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PARA(NOIA)METRIC: ARCHITECTURE BEYOND THE EDGE OF RATIONALITY

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Abstract

Nowadays, efforts are being tremendously put in order to facilitate opportunities for the fourth industrial revolution to play a real role in the destiny of architectural design and construction. Parametric design and digital fabrication are some of the tools that have been contributing in this uprising for the last two decades. The amount of solutions developed so far has, sometimes out of curiosity, been used in alternative ways that occasionally lead to highly appreciated outcomes, and sometimes immersed us in worlds of rationally controlled complexities that might be not so useful. Some of the highly sophisticated computational design processes strengths are easily capable of hallucinating us with the ridiculously marvelous forms that make us see unimaginable things and which, by the help of digital fabrication, are sometimes attainable. However, and basing oneself on some rationality keys in architecture, the question of the real need for such complexities to be the predominant scheme of our thinking strategies arises. One specific issue that is tackled in this paper is the influence of technologies in architecture from a critical perspective. With great impact on all ages of architectural history, sooner or later, technology has influenced the way in which buildings were conceived, documented, and constructed. It is to say that a great deal of effort has been put throughout time in order to innovate, understand material behavior, and to find an aesthetical balance between science and art. In this sense, the argument of the digital technologies in architecture will be set up as a not too long time frame, only a few decades long, but due to the constant progress of technology, it seems that advancements in design and fabrication are either slow or not accepted yet. The speed is an issue not due to the fact that there are not clear innovative principles, but because of its wide variety of tools being developed constantly that opens the possibility for creative exploration, to the point that the simple can become complex, the material can become immaterial, and the rational can become humanly irrational. Not because it is not geometrically or parametrically descriptive, but due to other parameters that maybe are not in need for provision right now. The paranoia comes with the idea of delivering a concept in a way that requires efforts greater than building non-standard architecture, leading to the frustration of building a challenge that requires extra determination, manpower, advanced machines, or just more money for all of that. However, this is related to the customization design philosophy that architecture in many ways was imposed to follow for many reasons. It is therefore questionable what the role of sustainable development would be among all this mess.

Keywords

Parametric Design, Digital Fabrication, Rationality, Technology

1. INTRODUCTION

Times are constantly changing. So are the needs of our generations, and in fast ways that alertness is required to cope with it. There's no doubt that technology has, and probably will, continue to play in an even more intense way on the way we live, learn, and work. And in architecture, technological advances have always played an important role in the development of the discipline. Some of the most promising contemporary trends in architecture in the last two decades included digital technologies. Being declared as a radical and innovative type of approaching architecture, the digital revolution of the 1990s raised serious doubts concerning the role of the architect in controlling complex shapes out of the screen. Besides powerful graphics directly influencing design, digital fabrication was a protagonist in the process of the digital-analogue system, translating some forms from the screen to the physical world. One of the most fascinating examples of emerging pioneers were documented by Frederic Migayrou, where the radical experiments in architecture reflected the tremendous changes in the aesthetic of young designers engaged in the complicated issues raised by computerization and globalization. But besides architecture, several essays by leading critics, historians, and theoreticians discussed various aspects of the field (Migayrou et al, 2001).

Promising times were ahead with for instance Bernard Cache explaining topological concepts and transforming surfaces into digitally fabricated objects, or Mark Goulthorpe, challenging the sensorial principles to develop an interactive Hyposurface wall. Visions of high creativity and deep meaning were the emerging base on the bet that technology would find a way out for this revolution to become a style of designing and building. These designers were able to show not only their strength by relating philosophical approaches to design, but also by showing that there would be a time where it would be possible to control complex sophisticated designs and actually fabricate them. Architecture usually evolved functionally, artistically, and technologically, within a certain rationale. But computational design has opened the doors of the unimaginable. Due to the amount of data that should be related to architectural principles, and that can easily be shared today, part of it is becoming something of almost no value except for aesthetics. It seems as if we are on the way to being dragged into the cybernetics and virtual worlds again. It is not about the wonders that the virtual provides, but the endless possibilities that computational design is offering us. Tools have the great potential of being again shifting our concerns towards the appreciation of the beauty of complexity, disregarding basic functional needs, and in times where sustainable development goals are to be taken care of more than ever. It is not that what has been accomplished till now is not of merit. However, not every context, not every function, not every aesthetic, can support such complexity. Icons are important for a context, but of less relevance to middle and low class families looking for an affordable shelter that could have technology integrated in a sustainably designed environment. Parametric design plays a role here, providing the possibility to deal with performance data rather than formal glamour. In the end, it is unfair to disregard the efforts done in order to reach rational results and systems that can make architecture more advanced, challenging, interesting, and maybe useful in innovative ways. It always seems that the digital trend will affect the way of designing and building. Plans will not be needed anymore thanks to augmented and mixed reality. Sensors and smart systems can make our lives comfortable, if it's really what we need. Robots, drones and automated systems controlling building machines like diggers will dictate the future sites, with the potential of making human labor scarcer. The internet of things is affecting part of our lives. Artificial intelligence is growing fast and in no time they will overrule humans if we are not careful. Computational design is getting more complex and more accessible to any designer. It is becoming largely and nonsensibly, in a critical way, a system of logical design trying to be rational in the principle but frustrating in the results regarding needs, costs and effectiveness, which leads us to think that a paranoiac system is becoming the predominant aspect of the design, totally disregarding the basic essences of architecture that is supposed to provide humans with descent and proper wellbeing.

