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New perspectives and complex challenges in design epistemology

Abstract

Complexity is a subject of major relevance in contemporary studies. According to several authors, the complexity of current environments has been imposing severe limits to deterministic, centralized and hierarchical design approaches. Its dynamic condition calls for a thorough review of contemporary design methods of thinking and action. This paper addresses and discusses the main features of complexity in the design context and indicates epistemological revisions of the design activity as practice and as discipline, such as: demand for adaptation, programming, and hybridization. The main objective is to bring renewed conceptual approaches to contemporary creative practice, especially in the areas of architecture, design, art, and computing.

Keywords

Complexity. Improvisation. Adaptation. Programming. Reflection-in-action.

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NUEVAS MIRADAS Y DESAFÍOS DE LA COMPLEJIDAD EN LA EPISTEMOLOGÍA PROYECTUAL

NOVOS OLHARES E DESAFIOS DA COMPLEXIDADE NA EPISTEMOLOGIA PROJETUAL

Resumen

En el campo de la arquitectura, contextos de complejidad vienen imponiendo límites severos a los abordajes proyectuales deterministas, centralizadores y jerarquizados, exigiendo de los arquitectos una revisión profunda en sus métodos de pensamiento y acción. Tales contextos demandan de esos profesionales habilidades cognitivas y operacionales diferenciadas, que potencien la emergencia creativa, la adaptación constante, la integración con otras inteligencias colectivas y un vínculo directo con la acción transformadora. En este artículo, se discutirán las principales características de la complejidad en el contexto proyectual, y se presentarán los redireccionamientos epistemológicos que ellas engendran, para la práctica creativa contemporánea. Los principales desafíos que trae la complejidad son: la demanda por la adaptación, la demanda por la programación y la demanda por el híbrido. El objetivo del artículo es poner en relieve nuevos direccionamientos conceptuales para la práctica creativa contemporánea, especialmente en las áreas de arquitectura, arte, diseño y computación.

Palabras clave

Complejidad. Improvisación. Adaptación. Programación. Reflexión en acción.

Resumo

No campo da arquitetura, contextos de complexidade vêm impondo limites severos às abordagens projetuais deterministas, centralizadoras e hierárquicas, demandando dos arquitetos uma revisão profunda nos seus métodos de pensamento e ação, além de habilidades cognitivas e operativas diferenciadas, que potencializem a emergência criativa, a adaptação constante, a integração com outras inteligências coletivas e um vínculo direto com a ação transformadora. Neste artigo, serão discutidas as principais características da complexidade no contexto projetual e apresentados os redirecionamentos epistemológicos que elas engendram para a prática criativa contemporânea. Considera-se que os principais desafios trazidos pela complexidade são a demanda pela adaptação, pela programação e pelo híbrido. O objetivo do artigo é trazer à tona novos direcionamentos conceituais para a prática criativa contemporânea, notadamente nas áreas de arquitetura, arte, *design* e computação.

Palavras-chave

Complexidade. Improvisação. Adaptação. Programação. Reflexão-em-ação.

Introduction

An epistemological approach to architecture focuses on an analysis of the nature of the architect's work through the assessment of his methods, processes, principles, values, ??and the whole body of knowledge that builds the foundation of design practice. This methodological and theoretical body is not a static entity, but evolves over time, unfolding itself into new challenges, new ideas, and new processes of the professional activity. The natural process of evolution of the design *episteme* opens possibilities for the emergence of new concepts, as well as allows previously-disregarded concepts to gain future importance. The analyzes presented here had offered essential support for the doctoral thesis entitled *Complexity and Improvisation in Architecture*, developed by the author of this article, under the guidance of Prof. Dr. Carlos Costa Zibel, and defended at FAU / USP in 2015. This thesis discusses the potential that broadly experimental, open and intuitive processes have, such as improvisation, in complexity situations, notably in the architecture and design contexts.

Numerous structural changes in traditional design paradigms, which emerged mainly from the second half of the twentieth century, have redirected the design practice towards new courses of adaptation, participation, and innovation. The new approaches of design practice towards the arts, scientific and technological knowledge, theories of complexity, information, and systems, have provided fertile ground for more agile and intuitive creative practices to gain ground in design circuits. Among these creative practices, the strategic openness for change and continuous adaptation stands out, or in other words, the ability to improvise. In the last decades of the twentieth century, advances in digital technologies have made possible the emergence of completely new models of Design Thinking, as well as the emergence of new forms of spaces, objects, and systems endowed with hybrid, adaptive and interactive qualities. In parallel, these same advances have greatly increased the complexity of human relationships, with intricate developments in the ways our society is organized.

