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# The Impact of Philosophy and Mathematics on the Aesthetics of the Digital Architecture based on Parametric Design

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***Abstract***

We are currently seized by the diversity and originality of contemporary architecture throughout the world, an architecture often characterized by fluid forms and non-standard realization processes. The purpose of this article is to throw light on the mathematical and philosophical foundations that have opened architecture to the hegemony of digital technologies. We will try to explain how, originally, this mutation was co- driven, essentially, by mathematics and philosophy. Signs of this mutation date back to the late 1960s, years of the advent of the microprocessor and the discovery in mathematics of other types of non-Euclidean geometry. It took about twenty years, which were necessary for the development of machines, for a handful of American architects to adopt what they agreed to as French theory of certain French philosophers to define new architectural forms. The architectural aesthetics of digital design, whose transcendental meaning is linked to its generative logic, is now subject to the hegemony of the algorithm. The nature of this one confers to the conceptual approach of multiple appellations such as: Morphogenesis, Genetic Architecture, Tectonics, fractal geometry.

***Keywords:*** *Architecture, Parametric design, Philosophy, Mathematic, Fractal Geometries, Computational Design, Generative Design.*

## 1. INTRODUCTION

This reflection finds its justification in the questions - still pending - on the future of architecture and the profession of the architect in the digital age. Today we are living a stage that divides the theorists between those who legitimize all orientations by advocating the materiality and the plastic dimension of architecture and those who advocate a redefinition of contemporary architecture in the light of the evolution of the digital technology. According to the architectural historian *Mario Carpo*, it would take a great historian, a mathematician and a philosopher to explain how and why this cultural revolution, marked by digital technology, has spawned a new architectural style based on lines and smooth surfaces and curves(Carpo, 2017).

This questioning concurs with the concerns of this research and being convinced that the prediction of the future is already behind us, we intend to dwell on the intellectual genesis and "tectonics" that was at the origin of this revolution in architecture. We are indeed seized, today by the diversity and the originality of the contemporary architecture throughout the world, an architecture often characterized by fluid "blobs", by forms with double curvature and by non-standard processes of production. These daring and exuberant curves

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push some architects to call this architecture Baroque or Neo-Baroque II, words that resurfaced during the 1990s, in some speeches about the digital architecture and changes that have generated the design software by computer. The *Guggenheim Museum* by architect *Frank Gehry* in Bilbao is the most exposed example by all the protagonists of this digital revolution, whose consequences for the entire construction sector are similar to those of the industrial revolution. The beginning of this digital revolution in architecture is often dated by the realization of this museum in *Bilbao* in 1997 although some publications reveal an origin a little older than that(Lynn, 2015). The consequences of the digital revolution will have to be perceived in a similar way to those of the industrial revolution, and a parallelism will have to be established between the *Guggenheim* of *Bilbao* and the Crystal Palace realized by Joseph Paxton in 1851, in order to measure the extent of this change. , among other things, aesthetics that the digital is doing to the architecture. This comparison will have to trigger a responsible debate and a serious comparison, which points out the aspects of novelty and the profound changes made to the professional mentalities by one as to the other(Kolarevic, 2003). The revolution in the Crystal Palace brought a change in the levels of materials used (the use of glass), but the same principles of design and aesthetics that were used before remained the same. It took a century for glass and steel buildings to be ubiquitous throughout the world. The digital revolution is shaking up the old paradigms that have governed the construction sector since the renaissance; it is revolutionizing: (1) how to conceive (Computational Design), (2) how to collaborate (Building Information Modeling) as well as (3) how to build (CNC, CAD / CAM / CFAO)[1].

New skills and new professional mechanisms are emerging and maturing in a series of isolated initiatives requiring huge adaptation efforts. These improvisations are initiated by architects scattered on the planet without a legal framework, able to follow the upheavals suffered by the classical professional ecosystem be made. In the same way, to conform to the new requirements of these technologies, cannot be carried out in the absence of an updated pedagogic teaching, without which still other generations of architects will be sacrificed. It is time to agree that the concern over architecture style is dead, giving way to other ambitions and challenges that make architecture what it is today. By exploiting what technology currently offers at all levels, architecture has redefined other dreams, desires, and other quirks.

## 2. METHODOLOGY

The methodological approach we intend to adopt in this context is qualitative based on an inductive approach. We will base ourselves on the texts, the conferences and the publications dealing with the problems related to the introduction of digital technologies in architecture. We will analyze the discourses of avant-garde architects to dust the philosophical foundations that serve as arguments to justify an architecture marked by connections and complex structures.

