PARAMETRIC DESIGN AS A TECHNIQUE OF CONVERGENCE

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Abstract. Following the introduction of parametric design into the contemporary digital architectural scene, this paper exposes its principals as well as some of its major potentialities that emerge from its use in the discipline. It is argued that parametric design is a technique that embraces the concept of “convergence” in multiple dimensions. Through this explanation this paper intends also to highlight the relevance of the integration of this technique in architectural education. Student’s projects are described to illustrate some of the concepts.

1. Introduction

New digital technologies of design, engineering, manufacturing and communication are challenging architects in thinking about new ways of doing Architecture. Contemporary architectural practices have been fully embracing the digital, to create a variety of design techniques that promote the emergence of a landscape of research fields. Some of the most visible trends focus on extending the impact of the computer to digitally reconfigure the processes that drive towards the physically built object. Building concerns are joined together with conception and communication, revealing a deeper understanding of the specific potentialities of the digital for the “making” of architecture.

When Kolarevic (2001) observes that “the Information Age, like the Industrial Age before it, is challenging not only how we design buildings, but also how we manufacture and construct them” it’s possible to identify the actual relevance of those digital research fields dedicated to design-to-manufacturing methods. It is precisely in this scene that parametric
design emerges as a digital technique, which by offering particular possibilities to bridge conception-to-production processes, promotes new forms of developing architectural projects.

2. Parametric Design

Coming from other design related areas (i.e. automotive, aerospace and product design), parametric design supports a different kind of architectural proposal. Also known as “associative geometry” (Burry and Murray, 1997) “relational modeling”, “variational design” or “constraint based design” (Monedero, 2001), parametric design implies the representation of a design intention with a series of associative operations, controlled by constraints and parameters. As described by Kolarevic (2001), “In parametric architecture, it is the parameters of a particular design that are declared, not is shape”.

Parameters are numbers and geometrical relationships. To design with parameters requires the establishment of a series of parametric principles; the creation of a model that includes geometrical elements defined by changeable variables, acting as a system of interconnected information. The manipulation of the parameters built-in to this system, offers the possibility to obtain multiple adjustments of the model, yet following the same guiding design intention. Acting as a kind of organism, the parametric model is a whole that has the capacity to react to specific changes occurring in its parts. Parametric modeling becomes “invaluable for both preliminary and developed design, where there is a need for definition, manipulation and visualization of complex geometry” (Burry and Murray, 1997).

Being an associative digital environment, parametric design provides a fluid workspace that interactively merges digital files from multiple software modules. For instance, its possible to develop a 3D digital model, while 2D orthographic views, manufacturing instructions or other associated representations get updated in real time.

It can also be seen as a technique that provides precise tools for control, as well as an environment that stimulates creativity. In other words, generating a parametric model (which contains all the data and geometrical relationships susceptible to be adjusted and/or updated into different versions) it’s like designing multiple possibilities at once, including unexpected ones.

To illustrate this idea, the following example shows the result of an introductory exercise on parametric modeling, which begins with the selection of similar objects to define a “family” or “collection” (Fig.1). The exercise asked to identify the constants and variables throughout the collection, in order to translate them into the constraints and parameters of a parametric model (Fig.2). This single model should be able to generate, through the manipulation of its parameters, the outline of all objects of the collection (Fig.3). To explore the creative possibilities of the model, the exercise ends
with the generation of a set of new contours, by testing the “limits” of its parameters to produce unpredicted solutions (Fig. 4).

Figure 1. Object collection.

Figure 2. Parametric model
3. A technique of convergence

Due its capacity to interactively assimilate and manipulate different types of data, a parametric model implies a digital design technique that embraces the concept of “convergence” in multiple dimensions. These conditions of convergence occur at different levels; the disciplinary, the representational and the modalities of practice.

2.1. ON THE DISCIPLINARY: BETWEEN ARTS AND SCIENCES

Architectural design is the result of a process that keeps shifting between modes of representation: those aiming to develop creativity (as in the Arts) and those performing analytical and descriptive tasks (as in the Sciences).