Complexity: the challenge of working with uncertainty

By stating that *"in a world that is not predictable, improvisation, evolution, and innovation are more than a luxury: they are a necessity"*, Gerhard Fischer and Elisa Giaccardi (2004) invite us to reflect on more creative and appropriate ways to solve contemporary design problems. This statement relates to a central issue of contemporary design, directly connected to principles of complexity: it is not possible to fully anticipate all problems of a design, as well as it is not possible to predict all forms of appropriation of spaces and objects by users. Patrik Schumacher (2012, p. 311) reinforces Fischer and Giaccardi's position (2004), warning us that we should not assume that the design process can be fully pre-plan. An emerging awareness is then revealed, fruit of a more flexible and experimental design

thinking, which recognizes the limits of the classical disciplinary thinking and seeks new methods and processes through which one can operationalize complexity.

Unlike the rigid exercise of control and determination, Schumacher suggests that, in situations of complexity, sequences of design decisions should be subjected to constant trials, so that it is possible to infer the best direction to be taken at each stage (ibid). Therefore, it consists of a method endowed with a closed sequence of procedures to be performed linearly, but an initial structural configuration of the problem situation that progressively evolves in a recursive and integrated manner. This configuration requires that the designer has not only a central idea that is then developed linearly, but a concatenated sequence of cyclic reasonings.

Still in the 1980s, North American educator and professor at the Massachusetts Institute of Technology (MIT), Donald Schön, dedicated himself to exploring such circularity from a model called *reflection-in-action*. This important approach considers that each movement of the designer towards decision-making arises from an ongoing conversation process with the problem situation, like a system whose relations are structured in a network fashion. The main objective is not to solve the problem directly, even because complex problems have their configuration changed during the effort to solve them. First of all, it is important to develop a system able to monitor problems effectively and get the best results of each reflection cycle in terms of consistency (SCHÖN, 1983, p. 79).

In his book, *The Reflective Practitioner* (1983), Schön, who also studied music at the Sorbonne University and at the National Conservatory of Music in Paris, utilizes the jazz improvisation process as an example for his *reflection-in-action* model. Among his arguments he highlights the way jazz musicians create variations, combinations and recombinations on-the-spot[1], in distinct sets of forms based on structural schemes of reference which foster the evolution and coherence of the performance (SCHÖN, op. cit., p. 55). Schön states that, even in performances of great complexity, there is an internal coherence to the improvisation process, which lies precisely in the way this structural scheme is programmed. One can note in his indicative arguments that the practice of improvisation embodies many qualities, both in practical and cognitive terms, which can be applied in similar manners in design processes, and which are notably related to how the improvisational action configures structural schemes with variability and adaptability, in situations open to uncertainty.

Recent research in the context of *Design Thinking* presents similar inquiries when approaching the concept of *frames*, for example. *Frames* can be understood as design working principles, a set of implications which guides, but does not determine, the behavior of a system of relations over time. Regarding a process of design, Kees Dorst explains that *frames* are sets of affirmations which include: the specific perception of a problem situation, the schemes which describe it, and the working principles that support its possible solution (DORST, 2011, p. 525). This approach suggests parallels with improvisation structural schemes described by Schön.

[1] The expression *on-the-spot* means "in a spontaneous, immediate way, and without delay." It also means being in a situation where it is necessary to make a difficult decision or answer a difficult question (OXFORD AMERICAN DICTIONARY, 2014).

Jazz performances are undeniably complex situations. In addition to the variability of the performance, they are operationalized by underlying networks of highly fluid and constantly-changing temporary relationships. It is a situation of inherent tension between the uniqueness of individual expressions and the cohesion and participation of the collective (MOLSON, 1996, p. 66). It is an informal and negotiable process of creation and expression, which reinvents itself in a deeply participatory, interactive, heterogeneous, and socially-constitutive way. Research in *Design Thinking* has been investigating similar modes of articulation of complexity which enable designing structures (*frames*) able to dynamically respond to the paradoxes inherent in complex problems, such as relationship between the uniqueness of parts and the cohesion of the whole. In this sense, they admit the validity of improvisational principles as mechanisms for managing uncertainty, as above exposed by Fischer and Giaccardi (2004).

According to Dorst, the beginning of a design process dedicated to face problems of complexity is marked by the structuring of possible thematic paths which arise from invention, discovery, and revelation processes. According to the author, one must seek means to identify and find sense in implied phenomena (DORST, 2011, p. 528). Instead of directly attacking the most obvious paradoxes of the problem situation, the idea of ??working from an improvisational action allows more speculative and experimental development of parallel hypotheses leading to the emergence of possible solution paths.