2. THE ORIGIN OF THE PARAMETRIC IN ARCHITECTURE

Parametric design is a terminology related to the provision of settings that ensembles a series of parameters to determine and control relations and results of building components and systems in an interactive way (Woodbury, 2010). It is a process based on a set of geometrical principles that can be either fixed or varying, thus allowing for flexible manipulation. Contrary to the conventional design of geometrically fixed models, in which greater efforts are required to execute further alterations to forms, parametric design has aspects of the project that are previously assigned in order to explore the flexibility of the relations in the design model. When the parameters of a particular design are declared instead of the shape, the problems begin in parametric design (Kolarevic, 2000). A fundamental change is introduced in the process, in which the parts relate to each other and change in a systematic way, coordinating and re-establishing connections. The parametric allows the increase in formal possibilities, and there is no restricting to complex shapes and organization of architectural project as long as there is a linking rationale that leads to an outcome, by handling relations and creating associative geometries for problem-solving that emerge without a pre-determined formal outcome (Kolarevic, 2005). Algorithm management possibilities are offered by software, which allows the manipulation of large amounts of data and the increasing level of complexity of the systems in the digital simulation environment. It is a powerful tool capable of demonstrating analysis optimization, control, and production of components in a project. The idea of parametric design is linked to Giles Deleuze and his book "The Fold: Leibniz and the Baroque", which was first published in 1988. Composed of mathematical functions based on parameters and variables, Leibniz's modern approach to differential calculus was the challenge set by Deleuze who searched for a logic interpretation. Deleuze defined this parametric notation as "Objectile", or a generic object. Then Bernard Cache, one of Deleuze's outstanding students, saw this as an ideal opportunity for computer-based design and fabrication. With his vision, he defined the path for the non-standard architecture in the digital age. That was in 1988. Since then, many saw the potential of such line of work in the service of the digital architecture. Twenty years later, Patrik Schumacher reestablished parametric design in the architectural discourse in an influential manner. Parametricism, as he named it, has become the symbol of digitally intelligent architecture. It became presumably a new style linked to the digital tools for design and fabrication. The trend was interpreted and set evident forms to its technical logic in praising, but abusive ways. But between Cache and Schumacher there is a line of thought, research and work that may have led either to a different type of appreciation of parametric design or the loss of its destiny track, even after Schumacher's imposition of Parametricism. The exploration and creation of forms were the main concerns during the digital revolution in architecture of the 1990s. This fact was the main driver of the digital change intentions in the architecture, maybe inspired but detached from the cybernetic approaches of the 1960s and 1970s from Archigram for example, which were well diffused but less imposing.

3. THE BEGINNING OF THE PARAMETRIC CONTAMINATION IN ARCHITECTURE

Vitruvius used to apply verbal and written techniques in order to describe rules and proportions to build columns, with no graphical data to refer to. Similarly, medieval guidelines clearly described how to gradually build components, without determining their shapes. As a result, and even though these built components could be used for similar functions, they would not be identical. They would be categorized as components of the same family, but at the same time, and to a certain extent, different. This is an example that has a direct relation to parametric design. Therefore it is possible to say that traces of such line of thinking clearly existed before the computer revolution in architecture. With the influence from the Industrial Revolution, the way of working and building started to drastically change. The idea of mass production was imposed. Building identical objects suddenly replaced the handcrafted variations from the medieval principles. Therefore, at the end of the 20th century, the parametric design values were raised to stand against this part of the modern culture principles. This is the reason why parametric design was, and still is, part of the digital revolution standing for the idea of building variations, similar to the medieval principles of building, but this time with the help of machines. With an industrial modernity mentality, but able to produce variations in mass, this was a trend that could fuse both ancient and modern principles. Parametric design during the digital revolution of the 1990s did not come detached from digital fabrication. In fact, one complemented the other within the digital to analogue language. However, and this is where things get lost in track, to link both we have to go back to the generators of this trend. Curiously, and in parallel to developments for instance from Greg Lynn, Bernard Franken, Ben Van Berkel, among many others, this tracking would lead us to two giants: Antoni Gaudí and Frank Gehry. Projects like the Sagrada Família would show examples of mastering rationalization, creating and relating variations of formal and structural values, while Gehry would show that almost anything is buildable and architects could free themselves from many formal constraints.

