminological deficits create very complex communication. This makes the conceptualization of design a very difficult task, mostly because we usually build new conceptualizations by building a scaffolding based on previous notions and conventions. The lack of adequate terminology increases the possibilities for misinterpretation and misunderstanding. Yet, we know that the definition of only one concept might be a dissertation-scale scholarly work.

Following the methodological preparation and the major considerations, we will continue with localizing design in the larger artification context. We will start from the top and will move down to more concrete layers. Metaphorically, we will use a "peeling the onion" or a "nested dolls" approach. The idea is to localize design in the universe of the artificial by referencing its relationships to other important entities and phenomena. This will allow us to continue peeling the outer layers of design until we reach the core. Our assumption is that by analyzing the core we can get to the essence of design.

In this case, we construe the most outer layer as the universe of the artification objects and processes. From this position, we move inward to the next layer, calling it the artifact delivery process. This concept is created by analogy with the (design) project delivery process and facility delivery process already used in the construction industry. The concept is adapted to this study and, at this time, doesn't claim an exhaustive coverage of the process.

The artifact delivery process will tentatively have several phases, starting with the project inception, moving to planning, into the design project delivery phase (or process), to manufacturing, and in its expanded version, to distribution, maintenance, and other lifecycle ending phases. We understand that the phases in engineering and industrial design will be somewhat different and will be named somewhat differently. However, as we mentioned earlier, we very often refer to the construction industry for selecting examples, concepts, and terminology. Because of our interest in design, and because of the genealogical separation of the design and manufacturing processes, we will look at the connection between design project delivery and manufacturing.

In this respect, the design project delivery phase (and/or process) produces a

model of the artifact. The model can be presented in many different ways, but most frequently these are drawings and texts. The model will feed information about the artifact into the manufacturing phase. These documents provide the artifact dimensions/specifications to the manufacturing units, which then use their machinery to materialize the artifact model.

The (design) project delivery process is another way to look at design and what we would call a design practice. The concept allows us to imbed the design practice in the larger whole—the artifact (e.g. facility) delivery process. The project delivery process conceptualizations allow us to analyze and articulate design to the point when it becomes quite clear that what previously seemed to be one homogeneous activity called design, is actually a complex conglomerate of activities with different natures. This conglomerate can also be understood as sheaf of parallel or intersecting heterogeneous activities and tasks. Furthermore, many of these activities are also conducted and perfected in other social institutions like science and management. This is one of the reasons for hearing interesting, yet astonishing, statements that design is research, design is an art, design is this, and design is that… This kaleidoscopic nature of design makes it so difficult to categorize as an entity of its own class. Any time we rotate the kaleidoscope, we see a different configuration, a different picture, and a resemblance with another social institution—art, science, technology, or whatever.

According to Eckert and Clarkson (2005: p. 4) the design process includes a wide variety of tasks that require different cognitive abilities and skills. This is the key to understanding the elusive nature of design. Furthermore, these tasks and/or activities are very often arranged in iterations or cycles, although we can talk about a forward spiraling movement. But it can also be seen as a rhizome (tangled roots or yarn). We may not always be able to explicate all those complex interactions and iterations, even when studying the interviews with very reflective designers. However, in this heterogeneous pool of tasks, we still can talk about some tasks with very distinctive nature that carry the essence of design. And we can clearly detect information search and research tasks in the incredible variety of activities.

The models of the project delivery process are at the meso/middle levels of artification, but at the same time they are industry specific. They are very helpful to investigate design in a particular industry, considering each industry's peculiarities. The work processes that they cover vary in content depending on the types of artifacts, materiality, and industry practices. They represent work involving many departments and people, teamwork, and human interaction.

These models cannot help us move to the generic and abstract understanding of design that we need for working in the field of general design studies. They are created with industry and discipline specific concepts and terminology. Although these models have breadth and scope, they are not very abstract. On a somewhat different note, these models cannot help us much to see design as an individual creative act.

