Unfolding the design of architecture as a strategy to assess intellectual property

Bridle pirating architecture

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Modeling tools are evolving the process of architectural design from the use ordinary digital tool into a role of creator of complex shapes, through coding configurations. These procedures are becoming the structural ground of the architectural shape, going beyond their sole tools role. The increasing in importance of such codes implies a major level of awareness for their use, which is worth of a deeper analysis. The system of relations among parts in an architectural design picks a single configuration among infinite others, because it is produced by a design process which find its fulfillment in the final portray. Through the spreading of digital design tools, such final configuration becomes a step in a clearly reproducible process. The project is achieved through a series of starting conditions, which undergo a parametric process, that produces the final result. An identical parametric process can be applied under slightly different starting conditions and produce completely different results. These results are connected with the code which produced them, but is the authorship still property of the original author?

Keywords: *Morphogenesis, Parametric, Authorship*

INTRODUCTION

Reading from Dezeen website, 2/1/2013: "Satoshi Ohashi, project director at Zaha Hadid Architects, told the German website: "It is possible that the Chongqing pirates got hold of some digital files or renderings of the project." He was speaking about the Chongquing project, which was a copy of Hadid's Galaxy Soho Complex in Beijing. From this brief comment, it is clear how the deep integration of digital tools into the generation process of architectural shape has transformed its role from pure support digital tool into a complex shape creator through computerized codes and procedures. The increased importance of such codes implies a profound awareness in their use, which is worth to be analyzed in a more detailed way. The code exists as a connection between the idea of the architecture and its representation. The study of such relationship is fundamental to understand the origin itself of architecture as a totality of geometries and constraints. The way in which these geometries interacts each other has changed deeply through time, enduring an abrupt acceleration with the dissemination of generative design modelers. Through the studies of (Moussavi 2009) and (Pottman 2007), it was already clear the dependency of the components which build up the architecture system, starting from geometry which is connected with a system of analysis and discretization of the infographic knowledge model (Empler 2007) . In this system the software tool intervenes in defining the bidirectional relationship between model and idea, aiming to representation. With the spreading of advanced digital tools the representation diminishes its role as aiming point in the process of architecture definition. The centrality of architectural process is shifted from representation to the process itself. In this design path the singularity of the final result is counterposed to a multiplicity of results linked together by the original code. The concept itself of architectural originality is absorbed in this way by the code itself, subtracting importance from architectural manufacture. Starting from the single digital code it is possible to create an envelope of multiple architectures, which share common generative features. It rises therefore the problem of defining the affinity of different architectural manufactures within a certain degree of originality and recognizability. Is it possible to scientifically differentiate different architectures if they are generated by a single code? Is it possible to speak of finalization of architectural process of a single building or it would be more adequate to speak about an arrested development in the progressive refining path ? This process of systemic evolution is not limited to modify the whole building but it spreads its influence on the single part of the architectural manufacture.

The relationships among the parts, once they have been drawn through traditional representation tools acquire a unique spatial configuration, which derives from a design process which finds its fulfillment into final definition. With digital design tools this final configuration is a single step in a reproducible and modifiable process, available to anybody who owns the original code. The architectural project is fulfilled through starting conditions, which undergo a parametric process that provide a (final?) result. Therefore starting from initial condition (the problem invariants) it is possible to define an envelope of results. This process can be outlined through a coordinate Cartesian system, where it is possible to point out the single generator character of the architecture on the abscissa, and the application intensity of the previous characters on the vertical axis. This scheme can be updated for any step of the shape generation process. The results envelope can be combined in an animation which represents the variation of the influence of single components in function of different steps in time. A function of this scheme, obtainable by changing values of variables, is the identification and differentiation of the result belonging to the same envelope, which houses interconnected architectures. Among all the possible generative features of a building, a small part among them build up the shape of architecture, so a question arise, how it is possible to distinguish one from another? Some designers describe in detail the morphogenetic process that brings to the shape of the buildings; many others instead leave unexplained details.

METHODOLOGY

Starting from aforementioned thinking it is possible to grasp the need to describe the generative process in the most detailed possible way. The main reason for this necessity is the extension of the right of intellectual property, up to the possible iterations with adequate software tools. It is impossible to fill with these methodologies the whole spectrum of cases falling into the architectural envelope, because it would prevent the use of known architectures as a base for new buildings. It is paramount to identify a separation between the group of buildings falling into this envelope and the rest of architectures. An hypothesis of the process of building a class of architectures that can be considered linked to the initial one is the purpose of this work. Once an architecture has spread out the knowledge of its shape features, it is a common habit to describe the process of form generation through the means of media as Internet *conference* hardcopies. This process is accomplished through isolated spots on the design process, which focuses on main features only. It is metaphorically as a seeing a movie where the projection lamp works for brief lapses of time, leaving long obscure timespans. The process of rebuilding all the steps of morphogenesis is a work which has been started in Politecnico di Milano from the mentoring of prof. Andrea Rolando. Students of the courses of School of Architecture, as 3d Parametric Cad drawing (Disegno Cad Parametrico 3d) have built a share of studied buildings from contemporary architecture. These architectures has been studied starting from representation point of view, producing all the missing steps from the "metaphoric movie". These studies have been deepened into the parametric approach, analyzing the morphogenetic process using a generative design tool as Grasshopper. This process has built a limited sample of buildings which has been the base for the present analysis. Each case study has a unique path which end with the final shape, passing through a series of steps. Each step is a set of basic geometric transformations, clearly identifiable. Two kind of directions arrive to the final result. First one is a simple consequential series of transformations which, taken one after the other, lead to result. The other is an application of the same series of transformation within a certain number of iterations. Editings can be understood by applying methods explained by the text explained above, both of which follows the general rule to show only a step in the whole process of transformation. Pottman's studies groups transformations into chapters, so the explanation is limited to one figure; Moussavi's text is made of data sheets with small drawings where comprehension of the full morphogenetic process is very limited. Although endowed with incomplete descriptions, for the purpose of this work, the aforementioned book have a value as a mark for categories of transformations; acquiring categories from both books it is possible to cover a wider range of the possible building operations. Some examples of categories will be explained to clarify this issue, more specific details are worth to be analyzed in further following studies.

A first group of transformation valuable to be analyzed is the standard volume modifications, specifically, rotation and scaling. Furthermore rotation is itself a group of sub operations, because it includes more specific alteration, as revolution and roto-translation. Starting to focus on rotation only, it is easily recognizable the possibility to choose a given form and apply the transformation. The choice of the architecture for the transformation to be applied is important, because the parameter to be adjusted must be present in the morphogenetic process. In fact, for the present transformation, it is important that the process of building-shaping would possesses the rotational parameter. A practical example is described in Figure 1, it is the Turning Torso, a skyscraper located in Malmo, Sweden, designed by Santiago Calatrava, where the process of rotation is evident.

Figure 1
Turning Torso,
Malmo, Sweden, by
Santiago Calatrava,
photo of the author

A Grasshopper algorithm has been worked out for the aim of rebuilding a shape as similar as possible to the original Calatrava's building. The step of form generation evolves by the rotation of a single layer around an axis that run perpendicular to the ground up to the top floor of the building. The building is composed of nine blocks, each of which rotates a fixed angle, creating a whole arc of rotation of 90 degrees. Each block is divided in five floors, each of which rotates of a submultiple of the rotation of the single block. Furthermore the void between two modules gets involved into the rotation; the result is a continuous wave of rotation that starts at the first floor and goes up to the top of the building. The parametric approach to this building has choses a set of shape-drivers that remains constant, as it is the axis of rotation and the base perimeter, which is generated by a parametric procedure itself (D'Uva 2014). Six parameters are instead flexible, the floor height, the floor distance, the number of stories per module, the number of modules, the panel width (in which module windows are built) and the number of modules. The sixth parameter is evidently the rotation, which is 90 degree in the built architecture, but it is possible to increase the rotation, to a higher value, as 180 or decrease to zero. Both extreme values, as 180 degrees or zero give possibilities to build a real building where structural, HVAC considerations are similar to the original one. Other possible variations based on rotation only is the inclination of rotational axis from the ground. It is clear that an infinite number of results can be obtained, whose intellectual property is worth to be preserved. In this case the envelope of preserved building can be obtained by the extension of rotational property which group all of possible alternatives to the original.

