Recovering historical urban texture by parametric computing modeling" Historical Tehran as case study

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Abstract

Traditional urban texture shaped by nature, was forgotten by the industrial revolution and the advancement of technology in the field of architecture. Traditional urban design processes lack of the flexibility to deal with the complexity of the community. The complexity and uncertainty of urban environments by using traditional design methods have made it difficult to make definite plans for urban design in many cases. Since the structure of environment is having ability to convert to design parameters; therefore by using method of the parametricism, it will be possible to easily change the environment information. And the result of the change and adaptation of the design at each stage will be with new data. Because of this system dynamically updated, the design is updated with each change of input by the designer. The aim of this study is to identify features and benefits of using parametricism and computing for rebuilding a newly designed urban fabric after destroying and recovering the ancient special identity of a city. Unfortunately in the city of Tehran, the capital of Iran, the traditional face of the city is destroyed by builders and most of buildings which are our monuments convert to shopping mall and towers. In this article we first talk about the traditional urban texture of Tehran then we discuss about patterns obtained from urban texture of ancient Tehran. Finally by inputting these patterns as design parameters in grasshopper plugin, that is the most widespread plugin for parametric design, we rebuild a newly designed urban fabric of Tehran.

Keywords: **Traditional Texture, Parametricism, Rebuilding, Recovering, Grasshopper**

Introduction

Traditionally, urban plans are developed following methodologies aimed at the production of a single layout representing a rigid, definite solution. In addition, plans are centered on the definition of tight and interdependent urban parameters that tend to reduce design to a direct formalization of such parameters. However, legislation constrains neither design nor its representation to such an extent that they forbid design flexibility. In fact, it does not impose specific representational devices, nor does it imply any specific way of designing [1]. The context of a project, as a starting point of urban design, is changing constantly in non-linear way [2]. Therefore basic inputs of a design process, may change from time to time. However, the interrelations between elements of urban form can be fixed and predefined by designers. Current urban design practices ignore urban 'processes' and 'time' [3]. Planning processes have to become more flexible to reflect the opinions and actions of a wider range of stakeholders. [4] Therefore, objective of urban design need to move from static design of a specific layout toward complex and dynamic design of generic solutions [3]. The design of plans for cities can only be improved if designers are able to address measurements of some

of the relationships between the components of cities during the design process. These measurements are called urban indicators. By calculating such measurements, designers can grasp the meaning of the changes being proposed [5]. In this research, a urban design system is designed based on parametricism in order to achieve the above objectives. The purpose of the present research, besides introduce the features of this method of designing, is using the parametric urban design process capability to recover the old historical urban texture of Tehran. Since this method is possible and harmony with any cultural and linguistic context, parameters and patterns obtained from the traditional texture of the old city of Tehran, They are algorithmically linked with each other in " Reno + Grasshopper" ,one of the commonly used software in the field of parametric designing. The design results in this process show that, in addition to creating a process that makes any changes and updates the output of the design quickly, the resulting form is also largely aligned with the surrounding texture and the special needs and requirements of the design.

Parametric urban design process

An urban design system should be able to:

• be applicable in every design context for any district size and be able to apply different kinds of design programs;

• be interactive and responsive providing good visualization output both in terms of design layout and associated analytical data (indicators, attributes, indexes, etc);

• be able to implement and design the main features that compose a neighborhood.

Considering these aspects we implemented. A parametric urban design system using a NURBSCAD, environment using a parametric programming interface. The CAD environment used in this work was Rhinoceros and the programming interface was Grasshopper. The system aims at designing urban plans at the neighborhood level. Parametric design as a system of parameters, that are linked each other based on algorithm relationships. The relationship between the indices allows the general model, by changing the value of each parameter, final form is changed. The dependence of algorithmic relationships and mathematical formulas makes it possible to update the project in the design process. Urban design begins with a series of inputs. These elements are placed by the designer within the site and may be changed by the designer during the design process, and by changing the key points of the output, the design will also be displaced. Some inputs allow the designer to select the type of network [3].

There are two types of inputs – geometrical inputs and data inputs. Geometrical inputs, which is divided into 4 basic types: the site (defined by polygons); the composition elements, which are subdivided into main streets (defined by lines and curves) and focal points representing the location of the neighborhood center, local squares, public buildings and city objects in general; a vertical parameter to define the maximum number of floors; a set of grid types (rectangular, radial and recursive). Each of these inputs has a set of associated parameter inputs. A main street, for instance, has the attribute street width. [6].

To understand which design has more benefits (evaluate and analyze the design at each stage of the design), a geometric model can be connected to computing the metrics of density measurement or measurement of user levels. Whenever there is a change in the indexes, the calculations will be updated, so at any moment we will be able to get information about the changes in the design. By using this process, practitioners will be able to better understand their decision outcomes. In this process, any concept that can be expressed mathematically

can be related to a geometric model. [5]. The main steps of the proposed process will be as follows.