We try to reinforce intuition about the future of digital in society and in our professions by first answering the following two questions: Would we be faced with a passing wave? Or in front of a structural revolution that calls for updates and strategic epistemological reframing. Thus, before embarking on more detailed analysis of the role of digital tools in the architectural style and in architect's professions, it is necessary to present a series of key events and historical milestones that have marked the evolution and computer culture.

The historiographical approach we adopt is motivated, much more, by the ontological understanding of the technical object and its logical functioning, than by the knowledge of the history of the computer according to an encyclopaedic view.We will also confront their speeches with other antagonistic discourses in order to try to bring out other truths and to ensure the catalysts that

drive the mutation in digital architecture. Our concern to define the nature of this change is driven by the desire to make up for the delay in the teaching of architecture and the training of professionals, it is also motivated by the desire to anticipate the future to prefigure a technical-legal environment where digital will be at the service of the architect and its architecture.

Our specific variables in this article are architecture, digital, philosophy and mathematics. We will analyze all possible constructive joints in order to qualify between the particular and the general. We will begin by deconstructing all the prejudices that attribute to digital the change of style in architecture to verify to what extent and to what degree this statement should be validated or not. We will analyze, through a chronological reconstruction, of this transformation of architecture under the aegis of the digital, how crystallized this digital culture in architecture to constitute a new paradigm of reflection and of iterative and collaborative design.

## 3. RESULTS

### 3.1 Genesis and Origin

Attempts to include computers in architects' work can be traced back to the 1960s, a period perceived as fertile by the revolutionary impact that characterizes the architect's profession and architecture in general. The opening of the Internet network in the 1980s and 1990s to the public domain has led to a mass consumption of computers, which has led to an increasing prevalence of computer technology in all scientific fields. The effects of this ubiquitous and pervasive technology on society, have been sensed by *Nicholas Negroponte* who in *Being Digital* has deciphered the mysteries around the phenomenon of "*Bit*" and its impact on time and space. A "*bit is structured in a fair way to make a distinction between 0 and 1 .... it is the smallest atomic element of the DNA ..... it travels to the speed of the light*"(Negroponte, 1995). A very shared distinction between 0 and 1, which bases the mode "Thinking" on calculation, well hides another that makes its philosophical basis go back to Leibniz's computational computation and his tables of binary calculus based on 0 and 1.*Gottfried Wilhelm Leibniz* remains the first in the 17th century to have clearly recognized that we can calculate on something other than numbers and that there can therefore be a mathematical concept, proposals, classes and many others things besides the numbers(Bouveresse, 2001). In 1854, *George Boole* created a boolean binary algebra, accepting only two numerical values: 0 and 1. Bole developed an algebraic approach to logic that allowed him to describe arithmetic operations through the parallel language of the logic. This algebra will have many applications in telephony and computer science, thanks to the work of Claude Shannon. In his master's thesis, deposited in 1938 at MIT, almost a century later.(Bottazzi, 2018)

We begin by raising the issue around the origin of the pluralistic mind implying the multiplicity, variability and collapsible forms that characterize the architecture of the digital that is attributed to the philosophy of Gilles Deleuze (1925-1995), the one of the most influential French thinkers of the twentieth century. A vision that has been adopted by some avant-garde architects in the United States of America. Deleuze considers that reality and events are not organized according to continuous threads, in an orderly succession. "*Folding" or "fold"* is one of the many terms and concepts, such as affiliation, the smooth and striated space, the flexibility and multiplicity, which are attributed to Deleuze' s works and worldview: *"Baroque does not refer to an essence, but rather to an operative function, to a trait. He keeps creasing. He does not invent the thing: there are all the folds coming from the East, the folds Greek, Roman, Romanesque, Gothic, Classical ... But he curves and curls the folds, pushes them to infinity, fold on fold, fold according to fold. The line of the Baroque is the fold that goes to infinity; and first he differentiates*

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*them in two directions, following two infinites, as if the infinite had two stages: the folds of matter, and the folds in the soul. Below, the matter is amassed, according to a first kind of folds, then organized according to a second kind, as long as its parts constitute organs, folded differently and more or less developed*"(Deleuze, 1988). This vision has been adopted by contemporary architects such as Piter Eisenman, Greg Lynn and Bernard Cache [2], who have tried to invent a new aesthetic marked by folds and connected structures and, above all, to challenge the ubiquitous linear causality of "classic" conceptual thinking.

