Computational Architecture: Focusing on perception and functionality aspects of urban intervention
Motivation:

The scale and the factors that affect the urban design are always fascinating because of the level of complexity that it may reach and there is always a need to explore, to challenge, to find new solutions to cope up with this level of complexity and such type of problems. This new approach may open the possibilities in solving very complex problems and it solves the interaction problem with the system of finding solutions and at the same time it offers many other solutions that the capability of the human mind may not grasp in the same amount of time and afford. The flexibility level is really high, which is a key point for the nowadays dynamic society.
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1. Abstract

All aspects that are included in urban design (Density, form, typology, space etc.) are able to be defined by parameters. By making use of different programs and by bringing these parameters as inputs it results in a better, faster and more suitable urban design than the conventional way of designing in this scale. Parametric urbanism brings the parametric design tools into the complex problems of urbanism. The power of parametrics brings very thorough analysis of different situations in an urban scale and by making use of this analysis we can make possible the design of a better urban environment.

The flexibility level is really high, which is an important point in urban design scale because of its unpredictability and while the parametric modeling is working in real time we have a better interaction with our designs.

The traditional design relies on fixed lengths or fixed proportions as aesthetical elements while parametric design relies on connectivities between the parts which still a way to define a certain methodology for this operation is not found. But again without the possibilities which virtual evolution blindly searches the space of search will become too poor to be of any use.

**Keywords:** cities, urban design, parametric urbanism, dynamic society, dynamic system, computation, flexibility, complexity, traditional, analysis, urban development parametricism, real and virtual.
2. Introduction

First of all let’s start by defining “Design”. Design is a search in the process of finding solutions to problems acquired to be solved during the process and ends up with an end product. Parametric design is a tool to be used for designing which is based on defining the parameters, variables, and constraints. In the application of parametric designing, many different aesthetical, technical and economic implementations can be given as values during the design process and the whole system of physical, technical and economic data will update according to the given input at any point during this process.

According to Beirão, Duarte, & Stouffs, Architecture, urban design and urban planning are three different scales of design activity that merge within the context of the city. It is already defined that these scales have a range from the smallest (local) to the biggest (global) and bring with them many complex systems such as social, economical, environmental and political which increase the complexity and the uncertainty of the cities and their development. So, uncertainty and complexity seem to be the main models in the city growth. The main problem with the cities is that, even though you may plan beforehand, it is almost impossible to know or predict the development. While designing a city you have to deal with much complex behavior of the development and at the same time you have to predict desirable and the controllable development of the city. It has been proved that this is not possible to be achieved by the traditional way of designing. Furthermore, the constant change of the city dynamics as a fact of the contemporary society has made possible to understand that the traditional way of designing is not efficient enough.

As a result, what these problems bring, are the non flexibility after the design, even during the design as the process continues, because the process of urbanization is a never ending process. There must be always plans for expansions or differentiations of the functions within time and the conventional ways do not give the opportunity for such decisions, because it is really difficult since one single problem redefines the whole package. So, in order to get better results more flexible solutions are needed.

The design outcomes of urban design come not only from internal aesthetics of the design but also from some precise data because urban design as a field takes place in the public arena and there are variables that are precise which come out of the analysis of the problems. So, in order for this design to perform well, the decisions must be based on these variables which in other words can be the deriving parameters. In order for the design to perform on its best, everything must be done systematic and being fully conscious about the process and methodology used during this process. Density, form, typology, space etc. are all aspects that are included in urban design, each able to be defined by parameters. By making use of different programs and by bringing these parameters as inputs it may result
in a better, faster and more suitable urban design than the conventional way of designing in this scale.

So, a new approach to parametric design is the implementation of parametric design to urban design and as a result it forms the parametric urbanism. In this paper I am going to talk about parametric approach in urban design, compare the results of three different case studies to make the topic clearer and point out the problematic part for each approach (traditional approach and computational approach).