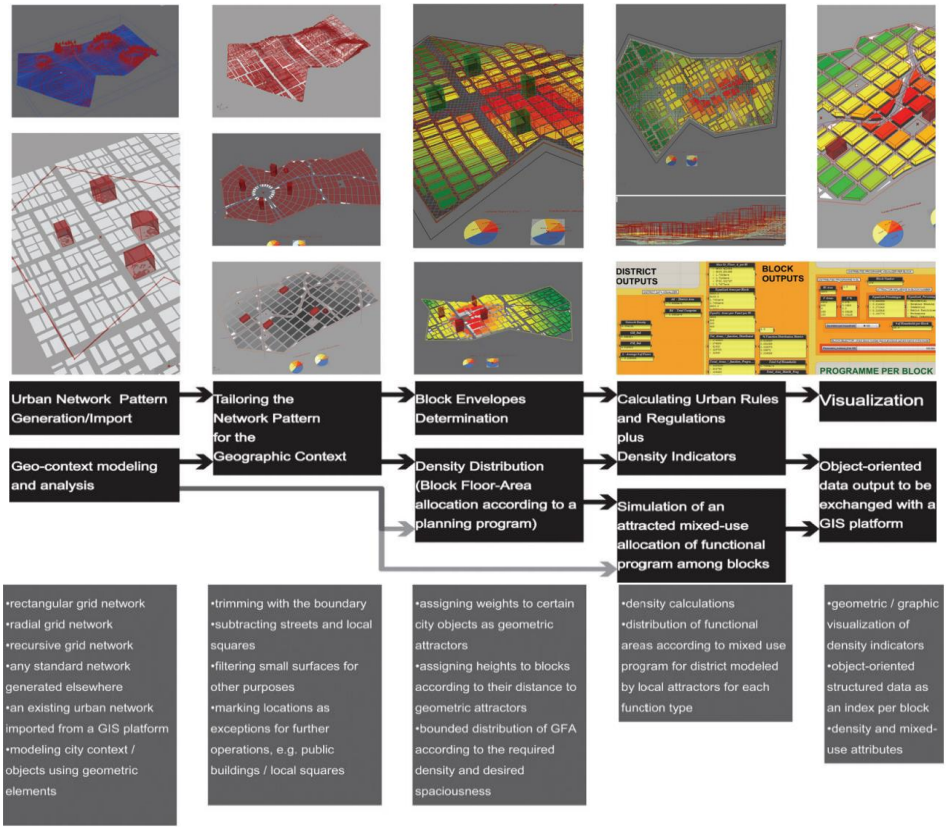
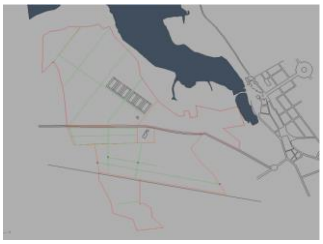


Figure 1: Parametric urban design process

Geometric features cut from the main geometry for having specific predefined conditions. The process can be replicated to create sets of geometry to which different generation rules can apply. The building height is managed by setting the maximum allowed number of floors. The number of floors is defined as a target number which is distributed through the grid as a simulation of land value. To simulate the effect of land value we defined the number of floors in a block as a function of the distance to a set of positive attractors – main square / main streets / the city center – and a set of negative attractors (repulsion effect) – site boundary. This function changes the number of floors depending on the resulting calculations [3]. And finally, the design process will be similar to figure 2-13

2: site limit or boundary



3: The main streets are designed manually by the designer

4: introducing focal points for radial grid option

5: definition of working areas

6 : main grids with main street subtraction.

7: areas to exclude pre-existences park areas and areas not suitable for construction

8: grids obtained from the previous operation

9: Subtraction of additional public spaces

10: location of public buildings or facilities

11: introduction of main squares (circle or polygon)

12: location of landmark buildings on top of axes

13: possible design

Tehran in Nasser al-Din Shah (Qajar period)

The city of Tehran has provided the legacy of earth's history as a capital of Iran more than two centuries. The historic center of Tehran (Nasser's fence) with an area of 2,250 hectares of approved historical texture, located in regions 11 and 12, has reached the official register of the Cultural Heritage Organization as the historical context. Tehran's historic texture, regardless of material values and physical values, is a messenger of spiritual values based on customs, habits and traditions. Therefore, preserving and reviving of this heritage should be an integral part of the plan to preserve and restore the historical heritage and texture of Tehran.