Scaling an architectural building is commonly an operation which commits in several issues, because of the quantity of components involved and the non-scalability of ordinary components. Therefore a scaling operation is not a simple changing in dimensions of an architecture, but it involves a changing in number of components. If an enlarging is needed, the result is not a modification in dimensions of single components, but an operation of multiple instances of the single elements, which fills up the increased volume. This operation is one of the sparkles that has been giving propulsion to the spread of Building Information Modeling, because of the modeling structure, that eases the copy of similar elements which are endowed with constrained one each other. It is more difficult although to control the shape, starting from the design of single elements. A proper strategy is to point out shape drivers (Rolando 2008) that give geometrical constraints to groups of elements. The case of scaling is applied the London Serpentine Gallery Pavilion (see Figure 2) by Cecil Balmond and Toyo Ito, built in London in 2002 and demolished the same year.

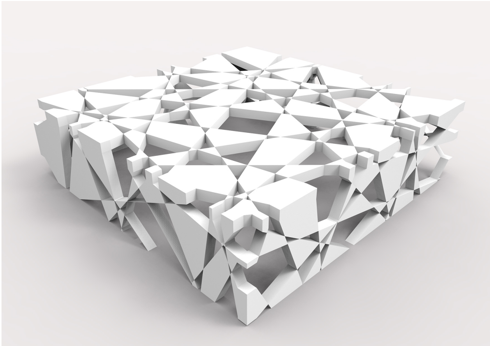

Figure 2
Serpentine Pavilion, London 2002, by Toyo Ito and Cecil Balmond, rendering by Paolo Tomelleri

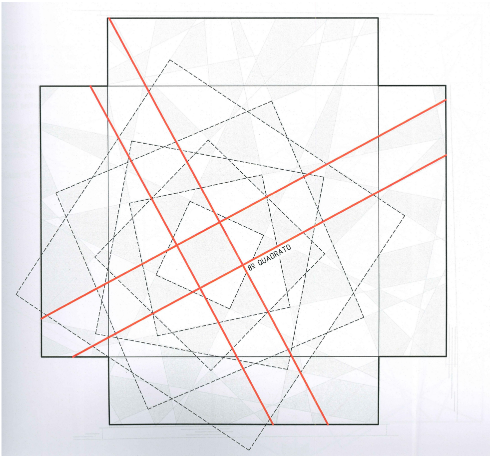

Figure 3
Serpentine Pavilion, London 2002, Toyo Ito, by Toyo Ito and Cecil Balmond, drawing by Paolo Tomelleri

The starting conditions are a box which contains the main shape, which dimensions are 5 modules of 4 meters, which is 20 meters, extruded by a module of 4 meters. The shape of this pavilion is based on geometric adaptation applied to a parametric system.

The geometric adaptation is the application of the same rule in plan and elevations.

The same procedure is applied on all the sides by the rotation of façade around a revolution axis which lies on the eaves (see Figure 3). With this premises all the rules applied to the base square are linearly extended to the façade. The parametric system that underlies beneath this architecture is the square, whose sides are respectively divided with the following scheme: two counterposed sides are splitted in two halves, the other two are splitted in thirds; the resulting points are connected by adjacent sides by forming a smaller square into the bigger one. The newly formed square is splitted in the same way, and process is repeated recursively for seven iterations. The eight iteration is impossible because the splitting would result in a degenerate square because of the side dimensions. The edges of all the created square are extended up to the boundary of the figure, together with the rotated façades. The edge of the second iteration are limited to the base only without extending to the outer border of the figure. The geometry generated with this parametric system creates a square based grid which makes the main structure of the building. The final step is the filling of part of the gaps created by the grid with an opaque white cladding. The substantial overlapping between form, geometry and structure is an envelope, where openings are defined by material subtraction. These subtractions are made starting from a model of the building as a result of the generative process. The resulting mode, indeed, is different from pavilion real consistency because it has been necessary to create variations for functional purposes. A paradigmatic example of this process is the cladding subtraction which has allowed the positioning of building entrance.

Once the pavilion algorithm has been worked out it is effortless to apply a straighforward scaling transformation to get a different building. In this very case it is the architect himself, who applies the scaling in upward direction to get the results. It is TOD's Omotesando Building in Tokyo (see Figure 4), whether in completely different context. It is pointed out, in this way, the problem of identifying the intellectual property of a potential new architectural manufacture generated by a parametric process already used by another building.

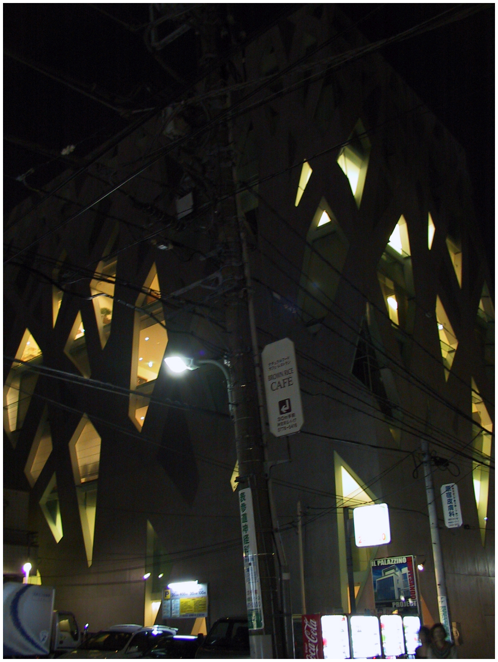

Figure 4
Omotesando Tod's flagship store, Tokyo by Toyo Ito, photo of the author

The plan has a base ruled by a similar 4 meters module with a perimeter L shaped instead of square. The structural system is strictly connected with the external skin façade, like in London pavilion. The façade has been thought using the same algorithm as London Pavilion, in a way to have a realistic comparison of similar mass volume structures. The algorithm flexibility has given the chance to modify the pavilion height to be similar to Tokyo building. Within these hypotheses, the degree of similarity is pretty high. In this very case, the buildings chosen as case studies have no intellectual issues, because author is the same. It would have been an issue, although, if two different architects had produced building whose codes were common. It seems evident, given the two case studies, to point out some of the elements discovered.

CONCLUSION

The first and most important commitment in design an architecture is the spreading of design path. Most of the architectural works are explained and published in limited printing, where a part of the design process is unveiled. Most of the times only the inspiring sparkles are explained in detail, together with deep sensations and genius loci which have driven the architect into creating a masterpiece. No explanation at all is given on how different parts of the building cope each other and how geometry is parameterized to create the final shape. A paramount example of this hypothesis is Calatrava's works which originates from natural forms, as human body, for instance the torso that rotates which is the base for the first aformentioned case study , or the eye, which is the base of Valencia's Ciutat de les Arts i les Ciències. Therefore it seems clear that once code has been completely worked out, it is possible to generate an infinite array of buildings linked to the original one by the code only, completely different in dimension, aim and location. In this way it is clearly recognizable the problem about intellectual property of an architectural product, which is generated by a second-hand algorithm. A need for rules to protect intellectual property is arising, with new tasks to accomplish. A possible field of research is the creation of an algorithm database where base designs are recorded and computer generated softwares forecast the possible variations needful to be preserved.

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