

Parametrics applied to Urbanism

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Abstract. This research aims to analyze the potential offered by parametric urbanism to increase efficiency and the quality of urban design proposals. In parametric design, the template can be changed throughout the design process, allowing to generate and test lots of versions without the need to return to the starting point of the project. The introduction of parametric design urbanism has great potential because several aspects pertaining to urban design such as density, use, shape, space and type can all be defined parametrically. Thus, this research aims to understand and analyze this theoretical procedure and contemporary methodology of urban design associated to new technologies,. It intends to analyze the advantages, disadvantages, applicability and improvement possibilities of this new way of designing the scale of the city and Brazil.

Keywords:Parametric Urbanism, Urban Project Methodology, Digital Design.

1 Introduction

The purpose of this article is to understand and analyze the theoretical procedure and contemporary methodological in urban design associated to new technologies, which is called Parametric Urbanism. This new trend is based primarily on parametric design systems, already widely used in the aerospace and automotive industries, in which the focus of interest is not in the form itself, but the parameters that generate it. The transfer of these technologies for architecture and urbanism is well known as parametric urbanism [SILVA; AMORIM, 2010]. This non-traditional method of urban design allows greater flexibility and variety of models. Thus, as an alternative to the traditional methodology, it allows a better control of the entire process, since the software tolerates changes during all stages of the work.

From this, and from the case study analysis of projects that have been implemented using this new architectural design method, we intend to analyze the advantages, disadvantages, applicability and possible improvements to this new way of designing in the city scale, as well as its applicability for the Brazilian cities. Importantly, this study is still under development as a research paper during the undergraduate course. This article, however, seeks to elaborate the theoretical basis underlying and supporting this research.

The computational advances of the last quarter of the twentieth century, which enabled the introduction of new technologies in the design process, has required a new way to deal with the traditional method of working of architects and designers [Kovaleric, 2000]. This new way of designing is the ability to produce information that can be manipulated digitally, and from this point, developing analyzes and simulations on any quantitative or qualitative aspect of the project. Mata [2003] has demonstrated this in her research that, among other issues, analyzed different types of digital architecture, unraveling the methodology adopted in each case, showing how the use of parametric allows information management and integration that is possible between different disciplines in a collaborative system of continuous architectural design development. Thus, this method increases the possibilities and solutions in different subjects, from more technical character as the acoustic, thermal comfort, structures, streams, etc., as well as relevant elements to the project, such as socioeconomic and cultural aspects. On this, the author adds that this practice allows a greater variety of solutions to the same problem, permitting to the architect a more favorable condition to experiment with different scenarios, "for designers these technologies provide the opportunity to have other areas and responsibilities such as data capture, data evaluation, optimization of solutions and simulation of planned results" [MATA, pg.11, 2010]. Therefore, that architectural and urban design method seems to have a great efficiency in the production of simulations and adaptations of solutions to be achieved in a project, greatly increasing the professional experimentation capacity.

From the analysis and optimization of results produced and tested during all phases of the project, the decision-making become more clear and informed on analytical data, making the whole process less intuitive and reducing the incidence of formalistic and superficial solutions. It expands, therefore, the possibilities of solutions to a given problem, moving away from the traditional and subjective form of traditional design thinking, as well as promoting new logic designs from the relationship of various systems [Celani, 2012].

2 Cases

As exemplary cases for the application of computational tools to urban planning, we chose two iconic projects that are distant in time and space and, therefore, they allow an analysis of the evolution of this design methodology applied to the city planning and urban design. The first is the Kartal-Pendik Masterplan in Istanbul, developed in 2006 by Zaha Hadid Architects, and the second is the design Flowing Gardens, developed in China by the Plasma Stúdio team in 2011.

In common, the analyzed projects explore a basic element of the traditional method of urban planning: the circulation system that, due to growing problems of mobility and its effects on the development of the contemporary city, has become a structuring element of almost all new projects for cities. The organization of flows has become a very important component for the development and implementation of any urban development policy, with particular concern for areas that suffer from a spontaneous swelling of the existing urban fabric, especially those with a steep and uncontrolled growth.

We also observed in the case studies that resulting grids from generative processes have the flexibility to simultaneously satisfy various circumstances; since their design and performance are obtained from analysis of various parameters, making them more adaptable to the various conditions, such as environmental, formal and functional.

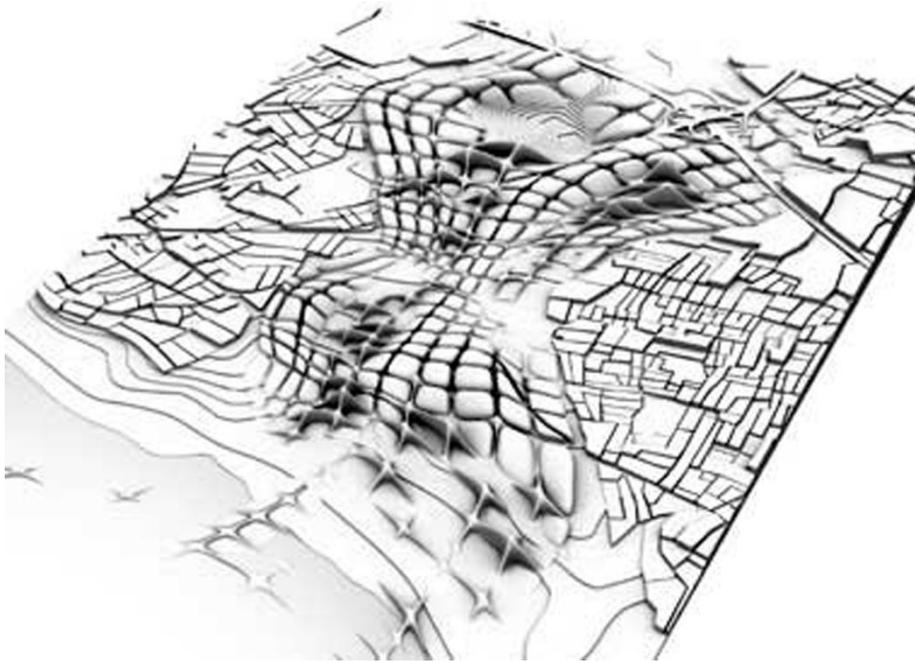


Fig.1. Drawing for the Masterplan of Kartal Pendik. Source: <http://www.zaha-hadid.com/masterplans/kartal-pendik-masterplan/>. Accessed: 01/30/2015.

In the masterplan for the Kartal-Pendik [Istanbul, 2006], the Zaha Hadid Architects developed the urban design from a method known as *Hair System* in order to optimize flexibility and circulation system. By definition, Hair System is a mesh or a branched grid without formal default setting because its configuration is the result of analyzes and simulations from several variables and implied specific and unique to each location and proposed project. Therefore, this resulting character allows the hair system becomes a living element, reactive to the demands and structuring the project, releasing the urbanist a real gain of possibilities for solutions and redesign urban settings. Therefore, it is not a formal solution to a problem, much less of a model that can be replicated in many places and independent of context, as a generic solution or a totalitarian and universal answer.

The project developed in Kartal-Pendik has a high flexibility that the method takes. The resulting grid has great elasticity to fit the topography of the region and ensures integration and fluidity with the existing grid in areas outside the project.

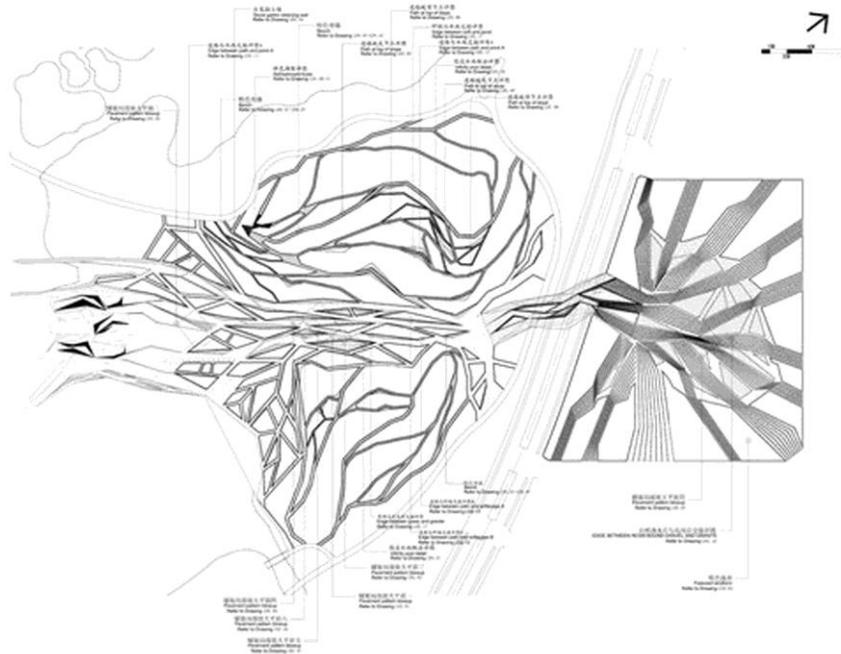


Fig. 2. Hair System deployed in Flowing Gardens. Source: www.plasmastudio.com/. Accessed 30/01/2015.

The second case study, which is another interesting example of a circulation system optimization also based on complex hair system methodology is the design Flowing Gardens, [Xian, China, 2011] developed by Plasma Stúdio together with Groudlab office. The project won an international tender for the construction of a pavilion that will house an horticultural exhibition.

