Drawing without drawing.

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Abstract

Parametric modeling integrates both experimental design (CAD) and its realization (CAM) and verification (CAE). It is susceptible generative systems variations and 'mutations', based on parameters that are translated into a programming language by 'genetic algorithms', as the named John Holland in 1970. This raises the possibility to operate, simultaneously, with multiple solutions, for the sake of ideation and prototyping later. These prototypes programmatically parameterized with Grasshopper, may even become smart objects with Arduino hardware microprocessor programming electronic components.

Parametricism. Digital morphogenesis. Genetic architectures.

The new paradigm of Parametricism.

The dilemma that arises seems to be whether to elucidate the priority of the hand over the machine or vice versa; But it seems that the answer is obvious: since the hand is still a tool, the quality of the result depends above all on the concept or, in other words, on the mind and sensibility that guide the hand and/or the machine. In any case, there is no doubt that the new key competence, associated with the control of the aforementioned final result, is to know how to program in open source languages, that is, to draw without drawing.

Patrik Schumacher defines Parametricism as the new great style after the Modern Movement. In his well-known manifesto, he contrasts, for example, the concept of space with that of field, or that of form with that of deformation, thus making explicit reference to a multifaceted reality, but also to the dynamism and complexity of today's society. With these new technologies of parametric modelling and digital fabrication, in some cases linked to singular buildings, the maximum optimisation is almost always sought from multi-production components that are easy to construct using low-cost industrial materials, especially with furniture prototypes (Rivera, 2014:244). On the other hand, geometry and art go hand in hand in the present moment more than ever (Cabezas Gelabert, 2011:69), definitively overcoming the traditional divorce between art and science and with a new generative geometry, associated with Parametricism. Thus, parametric or algorithmic design unquestionably enriches its predecessor, descriptive geometry, and it does so through research and innovation. In this sense, compared to the metaphor of the drawing table, parametric modelling "is based on the metaphor of a mechanics workshop" (Cardoso Llach & Capdevila Werning, 2009:138), which means that the generation of the model is associated with its numerical definition, that is, the model is defined from a system of relationships that allow multiple variations. On the other hand, it is true, however, that Parametricism does not have to be a unified style as Patrik Schumacher claimed (Schumacher, 2009:14), but should be understood as a comprehensive approach that attends above all to economic and functional approaches and not exclusively formal.

On the other hand, from a formal point of view, the curved line and the straight line seem to have been incompatible in numerous stages of the history of architecture, with sometimes radical positions in favour of or against each of them, respectively. In relation to the above, traditional concepts of drawing such as grid, even in twentieth-century architecture (Cortés Vázquez de Parga, 2013) or proportion (Padovan 1999:221) can be associated indistinctly with both types of line, combining the Eastern tradition of the wisdom of nature with the Western tradition of rational knowledge (Doczi 2004:127). In this sense, some brilliant architects have known how to reconcile them and make the most of each of them. On the other hand, the uniqueness and singularity of matter-images (Brea, 2010:12) contrasts with the specific attributes of other types of images such as those that incorporate movement (films) or any modality of e-images, the latter certainly spectral and characterized by ubiquity. For this reason, it used to be common to speak of an antithetical art-technique; although it is, by all accounts, a conceptual opposition that is considered to be largely overcome today.

Thus, a new architectural paradigm emerged, that of geometrically ambiguous forms, endowed with enormous formal complexity and indissolubly associated with the concept of digital technology, could find a complement with other technological approaches; An example of augmented reality on a mobile device is that of hyper-realistic purposes. This new paradigm must also be framed within a global context of crisis of science in its relationship with the obtaining of situational or sensory information (Burgos, 2008:111), which supposes, when we talk about architecture, a reinterpretation of creative processes that also entails a surprising component of renewal or highly motivating pedagogical revision. Thus, from a general point of view, digital technology would occupy a leading role in the management of production processes and would become, now more than ever, at the service of human beings in the sense of being focused on solving real or practical problems. For this reason, we speak of transversal technoscience, together with performative or collaborative design, the latter based on the use of hypergraphs and genetic or parametric algorithms for the generation of patterns. On the other hand, the so-called cyberspace appears as a new social telematic scenario (Burgos, 2008:114) that requires the interaction or active participation of spectators, which radically modifies the concepts of space and time in interpersonal relationships, with avatars and new immersive environments loaded with experiences and sensations in which the real body actively participates within this new Noosphere. Thus, Interactive Three-Dimensional Modeling and Simulation together with Virtual Reality (VRML) investigate the potential of the so-called telesenses by the hand of pentasenses. Thus, there is more and more talk of ephemeral architecture, with the new concept of Event-Oriented Design (DOE), but also with reused materials or mutant furniture, with 'fluid' or 'evolutionary' architectures, in the so-called 'digital morphogenesis' (Kolarevic, 2008:3). In short, it is about learning to build from the crisis and live with chaos through the use of exploratory and investigative strategies.