An improvisational outlook towards design

Addressing the concept of improvisation in design context is undoubtedly an equally complex challenge precisely due to the great rigidity that the rationality and objectivity of a design or planning process requires from architects, designers, and other professionals dedicated to design. This factor considerably hinders the imagination of how an association between planning and improvisation could be articulated. However, it is clear that, parallel to the rational model of design whose theoretical foundations lie in the tradition of technical and scientific determination, there are other approaches that allow possible openings for a discussion of the potential of improvisation processes in design processes. This is what Dorst and Dijkhuis (1995) reveal to us in *Comparing Paradigms for Describing Design Activity*. The authors state that, despite rationalism having been the dominant influence in shaping much of the design methods used to the present day, different approaches arising since the 1960s sought to reflect on the limits of scientific thinking in the design practice. Arguments make clear that, if on the one hand, Herbert A. Simon, North-American researcher, author of *The Sciences of the Artificial* (1969), has made great contributions to systematize resolution processes of design problems, according to scientific principles, on the other, Donald Schön has developed a differentiated approach as he described the design process as partially

operationalized by unscientific, intuitive, and experimental thoughts. It is about his model of *reflection-in-action*.

Dorst and Dijkhuis (1995) consider these two approaches central references to understand two specific design paradigms: Simon's, focused on positivism and technical rationality, and Schön's, is based on construcionism and intuitive experimentation. The first refers to the positivist logical structure of classical science as a model for design processes, considering problem situations as stable and descriptive and generalizable entities. The second considers the uniqueness of each problem situation, and the need of design processes to be an ongoing conversation between the architect or designer and the structure based on which he approaches the problem, as we can see in the following passage:

> *The essence of Schön's theory is that designers are active in structuring the problem, and that they do not evaluate concepts, but that they evaluate their own actions in structuring and solving the problem. The unit of 'doing design' is not a design concept, but an action* (DORST; DIJKHUIS, 1995, p. 271).

The circular action of reflecting, testing, and evaluating causes the initial structure, created to manage the problem situation, to be constantly improved and reprogrammed. In the comparative analysis of Dorst and Dijkhuis, it is arguable that Simon's rational methods are best suited for situations in which problems have clear contours, while the *reflection-in-action* model, developed by Schön, is best suited when there is a lack of clarity in the definition of the problem, or for the so-called *wicked problems*[2]. Schön's model necessarily implies in the recognition of the active role that the tacit dimension of the designer's knowledge plays in reprogramming the problem situation structure, and which is directly linked to his involvement in the perception and the experience of the situation, not as a fixed entity, but as a dynamic structuring.

Schön's form of perceiving design knowledge dialogues with Cross, Naughton and Walker's understanding (1981) of the non-exclusively scientific nature of design, but rather endowed also with a technological/ productive nature, whose thoughts are based on processes of reflection, inductions, spontaneous and accidental discoveries, and that often transgress established standards towards greater benefit. A key point to support a creative process based on improvisation in the contemporary design practice is to discuss the fact that design methods and scientific methods might be regarded as distinct activities. The authors consider that design methods are closer to technological activities since they occur in an organizational context, aiming at practical tasks, and whose tacit dimension allows a relative lack of discipline in relation to rules and pre-established codes. Now, scientific methods are structured from analytical activities, assumptions, which are subjected to testing and can be proved or disproved. Scientific methods of empirical and logical verification tend to disregard deviant behaviors in favor of the regularity of facts. It is intrinsic to scientific knowledge to allow its findings to be rationally reconstructed (CROSS; NAUGHTON; WALKER, 1981, p. 196). The authors refute the

[2] "Wicked" or ill-defined problems, according to Rittel's approach, are problem situations that challenge efforts of defining its limits and identifying its direct causes (SCHUMACHER, 2012, p. 322).

notion that technology - and therefore design - is a direct application of science, and justify their position stating that design practice makes use of several specific types of non-scientific knowledge.

> *Designers make use of a variety of kinds of knowledge, from scientific knowledge of the properties of materials to the ineffable craft knowledge (derived from apprenticeship, experience, trial and error, etc.) which enables a skilled practitioner to say that a given design solution 'feels' right (or wrong)* (Ibid., p. 198).