In order to generate a more general and discipline-inclusive understanding of design, we introduce an abstract model of the project delivery process (pre-design, design, post-design) that is not industry specific. Due to the very abstractness of this model, it is easier to explore how it can work together with other design models at the level of the individual designer. Here we refer to the analysis-synthesis-evaluation model (Asimov, 1962: p. 44; Jones, 1963).

The abstract model of the project delivery process has only three phases: pre-design, design, and post-design (evaluation). This model offers one good advantage for the present study—it allows us to compound all phases that produce information for design decision making into one conglomerate phase that we will call pre-design. Using the term pre-design simplifies the project delivery process model and allows us to focus on design. The evaluation phase is also loaded with investigative and research activities. It is therefore possible to tentatively discern design from pre-design and evaluation, at least at this level of analysis.

In this way, we can shorten the presentation of the project delivery process and reduce it to three parts so that now the design phase stands alone and gets more weight in the overall process. In addition, this three-part modeling of the project delivery process shows a pretty clear correspondence with the three parts of the analysis-synthesis-evaluation model, which will be discussed and used below. So, pre-design roughly corresponds to analysis; design to synthesis; and post-design to evaluation (in this case). This operation allows us to relate the industry specific versions of the project delivery process to the abstract analysis-synthesis-evaluation model.

Along these lines, we are building a multilayered, nested conceptual entity where we can trace design, and in particular the core of design, from the most outer layer of the artification universe, to the artifact delivery process, to the project delivery process, and then to the individual creative processes. This also provides continuity of modeling at all levels in respect to the core design components at each level. And it allows us to perform methodological operations moving between levels of abstractness and industry specifics. We need to "zoom in" and "zoom out" in the process of analysis in order to better understand what design and its essence is.

A general review of the pre-design processes or phases reveals that they are filled with the collection of information through research. The purpose of these processes is to collect information for decision making about the parameters or specifications of the artifact. In addition, the pre-design activities provide information for making decisions during the design process.

Now the design phase becomes the focal element of our analysis. As in the construction industry, this phase can be divided into schematic design, design development, and construction documents. The artifact model is conceptualized mostly in the schematic design or conceptual design phase. The construction/production documents phase of design is exclusively for communicating the artifact model in detail to the builder or manufacturer. Thus, we can focus on the con-

ceptual design phase to search for the essence of design.

The pre-design-design-evaluation model and the analysis-synthesis-evaluation model work well at several levels of analyses. We can use these models for analyzing both the project delivery process and the individual designer's actions. The project delivery process is a complex heterogeneous team activity, situated somewhat at the meso level of analysis. Its design component can be seen as several nested layers. The individual designer's actions have somewhat different "texture" and "shape," but they can easily be superimposed over these models as well.

From this perspective, we can view the design process at any level separated into several sub-components: 1) pre-design or analysis or information collection for decision making; 2) design or synthesis or the core component that produces the design solution; and 3) evaluation of what we have achieved vis-à-vis the initial information for decision making. We can also use this model to analyze an individual designer's reasoning, when a single mind embraces the whole design situation in a holistic way.

4. The Essence of Design

From this perspective, we are zooming in on the core of design or the synthesis phase, cautiously excluding the pre-design and evaluation phases because we consider they are heavily loaded with research and analysis. One major reason for this, which we will discuss later in this paper, is that information collection and evaluation activities are already well-defined in the institutional structure of society and categorized, in most cases, as research.

Now we can see that the core of design is about organizing materiality to produce a configuration that will function and fulfill certain requirements. The product of design is an ideal or mental model of a new artifact (Archer, 1979; Asimov, 1962: p. 1; Banathy, 1996: p. 18)—an ideal model of the organization of materiality. In this case, ideal means that the model is in the realm of thinking and ideas (here ideal is not about perfection or ultimate flawlessness). This is the starting point of thinking about design, a methodological foundation.

Materiality, in this case, is intended as a term that includes material or substance or substrate, but also activities, social entities, psychological phenomena, and even ideas. We refer to this term for a lack of a better choice because it is a more neutral option when we have to consider social organizations, experiences, and abstract notions and work with them.