Open Source versus CAD/CAM.

From a global point of view, this new contemporary paradigm is associated, as has already been mentioned, with interdisciplinary and collaborative research, and all this linked to a general restructuring of knowledge hand in hand with a new articulation of knowledge. Thus, the 'death of the author' gives way to architectural or artistic collectives that tend to work with the philosophy of the shared culture of 'Open Source' and free software, sometimes with the utopian pretension of low cost that 'everyone can build their own home'.

In 1963, Ivan Sutherland developed the sketchpad as the first graphical interface for computer-aided design (Cardoso Llach & Capdevila Werning, 2009:137); However, architectural design was able to react only after a few decades. Thus, CAD systems together with assisted manufacturing devices (CAM) make it possible to explore new territories today; This provides greater creative freedom based on new skills that are undoubtedly associated with new ways of digital architectural ideation, all with the implementation of increasingly complex visual grammars.

Thus, complex geometric shapes progressively take over Architecture, forcing the discipline itself to question its specificity, in the search for increasingly efficient, adaptable and flexible solutions. In this way, the concepts of module and series are supplanted by those of version and variation. In this sense, parametric modeling integrates not only the experimental designs, but also their materialization, the latter being one of the main distinguishing features from the methodological point of view. This constructive rationalization also involves essential issues such as performance or variability, along with other attributes such as complexity and efficiency. These are generative systems susceptible to varieties and mutations, which can be tested and verified.

In relation to the teaching of architectural drawing, we are currently witnessing a revision of the traditional teaching model based primarily on 2D drawing (Bravo Farré, Font Basté, & Contepomi, 2012:45). This is also the case for many other technical subjects, in which an increasingly interdisciplinary and transversal collaboration is necessary. In this way, BIM (Building Information Modeling) systems are beginning to gain ground exponentially, which represents a notable modification in relation to the way of conceiving architectural design. It is therefore a matter of covering the analysis and the whole of the project's documentation structured in a true interchangeable database, which, being interconnected, enables and encourages interdisciplinary work, which undoubtedly becomes essential. Thus, the traditional concept of drawing is gradually replaced by that of a 3D virtual model, with the additional advantage of parametric modeling, which means the automatic updating of the changes made in each and every one of the views associated with the model. This new approach also incorporates, in the professional field, the complete control of the life cycle of the building, which means that its maintenance is taken into account from the project from a greater constructive specificity almost from the beginning. With all this, it seeks not only greater coordination of work teams, based on collaborative models, but also gains in productivity by reducing time, thus achieving greater control of all aspects involved in the final construction of the building. However, the optimisation of the BIM model, characterised by an integrated practice associated with greater rigour and precision, goes without saying that it requires efficient coordination of disciplines and specialists, as well as shared, much clearer and more realistic planning. In contrast to all the advantages mentioned above, there are some drawbacks, essentially related to the loss of spontaneity, quality, originality or sensitivity of traditional drawing. Thus, the initial stages of ideation, exploration and sketching seem to disappear almost with the stroke of a pen and completely, or at least be replaced by new ways of understanding the sensitive component of the human being. For this reason, and given that good architecture is primarily art and not exclusively construction, the experimental component becomes essential, especially during the architect's training process. This undoubtedly means being able to interpret digital modelling and parametric design as authentic ideation tools, much more powerful and versatile than traditional ones, while at the same time being much more motivating for most students. In this way, the simulation and visualization of 3D models using digital tools involves the integration of the physical variables of the model with others of a constructive nature or of real location and contextualization in a specific environment (Velandia, 2011:1). It is, in short, a modelling of elements that become dynamic, essentially due to the permanent possibility of modification and visualization. Among the most versatile modeling programs, the most widespread in the architectural field is undoubtedly Rhinoceros, although the enormous potential of Grasshopper, born as a free parametric modeling plug-in, almost overtakes in popularity the program on whose interface it is based; especially because of its inexhaustible potential to generate dynamic elements. On the other hand, another of the great novelties are the CAM processes, which enable the development and cutting of surfaces, to make possible the manufacture of physical prototypes that encourage artistic creation based on experimental research (Zellner, 1999) of non-Euclidean topological geometries (Lootsma et al., 2004).

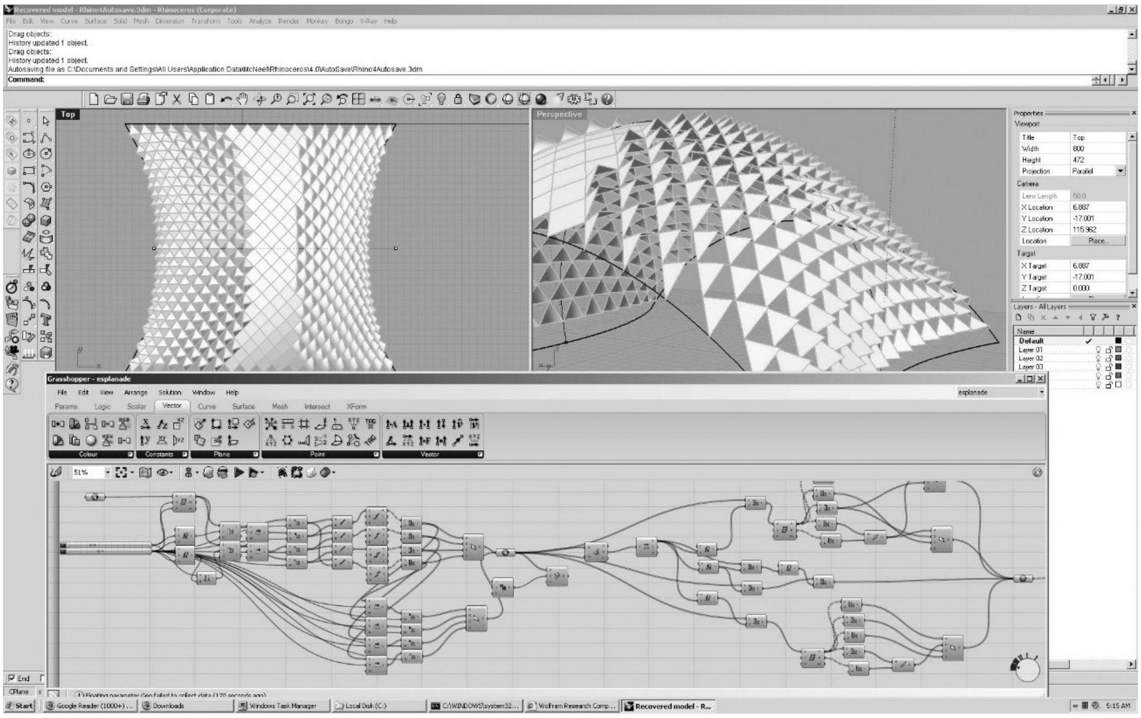

Fig. 01. Programming with Grasshopper.

Genetic algorithms.

Compared to the linearity of traditional design, the power and possibilities of parametric design, characterized by its greater degree of complexity, allows for greater flexibility and the capacity for experimentation and innovation (Morales, 2012:3). Thus, from logarithmic equations, mathematical relationship trees are established that produce a qualitative leap by allowing all the parameters involved in the definition of the model to be controlled, with the consequent saving of time by avoiding repetitions and allowing easy introduction of variations in the formal ideation process. In this sense, the great novelty lies in the emergence of a new paradigm associated with a new work methodology and which basically involves moving from the search for a static and single model to working with families of infinite formal possibilities. However, while the advantages of this new work methodology and the potential of modelling software are clearly unquestionable, the creative process and the functionality of the design still seem to be priority or essential issues. In this sense, it is essential not only to consider the historical context of the building, but above all to respond to the real needs of potential users.

This new geometric conception based on parametric algorithms (Rivera, 2014:246) forces us to reflect on a contemporary multicultural architectural design. It is also associated with the new formal possibilities of digital technologies and therefore has new research patterns based on hybridization and heterogeneity; In this way, culture, science and art are mixed, through a network of interdisciplinary and transversal interactions. All this with a growing interest in the corporeal experience based on a multisensory logic, in which all the determining factors of the environment come into play (Pereyra, 2013:1). These are designs inspired by biological processes (genetic algorithms), although with concern for local concepts such as identity or tradition, in the sense of adaptability to specific needs, always taking into account the complexity of human behaviour and the significant relationships of the architectural space (Pirela, 2013:36). On the other hand, and imperatively, it also seeks to be in line with sustainability approaches in relation to the planet's resources. The new virtual models often make use of biology, based on parameters that are translated into a programming language by means of 'genetic algorithms', as John Holland called them in 1970. Thus, the possibility of operating, simultaneously, with multiple solutions, for the sake of the ideation and subsequent construction of prototypes is raised.

On the other hand, the label of genetic architectures is associated with geometric innovation processes produced in the last two decades and that are based on programming codes that allow the control of parameters through algorithms and variables, hence the generative design label, which refers to the possibility of modification of these variables. This is the case, for example, with NURBS (non-uniforrm rational B-spline) curves and surfaces derived from Pierre Bézier's splines, clear examples of mathematical representations of 3D geometry. On the other hand, Grasshopper essentially works as an open-source algorithm editor based on components connected by wires, which makes it possible to manipulate variables.

This makes it possible to generate evolutionary structures characterized by progressive growth that is associated with the program's own work methodology. This is how the concept of metadesign emerges, which translates into the possibility of obtaining different designs from the introduction of mutations in previous projects that can be reused.

Some of the leading architects in this new approach can be cited, such as Greg Lynn or Lars Spuybroek, the latter researcher in addition to the relationships between art, architecture and computer science (Spuybroek, 2004) and main representative of the Dutch architecture office NOX ("NOX/Lars Spuybroek," 2015). Spuybroek does not hesitate to contrast the traditional analogue technique of sketching with the new digital technique of diagrammatizing; It is a 'clean' technique, in his own words, especially characteristic of parametric modelling and based on nonlinear interactions between components in interconnected systems. In this sense, experimentation and innovation take place above all during the search process, a stage that becomes a defining moment and that characterizes this new work methodology, which also requires prior knowledge of the software used.

Liquid Modernity, Robotics and Home Automation.

This new 'liquid modernity', according to Zygmunt Bauman, involves the replacement of old concepts with new discourses and paradigms articulated around fluid modelling, which postulates a greater harmony between nature and architecture as well as a new way of interpreting the world based on non-Euclidean spaces characterised by dynamism and change in the purest Futurist tradition.

Something similar happens with the hand and the machine, both with defenders and detractors in all eras, as if art and pragmatism were systematically antagonistic issues. Linked to the above, there is an almost firm belief that reason and function always go hand in hand (Gutiérrez Mozo 2013:128). It is perhaps for this reason that drawing machines seem to have traditionally been better reconciled with the straight line, which may, however, in some cases contradict certain artistic practices such as the gestural automatism of abstract expressionism or the automatons of Jean Tinguely (Gómez Molina & Cabezas 2012:453). On the other hand, it should not be forgotten that Le Corbusier himself emphasized the fact that 'les machines travaillent en collaboration intime avec l'homme' (Corbusier 1958:231), which translates into accepting that the progress of humanity goes hand in hand with technological progress. However, the revisionist role of art and science consists, without a doubt, in proposing new readings, sometimes even with the need to redefine traditionally hermetic concepts. Clear examples of this can be cited as artists such as

Bruce Nauman, who proposed the void as mass (Bruce Nauman: the true artist 2014:71) or Gordon Matta-Clark ruthlessly 'chopping' buildings (Sentís 1994:8).

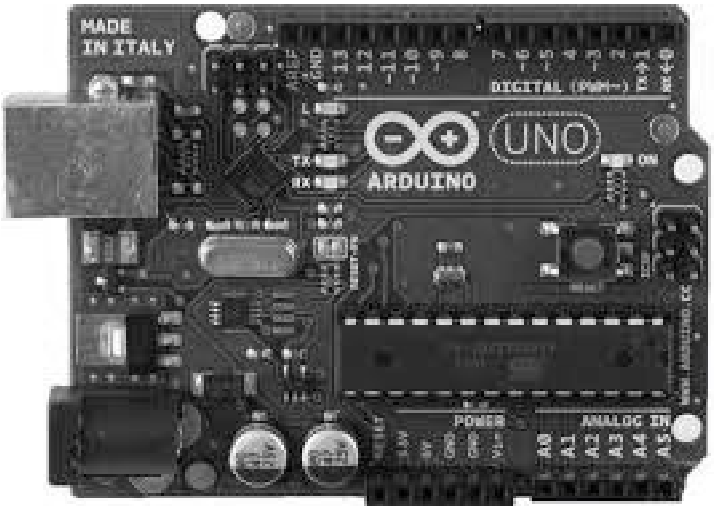

Fig. 02. Arduino ONE (microprocessor hardware with programming of electronic components).

Going back to Le Corbusier, in the year that also celebrates his fiftieth anniversary, his machine à habiter is now, more than ever, an increasingly credible possibility with home automation, but also with a robotization of architectural production. This proposal represents a real revolution in the materialization of architecture in structurally and formally complex and innovative, but functionally efficient designs. In any case, these are novel approaches, although they have enormous potential to transform construction processes. On the other hand, the new conceptions of the human habitat find a response in modular or multipliable design, the aforementioned low-cost. This idea is the basis for some examples of novel architectural enclosures understood as artifacts equipped with light and sound sensors and activated from an Arduino board, and which respond differently depending on the proximity of the user. These are designs based on cells constituted as responsive skins and defined as intelligent objects endowed with movement associated with a Boolean open/close condition and therefore capable of reacting to stimuli from the environment (Pereyra, 2013:2). These are examples of prototypes that are digitally modelled and parameterised by programming with Grasshopper, but in close relation to other areas of growing interest such as robotics or home automation (Chiarella, 2014:439), especially associated with new proposals for construction processes and sustainability.

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