The critical view of design, as a non-scientific activity, which is not exclusively backed by certifiable processes, is also shared by many authors who belonged to an extremely influential generation in design thinking, in the 1960s, called *Design Methods Group.* Victor Papanek, Donald Schön, Christopher Jones, Christopher Alexander, Henry Sanoff were part of it, among others. In all of them, one can see design principles which are more open to experimentation, error, intuition, and thus to the possibility of incorporating creative actions based on improvisation. Henry Sanoff, for example, says that research in design is seen not only as a process of creating knowledge, but simultaneously as education and development of consciousness, and of mobilization for action. (SANOFF, 2007, p. 214) In this sense, it is an emergent process which pursue change and understanding at the same time (Ibid., p. 214) The author's approach reveals a view of the design practice which differs from a mere normative application, but rather as a mobilization strategy directly articulated with the investigative and experimental action in real time, as a jazz musician when improvising on a theme. That is, it is not a convergent process of elimination of mistakes but a divergent process of hybridization of forms.

The analogy with improvisation helps understand how it is possible to operationalize this indiscipline present in every creative process - including design - from the definition of more flexible structurings in the design methodologies. The paradoxical duality between discipline and indiscipline must be articulated in design processes; and this articulation between contradictory positions is one of the main attributes of complexity. Indiscipline occupies a domain that escapes methodological rigor and therefore challenges the scientific character that feeds significant part of design epistemology. In the Brazilian context, authors like Fernando Lara (2003) embody a clear view that designing, in architecture, must be thought of as a process whose character is eminently founded in complexity, that is, in the search for methodologies of knowledge production which combine discipline and indiscipline. By stating *"let us be disciplined and then celebrate our delicious indiscipline"*, Lara (2003), reinforces the importance of considering the condition of complexity, present in the interaction between opposites. For architecture to be able to realize this other position before reality, which is more complex and integral, it is necessary that it overcomes certain traditional behaviors such as the authorial approach, which is essentially stylistic and distanced from greater social responsibility. For Lara, the interest of a large portion of the architects in designing forms that"thrill", or that extoll the"gesture of the creator", in pursuit of prestige, confers, from our

point of view, a perverse and anachronistic status to the architect, of a sort of conductor or incontestable authority. The same author presents an alternative definition to the conductor architect, which seems more coherent and in the tune with the complexity of contemporary problems and contexts: garage band architect (LARA; MARQUES, 2015, p. 6). In this condition, he assumes a position that has greater room for adaptation, sharing, experimentation, and horizontal interaction with the others actors involved in the process.

Demand for adaptation

> *If we can learn to improvise and adapt, life can be deeply meaningful and rewarding* (RIJKEN, 2011, p. 154).

In design processes, the adaptation concept was introduced in a more systematic way by Christopher Alexander in the 1960s, in the publication *Notes on the Synthesis of Form* (1964). The author was based on the idea that the most viable way to achieve adaptation is to create programmatic structures configured by interconnected systems and subsystems, but which are relatively independent of each other (ALEXANDER, 1964, p. 41). Alexander considered that for a particular designed form to adapt coherently to the context, the designer should be able to organize its various layers of confrontation, so that each has its own resolution structure, independent but coordinated with the others (Ibid., p. 18). The author specifically addresses adaptation as a methodological scheme which coordinates the form's conception processes, and whose applications are independent of the scale of the project under development.

In design processes, adaptation necessarily means choosing a position open to interaction and dialogue, either be it the architect's articulation with the design organization principles (endogenous) or in the appropriation of existing data and information in the context it is inserted (exogenous). In endogenous terms, there is a demand for the development of more dynamic and shareable methods of reflection, structuring, and linking ideas. It is important to explore methods of production of design knowledge based on collective intelligence, and of network platforms of information exchange. In exogenous terms, it is essential to design spaces, objects, and systems which are open to the interference of their members, which set themselves in mutuality regime regarding the context, and which allow adding social, cultural, and phenomenological value to our experience of reality.

Adaptation allows architects to assume a greater role of promoters of creative processes, rather than the absolute control over all instances. It gives conditions for adding new scales of dialogue and interlocution with users, creating new mechanisms for engagement and training, making them thus progressively co-authors and participants. Besides, it also allows building a more critical look at our material culture, recognizing potentialities in what does exist, in valuing reappropriation, reuse, in

recycling, and in the idea of post-production. Adaptation refers to improvisation in its circular and dynamic ability to reconfigure modes of creation and expression. It allows us to move forward on static and linear design models, whose linkage is strictly morphological functional, constituting a field closed to experimentation and neutral about dialogue.

In design contemporary context, there is a growing demand for the elaboration of structures endowed with what can be regarded as systemic opening, i.e., the ability to foster a continuous adaptation to the context in order to shape it, but also to be shaped by it. The concept of system, according to Niklas Luhmann (2009), introduces a new model of structural ordering, with emphasis on the exchange, which can be translated into systems that interpret the world and react according to that interpretation (LUHMANN, 2009, p. 62). The idea of ??producing artifacts or structures with adaptive qualities leads to one of the major epistemological changes in the design practice, which involves moving from the notion of design as *form* to the notion of design as a *system*.