*Deleuze* was not the only philosopher to have influenced American architects by philosophical paradigms. There was before him *Jacque Derrida*, the French philosopher, whose famous deconstructivity theory was adopted by *Piter Eisenman, Frank o Ghery*, and *Daniel Libskind*, and many others who adopted what is agreed as "the French theory". They have translated this theory into highly controversial architectural expressions. In his theoretical construction, *Jacque Derrida* unveiled the non-scientific legitimacy of certain ways of thinking that have lost their argument in the face of social and technological changes. In architecture, trabeation, for example, is a conceptual technique that has characterized architecture from the primitive hut, but today it is outdated with the appearance of self-compacting concrete that combines a very fluid fluidity and an impressive resistance. Thus, the principles of verticality once demanded by stability against the laws of gravity must be reconsidered. With the de-constructivist philosophy the window is redefined differently to assume its role of lighting and ventilation and to participate in the plasticity of the work and give birth to an architectonic whose characteristics exceed the three-dimensional qualities to add a 4th dimension which is perceived through the movements suggested by the forms. The action of investing space by giving it a meaning, always pushes architects to resort to semantics and metaphors that release coded messages and interpret the intellectual and social concerns of their times.

In opposition to the digital architecture, which wants to be fluid and connected, the de-constructivist architecture is characterized by Conflict and Contradiction. The use of the contrast often used to describe this architecture reduces its value and advocates that of digital which is known as "*Blobs architecture*"[3]. The contradiction and the conflict refer both to the same meaning of the opposition. The use of this semantics in architecture is motivated mainly by artistic concerns that an architectural work must meet because the realization of a work of art depends on its ability to express the contradictions that govern the human functioning(Boyes, 1993). These aspects, to which architecture is bound to conform, are neither of a technical nature nor of a philosophical order, and they are common to many works of art spread over several streams and periods in history.

### 3.2 The factors of change in architecture

One of the revolutionary characteristics brought by the digital technologies is that it has allowed the abundance of Euclidean geometry composition concepts in favor of other geometries, so-called topological and fractal, which rhyme with the spirit of the fold of *Deleuze*. The adjective "fractal", is a neologism created by *Benoît Mandelbrot* in 1974 from the Latin root fractus(Dehouve, 2014).Which means "broken", "irregular". This change in the modes of design is due to a series of reasons where the digital is only the facilitating element and where the philosophy provides the theoretical argumentation. We try to explain why this change took place and how it occurred.

The first reason for this mutation, which seems natural and remains peculiar to the human condition, remains the boredom provoked by the effect of repetition. Boredom is the first factor of change towards the "New". *Johann Wolfgang Von Goethe* said that "if the monkeys were bored, they

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could become men" (Johann Wolfgang von Goethe1749-1832). In fact, unlike the animal, boredom gives man the feeling of experiencing dissatisfaction in situations where nothing of his vital need is lacking. It is no coincidence that among the synonyms of "boredom" is idleness, displeasure, heartbreak and disgust, and among its antonyms recreation, activity, pleasure, joy and occupation. This first factor is obviously not specific to the transformation of the digital architecture, but it remains common to human evolution in a general way. Man is thus driven to evolve and mutate through the programs offered to him by his creator. *Gaston Bachelard* considered that man is a species that needs to be mutated: "*Through the spiritual revolutions required by scientific invention, man becomes a mutant species, or better still, a species that needs to mutate, who suffers from not changing. Spiritually, man has need needs*"(Bachelard, 1947) . Man is traumatized by repetition and multiplicity, which has no variability, it inspires stagnation and death. Repetition generates a negative and undesirable feeling when it does not reach any originality (Butler, 2013). As for Gilles *Deleuze*, he saw that "if repetition is possible it is miracle rather than law". She is against the law ... in all respects repetition is transgression"(Deleuze, 1968) . We will add that it is against the law of change that Heraclitus qualifies as the only permanent law in this world (Nothing is permanent except change). The repetition beyond a certain limit, creates an inflation in the originality of the artefact, it simulates a stagnation similar to the horizontal line in an ECG announcing the death of a person. To illustrate this, it is enough to take Bilbao's Guggenheim, however singular, and multiply it as it is, in the same city a dozen times.

The second factor is part of this quest for truth around architecture, which we have, and will always be difficult to define because they are defined more as a tradition than as a discipline. The truth has been defined by Clemenceau as a variable and subjective observation whose reception depends on the temporal space and the nature of knowledge "*The truth of today may have been the error of yesterday, and can become, by the increase of knowledge, the error of tomorrow*"(George Clemenceau, 1927). Man does so, with the artefacts he creates, he operates according to a couple of an interactive emission/reception that influences each other and continues in a perpetual rotation in spiral mode similar to the movement of the earth that travels around of its sun (truth) without ever having to reach it.