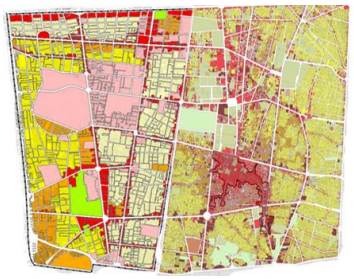


Figure 14: Today's map 11th and 12 regions of Tehran

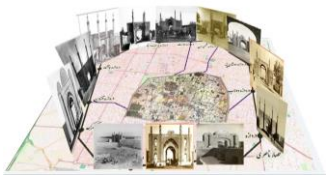


Figure 15: Nasseri Fence The gates of Tehran destroyed

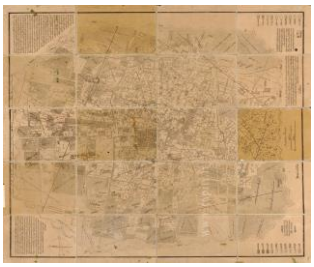


Figure 16: Tehran Map of Qajar Time

The 11th and 12th regions of the Nasseri Fence, which forms the traditional texture of Tehran and recorded in the cultural heritage, relate to the period of Nasser al-Din Shah. During this period, Tehran was expanding rapidly due to population growth. During this period, Nasser

al-Din Shah, considered Western patterns. He imitated the modernization of the Paris in the second half of the 19th century, and was equally used in Tehran [7].
These measures and reforms included: The construction of new neighborhoods in the suburbs and the creation of new streets in the old neighborhoods, making a network of wide and direct passages on the old city's texture, rebuilding of surrounding buildings with observance of the principles of mirroring, Fit the height of the walls of the streets along the street and the construction of a new urban network [8].Also, the streets were paved, the old roads were made by using the style of the neoclassical streets of Europe, new streets were constructed in Tehran. The most important feature of them being wider, As a result, roads become straight. [9]. These wide and direct streets where were places for commuting, business and Circulation. The first streets built European style by Nasser al-Din Shah were "Bob Homayoun", "Maryazkhane", "Naseriyeh", " Laleh Zar", "Cheragh Gaz" and "Baharestan"figure 17-22. Also square was made a central courtyard like many traditional squares of Iran[10]..


Figure 17: Baharestan


Figure 18: Cheragh Gaz


Figure 19: Bob Homayoun


Figure 20: Laleh Zar


Figure 21: Naseriyeh

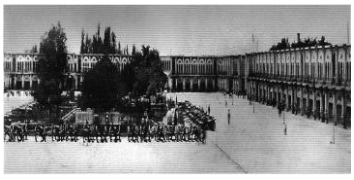


Figure 22: Maryazkhane

Due to changes in the texture of Tehran in the period of Nasser-al-Din Shah, two types of residential construction can be made available to Tehran.
Houses that were located in the Midwest texture and were often on the sidelines of the main roads (broad alleys). These houses were made up of one floor and often two floors with tall and decorated walls and on the top of most entrance doors was small window.
Houses that were located in the western context of Tehran, in most cases were located on the main streets, broad alleys of streets and squares. In this housing style, the non-geometric form of land which were influenced by passage forms became regular and It affected illumination of houses and huge number of windows was opened to the streets. Walls, brickwork and houses were built in two floors, which was adapted from the neoclassical buildings. [7].


Figure 23: Houses of Qajar period

The destruction of Tehran's monuments

Over the past decade, Tehran's houses Instead of being listed on the country's historical monuments and protected by trustees and historic property owners, monuments have been destroyed by traders and disregarding of authorities [11]. Samples of destroyed buildings are in regions 11 and 12:




Figure 24: Delgosha house Figure 25: Qajari Sangolaj Figure 26: Sedaghat house Figure 27:jalalal Aldin




Figure 28: Dayijan Napelon Figure 29: Ameriha Figure 30: Tekye Dolat Figure 31: Parcham

Parameters for designing in this research

The design process in this research includes the following sections:

1. Providing design background
2. Put geometric inputs and information in the program and blend them with specific design patterns
3. Changing the design and manipulate the value assigned to the parameters
4. View program outputs and reset parameters
   Since in this research, recovering urban texture of Tehran is done by patterns obtained from the traditional texture of ancient Tehran (the time of Nasser al-Din Shah). Therefore, it is necessary to study the traditional texture of Tehran to obtain the required parameters.

In this study, the parameters are classified into three categories:

1. Parameters related to Network
2. Parameters related to the elements of the configuration
3. Parameters related to the overall height of the texture and the skyline

Parameters related to Network

One of the key characteristics of recent studies on urban morphology is the use of networks to describe the built environment. In this perspective, the city is not seen as a collection of building blocks that may have geometrical regularities, ultimately architectural styles, but a network of interconnected open spaces created by those blocks – the urban grid [12]. The organic grid pattern should be regarded as an emergent pattern and therefore we did not use it as a designing pattern [3]. Therefore, we can use two key strategies: continuation (and not interruption) of the old grid; and following the organic lines of natural elements and environment. In contrasts are the modern master plans of the city[13].