Design approximation methods, supported by systemic approaches, can be identified in publications of Christopher Alexander, Yona Friedman, Nicholas Negroponte, and Gordon Pask. Their approaches have in common the fact that they are inspired by the principle of feedback, concept which in turn derived from cybernetic studies. Later studies by John Frazer (1995), and inspired by scientific research on adaptive systems made by John von Neumann and John Holland, gave great contribution to the evolution of the design methods conceived as a framework of information open to external variations.

The feasibility and relevance of systemic analysis in contemporary design culture can be identified in the publication *The Autopoiesis of Architecture*, by Schumacher (2011, 2012). Schumacher uses Luhmann as primary point of reference to consider architecture as a *distinct functional system*, dedicated to *"design ordination models aimed at managing spaces and forms produced as interfaces for the mediation between man and all other systems"* (SCHUMACHER, 2011 p. 171). The author specifically refers to the relationship of architecture, as a discipline, with other differentiated systems responsible for managing our society - concept which was originally proposed by Luhmann - such as: economic, political, artistic, legal system etc. Each one endowed with their own and particular rules, shaping an autonomous system that despite diverse from each other due to these rules and characteristics, operate together articulately. According to Schumacher (2011, p. 371) the function of architecture is:

> [...] *to frame social communication or, more precisely, to continuously adapt and re-order society via contributing to the continuous provision and innovation of the built environment as a framing system of organized and articulated spatial relations.*

When considering architecture as a framing system of spatial relations, the author adds new levels of complexity to the view, until then emphasized by modernism heritage founded on purely formal, functional,

and aesthetic principles. Schumacher's vision allows considering spaces and objects as systems endowed with exogenous behavior and responsive capability, which allow them to not only articulate spatial relations, but also integrate them with informational relationships. This view can also be explored from the notion of congruence and interaction developed by Humberto Maturana. Admitting that architecture is the system, we have the space as the means in which it is inserted, and which comprises contextual elements, users, the social environment etc. From Maturana's perspective, the system and the means are in continuous structural change, each behaving according to its own structural dynamics, but being modulated by the structural changes triggered in them by their recursive interactions (MATURANA, 2001, p. 176). Thus, all systems in recursive interactions change together, congruently. It is important to consider that much of the current architectural production is not even imagined in such a way, much less does it present such recursive qualities. Current architecture is taking very slow steps towards the acquisition of systemic potential that enables it to incorporate, into its structures, a congruent and recursive dimension in its interaction with the context. Consequently, there has been significant loss of not only the quality of the context in which we live, but also of our own conditions of habitability in those contexts.

Because of this demand of congruent systems in artificial framings, adaptation has been considered a fundamental condition to add value to design processes, as well as in order for architects to embody a social function more coherent with the complexity of our reality. Design and project development should be articulated with issues directly related to their experience, and the way they evolve congruently in the context in which they are. This cyber dimension of structures and artificial environments implies new challenges to the design practice, and outlines pathways to a different design epistemology.

Simultaneously with the systemic and adaptive design challenges, programming and computer languages have evolved in parallel. Their open and interactive qualities engender new opportunities for adaptation and evolution of artificial systems. The path towards systemic quality of artificial spaces and objects produced by man can be accomplished via intermediation of computing resources and digital technologies. There are historical precedents which show that since the first projects dedicated to investigate adaptation in processes and artificial systems, still in the 1960s, to the most recent experience with parameterization, there has always been a close link between the cyber discourse and its operability via computer. The increasing access by architects to the world of programmers has revealed a new forces field, with potential to develop open models of ordination, new ways of working and sharing information from articulated networks and platforms, at global levels.

Demand for programming

> *Today, programming in architecture has become a much more open process, one that is inspired by the capacity to generate new and unprecedented modes of expression* (SILVER, 2006, p. 9).

By making this statement, Mike Silver points to a field of possibilities of reflection that has still much to offer to contemporary design processes. Digital technologies have broadened the understanding and the application modes of the programming concept in architecture. In a culture specially shaped by numerical technology, architects have skills to analyze and propose new ways to create, distribute, access, share, remix, produce, design content and material and immaterial objects, directly out of the software culture. It is in computer science that we can find new terms, categories and operations that characterize our culture and action methods (MANOVICH, 2008, p. 256).