The third element is defined by the creative force and the sensitivity of the Man who always exceed his capacities of expression. It is not necessary to prove that many aspects relating to the senses, which the human being enjoys, are always unknown. The human spirit every time a new invention appears is given additional possibilities to be known by going after his dreams. To empty all the emotional charges resulting from his indifference to his experience and his condition. Governed by the law of change, Man always evolves to receive, each time, things in a different way, which produces different twists in an interactive and iterative process. These findings place digital technologies in their natural register as a tool likely to be outmoded in the future by another even more bluffing.

### 3.3 The digital and the new aesthetics in architecture

Before turning to a much more technical speech about digital architecture, we first tried to clean up the prejudices that make digital technology the only element that has led to change in contemporary architecture. If we perform this deconstruction / reconstruction it is just to demonstrate that the role of digital technologies is not the basis of evolution in architecture that it seems quite natural, and also to specify, that the The role of digital as "tools", consists in allowing to select among the several possible aesthetic orientations, the one that seems

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the most contextualized and that reflects the intellectual, philosophical and artistic concerns of his time. In this case, how did this fascination and attractiveness of the digital world affect architecture?We will avoid talking about the benefits of digital archiving for transfer, copying and printing, common to all areas and not just the discipline of architecture. This fascination with digital, which remains attractive, applies for other reasons, the most important of which we will decline:

### 3.3.1 Double curvature surfaces, NURBS and Bézier Spline

The first is related to new geometric representation skills. The classical mechanisms of projections of project concepts based on Euclid's geometry such as symmetry, centrality, repetition, rotation, etc., no longer amuses the architects. In spite of their utility, their beauty, their stability, and above all their universality, Euclid's laws are discarded by the necessities of change and the aesthetics of "*blobitecture*". *Viollet-le-Duc* often said that geometry is the cousin of architecture, but it has identified another topological and fractal geometry made manageable with the artificial assistance of digital technology, as we will show below.

If we attach great importance to this aspect of geometry, it is because it is at the base of the peculiarity of the architecture of the blobs. We admit that the predominance of the curve and rounded and bent angles is not peculiar to the architecture of the digital; it is present in many iconic projects well before that. The Sidney Opera is a relevant example in this context, the project was designed by the Danish *Jorn Utzon* in 1957 (1957-1973) and is one of the most famous buildings of the 20th century. The opera has an original and revolutionary architecture of its time; it looks like a sailboat for some, or a shell for others(Fromonot, 1998). The projects of *Eero Saarinen* (1910-1961), is also a good corpus that demonstrates the use of fluidity and curves well before the digital. Whether it is the Washington-Dulles International Airport Terminal, Terminal 5 at John F. International Airport Ferry Kennedy or the design of the Tulip chair are all works whose morphology and well marked by the curve and rounds. *Saarinen* is cautious in its use of the curve, which implies a rather limited applicability, and warns. Saarinen's cautious approach to the plastic form is exemplary, according to *Branko Kolarevic*, because it illustrates the apparent ambivalence of modernists towards curvilinear lines. Bernard Cache felt that *Saarinen* While allowing to break the monotony of the orthogonal and the linear, he felt the emergence of a new unknown geometry, of which they were still not certain(Cache and Speaks, 1995). We share this reading by *Eero Saarinen* who attributed the re-emergence of the plastic form to the progress of building technology, while recognizing that aesthetic reasons are the driving forces behind its use(Kolarevic, 2003).

But, The curve of the past is very different from that of today; that of yesterday is weighed down by Euclidean inertia, it was the result of a consensus between the geometric perception capacities of an architect and the quest for freedom in a movement seeking an aesthetic beauty. The laws of Euclidean geometry always intervened to approach this virtual not completely defined at the base in the imagination of the designers. Thus, curves as beautiful, as sinuous and elegant are inscribed in arcs of circles and ellipses iso-planes whose known properties of drawing, of which one has the tools of trace-curves and whose mastery of the techniques of constructions. This mode of operation, which involves projecting a mental image, so desired in the imagination, onto the drawing board, according to assimilation and geometric approximation, produces an important qualitative loss.

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Figure 1: Side by side Sydney Opera House of *Ero Sarinene* with a simple curvature Cultural Center Heydar Aliyev of *Zaha Hadid* with a double curvature.