Parameters related to the elements of the configuration

- Main streets: The width of the paths and their enclosures are the most important parameters associated with the main streets
- Focal points: The intersection of the main and secondary routes determines the position of the public spaces and sign elements and specific uses in the traditional

context. These elements include the entrance of an indoor house. We can also see a specific user in these areas like religious elements and etc. [14].

Parameters related to the overall height of the texture and the skyline

As stated above, the overall height of buildings was high, in order to imitate the neoclassical buildings and was built in one or two floors.

Design area and reason for choosing it

The suggested neighborhood for designing with the aim of recovering the old texture by using the parameters obtained from the Tehran (Nasser al-Din Shah) period is "Helel Ahmar" neighborhood where placed in the southwest of the 11th area(Nasseri fence). The area of the helel ahmar is 80 km2, formerly called Shiro Khorshid Street, which was renamed after the revolution. This neighborhood has been formed by historical monument existed in the past, such as the Qazvin Gate (Photo No.), Shahre No and Gomrok. Unfortunately all of these monuments are destroyed today. this neighborhood because of being in worn texture, is chosen for designing in this project [15].

Figure 32: Design area (left picture is this area in Neser-aldin shah period, was garden, the middle and right pictures are todays (helal ahmar neighborhood)

The following, features of the traditional context of old Tehran In the form of parametric design parameters have been introduced.

Findings from comparative studies of parametric design criteria and old texture of Tehran for designing Helal ahmar neighborhood

- Check the elements related to the range of the site
- Check the type of network
- Check elements of the configuration
- Checking the total height of the texture and the skyline

Check the elements related to the range of the site

- **Investigating the elements determining the general neighborhood**

In old Tehran , The neighborhood area must be clear and the neighborhood had at least one element of identity. Like Helal ahmar neighborhood; identity element: Qazvin gate in Nasser al-Din Shah Period and todays: Razi cultural center

Figure 33: Qazvin gate

Figure 34: Razi cultural center

Check the type of network

- **The general pattern of the communication network**

The general pattern of network in that period was organic; the orientation of the units was affected by the form of passages and streets which came back to previous period of Naseer Alddin shah.

Figure 35 Tehran Map of Nasser alin shah Time

Figure 36 pattern of Paths of Tehran in Qajar Time

- **The position of the main and secondary communication paths and the effect of the main pathways in the overall context of the region**

In that period the main tracks connected the index points to one another, such as the connection of the Tehran old bazar to Qazvin gate in Nasser Aldin shah period

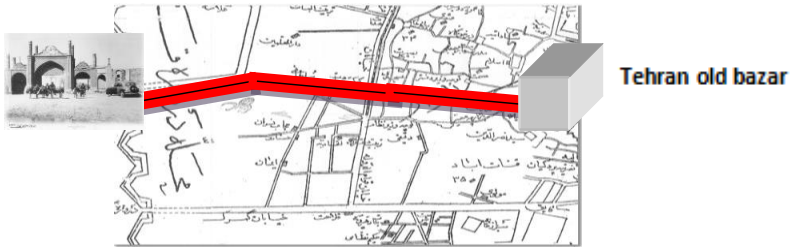


Figure 37: connection of the Tehran old bazar to Qazvin gate

- **Overall network orientation**

Overall network orientation was north- south

Check elements of the configuration

- **Geometry and location of houses**

The geometry of houses that asymmetrical quadrangle with the inner yard, was squeezed together. Houses were located on the main streets of the main streets - the broad alleys of streets and squares.

Figure 38 Compact texture of ancient Tehran

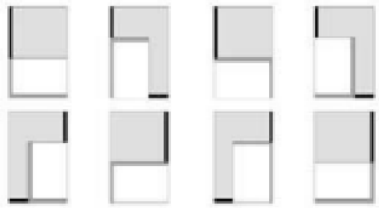


Figure 39 samples of geometry of houses

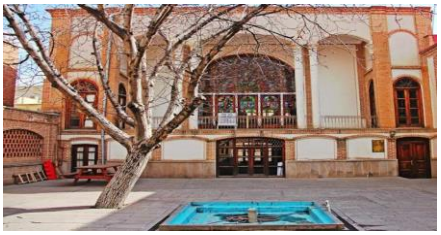


Figure 40 sample of houses with yard belongs Nasser Aldin shah time

- **Use parametric geometry in different parts of building**

Geometry is the basic knowledge of studying, measuring, and searching for the relation between forms, masses and spaces, and one of the most basic infrastructures of Islamic architecture. Material is valuable with helping of geometry and calculus it Creates a sacred space that the presence of God is felt in every corner of it. Geometric indices in Iranian Islamic architecture include semantic and structure. In other words, geometric patterns in Islamic art are used in the elements of the instruments and decorative forms. These patterns are derived from nature[16]. Figure 41 show parametric geometry in Sepahsalar mosque , one of the largest mosque in Tehran from Nasser aldin shah period.

