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EMERGING ARCHITECTURE, PARAMETRIC DESIGN AND REPRESENTATION BY MEANS OF INFORMATION MODELS

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Abstract

There is much discussion today as to the use of digital media integrated to the creation process in architecture due to the emergence of different ways that enable rapid visualization and modification of ideas during the design process. Parametric design in this discussion mainly refers to its capabilities and the kind of stance this practice demands from architects willing to work along with numerical parameter-based routines. This paper examines some of the parametric design practices, especially with respect to the likelihood of a creation process, in architecture, that relies on the interaction among parameters organized by the architect to enable an emerging architecture. In addition, this article briefly discusses the role of these digital media in this practice.

Keywords: emerging architecture; parametric design; digital media; organization; creation process.

Introduction

Today's architecture increasingly operates on the notion of a geometry that "is not one of section, elevation and plan, but one that tries to envisage these three – construction,

perception and action – within a single continuum" (SPUYBROEK, 2008 p. 56). Contemporary architecture deals with variety, continuity, performance, and the emergence of non-programmed features. Architecture is no longer produced top-down, a practice in which professionals "formulate an overall design concept and then refine the design at successively more detailed levels" (RAHIM, 2009), but a practice that operates in the way stated by Ali Rahim (2009):

> *Designers who use temporal techniques instead begin with the individual parts of a system, linking these elements together to form larger components until a complete assemblage emerges. Each step in the process reshapes and redirects the next. Hence, new associations and outcomes may arise that were not anticipated* (RAHIM, 2009, p. 2).

We can better appreciate the process of creation that defines the architectural element as emerging when we understand the use of digital media allowed by this practice of architecture. This type of architecture relies on digital media to facilitate a continuous flow of information, either to organize parameters that generate the architectural object or to promote exchanges among elements of the system. Parametric design anticipates this organization of information and provides the creation process with the possibility of visualizing this set of information in an organized manner. We should bear in mind that, with regard to architecture, the question of visualization, in the graphic sense of the word, is an important way of sharing information among designers of the process, whereas for the architect, design is the means by which the architectural thinking occurs.

With the flow of information in the process, representations gain a breadth far beyond mere visual representation. The possibilities of representation are expanded by 3-D models that are not mere graphic visualizations, but parameter-based data models.

Parametric design and emerging architecture

In order to fully grasp parametric design it is necessary firstly to understand the concept of parameter and how it is appropriated in architecture. "In mathematics, parameters are values that can be assigned to a particular variable, allowing the estimation of different solutions to a problem" (CELANI, 2003, p.21). Celani borrows this definition from mathematics to explain parameters within the scope of design or creative activity. In parameterized modeling, we use this definition of parameter implying that they "are used in the generation of different ways, but with the same fundamental features" (CELANI, 2003, p.22). These changes do not necessarily take place in plastic shapes; other design features may also be affected when we change some parameters of a project, e.g., structural performance or comfort features.

We understand the process of creation in emerging architecture as the choice and arrangement of parameters, allowing the final product to emerge as a feasible result out of a multitude of alternatives provided by this process. Architects play the role of element managers in the process, no longer mere agents of shape creation, but decision-makers: they

select elements that serve as project parameters, so that the arrangement among them within this complex system results in the emergence of factors that characterize the project.

From the understanding of the use of parameters in the process of creation, we are led to the study of the process of parametric design. Parametric design, however dependent on the use of digital media, is highly dependent on the architect's attitude about the creative process, i.e., creation should be seen as part of interaction among the elements and the emerging potential.

> *Parametric Design is more about an attitude of mind than any particular software application. Its roots lie in mechanical design, and as such, it lends architects to thought and technology. It's a way of thinking that some designers may find strange, but the first requirement is an attitude of mind that seeks to express and explore relationships* (WOODBURY, 2010).