3. Parametricism in an Urban Scenario

As mentioned by Rocker, I.M. (2011), Parametricism as a new mode of thinking ecologically suggests that humans, like any other constituent component of the earth’s ecology, are continuously in exchange with one another—and any other parameters constituting the system. Certainly the philosophical construct of the human as different, or even aloof, from the very ecological system s/he stems from is a historical construct of Western civilizations that has proven to be a fatal miscomprehension, bringing the ecosystem "earth," including its human constituents, to the brink of its resources.¹

As a new philosophical position, parametricism may allow for a rethinking, may allow for a radical change in how we think and design our built environment - finally comprehending it as being a part of and never apart from the living ecological systems we are living in and through.²

Parametric urbanism brings the parametric design tools into the complex problems of urbanism. The power of parametrics brings very thorough analysis of different situations in an urban scale and by making use of this analysis it will make possible the design of a better urban environment. Since parametric design on the building scale can bring many different results for different situations it is also possible to use these results in an urban scale to create a better environment at this certain scale. However, this media is still not too much integrated to the field of urban design even though it is well-established in engineering and increasingly in architecture. In urban design it is still taking its first steps mostly in the form of commercial software which is recently emerging in the market.

Many ways are used to design in the urban scale with the use of the computational medium. I will choose three of the cases, one from Jose’ P. Duarte, Joa” O M. Rocha and Goncalo Ducla Soares “Unveiling the Structure of the Marrakech Medina: A shape grammar and an interpreter for generating urban form”, one from the published article in the Architectural Design (AD) journal “Experiments in Associative Urbanism” and one from XXL

² Ibid, pg.99

The designs were chosen on the fact that the first one is based on the context to create new designs whereas the second one is creating its own context, but both are using parametric design approach in the urban scale as a solution to their demands, while the third case is a design which is based on the traditional way of designing in the urban scale. By analyzing the first two cases we may be able to see if the system is working on these different approaches appropriately or not, which will make possible the understanding of the advantages of using such methods and at the same time by making use of the third case a further comparison will be done to understand even better the contrast between two approaches.

4. Case Studies

4.1. Case Study 1

“Unveiling the Structure of the Marrakech Medina: A shape grammar and an interpreter for generating urban form” by Jose´ P. Duarte, Joa˜ O M. Rocha and Goncalo Ducla Soares.

This paper describes research carried out to develop a parametric shape grammar able to capture, and replicate in other contexts, some of the urban, architectural, and morphological characteristics of the ancient fabric of the Marrakech Medina, namely its Zaouiat Lakhdar quarter.\(^3\)

The project’s final goal is to develop a computational system able to generate novel urban and housing configurations that are more environmentally sustainable and energy efficient, while respecting certain cultural and spatial qualities as captured by the shape grammar.\(^4\)

The research described in this paper is focused on the creation of a shape grammar to describe the urban features of the specific quarter of the Marrakech Medina referred to above.\(^5\)


\(^4\) Ibid, pg.317

\(^5\) Ibid, pg.317
For the authors there were three reasons for choosing the Marrakech Medina as the case study for this experiment. First, it has an intricate between the urban configuration and the patio houses. Second, previous work on the Zaouiat Lakhdar quarter, recommended that a stylistically coherent quantity of designs existed, and the variety was enough to fit the research objectives. Third, the population increase in Marrakech during the last decades, has led to an uncontrolled urban growth that produced urban environments not so rich in spatial quality which could be seen in other historical vernacular areas.

Thus, this research intends to provide a computational framework that can assist designers in the design of urban environments that maintain traditional spatial and compositional principles while satisfying the requirements of contemporary life.

A simple shape grammar composed of ten parametric rules was developed. Then, it was encoded into a computer program implemented in AutoLISP to observe the behavior of the model simulating urban growth, defined by the successive and iterative application of rules. Finally, the program was run with 50, 100, 200, 500, and 1000 iterations. (Fig. 3)

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This approach failed because the results were not the same to what they were expecting, so there had to be done more investigations and careful observations on the site in order to get the right results.