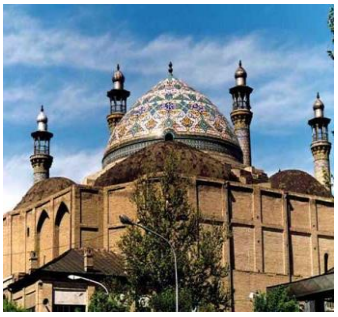


Figure41 Parametric geometry used in the interior and face of Sepahsalar mosque

- **The location of public spaces in local areas**

The intersection of the main and secondary passages was in the form of larger-scale spaces with landscaping and Courtyard (squares). Along the square, the (main core) buildings with higher altitudes and with the distance from the field, the buildings will be lowered.

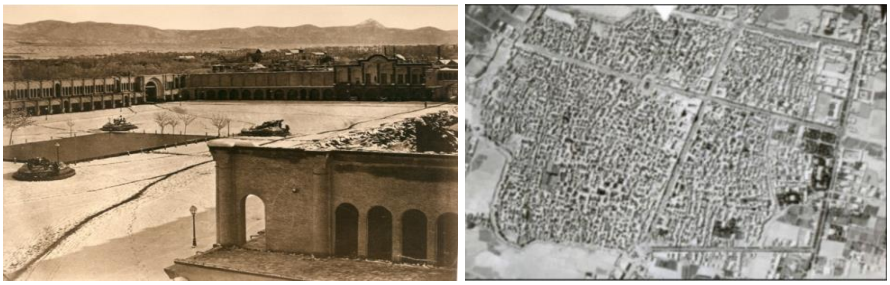


Figure 42: Courtyard (squares)

- **Investigating the effect of signs on public spaces and main routes: neighborhood structure and height of adjacent buildings**

Overall height of buildings was high and number of floors in the whole texture was one or two.

Checking the total height of the texture and the skyline

- **Investigating the density in relation to public spaces**

Significant and important elements were located around the public spaces and were visible in the skyline of the city. Such as Qazvin gate in Naeser al-Din Shah Period and todays: Razi cultural center

Designing Helal Ahmar neighborhood process

- **First step of designing (routes and type of network)**

To start designing, two factors are important: the main routes and type of network. In order to match with texture of Tehran in that period, the main lines must be follow the pattern of paths in Nassir al-Din Shah Period (Figure 36). This step is designed manually. The sub-routes are designed in such a way that the area has a combination of short and long paths and a large number of T-shaped an X shaped intersections and impasse. In the next step, it is possible to add paths or change the location and shape of the paths because with each change, the system will update the output data. In addition, as mentioned the intersection of the main and secondary lines creates cores. These cores can be larger-scale spaces with landscaping and Courtyard (squares).

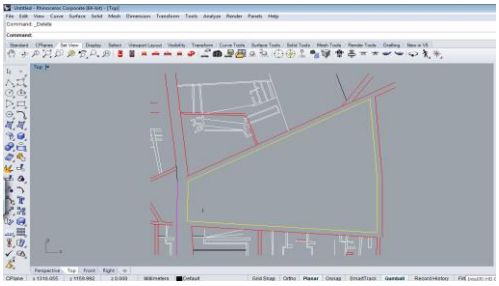


Figure43 :site limit or boundary in Rhino

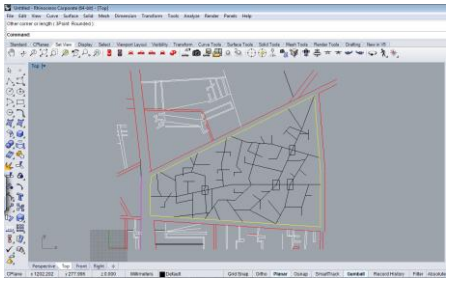


Figure44 : The main streets and cores are designed Manually by following pattern of Paths of Tehran in Qajar Time

After this process, completing the main and secondary routes, impacts and squares, are started by designer. Designer by using grasshopper plugin can add new routes in order to match with contemporary routes of Tehran.