As stated by the author, parametric design is an attitude that implies the understanding that project design, whether of objects, buildings, or even urban fragments, only becomes feasible when interactions among the constitutive parts of system are taken into account. It also entails that technology should be explored in conjunction with human creativity. By viewing "human creativity as a multitude of cultural, economic, social repercussions [...]" (REIS, 2009), technology becomes a possible organizational element that can process this wealth of information by creating representation models that allow this information to be dealt with in an organized manner.

Processes that function on the combination of parameters are rooted in mathematical problems directed to algorithms, in which the solution to a problem derives from triggering a logical series of questions. Algorithms are understood as a set of questions that lead to the solution to a problem.

> *To solve a computer problem one must first find a way to describe this problem clearly and accurately. It is necessary to find a sequence of steps that allow the problem to be solved automatically and repetitively. This sequence of steps is called algorithm* (CRUZ, KNOPMAN, 2001).

When this is taken into account in the creation process in parametric design, the designer begins to work on the development of these questions within a design proposition. Thus, because it is a creation process that seeks to identify questions intrinsic to the project, one cannot speak of a process that produces a general conception and only to later review and design layers by layers of consecutive subsystems. The process is developed from the understanding that the relationship among small parts generates answers to these emerging relationships.

Within the scope of a parametric process that works with the idea of a 'sequence of questions' aimed at an answer emerging from the inter-relationship among the parts of a system, it is possible to speak of architecture of an emerging nature. Like self-organizing systems, these

emerging factors can provide feedback to the initial problem proposition, thereby generating several adequate solutions so that we can speak of a type of architecture with generative potential. This expression, i.e., generative potential, was first coined in the hard sciences, e.g., mathematics and biology, which implies a sequence of questions fed back from generation to generation. When a system provides diverse and adequate solutions, it becomes difficult to achieve the same results linearly, "only a generative system would be capable of evaluating, selecting and optimizing architectural requisites" (CHATURVEDI et. al., 2011).

Each individual organization within this process generates a solution to a specific problem. Each problem features a plethora of appropriate solutions and each feasible solution when coupled with other feasible solutions to other problems can generate a multitude of 'final,'[1] appropriate, different solutions. Yet, the insertion of external parameters in this systemic process is still possible due to the opening to unpredictability of the system. This concept of arrangement among parts and possibilities of change while maintaining the adequacy of the final result may be equated to genetics, for example, to "the idea that in each generation, there are variable organisms that are produced based on their fitness" (KIRSCHNER, 2004, p. 30), considering performance the appropriate results to what the designer programs in the system.

> *It is interesting to note that the aesthetics were derived from the functional aspects of the design, which in turn were deduced from the technical logic of construction system. Thus the 'process of making' was as 'the DNA of the creation', where quantitative pursuits become qualitative* (CHATURVEDI et. al., 2011).

This brings to architecture issues such as evolution and variability, taking into account this process of creation based on the development of complex systems, in which the designer's role is to organize and plan elements through representations provided by digital means of parametric design. From the emergence of varied solutions, the shape of the final object ceases to be merely the designer's plastic choice and becomes an emerging element to the process. The 'final' shape consists of a solution to systemic organization proposed within a set of programmed actions. The system supplies the results as products, which can be varied and still adequate. It may also have an evolutionary character, when one imagines that the creation process established within a complex system does not end when the architectural element is built, for example, but remains liable to evolve from use. That is the time the architect counts on this factor when designing the system.

As regards the aspects that juxtapose systemic features based on behaviors of living beings, Wiscombe states:

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[1] The term 'final' is placed between quotation marks because, from the perspective of the creative process addressed in this text, the end of the process is but the designer's decision to freeze the process at some point. The process of creation is seen as a growing, nonstop, and never-ending cycle; it only has a moment in which an object is the result of it. But this object is still subject to changes caused by elements of the system to which it belongs.