3.1 Frank Gehry's Liberation from Restrictions

Among the various architectural projects that were being carried out between the 1980s and 90s, many stood out for their new forms, new construction systems, or new materials used (Glancey, 1999). After an exhaustive study of projects that could have had some relationship with computer-assisted production, the Guggenheim Museum in Bilbao stands out in an unquestionable way, completed in 1997. But its history is directly linked to the sculpture of the same creator, Frank Gehry, dedicated to the 1992 Barcelona Olympics (Shelden, 2002).This link between the two projects was due to the implementation of computer-assisted construction processes for the fish sculpture in Barcelona that would serve as a later experience for the execution of the project in Bilbao. CATIA, originally developed by Dessault Aviation, was a CAD software that helped in the development of the Mirage fighter jet. Once launched as a commercial program through IBM, it quickly became popular in industries such as the automotive and aerospace ones, mainly due to its capability to deal with Bézier curves and algorithmic surfaces. In addition, the program was a powerful tool for engineering purposes, with strength in surface analysis and curvature. Among the innovative options, the software was capable of allowing curved surfaces to be flattened and with enough precision for fabrication which was mainly based on profile cutting.

At the beginning of the digital fabrication era in architecture, these tools were powerful enough to provide support for one of the first parametrically designed projects in architecture: the sculpture for the 1992 Barcelona Olympics designed by Frank Gehry. With CATIA, it was clearly demonstrated that the possibility of exactly building both the curved surface and the structural steel geometry with the compensations and intersections derived from the curved surface model were real. At the same time that the initial experiments in the description of the digital project were conducted by Frank Gehry's architects, Dassault Systèmes developed an all-inclusive system to assist in the design of the Boeing 777, 279 Dassault aircraft line. This defined a methodology baptized as digital models or "Digital Mockup" (DMU), with the intention of supporting the design, detail and manufacture of airplanes through numerical control in an integrated way, without paper. The result was beyond the partial performance of the curved surface description that Frank Gehry initially required. This was an important step towards the digital design and fabrication advancements that were crucial for the real digital revolution in architecture, which happened simultaneously with the efforts of Gehry's partners developing similar applications in parametric design and digital fabrication. Subsequently, and with a CAD / CAM system offered by CATIA, later projects would be designed by the team using a part of the process tested in the sculpture of Barcelona. Finally in 1997, the full process development concluded with the inauguration of the Guggenheim Museum in Bilbao. The early achievements of these projects came as a result of these procedures, even though improvements of the process were still being carried (Shelden, 2002). When the construction works of the American Center in Paris began in 1991, a series of programs were carried out in parallel to the investigation of the sculpture for the Olympic Games, trying to develop systems for cutting curved stone cladding by using numerical control. The system development would also serve to execute a prototype for the Walt Disney Concert Hall in Los Angeles and later triumph with the Guggenheim museum in Bilbao.