The mental model of the artifact represents the organization or composition of materiality (or substrate or any kind of components, including ideas). This organization or reorganization is the essence of design. Furthermore, in most cases, the organization of materiality has to support the (controlled) reproduction of (natural) processes with the purpose to produce certain outcomes (work, power, information, accommodation, etc.). These outcomes are necessary for fulfilling systems or user requirements—an umbrella term for needs, wants, functions, cons-

traints, restrictions, priorities, resources, and so forth. In the process of organizing materiality and components, designers have to foresee or predict how the parts behave and work together, as well as the outcomes produced by the whole arrangement or composition. The materiality has to be organized with respect to the natural laws that govern it, the purpose/role/objectives/requirements of the artifact, and the context or environment of its functioning.

The key words for understanding the essence of design are organizing, composing, arranging, assembling, and so forth. The essence or the core of design is organizing materiality or components, making a composition, putting things together (in most cases, in a new way). Similar views have been expressed by a number of other authors (Nelson & Stolterman, 2003: p. 5, p. 208; Simon, 1996: p. 4). Here we would like to emphasize the act of organizing and make it the center of the conceptualization of design. All previous methodological moves were made to come to this moment and to display it in a prominent way.

We select the act of organizing, the compositional work, as defining the nature of design. What makes design different from other social institutions and activities is the predominance and prevalence of the acts and tasks that organize a certain materiality. The rest of the activities in the design process support the organizing or compositional work, for example, activities providing information for decision-making or design evaluation.

To illustrate some of the points up to now, we will talk about the design of the internal combustion engine. Multiple times in that process, designers needed to reproduce the natural process of changing the aggregate/physical state of liquid fuel so that the fuel could move engine components and produce a particular kind of work. Designers needed to organize natural phenomena, processes, and materials so that the liquid fuel would rapidly evaporate in the engine cylinder, would expand, and would move the piston. After that, the fuel gases are released to allow the cylinder to go back to its starting position, and then the next cycle will start with injecting fuel, vaporize it, move the piston, and release the gases. Designers needed to organize materials to form a shell structure that will sustain and reproduce these processes in the proper order and in the proper way. They needed to organize material in a particular configuration according to the natural laws of mechanics and resistance of the materials. The engine needs to respond to a number of requirements, some of them regarding the nature of materials and structures, others emerging from other system components, and still others coming from the users of the specific vehicle (e.g. the engine needs to be powerful enough to quickly accelerate the vehicle).

While the work of physical processes and materials is tangible and visible in mechanical design where the artifact might consist of many movable components, it is not always so in many other specialties. For example, in architecture, the organization of materials and structures has to accommodate a number of social, group, and individual processes that will take place in that shell. In addition, the materials and structures need to be organized with consideration of the

laws of statics and dynamics. In this industry, there is a division of labor: the social functioning of the building is designed by architects, while the mechanical functioning of the building structure is designed by structural engineers. In addition, there are building mechanical systems engineers. Now when we see this division of labor, it is easy to suggest that the organization of the social processes taking place in the building has to be done (ideally) by social or organizational designers. Then the architects will focus on the material shell/skin of the building, and the structural engineers will calculate the structures. In the current culture of division of labor, there are many specialties working on the design of a single artifact, even on some artifacts that look very simple.

In social design fields like organizational design and program development, we have to organize social phenomena, processes, events, power, control, governance, and human experience, and so forth. We need to develop activity structures, management and power structures, and shape the individual processes in accordance with the "natural" regularities of the social systems, activities, and human individuals, in order to reproduce desirable (work or leisure) processes and produce intended outcomes. The social structures need to have mechanisms to be self-sustaining and for reproduction, for managing processes and events, and for accommodating the social agents. The ultimate purpose of the social organizing/configuring is to produce the outcomes needed or required by the large system.

To highlight the essence of design, we purposefully narrow the discussion and will not talk about support, logistical, and managerial activities or activity bundles and clusters that are inscribed in the project delivery process. We will not discuss in this section the information collection and evaluation tasks/acts, although they are important for better contrasting and highlighting the essence of design.