According to Flusser (2007), the concept of programming has become central to contemporary debate. Although architects are already long familiar with the use of the concept of program, in the architectural design context, with computing, it takes on a different ontological dimension, more central and tactical. If, in the past, computer programming was an area of ??knowledge restricted to computer experts, it currently occupies significant part of the work of a growing group of architects, designers, artists, inventors, makers, and hackers. Programming has become an important means to create interactive systems, configure and parameterize software and hardware mechanisms, control systems of digital manufacturing, promote networks and collaborative work platforms, as well as for data visualization, complex simulations, and so on. In addition, programming moves towards being the standard language for all those who are not limited to the use, only, of software and hardware, but who also want to criticize, discuss, reconfigure, and reinvent them, i.e., to deepen in the digital world. Digital languages have ??brought other forms of non-linear thinking, they fostered the configuration of an extremely powerful collective intelligence, they have established other aesthetic references and triggered a whole behavioral logic which, due to its variability, paves the way for a more dynamic, adaptive, experimental, and improvisational thinking.

According to Schumacher (2012), design processes via computer programming scripts have arrived "replacing" direct manipulation of individual morphologies. In fact, it is worth mentioning that it was not exactly a replacement, as the author puts it, but a coupling of computational recursive functions to the process of generating and testing traditional models and simulations, giving them a much more dynamic experimental condition. This condition also extends to hardware devices such as microcontrollers, actuators, sensors, 3D printers, laser cutting machines, which still require programming knowledge for them to be explored in depth. But more important than giving access to software and hardware, programming is the feature that allows the emergence of open source

movements, hacker culture, alternative and subversive practices of cyberculture, included the *do-it-yourself*, *do-it-with-others*, *opensource*, *openhardware*, which together consolidate the bases of contemporary improvisational practices.

We agree with the thought of Pla-Catala (2013), that a new non-analog design culture, based on experimental digital procedures, emerges covering all areas of design practice. This evolution, according to the author, brings a new dimension to design thinking, more cybernetic, distributed, in which the linearity in problem-solving becomes recursion and chaining information. An important epistemological transformation highlighted by the Catalan architect is the greatest importance given by architects to an implied processuality towards programming the design rather than the explicit modeling of a specific form. The fact is that computer languages ??actually play a decisive role in the epistemological review of design processes. Linearity and the traditional morphological composition of classical, modern, and postmodern periods give way to a much more dynamic relationship between design constraints and possible solutions for the system to evolve. The ontological evolution of programming in design processes suggests that the program, traditionally understood as the first design stage, in which functional requirements are defined, becomes the very act of design and involves the entire network of behaviors and adaptations workable in a system.

To think design as programming provides conditions for the development of what Greg Lynn (2013) calls pliant systems, those that have the quality to generate unpredictable connections in the face of contextual, cultural, functional, structural, and economic contingencies, due to vicissitudes, that is, the quality of being variable, inconstant, in response to favorable and unfavorable situations that occur by chance (Lynn, 2013, p. 30-32). For Lynn, the vicissitudes of a system configure a tactical cunning to involve complexity.

The concept of programming refers to an inherently methodological action, which gained emphasis with the computer languages. It is basically dividing a problem into sub-problems, defining variables and functions that, subjected to a predetermined routine, aim to meet specific conditions. It is a process of writing a complex set of rules and functions that will coordinate a particular calculation procedure. The concept of program takes on a similar understanding in the context of architecture, though not restricted to mathematical calculation domains, but involving a system of communicational, semiotic, and phenomenological relationships and interdependencies, present as requirements and design conditions. Understood as the working principles that coordinate the behavior of a process of solving design problems, the program can be related to the concept of *frames*, or structurings. An analysis of the expression "a program runs on the computer," allows discussing an aspect inherent to the concept of programming, which connects the logic of digital systems and design processes: recursive operations. Both operate through self-referential cycles, continuously rotating the analysis of inputs and outputs. Donald

Schön (1983) comments that the production process of design knowledge is also a process of recursive conversation between the architect and the problem situation. According to Schön (1983, p. 132), *"the process spirals through stages of appreciation, action and reappreciation."*

The dissemination of design thinking based on programming have become more recurrent with Marcos Novak investigations, which, still in the 1990s, defended the need to find new ways to describe, generate and transform the fluid and metamorphic nature of architecture. His reflections considered that *"for the first time in history the architect is called upon to design not the object but the principles by which the object is generated and varied in time"* (NOVAK, 1991, p. 2). These processes are also identified as meta-procedural approaches, which Novak often referred as *metamorphosis*: a change in one aspect of an entity, as a function that alters other aspects (Ibid, p. 1). In Novak's view, the development of new computational means re-encodes architectural knowledge in such a way that our conception of architecture becomes each day closer to that of music (Ibid., p. 1). The author believes that architecture has been acquiring other morphological qualities that allow it to be changed based on reference structuring, or something equivalent to a music score.