The view of the Medina of Marrakech suggested an organic and almost chaotic city growth. However, a close analysis unveiled a well-established order with repeated urban patterns. For example, the way lots are placed on derb corners are similar. Such patterns are not geometrically but topologically similar, meaning that they can differ in the values of parameters like the angles and dimensions of lots and derbs. Consequently, it was possible to capture the variety of patterns into a reduced number of parametric schematas to develop a parametric shape grammar.\(^7\)

At the outset, it was considered necessary to deal with both the urban scale and the scale of the house. As such, the development of three grammars was decided: an urban grammar that would account for the layout of the derbs and the definition of lots, a housing grammar that would account for the functional organization of the houses and “negotiation grammar,” which mediates between the other two grammars and regulates the permutation of spaces between adjacent lots according to the necessities of their owners.

There are many approaches that can be chosen to be used in shape grammars and for further continuation of the research and recreation of the Zaouit Lakhdar zone the bottom-up approach was chosen to be used.

The bottom-up approach emphasizes the notion of growth rather than division. It requires shape rules that define both the incremental expansion of derbs and the systematic insertion of lots (Fig. 6). The basic idea is that entrance points are defined in the perimeter of the neighborhood (step 2), and then derbs grow independently from each one. Lots that have direct access from the surrounding street are defined at an early stage (step 3). Derbs then grow and fill in the empty space with lots until none is left and the whole neighborhood is packed (steps 3–16).\(^8\)

Fig. 6. The bottom-up derivation of the Zaouit Lakhdar zone.

The proposed Marrakech grammar is a parametric shape grammar defined in the Cartesian product of the U12W22 algebras. Weights are used to distinguish areas occupied with plots of those that are empty still. The derivation of designs proceeds through six stages.\footnote{JOSE’ P. DUARTE, JOA˜ O M. ROCHA and GONÇALO DUCLA SOARES (2007). Unveiling the structure of the Marrakech Medina: A shape grammar and an interpreter for generating urban form. Cambridge University Press, pg.325.}

Stage 1: Define limits of the neighborhood

Stage 2: Insert entrances to derbs

Stage 3: Insert extenders and articulators forming Derbs

Stage 4: Insert lots along bordering street and derbs’ extenders

Stage 5: Insert lots at derbs’ ends

Stage 6: Modify the layout of derbs and lots
Fig. 7. The complete derivation of the Zaouiat Lakhdar quarter. The numbers in parentheses indicate the number of times the rule above was applied.
Fig. 7. (Continued)
Fig. 7. (Continued)
In the Figures 7 it is seen clearly the process of the evolution of the design, which is based on the rules that are predefined according to the analysis done beforehand on site. It is clearly seen that the process can be stopped, and restarted at the same point without limits. In this way it is possible to construct a system which will work even for projects which are in a bigger scale and the advantage would be that we would be able to control the process and change the process at any time according to the needs. By the change of the users, will change their density and by that change, which is only one example, will change also the whole project itself, which means that the whole project will be updated according to this change. This is really important because in this case it is shown clearly how the rules, which come out of the analysis of a specific site, can derive the whole process and the design itself and at the same time it may relate the old project to the new one really easily.

4.2. Case Study 2

“Experiments in Associative Urbanism”, a published article in the Architectural Design (AD) journal by Verebes, T.

In this article there are many cases which the Design Research Laboratory (DRL) at the Architectural Association in London has experimented on an urban scale by using parametric design as an approach to the problem from the beginning.

According to the author, Global urbanization is developing at unprecedented rates, scales and densities, with over half the world’s population living in cities. In the third and final cycle of Parametric Urbanism, DRL v.11, this was concluded in January 2009, the DRL explored global urbanization and the diverse contingencies of four sites located in New York, Moscow, São Paolo and Ras Al-Khaimah in the United Arab Emirates. The studios investigated diverse strategies for radical urban development and transformation, aiming to progress from familiar models of emblematic internationalism towards new iterative organizational models for high-density urbanism, specified and differentiated to local contextual forces in four cities in four continents.\(^\text{10}\)