There are compositional or organizing acts or tasks in many activities. When these tasks are secondary to the main purpose of the activity, and they are not system-defining, that activity is not perceived as design. One example is science, which is not perceived as design, although its methodological and research design activities can be treated as design. However, as a whole, the other tasks in science prevail and create its nature and identity as a social institution.

On the other hand, there are many activities with substantial compositional tasks, but they are not considered designerly endeavors. The reason for this is that these activities have acquired their own and very strong institutional and professional identity, narrower social functions, and very specific and particular methodology. They are perceived as phenomena different from design, for example, musical composition, writing/composition, and sculpture. In these cases, the particular specialization and differentiation have gone a long way. These social institutions and human activities have found their own methodological ways, acquired separate identities, and are professionally reproduced in their own ways. They have acquired professional identities very different from the conven-

tional design specialties. That is why it is difficult for the public consciousness to categorize them as design. Because of page limits, we will not discuss them within the realm of this project.

When engaging in designing, the new reconfiguration of the materiality can range from almost zero to infinity. When we create an absolutely novel material organization, we engage in invention with all related parallel and complimentary activities. Invention is an extreme case of designing, involving a high level of novelty and new solutions. When we make small changes to adapt an existing typical project to a slightly new context, we have minimal design activity and work mostly on the means of communication (e.g. drawings) to coordinate and align these changes with the larger whole. However, in the design industry, even such small modifications of the original project are considered design. The terminological traditions of the industry and design studies are not always the same. As long as the design agent provides a model with well-defined measurements to the manufacturing/construction agent, this is design. Here we see design as a profession and as an activity for (re)organizing materiality. It is not possible within the limits of this journal article to resolve all these issues. We have already expanded our notions of design to reach out to the project delivery and the artifact delivery processes.

5. The Boundaries of Design

Before we continue with defining the boundaries of design, we will engage in methodological groundwork that will prepare the foundation for understanding the issues and the solutions. Like the discussion on the nature of design, it appears that the question about the boundaries needs a preliminary methodological examination before any attempt to provide a solution. The proper understanding of the boundaries of design is very important because we already presupposed that the demarcation will in turn influence the understanding of design.

5.1. Methodological Preparation

The boundaries of a social institution are very important for understanding the nature of that entity. What we consider as boundaries defines the content and the constituent components, thus contributing to the nature of the phenomenon we study. When boundaries shift, the institution might change as well. The boundaries and the boundary conditions are very important when we need to make sharp and accurate delineations. However, when we can accept and live with the fuzzy gray areas and the liminal zones, then the boundaries may or may not exert such influence on our understanding.

When our problem is to define "design" versus "science" as two holistic entities, the boundary question is very important. However, if we look at design as a heterogeneous system or a bundle of tasks, activities, acts, and other components, when we look at the heterogeneity of the project delivery process, the need for sharp differentiation diminishes. Rather, the need for finding ways for effec-

tive and efficient collaboration emerges and becomes the real research problem. Still, we will continue exploring the boundary conditions of design in order to discuss several related issues.

Boundary issues are as complex and multileveled as the nature of design. We have already discussed several models at different levels to localize and delineate design. They are all nested. Thus, at each level, the boundaries of design might be different. At the highest levels, the boundaries are more inclusive (the project delivery process), including many heterogeneous activities, some of them shared with other social institutions or developed better in other social institutions. And at the level of the core design act performed by an individual designer, we have narrowed design to organizing materiality, despite of our understanding that this core act needs to be supported by the act of information gathering for decision making (analysis) and the act of evaluation of the design solution.

There is no conflict or contradiction in this conceptualization of design and its boundaries. However, there is a research problem that arises from the conceptual and terminological deficit. Even when we realize that we talk about different phenomena, we still talk about these phenomena as design and use the word design. The project delivery model and the model of design as a social institution can be used to understand the design profession and its constituent components and boundaries. The availability of a lot of information gathering components should not distract us from the essence of design and how it is different from information collection and science.