Novak reflections are fully linked to the concept of cyberspace and, from it, to cybernetics. Considering cyberspace as this space of multiple relationships and interactions, cybernetics is the theoretical framework that allows us to understand how these relationships and interactions happen. Among the many cybernetics definitions presented by authors Paul Pangaro and Hugh Dubberly (2010), stands out that in which cybernetics is considered *"the study of the immaterial aspects of systems"* (PANGARO; DUBBERLY, 2010, p. 5) Retrieved from W. Ross Ashby studies, this definition brings up the idea that artificial systems can present a behavioral domain. This behavioral quality is gained via complex programming by which such systems begin to understand the context, process the information collected in it, respond to them and even reset their internal parameters from the continued analysis of this information. The main contributions that cybernetics offers to contemporary architectural design thinking lie in this behavioral domain of designed structures. In addition, cybernetic systems have, as basic foundation, procedural circularity and relationships of feedback that, on a broader level, can also be thought of as processes of reflection, thought and knowledge production. Both in terms of the designed structures as regarding the reflection processes, there is a demand to investigate mechanisms which promote circularity and the evolution of forms. Behind this enormous potential of variability, electronic languages ??have proven that there is a complex programmatic arrangement that deserves to be explored.

Demand for the Hybrid

> *The question is not "what to do with novelty," but "what to do with this?"* (BOURRIAUD, 2009, p. 9).

In a culture inflated with information, codes, signs and references, Nicholas Bourriaud considers that the production of singularities is as or more important than the creation of new information. The analysis of contemporary culture, carried out by the author, reveals typical features of a culture of accumulation. From this context of accumulation, the author identifies a diverse set of artistic productions that are born and develop from the appropriation of all types of object produced by our culture, aiming to *post-produce* them. Artistic practices of post-production adopt procedures full of improvisational references that help us introduce and contextualize extremely hybridized contemporary operative modalities.

Post-production is the appropriation of existing objects and cultural forms, which are in circulation, as a starting point for creating new repertoires and updated versions. It operates in an intense procedural experimentation field, and its goals go beyond, both critical and operatively, the relationship with existing objects, such as those established in restoration or recomposition actions, for example. It partially recovers the character of sense-displacement of the appropriated object, of Marcel Duchamp's Readymades series. In what could be superficially called another updated version of the Readymades, Bourriaud believes that the artistic post-production practices seek an agreement with the view that assigning a new idea to an object and inserting it into new stories is an act similar to micro-piracy (Ibid., p. 21). Returning to the idea proposed by Vilém Flusser in *The Encoded World*, each object produced by man is equipped with a program, or a choice of "prescribed possibilities" (FLUSSER, 2007, p. 64), post-production acts in the sense of deprogramming them, removing their codes to then reprogram them under new conditions. It is, therefore, a form of recoding, in the ways that hackers do.

Noteworthy is the hybrid and circular post-production character that challenges, at the heart of accumulation culture, the predominance of novelty and the heroic quest for the unprecedented and the sublime (BOURRIAUD, 2009, p. 45). Post-production searches to reinsert the topics it works with in new cycles and narratives. Bourriaud points out that electronic technology had a decisive role in post-production practices, enhancing the emergence of hybrid culture from characters such as the DJ, the programmers, and their sampling, remixing, and scratching tactics, and the reuse of artistic fragments. Deepening his description about the DJ, Bourriaud (2009, p. 39) tells us that his work consists:

> *To show his personal itinerary in the musical universe (a playlist), and connecting these elements in a certain order, taking care of the construction of an environment (live, with the audience, which reacts to his movements)* [...] *his style is revealed in the ability to inhabit an open network (the history of sound) and in the logic that organizes the links.*

The DJ is a paradigmatic character of the hybrid culture. He is the main subject of the technoculture and the remixing practice. His work mode

challenges the established traditional values ??as the authorship culture. The technoculture, in turn, enhances the opening of new information, relationship and communication networks, complexifying the way our material and immaterial culture is designed and produced. However, it creates forces whose senses are opposed, such as new data democracies, and, simultaneously, new control mechanisms. Many technoculture improvisational initiatives derive from a desire to circumvent these new control strategies: open source practices, shareware software, and creative commons licenses, for example. These are new action tactics that today deserve an in-depth analysis, much due to the hybridized way they manifest (CERTEAU, 2011, p. 95). Despite recurring attempts to control, and the constant criticism of these productions by appropriation, it is important to recognize the hacker as a central character of contemporary improvisation. His challenge, posed to the limits of authorship and control, allows us to glimpse a rich ability of appropriation, reprogramming and recoding systems, which makes him the protagonist in post-production processes. Furthermore, the ability of aggregation between hackers, and their abilities to build working networks with a high degree of autonomy and cooperation stand out.