> *Nevertheless, despite their parallels, some of the primary terms with which both architecture and biology are concerned turn out to be different in kind rather than degree: what architecture calls function, in the dogmatic sense, biology calls behavior. What architecture calls order, biology calls DNA scripting. Biology, it turns out, defines its processes dynamically and generatively, while architectural processes still tend to be understood as fixed and stable* (WISCOMBE, T. 2005).

This mode of architecture that works with parametric processes attempts at subverting the idea of architecture being fixed and stable. Architecture, being subjected to human actions like a biological system, tends to adapt to these actions and evolve as a dynamic and variable element. It is important to understand that architecture, as well as biological systems, must be open to different appropriations and, to some extent, allow mutations, i.e., mutations as phenomena that "do not necessarily build something brand-new and novel on their own, but merely cause some existing complex process to be used in a different way" (Kirschner, 2004, p. 30).

For architecture to absorb this large amount of information and arrangements, it is necessary to combine the designers' creative skills (fed by a myriad of elements and relationships) and the processing capabilities of machines, making it possible to think of a parametric architecture. It is essential to understand the importance of digital media integrated into the process and not just as tools.

Parametric design is considered to be a creation process that makes use of technologies to design, organize, and visualize by means of software as well as to produce with the help of machines that dialogue directly with this software. It is a process based on accurate information correlated by linking parameters.

> *In other words, the processes of describing and constructing a design can be extracted, exchanged, and utilized with far greater facility and speed; in short, with the use of digital technologies, the design information is the constructions information* (KOLAREVIC, 2009, p. 7).

It is possible, based on the decision to use digital means integrated into the process by parametric design, for example, to explore complex shapes in the plastic sense, which can still be mass-produced by industrial numerically controlled machines or CNC machines. Thus, in the parametric design creation process, the project has feasible numerical data for production both in reduced scale and in real scale. It adopts the idea of production working with digital design files sent and produced directly in industry, known as "file-to-factory."

As stated by Kas Oosterhui (2007), the file-to-factory system is the "seamless fusion of design and production. It involves the direct transfer of data from a 3D modeling software program to a CNC (Computer Numerically Controlled) machine." This transfer can be conducted so as to produce study models during the creation process or even for the production and final construction of complete buildings, from which derives the concept of digital manufacture. This

concept is based on the production based on the use of digital media for the conception and production of design elements, be they in the model scale or in that of the final product. In relation to this integration between conception and production, Kolarevic (2009, p. 7) writes:

> *Much of the material world today, from the simplest consumer products to the most sophisticated airplanes, is created and produced using a process in which design, analysis, representation, fabrication and assembly are becoming a relatively seamless collaborative process that is solely dependent on digital technologies - a digital continuum from design to production.*

This process is feasible only if one accepts the idea that digital media are part of the process, that its operating logic comprises indexes for design proposition. When exploring parametric design, actions directed to creation need to be revised, for Kolarevic (2009, p.17) claims that:

> *In parametric design, it is the parameters of a particular design that are declared, not its shape. By assigning different values to the parameters, different objects or configurations can be created. Equations can be used to describe the relationships between objects, thus defining an associative geometry - the 'constituent geometry that is mutually linked.'*

Thus, the process is considered to be bottom-up, i.e., it is essential to establish relationships among the parts in order to allow the emergence of features compatible with the established parameters. It should be emphasized that a change in the attitude of those involved in the creation process in architecture is more essential than the use of specific software, despite digital media still being needed for the development of parametric architecture.

Information models

This article has discussed parametric design and its potential to enable a emerging mode of architecture whose creation process sees the architect as not merely a designer of shapes, but especially a manager of data. Representation is no longer a tool to visualize plastic issues, but a tool to organize numerical data, made possible by digital media.

Parametric design works with information models that guide decisions with respect to arrangements among parameters, carried out by architects. As stated by Kolarevic (2009), one should think of information organization as a continuum that generates the architectural product, from design to production. But to this end, architects' attitudes concerning the creation process must change. Their attitudes should be grounded on the understanding that the interaction between the parts is more important than the general design of the architectural product.

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