Therefore, we can discuss the boundaries of design in different contexts, for different purposes, and we can end with different scope and delineations. As we mentioned above, we don't discuss the boundaries of one phenomenon, but several nested, overlapping, parallel, and interrelated phenomena. It is natural that the boundaries will vary in each context, with every project. In this respect, before discussing the boundaries of design, we need to agree on which design phenomenon is under investigation: the profession, or the designer job description, or the educational major "design," or the design project delivery process, or core design, or the very core of the individual design act. Each of these phenomena is important in their own right depending on the situations. And each of them deserves to be treated as primary in different sociocultural, disciplinary, and project contexts.

The demarcation of the boundaries of design at each level depends on the theoretical and practical possibilities to abstract the core design act or activity from the other components in the process. For example, at the level of the core design action of the individual designer, it is very difficult, but also not pragmatic to separate information search and processing (analysis) from organization of materiality (synthesis) from the assessment of the solution (evaluation). But at the level of the project delivery process things are very different. We might be able to separate and professionalize information collection and research (pre-design) from design.

In this case, we have to talk about the boundaries of the project delivery process and include both pre-design and design in its field. And if we professionalize pre-design, we will get one or more new professions that are different from design, but very closely interwoven with it. There is no contradiction here, although both design theorists and practitioners will find this idea a blasphemy. Again, we need to name concepts and develop new terminology. And we need more research on pre-design, its functions, importance for the artifact quality, and the ways it can be separated and integrated with core design. While it is very fashionable now to talk about the (added) value that design brings, we would insist that the pre-design phase might be the most important one for increasing the added value in the whole process of artification. Or at least, second only to core design in importance.

5.2. Design and Other Social Institutions

In this section, we will look at the relationships between design and several selected social institutions with the purpose of clarifying the boundaries of design vis-à-vis these institutions. In some cases, the job is very easy, while in others, like the comparison to science, it is more contentious. The concepts of artification and the artifact life cycle provide a foundation for future studies of the localization of design in the universe of artifacts and human actions. The notion of artifact life cycle can expand the social functions of design without substantially contesting its boundaries. There is general agreement that the artifact life cycle needs to be considered (or designed) in the project delivery process.

The concept of artifact delivery process allows us to easily see the relationships between design and manufacturing/construction. Design provides information in the form of materiality descriptions/specifications that guide the production processes. There might be some minor differences between industries about which institutions will prepare documents that instruct the manufacturing entity what exactly to produce, but this is not a subject for the present paper.

The terms design and planning are frequently used interchangeably, sometimes in a circular argument (design is a plan). Nadler (1981) talks about planning and design as activities of the same class and sees their method as the planning and design approach. In the last several decades, with the increased popularity and status of design thinking, some activities that previously would have been called "planning," now are known as "design."

In this respect, we conceptualize planning as the activity that looks at the big picture and matches goals and resources, while still looking at requirements, constraints, considerations, values, and priorities. Design goes in more detail than planning and, unlike planning, focuses on the organization of components. In some industries or fields, the organization of material is usually called design, whereas the organization of social entities, activities, and situations is more likely to be called planning. Planning is a common term when activities and events are organized in time (like lesson planning or event planning) or large scale space

(regional planning). However, we have course planning and instructional design. In these cases, lesson and course planning comes from an older tradition of organizing course content, while instructional design is a newer specialty influenced by technological thinking and the corresponding design turn. As this all indicates, there is a tendency in many fields to switch terminology from planning to design. Together with the design thinking movement, we can say that there are grounds to talk about a "design turn."

The most discussed and controversial is the relationship between design and science. Science is about discovery, while design is about invention. Science focuses on the production of knowledge rather than producing models of new material configurations. A number of authors have written about this, and we consider it as a truism that has already fulfilled its promises (Archer, 1979, pp. 19-20; Banathy, 1996: p. 17; Simon, 1996: p. 4, p. 114). However, we will look at science from a design perspective and will see it as a knowledge production institution that provides design with information for decision making and tools for evaluation.