3.2 Antoni Gaudí's Rationale

Although Antoni Gaudí was influenced by the Gothic style earlier in his career, his destiny was to impose an authentic style in the late 19th century. Catalonia at that time was undergoing a revival of cultural and political pride. Gaudí's belief in such values led him to become in charge of the design of one of his most appreciated architectural masterpieces, the Sagrada Família, shortly after construction had begun. This peculiar work of Antoni Gaudí left his successors with an architectural challenge in order to culminate it, where designers would have to employ in depth research to solve the formal geometric principles and subsequently its construction process. The technology of the digital age was being investigated and implemented as a useful tool to solve some of the many challenges of this project. In 1979, Mark Burry appears in order be deeply involved in the technological era of the Sagrada Família. Based on his concerns, knowledge, and interventions at the CAD level, Burry was responsible for making the first study in the project through computer science. His protagonism in the investigation and advances led the parametric system to become at the service of the geometric interpretations that contrast with the geometric principles conceived by Gaudí in order to be validated as faithfully as possible before building (Burry, 2002). In 1986, Jordi Bonet, who was the architect chief at that time, commissioned Burry with more work on the geometric definitions that were behind the models of the creator of the Temple of the Sagrada Família, and from 1990, Mark Burry began his research on the appropriate use of the CAD for such work (Burry, Burry, 2006). Until today, his interventions with the parametric design applied to the architecture of Antoni Gaudí are important. The CAD system was the first in the digital technology line, but nonetheless, it was far from being considered a tool that could find answers regarding the construction of the temple. It was clear that CAD would help interpret the geometry, but what was missing was to find a way to transfer reliable information to means, both manual and mechanical, so that the digital could be transformed into physical in precise components that clearly demonstrated the ideas of the creator of this work. In a project such as the Sagrada Família, information concerning its history, geometry and symbolism are well documented. Through various types of disclosures, recognition in the field of Gaudí's geometric principles and style are valued. Subsequently, building systems and CAD innovations implemented in the temple have opened the doors of knowledge, with a consequent international recording of the project. And in the era of computer advances in the field of digital architecture, or just in the field of design of complex shapes, Antoni Gaudí is internationally recognized by publications constantly linked to parametric design principles. Whoever knows in depth the architecture of the Sagrada Família mentions the ability that Antoni Gaudí had to devise architecture using fundamental knowledge, defining a new science, and being ahead of his time. This has always implied that the architects involved in the project had to put all their knowledge in search for strategies to geometrically understand the project and then build it. Early use of technology for the manufacture of parts has been a major factor in the new discourse of the architect. Designers at this point had to negotiate a new communication process with new applications to transform information into real architecture. The best way to position the historic chronologic facts in the proper place is by comparing the Temple of the Sagrada Família with similar projects of the time. Back then, few were at the height of the complexity of geometric principles left by Antoni Gaudí. Additionally, with the need to model and manufacture curved surfaces, the field of technology boosted architecture towards the non-standard. In an attempt to locate oneself within the history of technology in architecture, and assuming that the Sagrada Família's "column of Lleida" was one of the first architectural elements robotically built, a comparison was made with one of the first projects recognized in the technological field of architecture using CAD / CAM systems, designed by Frank Gehry, the architect who has unconstrained this new way of working in architecture. Completed in mid-1991 the sculpture dedicated to the 1992 Olympic Games in Barcelona used technology from the aerospace industry. The sculpture represented a sign of change in the history CAD / CAM system's design and use, focusing on the computer aided construction technology. During the same period of the construction of the sculpture, a number of tests concerning cutting stone with the help of CNC machines were done for the American Center in Paris and a prototype of a curved stone wall for the Walt Disney Concert Hall. The computer-machine relation in architecture starts in 1988. This reference is the starting point of the revolution in both parametric design and also digital fabrication. This fact should be valued as one of the turning points of a contemporary architectural culture that is becoming more familiar, in pace with technological means. For instance, Mark Burry favors this type of design process as long as the architect firmly controls the development, away from algorithms created by others and for other purposes than the one he is working on (Burry, 2016).

Suddenly, Parametricism became in my opinion a vulgar display of power. By spreading the parameters related to architectural design to embrace so many data inputs necessarily displaced the practice towards a selfish role. What has been achieved at some point meant that working parametrically with ideas, data input, and outcomes, provided abundant opportunities to enhance the architectural practice. But to do so architects have to shift their way of thinking and adapt themselves in order to find methods to use and control computationally mediated principles. It would be then possible to contribute in the use of a wider range of variables to the fusion drawn from professionals who are not from the architectural field.

4. NON-STANDARD AND MASS-CUSTOMIZATION EXCUSES

With the help of parametric design and digital fabrication, it is possible to mass-produce non-standard, highly differentiated products of different scales and purposes. Mass-production stands for the fact that, thanks to digital technologies, variety does not compromise production cost and efficiency. Moreover, with parametric definitions that can be accessible to anyone, and with the help of interactive platforms, people could design their own customized products. Mass-customization is part of a design democratization that promotes possibilities for variation in directly personalized manners. Participatory design of digital mass customization happens when the main author creates a basic parametric design and other people customize the design by changing some parameters according to their needs or taste. Participatory design is commonly found in BIM systems today. It follows the old fashion way of for example a car industry design, where components are designed separately but assembled in one main file that forms the car, to the point of even embedding the most meticulous details.

The concept of mass customization in manufacturing can combine the economic benefits of streamlined mass production with customization to individual needs. But there is some concern that these technologies are not as fast when it comes to delivering based on market needs. For instance, chairs can be 3D printed at a mass customized shape and price. However, to get them at the same time that standard ones could be acquired is mostly arguable. What needs attention is the time-cost optimization factor. If they go hand in hand, then the process is safe, otherwise, which is very probable, the standard prevails. In addition, there is the factor of decidability in the scene which will play a negative impact in the decisions of purchase. With pre-defined catalogues, even though it may take time, decision comes in a specific amount of time. In the variation design, or customization, it will take a bit more of time due to the variants that will appear. This will provide more options even though it may affect the decision time to choose the final product. This leads us to the argument that we have, due to human nature factors, to provide somehow pre-defined choices to customers as clear as possible. Dealing with customized means of production requires tasks that provide balance among decision parameters, machine and human, cost and optimization. Achim Menges, argues that the industries can be positively affected by the introduction of cyber-physical fabrication systems which can in turn cause a major impact on architecture, not only by challenging building construction principles, but also taking into consideration formal creation, tectonics and space (Menges, 2015).