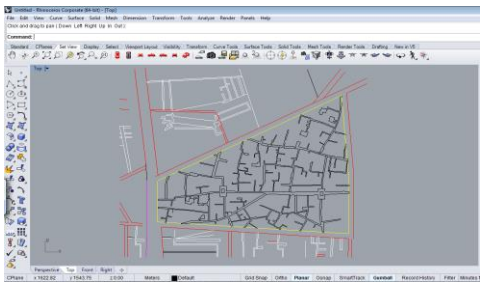


Figure 45 complete the main and secondary routes, impacts And squares

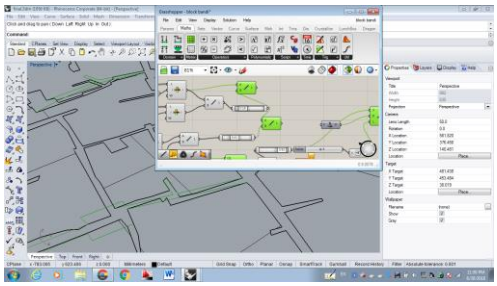


Figure 46 sample of algorithm for adding new routes in order to match with Contemporary routes of Tehran in grasshopper

- **Second step of designing (creating designing area (large block) by grasshopper)**

In this design we have 39 large blocks (39 items) for designing which each of them are divided to small block in terms of geometry of houses in (Nasser Aldin shah period), for designing residential and commercial place and etc.

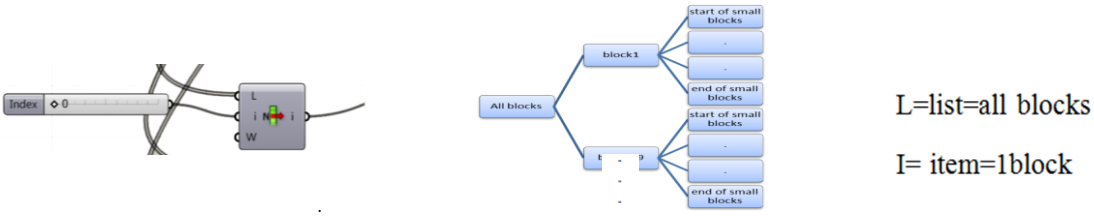


Figure 47 division blocks diagram

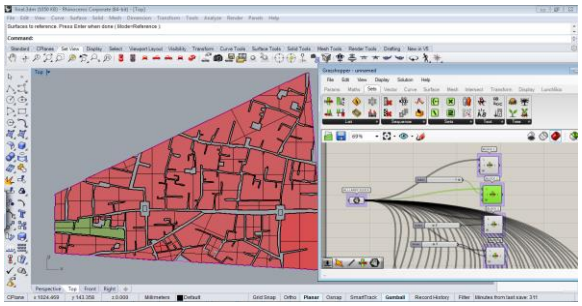


Figure 48 Creating large blocks by grasshopper (39 blocks)

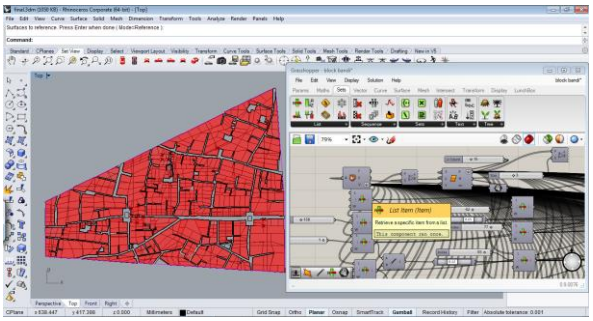


Figure 49 (39 blocks=39 items) each block is divided to small block in terms of the geometry (shape of residential houses in Nasser Aldin shah period

- **Third step of designing**

In this research, a parametric design has been used to generate three-dimensional patterns that can be changed during the process. One of the most important parameters is the height of buildings and density. In the parametric system, the height factor is considered as a

changeable parameter, which varies in the direction of the distances or proximity of the main nodes.
Due to the fluidity of the density in the design system, several types can be considered for the system. In this system, according to population density, the number of core and density changes simultaneously .As the population increases; we need to increase the height and the public spaces and service core in the system. Thus, by changing these two different things, you can create different types of system that can be modified in any of the following ways.

- Number of blocks
- Block sizes according to the surrounding paths
- Width and enclosure of paths
- The shape and size of the core
- Spacious public spaces

In all these species, with increasing distance from the core of the neighborhood, the density decreases with respect to the designated area. For example, for a population density of 90-120 per hectare, one of the proposed species can be single-core. In this project, a main core is considered as the square, which is considered as the old squares of Tehran during the time of Nasser al-Din Shah with the pattern of the central courtyard.