One of the examples is the DRL Sahra team (Tutor: Tom Verebes; Students: Saif Almasri, Suryansh Chandra and Peter Sovinc), “Parametric Urbanism 3” taking place at Ras Al-Khaimah. Ras Al-Khaimah is shaped by the abundance of the oil, vehicular movement and air conditioning with almost no consideration for the pedestrians, environment or the public transport. The project of DRL Sahra team criticizes the globalised form of urbanization in this region and instead proposes a gradient of massing and movement figures, densities, proximities and interconnectivities, on the chosen site. While doing this they have taken in consideration the climatological and urban parameters such as sunlight, wind, view, programming and routing.

Ras Al-Khaimah is spread 30km along the coast and only 4 km on the other side. The site is located in the heart of the city making possible to show the urbanism in three varying

\(^{10}\) Tom Verebes (2009), Experiments in Associative Urbanism. Architectural Design (AD), pg.33
geographies, the coastline, the desert edge and the estuary edge. (Fig. 9) The site is recently populated by a very few plotted residential developments. (Fig. 10)

Depending on a large number of factors including Global Economic trends Ras Al-Khaimah could become either a business/financial district, an area of duty free malls like Dubai as a tourism center, or residential satellite town feeding Dubai with its low property rentals. (Fig. 11)

4.2.1. Site Analysis

Site analysis is one of the key point through the process of designing, because through analysis it is easily understood the values, problems and many other factors of the city. By analyzing these factors it is possible to relate the design easily and it is also possible to find out the problems of the previous development which somehow need to be solved. Site analysis makes possible the thorough understanding of the area the design will take place and gives references to the new development. This is crucial because without this information it is almost impossible to design something because there would not be any starting point.
Site analysis are concentrated more on:

The main road intersections, which are really important to localize the main nodes in the urban area. Pedestrian walk ability is another key factor that was taken in consideration, which is one of the key factors in urban scale, because the city must be designed in such a way so that people may have access to different places by just walking. By this analysis the further development may take place accordingly so that both the already built part and the new urban plan to relate and create a unity.

The location of the transport nodes is of a great importance to be analyzed in the urban environment because these nodes make the whole transportation system work in this scale, and also by knowing also the capacity of each node it is possible to decide on the density that the design must have at each part of the city. Also by this understanding of the system it will be easy to locate another node/s which may be required for the new development.

Waterfront, in this case study has a distinguished importance because it is a point of attraction for activities, and this is also a result of the fact that the place is situated near to the desert, which creates the great contrast between both parts.

Another key point that is analyzed is the existing development. By analyzing what is already developed in the site it is easy to locate the built environment because it is the existing development that creates the starting point of the design that I going to take place next to it, which means that it is this environment which may create a reference system for the new development. And at last it is the road network.

This network is responsible for the traffic control and the whole transportation system in the city, and a change in this system can be vital for the urban area. The road network is like the system of the blood vessels in the human body, which connects each and every part of the body and makes possible the take of blood in every part of eat so that the body may stay alive. In the urban scale it is too important to locate these vessels so that it can be possible to extend them or redefine them in order to respond to the needs of the areas designed. It is near to them that different functions and activities will take place so more it is known about the road network the better the location of each function and activity can be defined in the area.

All these analysis are done in order to have a better understanding of what and where the urban development is taking place so that the new urban development integrates to the existing values and characteristics but at the same time by knowing better each part of the urban are to reach the freedom of taking decisions which come as a result of the better understanding of the whole system.
Main road intersections (Fig. 12)
Pedestrian walk ability (Fig. 13)
Optimized locations for transport nodes (Fig. 14)
Waterfront (Fig. 15)
Existing development (Fig. 16)
Road Network (Fig. 17)

A point grid is created according to the programmatic distribution along the site.
As the user moves the point inside the triangle the system adjusts the programmatic distribution along the site in real time. Creating different programmatic distribution along the site. (Fig. 19 – 19.5)

4.2.2 Urban generating typologies

Typologies in an urban development are important because by creating a typology you create a grammar of the whole development in which the typologies are related really closely to each other, and so, they are easier to be controlled and at the same time the typologies define a unity on their own. So, there are these different typologies and their correlation that will generate the urban environment.