The project proposes the creation of a mesh composed of a complex network of branches that operates in a number of scales associated with landscaping, creating micro-regions that will change as the observer moves by the project, breaking the monotony and giving vitality to the grid. In both projects, we note that the matrices formed from parametric analyzes assume a more fluid and organic configuration, following a rhizomatic logic.

When we analyze the concept of branched or rhizomatic grids, we must mention the contributions of the research carried out by Frei Otto. From studies conducted between 1958 and 1960, Frei Otto analyzing a system that he designated as minimal path system [CRUZ, 2012]. The analysis was made from experiments and simulation

elements of nature, such as the structures resulting soap bubbles "As mentioned above, te soap film surfaces to reduce the minimum required configuration, thereby revealing the shortest path to create a form" [CRUZ, pg.218, 2012].

The concept of minimum paths were to create branched meshes always aiming to create a route that offers better performance in many ways, whether by optimizing the circulation, or through the need for fewer materials for its implementation, greater flexibility of use. Thus, his research methodology incorporating the concept of projetual higher optimization.

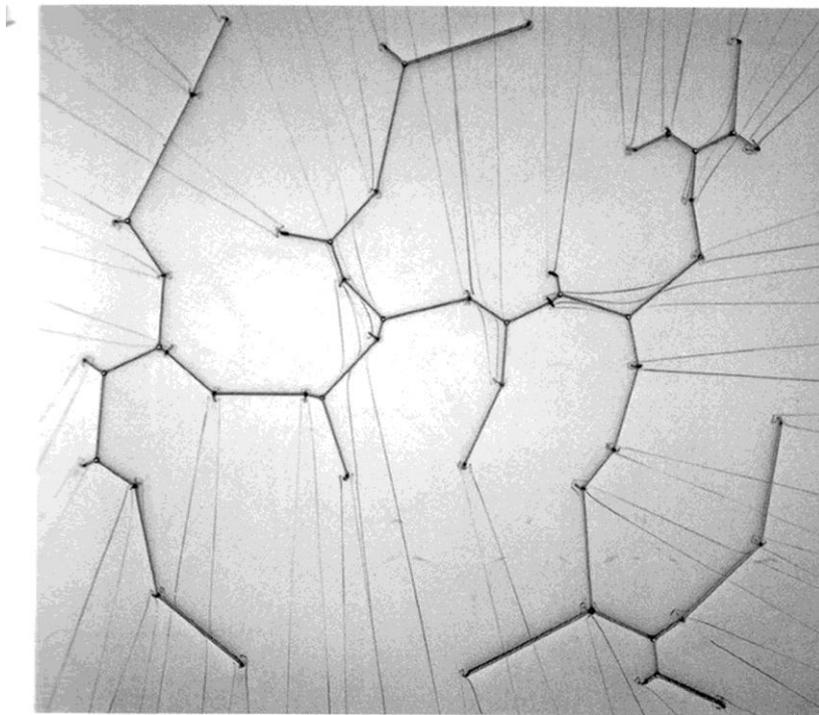


Fig. 3. Paths experiments minimum. Source: OTTO, 2011.

2.1 Application of new paradigms to the informal city intervention.

The incorporation of generative systems to urban design methodology seems better suited to the complexity of the contemporary city, especially when one considers the informal portion of these cities [Romano, 2010]. Elizabetta Romano together with Giancarlo Tonoli developed a research called *Genetic Code of Slums*, in which they developed a method to identify the logic of the so-called informal city, recognizing their complex relationships that make these spontaneous urban areas generate problems difficult to solve and a mismatch compared to traditional lattice grid, widely

used in Brazilian's urban projects. From the research on the logical expansion of the informal city, a parametric script was generated that would adapt the socioreality of that particular site. After identifying the agents who acted as process forces, the authors understood the complexity of these clusters, which is due to the fact that all the components of its spatial morphology, social, cultural and economic character are directly linked, promoting constant changes and establishing relationships between its inhabitants, "*assuming that the city is not a finished system, but a living organism in constant development*" [ROMANO, pg.02,2010].

The authors argue that, given the formation of these settlements based on accommodation of the needs of the community, the space resulting from the occupation should be able to adapt to new requirements and accommodate varied use of programs. Therefore, they say, interventions in these areas that do not take into account such complexity, fatally would fail. The application of the resulting algorithm of this investigative process allowed the authors to conclude that the use of a design methodology with more analytical and flexible resources allowed a closer result than is actually required for the complex organization of informal areas in Brazilian cities.

3 Final thoughts.

The resulting methodology from the application of computational tools to urban design and city planning extends the possibilities for solutions to the city, allowing urban regeneration projects in areas with complex features, like the Brazilian favelas, resulting in designs that are more consistent and that best fit the territorial conditions and the real needs of the inhabitants. The study of international examples, as well as an analysis of informal areas morphology, seem to point to the fact that the traditional orthogonal grid widespread by modern urban planning, due to its totalitarian rigidity, does not have the necessary performance for urban projects in these areas, without the loss of the very identity of the informal city.

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