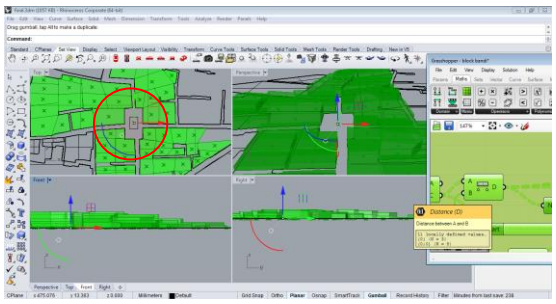


Figure50 single core type, population density of 90-120 per hectare, Determine the range of altitude changes according to the distance from the core: with increasing distance from the core of the neighborhood, the density decreases

- **Forth step of designing**

After the third step and determined altitude of building in terms distance of core the position of the elements of the public and specific spaces and important uses is determined. Because of dividing blocks in small one we can choose each of them for different places. Some of blocks are chosen for residential place some of them for commercial, bank, mosque and landscaping. From the findings of the old urban texture of Tehran during Nasser al-Din Shah's time, it follows that residential blocks are located on the edge of the secondary or main passageways and the broad alleys, and main core as a square is built as a central courtyard. And round the square where placed public and commercial fields such as the bank and etc.

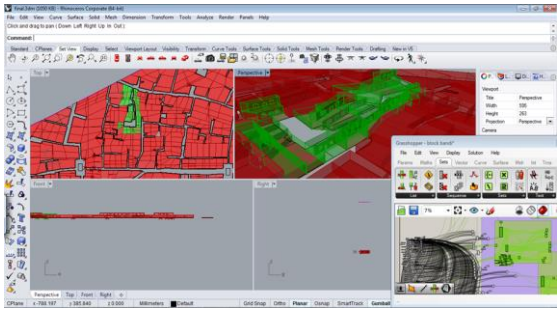


Figure 51: designing Alley, choosing one large block near Paths and some of small blocks (29 items) on it and designing them as houses by algorithms in grasshopper

In this figure(51) we can observe that each block can be designed for different Uses . The size of blocks the number of floors (one or two floor), the altitude of house, the number of windows, doors can be controlled and rehanged in every stage of designing by algorithms which designed by designer.

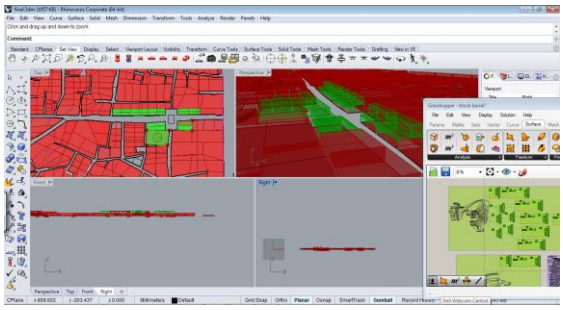


Figure 52: designing commercial fields such as the bank mosque and .., around core, choosing small blocks (items) from large block around core (square)

As I mentioned in that time round the square where placed public and commercial fields such as the bank, mosque and etc.

- **Fifth step of designing (geometric patterns of buildings)**

At this stage of the design, materials and patterns used at the time of Nasser al-Din Shah, is designed. The dominant material on the buildings was brick and the geometric patterns used in the face of typical buildings such as mosques.

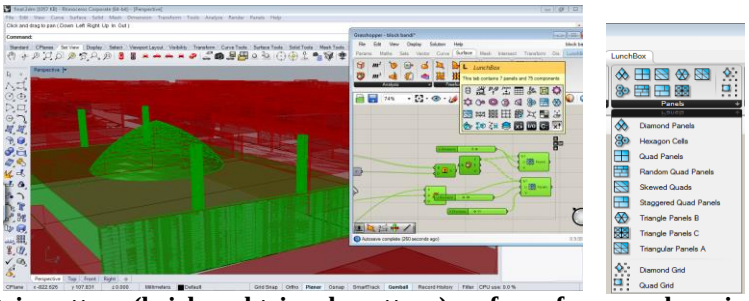


Figure 53 creating geometric pattern (brick and triangle pattern) on face of mosque by using lunch box panel in grasshopper

- **Final step of designing**

After design each block all of them are beaked (convert to mesh object in Rhinoceros).