As illustrated above, a parametric project collapses both into a single medium. The parametric model, commonly seen as a highly constrained environment for design, can thus encourage the emergence of artistic possibilities from its own control mechanisms; it provides a “meeting place” of the processes of “intuitive, perceptual and structuring knowledge” with
those of “logical knowledge geared toward the control of material construction” (Lisboa, 1997). Convergence, in this case, results in an interactive relationship between the two, questioning the traditional one-way design method, based on going from creation to description.

2.2. ON REPRESENTATION

Parametric design can be understood as a technique of convergence, as it collapses different representational systems. Providing a fluid workspace, it “flattens” different tools, materials and supports in a single digital setting. 

This discussion becomes more complex when one understands that the principles behind parametric design pose an interesting semiotic discussion: a debate that arises from a revised relationship between the system(s) of representation (now collapsed in a single parametric model) and the desired architectural object (now turned into a set of possible versions of it). The built object is no longer an inclusive representation of a set of partial design documents, but rather becomes a partial representation (or manifestation in built form) of the single digital construction that generated it.

Massie (2002) observes, “according to Cache, since design occurs a 3D simulation and this simulation can be milled, the simulation takes precedent over the physical object. It should be argued that, in fact, the virtual simulation and the physical object are one and the same with no hierarchy”. This idea can be interpreted as another moment of convergence: a merging of both physical and virtual information in a single parametric model.

2.2. ON MODALITIES OF PRACTICE

An associative parametric model encourages an interactive participation of different specialists on a common medium (the digital environment). As it has the potential to simultaneously incorporate parameters that respond to different disciplinary fields, it promotes the convergence of all these interests.

This common workspace supports a form of collaboration that challenges the linearity that characterizes an architectural project.

The following example, developed in an academic environment, illustrates that, when associated with digital production technologies, parametric design promises a dynamic process where conception, simulation, analysis, presentation, detailing and construction can happen simultaneously in a fluid and interactive environment.

The design problem asked to analyze an exiting urban situation and develop a parametric proposal, understanding the specificities of different locations in parameters and geometrical constraints (Fig.5). The design intentions were incorporated in a single parametric model, which would be able to be adjusted and generate multiple solutions, to be implemented in different locations (Fig.6). For development of the design, new parameters
were added, in order to address the qualities of every different scale of the project or include CNC fabrication concerns (Fig. 7). The built prototype is one of many others, possible to be interactively generated by this parametric process (Fig. 8)

Figure 5. Urban parametric description

Figure 6. Parametric adjustments at different locations

Figure 7. Tectonic development
4. Convergence: a pedagogical opportunity in architectural education

After the period where “early applications of computer-aided design (CAD) technology in architecture (…) were most employed as accurate and efficient replacements for traditional drafting instruments in the production of construction documents” (Mitchell, 2001), contemporary architectural education has indeed fully embraced the digital as well, creating a variety of techniques as research-oriented design methodologies.

Parametric modeling is emerging as one of the most recent attempts to bring a digital, cross-disciplinary research field into architectural education. As noticed by Burry and Murray (1997) an “effective use of parametric modeling tools provides a fertile medium for teaching architecture and research into design processes”.

Moving away from a “singular identifiable model, prototype or master form in which all variations or evolutions can be measured by, or traced to, one specific source” (Shop, 2003), the parametric model organizes all the conditions and operations of a design intention, producing an architectural model which is inherently adaptable, evolutive, aligned with an idea of architecture “as a processual data-design, a continuous processing reciprocal convergence of projection and production” (Rocker, 2002).

In design education, parametric modeling encourages a convergent, multi-dimensional idea of design; it provides students with a kind of “hyper-experience” of the architectural object, which flows from the design foundation, to representation and technical description, even to fabrication programming, to manufacture real scale prototypes at 1:1 scale.
Ultimately, parametric design as a technique of convergence offers a completely new perspective; where creativity is not suppressed but re-emerges in a different form of expression; where the technical is not seen as a consequence but as an instrument; where representation is a means for an interactive mode of communication; and finally, a technique that develops a “hyper-awareness” in students, to develop new modes of architectural practice for the beginning of the century.

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References