There is however certain confusion towards individualization when dealing with the mass-customization trend. Customization is a well-known strategy followed by many companies that captivate consumer businesses in order to offer customized products. When dealing especially with consumers looking to express their personality due to their purchasing power and requesting customized products, manufacturers are enforced to build production systems with constantly growing number of alternatives and variables. The result may lead to a system of production of a unique unit. This means that instead of looking for something which could be considered as state-of-the-art, consumers may want in the end something tailored to them, and totally personalized. The proposition of mass customization starts exactly in with the action to provide custom products for large masses instead of few customers.

A series of critical observations should also be taken into consideration. Mass customization is not a universal solution that would fit in all instances nor is it the right strategy for all frameworks. Basically, mass customization has a great potential to play a significant role in the near future. However, mass customization implementation is not always positive when dealing with performance outcomes. Great caution is required before abiding by mass customization strategies. An ideal strategy is neither mass customization nor mass production according to many studies, but somewhere in between them. Customers are at stake due to the fact that the greater the choices they have, new complexities will emerge, leading to a perspective that can be more frustrating than satisfying. Therefore, the choice of variety in customization should not be excessive, in addition to a careful selection of options for variation.

At the administration level, mass customization demands robust transformation of management proficiencies. Practices must begin at the level of normative controlling with the aim of transforming the confrontational perceptions of customers by an approach of listening and helping, thus aligning with clients. This is a more customer centric approach that can contribute to the management process change towards mass customization strategy. Mass customization has great potential to provide sustainable, economic, and strategic benefits. However, operational and marketing effectiveness are key issues in mass customization, which raises doubts about the true meaning of selling a design nowadays based on architectural principles versus the commercial ones, abiding by the glamour and uniqueness of parametric design.

5. THE MISLEADING COMPUTATIONAL DESIGN EXCESSIVENESS

Computational design deals with solving design problems on an abstract model defined as computational model. In this platform, the problem is denoted with a set of variables and logical associations between them. Basically, any design problem capable of being described as a computational model can be answered with computational techniques. According to the work in the architectural field, computational design provides multidisciplinary methods for designers in connecting design processes in deliberate and sensible ways. The concept of computational design in architecture comprises algorithmic logic thinking that should be rational, systematic, and consistent. In addition, the algorithms should be used in a way that automates manual methods, and that is the reason for computational design thinking being labeled as algorithmic. Some architectural practices have Research and Development departments responsible for applying computational techniques and analyzing their possible impact on the designs. They can enhance their proposals by trying to figure out the numerically driven methods of computation, which is usually data that is not visual. For instance, facades can be calculated by design systems and evaluated based on building performances under various conditions. This requires architects to possess a clear familiarity with design systems use. This is a perplexing task when it comes to educating architects, as they need to learn the basics of programming, in addition to training to think using logical approach to problem solving. Principles like these are taught at many schools of architecture as part of innovative and advanced design education methodologies. They are basically developed in order to explore new design generation possibilities at the intellectual, theoretical, and practical levels by using algorithmic strategies as concepts for design computing. These methodologies introduce to students the basics of computational design thinking as an alternative design method.

One of the researchers who have most developed the profile of technology applied to architecture has undoubtedly been Bernard Cache (Kolarevic, 2003). With his theories and experiments of small and medium scale, it was possible to contaminate the discourse of architecture. After the beginning of his research, concepts of parametric design and manufacturing through numerical control machines began to take protagonism in the discourse of the new techniques of the digital era in architecture.

The series of objects, similar and at the same time different, are compared with the means each dune in the desert symbolizes a particular morphological variation. These non-standard objects, according to Bernard Cache, are not designed but rather calculated by computer and industrially produced by digitally controlled machinery (Cache, 1995).

Objectile was later created by Bernard Cache, Patrick Beaucé and Jean-Louis Jammot in 1996 in Paris. Their intention was to work on the design and production of variable curved and complex shapes of different scales such as sculptures, design, furniture, building components, and architecture, among others. With their TopSolid software program from Missler Group, they were able to introduce an original automated production method, and with the conviction that architectural design was to be highly supported by technology. With the software Objectile, parametric design was fully applied in design with calculations instead of shape drawings. Traditional CAD was easily surpassed by the computation power system capable of dealing with curved surfaces variation and control. With such reliability, relations resulting in forms could provide unlimited number of variations that could be presented in the form of sequences in an interactive way. To take full advantage of these generation resources, Objectile developed a modular machining program that made it conceivable to digitally manufacture different industrial items in series.

After Objectile’s revolution, all kinds of technologies appeared to help in the design, generation of models through rapid prototyping, or 3d printing, manufacturing molds with CNC machines or even sculpting components with a robot. What architects and students experience nowadays has to do with the relationship between designing and building, where parametric design, 3D printing and digital manufacturing are totally linked. Due to the huge excitement that technology provides, sometimes programming imposes computational principles that require architects to behave like a programmer. However, technology can help architects to develop ideas that lead them beyond object manipulation. Nevertheless, designers can be easily carried away from the basic design criteria without being aware that they have been suddenly dragged into a place where the only challenge is to make the definition work. The potential start for missing the essential values of parametric design may be in this mentality of losing the track of the essences of this potential tool, which is seen as a solution looking for problems in a rational and systematic way and not the opposite. A sense of machine vs human in the irrational logic of design and construction starts to emerge as a potential generator for architectural depreciation.

Parametric design has the power to provide and control the design process and their rules that can help define, encode and clarify the connection between concepts and outcomes (Jabi, 2013). Rather than becoming a method or a design philosophy like Patrick Schumacher said in 2008, parametric design should be instead a way of thinking (Oxman, Gu, 2015). Dictated solutions should not be part of parametric design. Instead, a parametric analysis of the design problem should provide the possibility of exploring conceptual and tectonics in a deeper way, in addition to offering users and clients' logical and rational possibilities.

Parametric design has definitely many challenges ahead. It still needs to further evolve and confront criticism marginalizing it. Architecture can be based on radical and innovative principles, without the need to base oneself on the requests for urban and architectural complexity, since this is an excuse to usually end up with iconic projects. But in our days, we don't need icons. We need equality. Quality of life. We need to invest our efforts in making the world a better place, or at least to still survive.

Maybe this is too much for what is needed now, or this is just the fact that architects are losing direction. A portion of architecture from the parametric design world is about to take the wrong path where building design is becoming about the aesthetics and formal complexity. It is not clear what happened to the essential values like functionality, efficiency, and adaptation of the building to its surroundings. Starchitecture is caring more about the exaggerated shape complexities with extravagant, and sometimes very badly crafted, facades. The functionality of most of the parametrically designed projects unfortunately remains suspicious. This is probably due to the fact that the parametric design drive has not managed to deploy enough emphasis on the argument concerning this vital issue. While art, technology and design process must still play a part in creating the character of this high-tech trend of work, parametric design must retreat and stress on social performance if this technological driven effort is to be popularly accepted in the practice. It should play a vital role in the computationally empowered society.

6. THE FUTURE

It's not to take the pressure that building technologies are advancing slowly, but let's think that architectural design and construction has been already well thought of throughout its different ages. Even before the fourth industrial revolution, most of the aspects related to human needs have been tackled in architecture, with a sense of balance and harmony between arts and science, delivering aesthetics, structural challenges, philosophical arguments, and so on. Issues related to architecture have been engaged from as many angles as possible and within a certain rationale that was able to create constructive arguments that would become a palpable part in the development of the history of architecture. Being carried away by robots and 3D printers in the same way that we got excited in the 1990s by the computer graphics, it's as if we are committing the same mistake again by taking the longest path possible to realize that efforts are being put in places not really needed for now, or let's say in rational orders, to reach results able to provide us with contemporary solutions that would cause an impact in the construction world. It's not everybody's task to become a starchitect since it is not healthy for the sake of architecture, but only for fame and money. And in this case, it's more of a pride to become an actor. We are living in times where every decision we make may affect positively or negatively the future generations, and instead of putting efforts in the wrong place, we should be more conscientious that a sustainable planet and future is in play, and if we don't act with all the tools that we have, if sustainability does not become a way of living, we will be nothing more than a series of decomposed non-functional bits spread throughout the infinite. Parametricism is definitely experiencing acceptability problems. And that is probably because it must emphasize on functional values and social drives rather than stressing on formal principles and design processes. A more strategic way of dealing with design research should be carried on, leading towards practical and performance oriented proposals, so it can become a serious trend or style capable of causing a positive impact in the world. When protagonists apply their opportunities in a systematic way, a real impact in the field can then be expected to occur. Many architects dealing with parametric design have been influenced by the greatly innovative work of architects like Antoni Gaudí, who is recognized somehow as a pre-digital pioneer. But there are serious doubts that the lessons were learned since rationality somehow was suddenly depreciated along the track. Let's remember meanwhile that paranoia is an instinct or thought process deeply influenced by anxiety or fear, often to the point of delusion and irrationality. Rationality is not in the capability of controlling forms. It's a balance between intentions of expressions fused within material logic needs. The Paranoid Critical Method established by Salvador Dali and architecturally backed by Rem Koolhaas was defined as the second phase of surrealism. Based on the critical and systematic objectifications of delirious relations and understandings, it was seen as the conscious abuse of the unconscious, an impulsive way of irrational knowledge. It dealt with combining historical references into an ambiguous position and allowing the viewer to see the work as a multiplicity open for assumption mixed with criticality and paranoia (Koolhaas, 1978).

7. CONCLUSIONS

Being intensely involved in work with pioneer architects of the digital age such as Mark Goulthorpe, Mark Burry, Francois Roche, Zaha Hadid, in addition to Antoni Gaudí's work, the modest experience acquired allows to state that this has been a challenge facing the standards of design and construction. It is living architecture in a frustrating, since there is the need to attain unconventional and maybe never seen results, and the fun, exploring tools and methods to fuse them in ways that if they are effective, the effort pays off. It has been a unique opportunity that allowed experiencing works of complex applications that would contribute in widening the tridimensional mentality. Project complexity is not just on the screen, but transforming from digital to analogue states in fluid and unimaginable ways. Every single technology tool available changes frustrations into joy, be them 3D printers, numerically controlled machines, or robotic arms. Having lived in this digital world for almost 20 years allows me to expose the negative side of all this joyful, optimistic, radical, and digitally-physically transforming pleasures that complex-to-human computational design is leading to.

Parametricism is definitely not a style. A style should fuse art, science, technology, craft, form, function, and structure, among others. Or better, to be a style there must be a rationality that society can accept, abide by, understand, purchase, and disseminate. Parametricism has predominantly, and so far, only reached a small part of society. The level of potential present in projects such as museums, airports, luxurious hotels, headquarters for big companies is way too different when design requirements deals with for instance, low income residential projects, or community projects, which are in certain ways the challenges of the contemporary times. Especially with the global economic changes, climate crisis, and sustainable development goals deadlines just around the corner. Unless it tackles rational principles that deal with the necessities of the current generation without affecting the future ones, parametricism will hardly become a style, since it is predominantly showing and affecting the minds of future architects as a fancy, starchitect fashion. There is no doubt that parametricism has unmeasurable potentials, however, it is a question of dealing with issues in a simpler, more down to earth manner. If we had no global problems affecting social, economic, political, geographical, and health issues among others, maybe it would make no harm in investing time to advance with it. However, this digital world should be taken as if when a teenage is going to a party, where he can drink, dance, socialize, but to be aware that if he access drugs, the fun could lead him to undesired consequences.

Therefore the job starts in education, awaking students of the potentials of such a dangerous tool that can do as much good as harm to architecture. Providing a better quality of life for instance is more important than building Disneylands of architecture.

These words don't come out of rage, but of frustration that much more can be done. Almost two decades have passed and very little progress is palpable when considering what other disciplines are doing. Is that because architecture is already too advanced? We are maestros capable of mixing and fusing studies, theories, histories, societies, and any parameter possible to device design concepts that can connect to people in different ways. And very little disciples, if any, are capable of assimilating such amount of data from so many different sources for a purpose. We are able to orchestrate projects with thousands of people involved. We deal with materials in the same natural way that fashion designers do to dress people, but we dress buildings. We think of the rich and poor, the old and young, we are able to zoom in and out of any context whenever we need to analyze, interpret and conclude something. With parametricism we are just a tool in front of a potential tool that can twist our heads in a fraction of seconds and make us forget about the essences of architecture.

Thanks to technology, we can say that we are in the fourth industrial revolution. But we must not forget that a balance between digital tools and manual rationale will be essential, in addition to the dedication to continue working to develop innovative solutions that will be vital in the challenge of driving design and construction to a greater sustainability standpoint than we have in mind right now.

In architectural design, the users should be considered as the ultimate parameter in the design process and as the main enhancement factor for the final outcome. It is a natural fact that when designing using new strategies, there are factors, sometimes unknown or unforeseen, that need consideration. In addition to that, the known parameters of great importance such as context, culture, or history should be fused. Unless intended, that is a statement that seems trivial, but unfortunately, creating something that has no relation to the city or to the inhabitants are becoming common, appearing confusing, and, many times, establishing negative perceptions.

Exactly on this line of thinking, it is relatively easy to find the Starchitecture that is capable of conceiving something alienated from the already existing surroundings and explicitly defending it. But, in the sense of modern architecture focusing on essential issues such as the building functionality, starchitecture can be hardly considered a continuation of the modern movement. The fascination for some starchitects is to get their practices recognized at the expenses of parametric design. Unfortunately, many of their trendy buildings can be placed anywhere, disregarding surroundings, history, and with a selfish identity of their own.