The more science intersects with design, and the more design is loaded with science, the more we get into some contentious situations. The major disputes about the boundaries between science and design originated in academia rather than in practice for reasons that are political. Designers teaching in academia are required to engage in research and publish regularly. On the other hand, many designers are reluctant to do that, are not well trained for such endeavors, or do not want to spend time on such activities. As a result, they "push the envelope" and try to pass the knowledge creation process in design as science. In many cases, such design academics disregard major standards and norms of scientific activity and get in conflict with the academic adjudicators.

Here we have two related, but yet separate issues. One is the reluctance of some design academics to understand the benefits and advantages of science as a major knowledge production institution. The other issue is the reluctance of some academics to understand that science is not just the Positivist (scientific) method, but a social institution that encompasses several paradigms (methods). However, if the two communities could make a reasonable effort, the design academics would not try to pass over a design project for a research report and the scholars would be more tolerant to design knowledge production activities like artifact type studies/building type studies and more descriptive engagements.

The big question is not how to draw boundaries between science and design. The issue should be how to develop effective and efficient collaboration between science and design. We already saw that the project delivery process has a number of phases or components and many of them are focused on information collection for design decision making, including scientifically produced data and knowledge. However, this is a large and vast topic that needs a separate discussion.

The relationships between core design and science are somewhat well organized in practice and in the practical world designers do not worry about not being recognized as scientists, and researchers in the industries act as collaborators rather than critics (or at least they should act that way). The activity theory perspective on the project delivery process and the design processes as systems of heterogeneous tasks, activities, and acts provides a comparatively good platform for organizing the collaboration between design and research. From this perspective, the problem with the boundaries of design vis-à-vis science looks quite different. Here, we have tasks that focus on information collection and knowledge production, and we have tasks that focus on organizing materiality and components.

This perspective helps us to see a number of different issues that need to be explored: widening the education of the project delivery agents, developing protocols for interdisciplinary and interprofessional collaboration, and a host of related considerations. There is a lot of "room" for improvement and such developments will lead to better outcomes of the artification processes.

And finally, there are some social institutions that involve a lot of design, but as we mentioned in this paper, we never relate them to design even in the slightest way. For example, musical composition is about arranging components. The musical scores are like drawings. They relate to music performance as design to a production process. Sculptors and painters very often start their work with sketches. These are their designs that clarify the major ideas and provide direction for the production process—painting and sculpting.

There will always be grey areas on the boundary of design and science, and to a lesser extent manufacturing, life-cycle phases, and planning. The boundaries of design will shift depending on the expansion of the object of design into the realm of its functional environment and the corresponding division of labor in the artifact delivery process (Friedman, 2000).

5.3. The Object of Design and the Boundaries of Design Specialties

Design is a stable social institution, and its boundaries are more or less resilient to sociocultural changes, just like many major social institutions. However, when we move toward more detailed analysis of core design acts in different design fields, we start seeing obvious differences. In some fields, the design acts are so idiosyncratic and esoteric that researchers have hard time relating them to general models.

There are several phenomena that define the boundaries of design specialties—the object of design (a car versus software), the kind of materiality (that might dictate the instruments and methods), and the subsequent system of methods and techniques used in the design process. However, these factors start "working" mostly when people engage in specialization and very narrow division of labor in order to achieve high quality and efficiency. In such cases, different design fields resort to very narrow, highly specialized, and idiosyncratic

methodologies that substantially differ from other fields.

In addition, the interactions between the heterogeneous tasks and activities in the artifact delivery process and the design project delivery process create more opportunities for changing boundaries between design and manufacturing. But all these changes will stay "inside" the project delivery process and will lead to relatively minor adjustments in the scope of engagements of different collaborating agents. Even the electronic means of interaction between design and manufacturing, the CAD-CAM technologies, still do not have a substantial effect on the relations between these social institutions. The designer-maker is still a designer, but with extended responsibilities and scope of engagement.

The bigger changes happen in the shifting of boundaries between the design specialties. There are several reasons for that. With the advent of new design and manufacturing technologies, we face additional complexity in everyday work operations, in educating professionals, and in better and faster specialization in a particular narrower area.