This handicap is at the origin of the gap that separates the aesthetic quality of the first gesture that springs from the spirit of the architect and its geometric and technical projection on paper. Whether consciously or not all the architects of the old school have been exposed to this difficulty. The second handicap is related to the difficulties of construction. For reasons of feasibility, formwork and casting, the masses are often inscribed in Platonic and elementary geometrical forms. This simplistic paradigm produces easily identifiable forms, which are grasped and dominated by perception, which produces in the observer only a little satisfaction, which remains temporary. Moreover, the boredom ends up producing feelings of rejection in the absence of a defiant aesthetic. The most eloquent example is that of *Frank Ghery's* Guggenheim Mussé in Bilbao. The project, although it remains identifiable, refuses, by the richness of these lines and its sculptural interlockings to be memorable or to be grasped by the perception. Its plasticity allows it to escape the Euclidean rigidity and to expose itself to the observer's view, to take at each meeting a different manifestation and an appearance of incompleteness which is motivated more by the desire to reflect the design / manufacturing process only by that of reflecting a still image.

Why curvatures are so present in the digital architecture? And what makes architecture so much subjugated by curvature more than ever? What makes this return to the curvature allowed by the software as attractive?

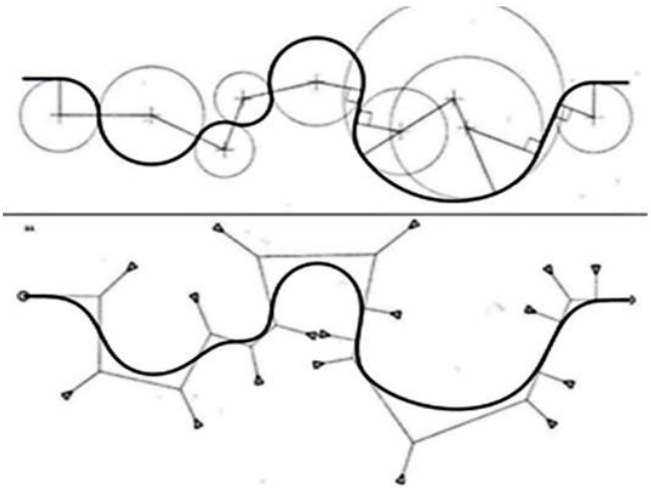

Figure 2: *Greg Lynn*, Euclidean geometry curve at the top and Spline curve obtained by *Bêzier* Spline, as used by 3D modeling software (bottom). The curve at the top is composed of 9 fragments of arcs of circles whereas the curve Spline is composed of infinity of arc.(G. Lynn, 1999).

With the possibilities of the algorithm, the properties of the curve controlled by Spline, by *Béziers*[4], offer a new aesthetic wealth much more interesting. The radius of the sections of circles that join to form the curve changes continuously and gives more softness and finesse. Now in classical geometry the curve comes right from an assembly of 3 or 4 (10 maximum) arcs of circles whose center is defined. Without the software, it is impossible to draw a curvature formed by an infinity of arcs of circles.

This is how the infinite has become not only reachable by the algorithm but especially parameterizable and controllable thanks to the capacity of the calculation. This mastery of the infinite has been well revealed by mathematics a long time ago, several mathematicians have demonstrated that the arithmetic or geometric sequences to infinity often result in unexpected results or outright opposite to what the we can believe. *Ramanujan* in summer one of these mathematicians; he was called the Man who knows the infinite. It is the same man who says that an equation has value only when it transmits the intention of God and it is the case of the fractals that we will see below. What is this intention?

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What is the phenomenological meaning that transcended the curve in the particular Euclidean geometry and the one that transcends it in topological geometry. The return to the curve is driven by a technological change that has both nourished and facilitated perception and is facilitating their rebound on the real. The nature of infinite curves in their definition springs forth as a universal conspiracy to imprisoned dreams. The conceptual production chain, which gave birth to architectural artefacts, took a path where there was a lot of qualitative wastage. The architect, when looking for the original, never managed to project his imagination, he proceeded by a series of approximations whether during the reflection, during the drawing projection or during the construction. The gap between dream and reality was so great that the project was only a symbol or an avatar of the original project. This potentiality of *NURBS* curves to have a variable continuity generates a multiplicity, a diversity that produces several angles of beauty and several profiles as convincing one as the other. This potential gives the possibility to challenge perception each time differently from where the spectacular nature of this defiant aesthetic that wants to be dominant and refuses to dominate.

### 3.3.2 Generative Parametric Design

The second attractive element is related to new design and composition skills. This is Generative Design based on morphogenesis, tectonics, L-system and fractal geometry as a new approach to design.