High tech trends usually aim the complete use of automated systems in construction. They also help in the design process of complex geometries. However, and through a modest experience, it has been noticed that the human help is difficult to avoid. Parameters such as the characteristic of materials, or just human feelings play an important role in the intervention of manual labor. But parametric is a solution looking for a problem. Rationality plays the role of mediation between the complex design and simplification of execution that relates to the choice of high or low tech.

Parametricism can be said, unfortunately, to be an autonomous capitalist way of designing buildings. Designers mostly rely on computers to process complex data in the creation of sophisticated architectural shapes, which is nothing bad. Concerning functionality issues linked to the use of algorithms to design adaptable buildings is a promising challenge even though it is still to be seen. And this raises doubts concerning the possibility to shape architecture perfectly to the complex and unpredictable uses. So far, some of the buildings from parametric design have shown very little response to its surroundings based on issues such as adaptability, fluidity, or the connective surrounding. Information technology is helping in the creation of new challenges and possibilities, but so far, there is no predictability about forms.

Feeding every imaginable factor into a computer that will then help in the delivery of a harmonious building reflecting and responding to all the factors is still a dream. Rather than intuitive judgement, architecture might base itself on scientific data. However, the formation of relationships between parameters is the prior methodology of parametric design. For instance, the absence of a back in a chair design means parametrically that its height is equivalent to zero. If this is the case, the method for fixing the arms would have to change as a result. However, if the seat is too high then the model may collapse. Therefore, the key to parametric design is based on constraints.

Therefore, there must be logical limitations to the values introduced in parametric systems. Going back to the chair, the user would not be allowed to determine the number of legs or the seat's maximum height. In this case, parameters will interact in a more rational way. At the same time, the connectivity among parameters could have a different formulation, such as for example, to make the arms of the chair extend as the seat projects out further. But this is done intentionally, and not irrationally. This is said because some parameters get in conflict, like for example, if the arms of the chair go back too far they may hit the geometry of the chair's back. And let's not forget about the ergonomics.

People who use CAD or BIM systems understand that the parametric design principles and constraints such as of chairs are fairly modest. In this sense, there are pre-defined libraries of furniture and building elements with fixed parameters and variable ones. However, the complexity of parametric design gets into action with bigger entities, such as buildings. The building design can be made up of numerous relationships and constraints, involving meticulous arrangement of parametric components that would provide variable formal consistency.

To use these tools in explorative, productive, and rational design contexts requires the designer to have sort of geometrical awareness and logical computational abilities. In this sense, the role of the architectural education comes in with an urge to put greater effort to cope with the rapid transformation of digital technologies and computational methodologies. While computational design is progressing, a gap between the architectural education and this design becomes clearer and more dangerous.

There is no doubt that design experience in the computational design world is necessary, as the tools do not provide designing guidelines. They are nothing more than auxiliary design tools in which the design can be fully controlled from concept till production. However, they spread a computational thinking mentality, where problems can be solved by systems established on fundamental computer science concepts. Computational thinking will be part of the fundamental skills to be used by designers in the near future, not as computer scientists, but as architects of the digital era.

Constraints and limitations are familiar terms to anyone who has worked in the area of parametric design. It is clear that the use of parametric design helps in the production of elegant buildings of extreme formal complexities, with continuous organic and elegant facades and roof structures. However, floor plans with optimal circulation routes and spatial intervention usually convene in a secondary plan. Glamorous skins, stylish surfaces and sculptural abstractions are the result of the constraints and their interdependencies managed with algorithmic control.

Parametricist discourse marginalizes itself by jumping over the several years of research towards a new paradigm, ambiguously presented. Parametricism, which is appropriately named in a marketing point of view, finds the chance to be sold with authority of parametric acquaintance and techniques determined on replacing some of other complementary fields.

Many starchitects are nothing more than marketing personalities trying to sell fancy ideas that marginalize parametric design which are non-affordable and exaggerated in aesthetic values, rather than concentrating on the use of advanced tools to solve problems and provide a level of flexibility for customers to explore and take advantage of customized possibilities, or providing solutions for communities at the urban scale for participatory opportunities, expressing the true meaning of democratization of information. It is supposed to complement architects' skills in a way that they remember that architecture has to deal with essential parameters that has been taught during generations. Scale, order, functionality, material, performance, and the list go on. Let's not argue if parametric is affecting positively or negatively on contexts, but let's say that it is playing a dangerous role on future architects. Essences are not priority anymore. Instead, parametric is unfortunately becoming a paranoia.

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