Many are the implications of this technoculture accumulation for contemporary design activity. Even though much of design activity still lies on the model of originality, the unprecedented, and authorship, architectural post-production practices have become increasingly common each day, and more than that, they are becoming recognized as an important part of the architecture's autopoiesis. However, we must recognize that the image of the architect as genius creator still exerts great influence on current architectural design imagery. It would be no exaggeration to say that it offers, in many cases, a perverse tale for the younger generations, who are led to believe in a supposed privileged aura of the architect as the coordinator and holder of the entire creative process. In that which Guy Debord, centerpiece of the Situationist movement, would call a society of the spectacle, the imaginary of the starchitect is reinforced with this position.

Contrary to this posture, recent research conducted by Eric von Hippel (2005) shows that significant innovation processes have been occurring in less spectacular, more shared and informal circuits. Hippel argues that open source projects are practices that have taught us ways through which professionals and users can create, promote, cooperate and mutually develop complex systems and products in the context of innovation communities (HIPPEL, 2005, p. 14). Unfortunately, a significant portion of design professionals is still not convinced of the importance, for the design culture, of innovation networks, and its potential to deal with the increasing complexity of design problems. The author warns us that, in complexity contexts, it is necessary to recognize the limitations of top-down[3] design processes, and seek new alternatives for managing problems in the bottom-up[4] organizational models.

The emerging organizational models and alternative modes of non-standardized production are study subjects of Charles Jencks and Nathan Silver (2013). The authors provide a comparative study between post-

[3] *Top-down* mean a "from top to down" methodology, i.e., characterized by strict hierarchies and centralized decision-making systems. See Johnson (2003, p. 36).

[4] *Bottom-up* is related to methodologies based on the principle of emergency. The emergency is handled by Johnson (2003) as an ascendant manifestation, the antithesis of *top-down*. For the author, emergency is a "bottom up" behavior, in which parallel interactions between local agents give rise to global standards. Ibid., p. 14.

produced constructs executed in various cultures, and the serialized products of large corporations. This study shows that if, on the one hand, there is a global trend towards garnering the maximum number of consumers through standardized products, similar to what in architecture is defined as the *International Style*, on the other, there is a growing part of society seeking competitive mechanisms to develop customized, unique solutions. This portion has been organizing itself in networks and digital platforms, exploring self-organization and emergence mechanisms, and shaping a new possible imagery based on appropriation and customization of goods, products and services. On these productions geared to specific purposes, the authors comment:

> *Today we are immersed in forces and ideas that hinder the fulfillment of human purposes; large corporations standardize and limit our choice: philosophies of behaviorism condition people to deny their potential freedom; 'modern architectures' become the convention for "good taste" and an excuse to deny the plurality of actual needs. But a new mode of direct action is emerging, the rebirth of a democratic mode and style, where everyone can create his personal environment out of impersonal subsystems, whether they are new or old, modern or antique. By realizing his immediate needs, by combining ad hoc parts, the individual creates, sustains and transcends himself. Shaping the local environment towards desired ends is key to mental health; the present environment, blank and unresponsive, is key to idiocy and brainwashing* (JENCKS; SILVER, 2013, p. 15).

In this passage, a direct mode of action stands out, which is the way these ad hoc models act[5]. The authors comment that these renewed production models have qualities in creating connections between existing systems, reusing objects that are in state of disrepair, implement couplings, adjustments and adaptations in degraded infrastructure, and that they can be seen in different scales: from objects of daily use like chairs and appliances, to urban interventions.

[5] *Adhoc*: Latin phrase meaning "for this" or "which is intended for specific purpose" (Priberam Dictionary Of The Portuguese Language).

Conclusion

The reflections presented here lead the understanding that it is not only possible but desirable that improvisational practices, that is, practices based on continued adaptation and articulation of different knowledges, be incorporated effectively into design processes, notably in contexts of complexity. Through the association between flexibility, instantaneity and complementarity, it is revealed an expanded field of reflection-and-action possibilities for contemporary creative practice which, driven by the diversification of computer processing mechanisms, creates fertile ground for renewed approaches dedicated to studies of complexity. It is from this sense that we approach an epistemological review of the design practice: from a new outlook at procedures hitherto seen with resistance, such as the case of the improvisation practices, whose spontaneous, tactics and hybridizing dimension, today, gains relevance and operational support by means of the broad range of possibilities for.

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