In addition, a major factor of change is the expansion of the boundaries of the object of design to include new layers of its functional environment. This is in part because of the influence of systems thinking and the propensity to see things interconnected, continuous, and constantly moving around their core. When designers include the new layers of the functional environment in their object of activity and have to deal with them as problem and solution spaces, they need to assimilate new knowledge about these areas, develop new skills, and grow their expertise "horizontally." Designers will need to accumulate new knowledge and skills, process exponentially growing quantities of information, and may have a hard time oscillating between information processing tasks and material configuration tasks.

At some point of time, this expansion will not be sustainable and there will be "seceding" or splinter sub-specialties as allied or complimentary positions or professions in the project delivery process. These sub-specialties might be loaded with expanded information retrieval and research; or might focus only on one aspect or component of the artifact; or might engage with a new set of requirements. We should pay more attention to these processes rather than the conflicts between design faculty and research faculty in academia. We are aware of the adverse side effects of specialization that lead to professional community tunnel vision, loss of the whole, and missed opportunities for satisfactory solutions. But at the same time, we need to be aware that although specialization is constricting, there is still no substitute for it regarding human ability to develop in-depth expertise.

In this respect, the boundaries of the design specialties fluctuate more than the boundaries of design as a social institution does. In some way, this happens as an "internal" phenomenon inside the social institution. But the expansion of the design object to include the proximal layers of its functional environment does not affect the configurative/constructive nature of design. It might increase the need for including more science modules and tasks in the project delivery process.

This in turn might create a host of problems in project management because of the different cultures, ways of thinking, and codes of communication entering the project delivery process form different design and research fields. Still, the nature of core design remains comparatively constant. What changes is the structure and content of the project delivery process.

6. Concluding Remarks

Design is about organizing materiality or substrate and creating configurations (material or social) that have never existed. We can conceptualize these configurations as models of artifacts that are submitted to the production facilities for manufacturing. Design requires support infrastructure that consists of a multitude of activities, including information collection and management. This extended system of activities can be conceptualized as the project delivery process.

The differentiation between the design act and activities on the one side, and the project delivery process on the other side, allows us to better understand the process of creating models of new artifacts, to understand the variety of diverse tasks with their correspondingly diverse knowledge and skills, and to improve the processes by introducing better education, training, and coordination.

The ideas from this paper can be used for further development of a general science of design. Our work aimed at creating the foundations and guiding directions. Our aspiration is to see a new social arrangement that will more effectively use the strengths of design and science, an arrangement that will encompass many institutions under the umbrella of the artification processes. In this respect, there are numerous problems and issues to discuss, many new topics for research, and a host of opportunities to pursue. In contrast to design, science provides information for design decision making. It engages in studying existing phenomena, including existing artifacts. When we study artifacts, we are in the realm of the design sciences, but they are not design. Scientific activities can be introduced and integrated into the project delivery process to provide information for design decision making and evaluation. In many industries, scientists work diligently in the design project delivery process; yet, they are not designers.

The concept that design is about organizing materiality can be used at the disciplinary level for reassessing current views about design in many disciplines. It can help disciplinary researchers see the "mechanics" of design in their fields and propose discipline-specific solutions to problems regarding the boundaries of the design object, the interaction with other design and academic disciplines. The understanding of the nature of design and its boundaries can also help develop new collaborative relationships with other social institutions, beyond the traditional connections with the arts.

This paper can benefit practicing designers as well. The concepts of organizing materiality can help practitioners reflect on their work in a new light and see new opportunities in searching for new configurations. This concept also highlights the necessity of looking at design methods as methods for organizing

(materiality) according to particular requirements and constraints. Designers from disciplines like organizational, service, and instructional design will be able to further integrate with the traditional design community and understand better their colleagues. This will contribute to sharing ideas and methods.

The current treatise is limited in time, exposition space, and objectives. This is a subject matter that is like a rhizome and requires extensive resources. Our motivation to participate in this discourse is driven not only by our history with this subject, but also by our belief that it is high time to conceptualize design and design practice so that it will interact more productively with science. We would like to see in practice the synergy of these two social institutions, which are still struggling to find the right modes of collaboration and exchange of information and outcomes.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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