In this case different typologies are created for different parts of the whole design. There are parts of the design which the design is so correlated to the existing built environment that affects quiet much the development of the new buildings at that are.

Being a design which is being implemented in a city which has a part of desert, it is really important to introduce another typology which follows the characteristics of the place, in this case that of the desert, where the temperatures are really high and in this case surface area is really important because less surface area less the heat gain from the construction.

In an urban development opened spaces are important because these are the spaces which give the possibility to people to interact, communicate to each other and these spaces react also as relaxation areas, at the same time it is developed also a topology for outdoor courtyard like spaces which will react more on individual houses (in many cases used to create outdoor relaxing spaces and at the same time to create the gradient of movement between the most public areas like plazas or squares to the most private areas like houses).

According to the urban situation they have designed typologies that will fit in long linear streets or other ones which would work well within the hexagonal grid (in this case the grid
used in the design process as reference grid, which will derive the whole system), and some of them are created to for high density areas which in many cases are used in the most favorable and expensive plots in the area so that the profit out of those plots, would become higher.

Designed to resemble the existing development. (Fig. 20.)

Designed to minimize surface area in the hot desert climate. (Fig. 21.)

Designed to form large continuous open spaces. (Fig. 22.)

Designed to fragmented open spaces. (Fig. 23.)

Designed to work well with long linear streets. (Fig. 24.)

Designed to produce high density or (Fig. 25.)

Designed to work well within the hexagon grid. (Fig. 26.)

Designed to create outdoor courtyard like spaces (Fig. 27.)

Morphing transformations of massing diagrams, generated in Maya, demonstrating the potential to order space with coherent yet differentiated systems. This approach argues for a vast array of architectural difference, while maintaining a legible, negotiated density, open-interior massing ratio and varied floor area ratio (FAR).\(^\text{11}\)

\(^{11}\) Tom Verebes (2009), Experiments in Associative Urbanism. Architectural Design (AD), pg.32
4.2.3 Urban Scenarios

Many different scenarios may be created by just moving the point inside the triangle.

Tourism scenario maximizes the coastline and put the most significant program next to the waterfront. (Fig. 31.) Business scenario gives an equal importance to the coast and the other part and creates high rise whenever these two parameters are found together in optimal conditions. (Fig. 31.1.) Satellite scenario, are mostly placed away from the coast and closer to the desert and other areas of the site. (Fig. 31.2.)

We may have an extremely dense high rise mega structure like development, low rise high density like development, a mix of both or low rise low density like development.
4.3 Case Study 3


4.3.1 Urban Development

By starting the stadium project in Rotterdam, the first approach was about understanding the social, cultural, economic situation of where the stadium site stands in. The new stadium site exists in the southern part of Rotterdam city. As perceived, people living in this area generally have lower economical, social and cultural condition compared to the northern part of Rotterdam.

Then it is decided to think about the new stadium as not just a stadium, but also as an urban developer and activity center of the area to improve the life quality of the people living in this part of the city. By this, the area will become lively and a set of activities will be created accordingly, which results in lots of jobs and more visitors not only at the match’s days but every day. This will help to grow the economical, social and cultural situation of this part of Rotterdam.
Fig. 32. Old Site as an important nodal point for the new stadium in the overall urban fabric

Fig. 33. Relation of the new site with respect to the old site
4.3.2 Site Analysis and Introduction of the Concepts

The new stadium’s site surrounding areas were analyzed. The most important element of the site can be considered the old stadium of Rotterdam, and the island close to the site. The old stadium of Rotterdam gives a historical value to the area as the “Feynoord” team, and also the activities which take place inside it, can be integrated to the area to have relation with the new stadium. The island also is a good potential of the site. Since it is all green the integration with the other green areas can create nice areas for the people to enjoy.