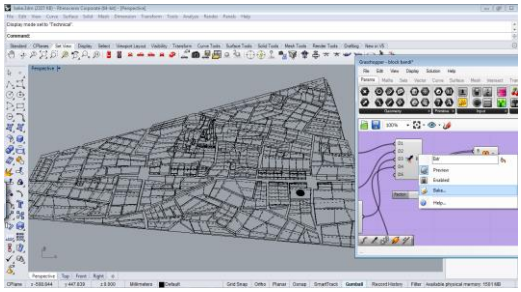


Figure 54 converting blocks designed by grasshopper to mesh in Rhino for rendering

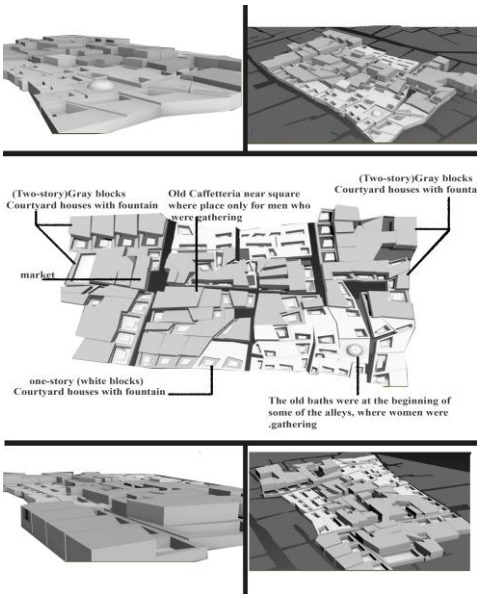


Figure 55: Final design in Rhinoceros and Grasshopper plugin

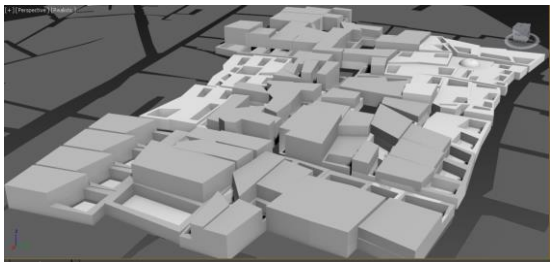


Figure 56 perspective of one part of Helal Ahmar neighborhood

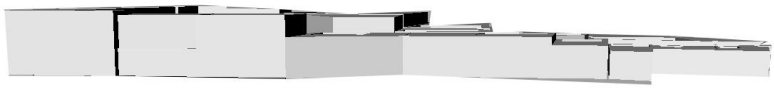


Figure 57 skyline in terms of distance of main core (square)

Using this design system makes the overall image and coordination of the limits of height and density in range. In the final design, a series of factors such as the distance from the core, the encirclement of routes and commercial buildings around the square affect the density. Therefore, it can be said that the mind of the designer in the traditional design method is not capable of creating such an image of the design scope. However, in the above method, a number of factors are affected, and in addition, by increasing the density of the future, the design can be updated. In addition to this, the system's ability to make data changes and update the layout in the following cases creates a flexible design. Change the value of the parameters associated with each of the components of the design such as:

- Change the number and dimensions of blocks in each range
- Redirect the main and the secondary paths
- Change the size and shape of public spaces and specific uses
- Ability to redefine the maximum allowable height in the range of change
- Enclosure of paths and height of adjacent buildings
- Change the location and shape of the particular user
- **The resulting design review from the parametric design process**

The form created in the process is largely In accordance with the geometry of the time frame of Nasser al-Din Shah, because main routes have been created along the paths of that time and as wide as them. Houses are located on one or two floors alongside the main roads. it is possible to create new blocks at each stage. Commercial spaces are located near the main core, such as those of that time and it is possible to control the distance between the core and the surrounding blocks. The factor of the height of the surrounding buildings, the distance to the public spaces, as well as the confinement of the routes, has been effective in determining the height of the buildings, and the effect of each of the above parameters is determined by the designer so According to the elevations of Nasser al-Din Shah's buildings, Along the square, the (main core) buildings with higher altitudes, and with the distance from the field, the buildings will be lowered. The overall height is in line with the texture of that time. The changeability of this process helps the designer to be able to temporarily move the main routes and important buildings as well as the elevation of buildings. Therefore, the advantage of the process used can be the variability of this amount to match the texture of that time.

Conclusions

From studies obtained by using parametric design, is deduced that the parametric design system is very dynamic and interactive. From changing design parameters and with the value assigned to the parameters, create different outputs for the design. Due to the obtaining of parameters from Tehran's traditional texture, the final form is largely in accord with the geometry of the organic texture and the texture of the old Tehran (Nasereddin Shah's time).
Since the factor of the height of the buildings, the factors of distance to the public spaces and the enclosure of the paths were effective in determining the height of the buildings, the altitude change in the sky line was slowly taken. Finally, the capability of this process helps the designer to be able to relocate the position of the main routes and their important altitude elevations. As a result , in the traditional design system it is not possible to consider the impact of several factors simultaneously such that the system has the ability to change the design with regard to altitude changes. Thus, using this method and taking into account the urban elements in the traditional context (such as the distances of the neighborhood node, the texture of the paths and the placement of nodes and specific uses), the new texture will have an coordinate identity with the old Tehran texture and will have the same characteristics of ancient Tehran.

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