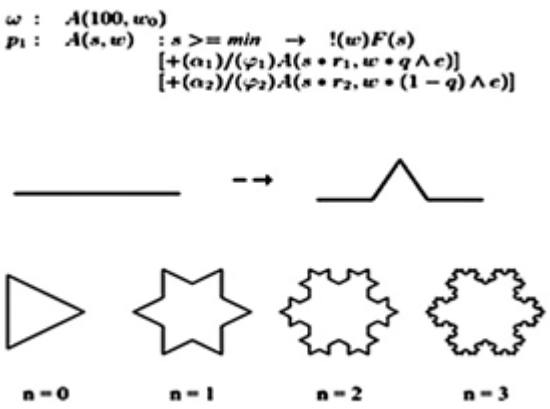
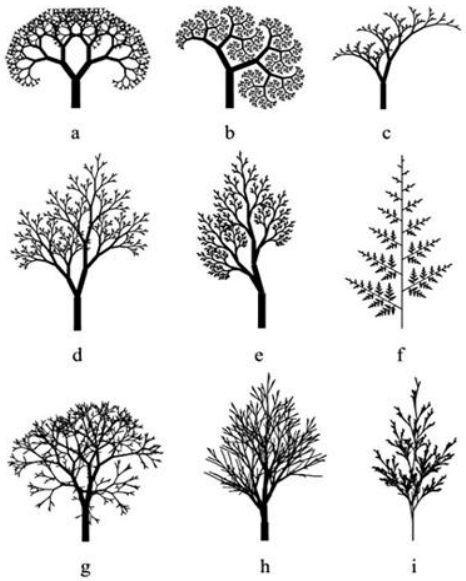



Figure 3: visual interpretation of production of the snowflake curve, and curve after n= 0, 1, 2 and 3 derivation step. (Przemyslaw Prusinkiewicz, Jim Hanan, Mark Hammel, and Radomir Mech, 2004).

These are computational operations during which software is no longer a representation tool for Visualization, but functions as a generating tool through the derivation of masses and shapes.

It is at this level the cognitive process of classical and linear reflection is jostled thus operating a decisive swing in the design modes of design in architecture.




| Figure | r1 | r2 | α1 | α2 | φ1 | φ2 | w0 | q | e | min | n |
|---|---|---|---|---|---|---|---|---|---|---|---|
| a | .75 | .77 | 35 | -35 | 0 | 0 | 30 | .50 | .40 | 0.0 | 10 |
| b | .65 | .71 | 27 | -68 | 0 | 0 | 20 | .53 | .50 | 1.7 | 12 |
| c | .50 | .85 | 25 | -15 | 180 | 0 | 20 | .45 | .50 | 0.5 | 9 |
| d | .60 | .85 | 25 | -15 | 180 | 180 | 20 | .45 | .50 | 0.0 | 10 |
| e | .58 | .83 | 30 | 15 | 0 | 180 | 20 | .40 | .50 | 1.0 | 11 |
| f | .92 | .37 | 0 | 60 | 180 | 0 | 2 | .50 | .00 | 0.5 | 15 |
| g | .80 | .80 | 30 | -30 | 137 | 137 | 30 | .50 | .50 | 0.0 | 10 |
| h | .95 | .75 | 5 | -30 | -90 | 90 | 40 | .60 | .45 | 25.0 | 12 |
| i | .55 | .95 | -5 | 30 | 137 | 137 | 5 | .40 | .00 | 5.0 | 12 |

Figure 4:Simple structures generated by parametric DOL-Systemwith different values of constants (Przemyslaw Prusinkiewicz, Jim Hanan, Mark Hammel, and Radomir Mech, 2004).

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By moving away from the centuries-old traditions and norms of architectural design, digitally generated forms are neither designed nor drawn as the conventional concept would, but they are obtained by generative calculation methods that are chosen by the designer. Thus, instead of modeling an external form, designers articulate an internal generative logic, which then automatically produces a range of possibilities from which to choose a formal proposition appropriate for further development. This is one of the possibilities offered today by the machine, and which remains the most original and the most revealing of the important changes taking place in Architecture. We are now talking about computational design or the role of the algorithm goes beyond the representation of virtual reality thought but participates in its manufacture. To understand how this was established in architecture, we must go One year before the invention of the microprocessor by an engineer and an physicist of Intel: Marcian Hoff and *Federico Faggin*(Binet, 2003); an angrian biologist named *Aristid Lindenmayer* (1925-1989) introduced a formalism in 1968 simulate the development of multicellular organisms(Kolarevic, 2003), which was later called *L-Systems*(Lindenmayer, 1968).

Figure 5: Plate GARDEN. Several Context-sensitive graftal species showing the variety easily obtained. (Smith, 1984).

Figure 6: Plate CARTOON. TREE. A–D Rendering of the context-free grammar in figure, (Smith, 1984).

This formalism, being closely related to formal languages, has aroused the immediate interest of theorists in the computer sciences. Its development, which was followed by applications in plant modeling, took on a revolutionary scale after 1984, when *Alvy Ray Smith* introduced cutting-edge computer graphics techniques to visualize structures and modelled processes(Smith Alvy Ray, 1984). The effects that are, now applied to materiality and form, by the software, are not plastic but are mathematical laws transcribed in scripts that make them undergo forms.

The *Dynamo* module for *Revit*, *3d Studio Max*, or *Grasshopper* for *Rhino* are good examples to illustrate this level of computational design. We no longer proceed in this process by the determination of the mass, the skin or the envelope, but begin by defining the inner rule of "*tectonics*" which orders outward morphological manifestations. This configurable process gives a multitude of morphological results that allow the architect to make validations by phase and according to a very controlled progress. The classic relationships that link the representations to design are shaken, in the face of the infinite possibilities that computational design currently offers. The plan no longer generates the design and the cup has a purely

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analytical role(Kolarevic, 2003).Thus, terms such as Computational Design, , Algorithmic Architecture (Terzidis, 2006), Parametricim (Schumacher, 2008) Scripting Culture(Burry, 2011), have come widely to see synonyms of contemporary architecture. So many appellations and concepts that give a central role to algorithmic calculation in the emergence of an architectural aesthetic marked by the curve, the fold and the interconnections.

### 3.3.3 The infinite variability of mass

The third attractive element, which in turn rhymes with *Deleuze's* visions, is infinite variability according to a similarity. Grids, repetitions and symmetries lose their raison d'être because infinite variability becomes as achievable as modularity and mass customization presents alternatives to mass production(Kolarevic, 2003). The old principles of composition are neutralized, as classic as they are, it allowed to structure, to occupy, to fill, to harmonize, and to unify the elements of a conception. They also allowed to regulate the disproportion that can arise from the union of an element with the whole. Apparently, these elements of composition hinder the architecture; it does not support them anymore. Repetition kills, we do not know where we stop and it is synonymous with limit, there is no evolution in repetition that we will always have to distinguish from rhythm. As for the symmetry, it recalls the monarchy, a single source of command where everything is reduced to a single reference that is the axis or the center of symmetry. It is no coincidence that the spirit of modern day architecture, which is free, fair, sustainable, has a hard time coexisting with these principles.

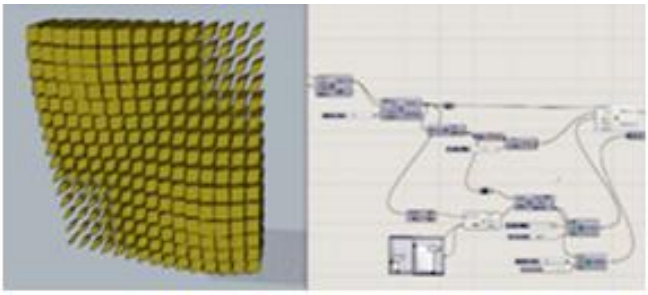

Figure 7: Scale Nu - Grasshopper Tutorial », Parametric House - Rhino Grasshopper Tutorials (blog), Of *Mohamed Yazdi* .

With a coherent, unified, recognizable and perceptible design, the computational design offers an infinite variability as well as monotonous repetition, it produces a diversified architectural dialectic but unified by its obedience to the same generating scripts. In the multitude of forms, produced with this paradigm of infinite variability, one cannot identify any identical copy except formal similarities and similarities perceived through the referential of the gene that applies to all forms. The computational allows a contextualization to which the architecture continues to aspire and if this contextualization was manifested by the steel, the glass, the concrete in the modern architecture, it is doing it today computational.

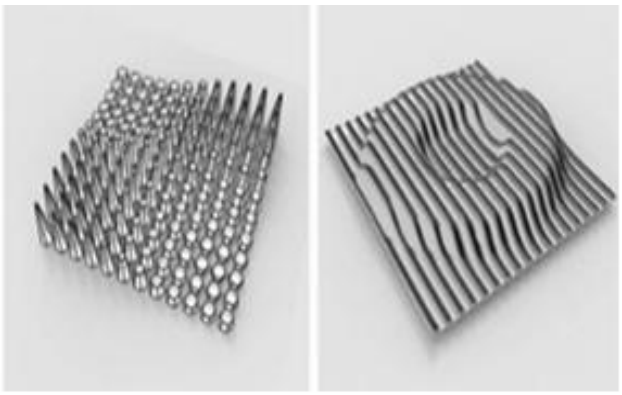

Figure 8: The infinite variability of mass Parametric Design-Rhino Grasshopper Tutorials (blog), Of Mohamed Yazdi .

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## 4. CONCLUSION

The mathematical algorithm combined with the transistor is ravaging today, they embark on their mutation process all areas. The architecture is embarked in turn, although it is the last fortress that resists the conquest. The architecture is imposed a new seductive geometry, whose laws and mechanisms are as mathematical and universal as those of the classical geometry of *Euclid*.

The generative design paradigm by computational allows the algorithm to compete with the architect in his role as creator. The compositions and forms obtained at the end of this conceptual mode characterized by a mixed intelligence (real and virtual) often appear as surprising and unexpected results in which the architect remains as a spectator and not as an actor.

The paradigm of mass variability obtained by computational is perceived by avant-garde architects as an escape from the paradigm of mass standardization that has neutralized architects and which has only benefited manufacturing firms. We must expect a smarter, more connected future where the information transmitted from the surfaces to the environment will become more important than the formal and aesthetic aspects.

The current predominance of aesthetics will decline in favor of the number of mathematics. Aesthetics, for want of defining universal theories, capable of giving it a great longevity, will be absorbed by the rational machine of the mathematical algorithm. The aesthetics in architecture has wandered for a long time, left and right without really reaching beyond a subjective and often ephemeral beauty, an essential argument for the human condition. The philosophical struggle between good and evil has been concealed under another duality that opposes good to beautiful. A question that has been solved at the level of painting for the benefit of the beautiful but which remains at the level of architecture whose reason for being convoked also and especially the considerations of use (Utilitas). The *Performative* Architecture or what can appear nowadays as "*Performalism*" tries today to dissolve the oppositions likely to distinguish the good of the beautiful by founding the aesthetics of the beautiful on the good in a conceptual approach, which takes the optimization and the performance the representation of the force lines of the site as starting elements.

Thus, in a future dominated by numbers, by information, by multiplicity, by optimization, by the automatic management of energies and comfort, by connected objects, by the man whose eyes are fixed for several hours on his smartphones; in a future marked by all that will be concerned with form or aesthetics. The importance of the Parthenon facade for a tourist (Even for many architects) comes down to taking a "selfie" to share on social networks "here is watching me I'm in Athens and was the Parthenon. "This is the most important, and when he returns he will be unable to remember how many columns have the main façade, how many steps and pedestals, the grooves, in relation to his foot, his hand, his fingers and, to his thumb, what's all this for? In any case he took pictures of 12 MP with his iPhone latest cries, photos that make the detail as visible and speaking to the naked eye and that from which we can extract the measurements in cm and the lumbar coordinates It is not the role of the machine or the algorithm which is worrying in this revolution but it is the high speed which scrolls the novelties without these novelties being completely consumed and are digested. We are seized by this speed.

This is worrying dematerialization is killing the present. If this has already been pointed out by several philosophers, no one could measure the extent and precision that crystallize day after day in our daily lives. The dematerialization that is one of the novelties brought by the computer makes the present insignificant by replacing it either by a future who installs a chronic anxiety or by forcing a nostalgic trip into the past; from the cost there is

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more present there is only the future with some moments of the past. This is what the philosopher *Bernard Stiegler* called disruption, a concept that defines the inability to follow and synchronize with the novelties that pop up from time to time in digital technology. This reality is noted in the software update that is added, from one year to another, many modules praise the latest version without precedents are mastered and used. Technological phenomena unfold in a non-linear sequence and according to a speed that they do not even let the time to philosophers, chroniclers, sociologists, psychology to study the impact and to mitigate the risks.

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## 6. NOTES

[1]This article will treat the design process.

[2]Bernard Cache was one of the few French architects who is interested in Deleuze's philosophy of folding.

[3]This naming was first used by Greg Lynn in Folding In Architecture.1995.

[4]The Bézier curves are parametric polynomial curves described for the first time in 1962 by Pierre Bézier (Arts et Métiers engineer and Supélec at the Régie Renault in the 1950s). Wikipedia