The site was analyzed according to the types of the functions present there: commercial, residential, recreational etc. and also according to the public transportation roots and the crossaction of the main roads passing near the site. The concept for the urban circulation of people is to create a separation between the people coming just for the matches, who would be in direct relation with the stadium, and the people who come to enjoy and to have a good time by the use of the green areas, shops, restaurants etc. provided in the site.

![Fig. 33. Public transportation points and flow of people](image-url)
For the people coming to the stadium for just watching the matches, a path is considered. This path connects the old stadium with the new one and makes a relationship between them. In this path, the public transportation points are considered as a main parameter as people approach the site mainly from these points. Then by providing a plaza at the southern part of the street, people will be gathered and by means of a bridge these people can pass the street and go to the plaza at the other side of the street or directly enter to the stadium. Also from the eastern part of the stadium another connection is created, which can lead people and the guest team supporters to the eastern part of the stadium.

The ground at the northern part and southern part of the street has a level difference which avoids eye contact of two sides of the street where the plazas are standing. Then by putting parking lots under the plaza, the two plazas have the possibility to connect visually to each other which empowers their relationship. Yet there is another parking area close to the southern plaza which aims to increase the parking areas for the people coming to the site by their own cars.
As mentioned, besides the path for the people coming for the matches, it is decided to make a green connection to the stadium which can be used not only during the matches but also for everyday activities.

As the western part of the site has a potential axis parallel to the river side, with the current commercial function, it would be quiet well to revive this axis by the use of existing green and continuing it towards the plaza next to the stadium.

The green axis leads people to the plaza next to the new stadium. By proposing some activities in the green island, the green axis can continue towards the island by adding a sloped green area to the eastern and northern part of the stadium. This will create an area with a very nice view towards the river.

Underneath this sloped green area there exists a set of shops which can be considered as continuation of commercial activities of the axis created. These shops together with the upper floors facilities (auditoriums, cafe and restaurants) at the northern side of the stadium can be used independently from the stadium so that even when there is no match in the stadium, this part continues its activities independently.

During the matches upper floors facilities will be used by stadium, but shops continue their activities during the matches by using some panel like elements which separate the flow going to the stadium and the flow which goes to the shopping area.
4.3.3 Urban Functions

For improving the life quality of the people in this part of Rotterdam, several functions and activities should be put in the site in order to create an enjoyable and lively area. For this reason different type of activities are proposed and designed in the site. We may define the main activities as commercial, cultural, sportive and social one. All these activities interact with each other to create a network of functions that will make possible the regeneration of life in this area.

Fig. 36. Activities Diagrams and relation to each other
Fig. 37. Activities proposed and designed in the site

4.3.4 Urban Development Process

Fig. 38. Urban Development Process
5. Case Studies’ Comparison Results

In both 1st and 2nd cases it is seen clearly that the computational design approach is very flexible. All this flexibility rests in the virtual world because, by changing the values it is possible to change the data and by the change of these data the project will change eventually. While in the 3rd case the biggest problem with the whole process was that the problem was so complex because for each and every part of the urban development there was a concept introduced that whenever a change would happen at a certain point it was acting in a chain reaction and the whole system had to be changed. And since this whole urban development system and design reacts to the stadium itself it will change not only the design of the urban areas but also the design of the stadium itself.

This process was done in the traditional way, which leads to all these problems. And for that reason there was a big loss of time to redefine again and again the whole system and the whole design because it needed to fit everything perfectly from the start to the end point. If we could have chosen to use the parametric modeling instead, all the changes at any stage would have been automatically reflected to the whole system and the whole model would have changed instantly according to the parameters, variables and the constraints defined from the beginning. This would save us a lot of time and the precision would be a lot higher and at the same time everything could have been related easily.

One other thing that we as a group wanted to achieve was to select a certain solution after exploring many possibilities. In this point, since the process chosen to design was the traditional one and because of the lack of much time, it was almost impossible to explore different possibilities or different relations within the system (only 2 explorations in the urban scale), while in the parametric modeling this is something that can be easily done, and many possibilities that sometimes we cannot think of could have come to light and after a lot of exploration in a short time we could have chosen maybe a better result which would fit better to the requirements.

Another key factor in designing in the urban scale is the implementation of the design in the real world. This passage from the virtual to the real gets an enormous importance because it is this moment which will show the truth of the system that is created; it is this moment which will prove the system to be right or wrong, flexible or nonflexible. Since the system created in the virtual world is a system designed to the details that means that it can be implemented and there must not be any problems during this implementation.

In order to implement this system, firstly the system freezes and the data that are present at that moment will be taken and used to construct the system in the real world. It is this moment when the problem of the system start to arise. Here, the system will be confronted with the highly dynamic society which is changing in very short terms. If this society, changes every day, or every year or every month, what would be the result that comes out of the parametric process, because after each change in order to implement we have to freeze the system and when another change will happen we have again to pass from the real world to the virtual world and change the parameters again and after that refreeze it.

How, many times may we refreeze the system or reevaluate the system in the virtual world until it breaks. Is this system after so many freezes still a dynamic system, and will it be able again to function as such? Because at this certain point it is clear that it will become like the
conventional system because every time we have to come from the real to the virtual, redefine the problem and implement it again.

As also mentioned by Manuel De Landa, since the embryological operations is able to produce a large variety of end results which have different metric measurements and properties from each other, then it is clear that the spatial structure which makes possible the creation of the body plan cannot be metric. In this case the body plans must be topological. If the architectural structures will be able to have the same amount of results from the combinations as it is seen in biological structures, then the starting point must be an adequate diagram which is an “abstract building” that corresponds in biology to an “abstract vertebrate”. At this moment design overpasses breeding only, by different artists designing their own topological diagrams according to themselves. Even though the process of design will be a lot different from the traditional way of designing which works with the metric spaces. The traditional design relies on fixed lengths or fixed proportions as aesthetical elements while the other relies on connectivities between the parts which still a way to define a certain methodology for this operation is not found. But again without the possibilities which virtual evolution blindly searches the space of search will become too poor to be of any use.

As a result, one key factor to know in this case is the cracking point of the parametric system which is previously created, otherwise after many freezes we may come out with a result which at certain moments was a good solution but in total the things may not coincide and may become a total chaos.

6. Conclusion

To conclude, all aspects that are included in urban design (Density, form, typology, space etc.) are able to be defined by parameters. By making use of different programs and by bringing these parameters as inputs it results in a better, faster and more suitable urban design than the conventional way of designing in this scale. Parametric urbanism brings the parametric design tools into the complex problems of urbanism. The power of parametrics brings very thorough analysis of different situations in an urban scale and by making use of this analysis we can make possible the design of a better urban environment.

The flexibility level is really high, which is an important point in urban design scale because of its unpredictability. Since the parametric modeling is working in real time we have a better interaction with our designs and the results may be seen and foreseen in an easier way.

Even though the issue of the passage of the design from the virtual medium to the real world may create problems and sometimes even crack the whole system, I believe is still a problem which can be solved by making use of different methods which will come as developments of this approach in the future.
Also mentioned by Manuel De Landa, it is indeed too early to say just what kind of design methodologies will be necessary when one cannot use fixed lengths or even fixed proportions as aesthetic elements and must instead rely on pure connectivities (and other topological invariants). But what it is clear is that without this the space of possibilities which virtual evolution blindly searches will be too impoverished to be of any use.\textsuperscript{12}

7. Bibliography

Alexandra Paio and Benamy Turkienicz (2010), An Urban Grammar Study: A Geometric Method for Generating Planimetric Proportional and Symmetrical Systems


Manuel De Landa (2001), Deleuze and the Use of the Genetic Algorithm in Architecture


8. Illustration credits

Figure 8-18:

Figure 19-19.5:

Figure 20-27:

Figure 29-29.2:

Figure 30-30.2:

Figure 31-31.3:

Figure 28:

Figure 1-2:

Figure 3:
Figure. 4:

Figure. 5:

Figure. 6:

Figure. 7: