A NEW METHOD FOR STRUCTURING THE RURAL SETTLEMENT

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Abstract. As we have known that natural villages were grown up with their own environment and social structure, in terms of form language they are in random process but in the level duality of village structure they have certain regularity. By using the computer technique we designed a simulator program with environmental parameters and used this program to grow up a village. This village could be similar to the natural village and its space form will not only relate to physical environmental factor but also to local people’s method of choosing the land.

1. Introduction

In China natural villages were formed in the agricultural society and still keep their life force in the modern society. In the recent time, one of the important works in the process of the urbanization is the rural settlement planning. There are big amount works to do in the rural area, which are removing the small size village for saving arable land, planning the new rural settlement and restructuring the village. But there is a big problem in rural settlement design, which there are no specific methods for the rural settlement planning; the technique used now could be used in the cities or any new area. However the qualities of the village are the way that grows up from its environment and the social relationship. Normally in planning we could simulate the natural village by lining up the houses, grouping the houses and making the open spaces to structure the settlements look like the natural village. But we could not approve that settlement has the qualities not only in space but also in its own environment and life.

Living in the rural area one could find each land has its own environmental meaning, which could be easily comprehended by the local people. There are many important physic environmental factors such as arable land, river or pond, road, existing houses and orientation, which relationships with the new house
decide the environmental quality of the house. This quality has been seen a prominent factor for choosing building site, which somehow was called “Feng-shui”. Nevertheless, these relations explore the life quality that could be felt by the people there. Geometric space is also a kind of quality and it never becomes the problem in the natural villages. The form of village has enchantments that were built by social activity, which shows the relation between people and environment. The social activity is the aim and the built environment is something following, so that the idea comes to us is how to structure a rural settlement with the both qualities in space and environment.

The cases are chosen in the south of Jiangsu province, China. The village in the south of Jiangsu province displays a pure, fresh and gentle style. Water is the main theme in constituting village, and each building unit stands by the group of buildings with its simplicity and elegance. With a distant view, the white walls, black tiles, stone bridges and piers by water melt into the greens on the water surface, showing unique pictures of the villages and the houses in this area with many rivers and lakes.

The development route of the rural settlements in this area during these 30 years is also that the rural settlements of other areas is facing today when the economy has developed. This is the significance and value of our studying the rural settlements in the south of Jiangsu.

2. Case Study upon Villages of ZJG

Zhang JiaGang (ZJG) is part of this area, which is settled by Yangtze River, the most activity small city. In the process of modernization and urbanization ZJG was developed very quickly, which directly influenced its countryside. The problems that happened there might be the problems of other place later, so I have investigated this area and chosen three villages for case study.

2.1. THE VILLAGE TYPOLOGY

ZJG is situated at the north edge of Yangtze River Delta on the south bank of the Yangtze River in its lower reaches. The topography of ZJG is divided into two parts, the alluvial plain of Yangtze River in the south and the river and sea phase alluvial plain in the north. The south has lakes spread all over and the north has a network of rivers and channels. In term of land resources, almost all the land in ZJG is fertile cultivable field.

According to our survey, there are two possibilities in the formation of other aggregated village and strip villages, one being closing together by several distributed villages and the other starting from one distributed small village gradually into the cluster or strip form.

The villages in the south are built by water and following the land relief and the buildings are in flexible combination. All dwellings in villages are parallel
or vertical to water ponds, almost without exception. Because of climate conditions, the house owner prefer to have their house front facing the south, but when they live by water, the primary factor to be taken into account is the water, then the orientation. The First house built in a village is always by water, and then new houses are added parallel with them, then producing the natural grids and road network. When the ponds around a village are in different orientations, the structure of the village would show a number of parts, each related to different water system.

In the north, the pattern of the water is different as one in the south and there are full of rivers and canals. The farmers first built a solid dyke along the beach to be reclaimed, and built their houses on the dyke. After a long time, a village in line shape was formed. As a result, all villages in the north are in lines along the riverbanks. In the south, the orientation of the house would not change, and the houses would be arranged by river in rows, and the gables would face the river. But in the north, the house would still be arranged in a line along the river, facing the east.

2.2. CONSTITUTION OF VILLAGES

The geometric forms of villages are based on the structure of villages, which have duality, in one hand it related with environmental phenomena and in the other hand it depended in the social ideology.

. Water: In ZJG the houses follow the vein of water is the primary matter to be considered by the villages and the form of water also determines the form of the village. In general, the combination of villages and water is the combination of artificial environment with nature, and the best form is to merge into the nature.

. Orientation: In the concept of geomancy, orientation is a very important factor. In ZJG area, orientation is also an important factor in building houses, only next to “water” and the theory of “sitting in the north and facing the south” is shown everywhere without exception in the farmhouses in ZJG.

. Farm: People prefer to build their houses by the “farm”, not because of convenience in work at recent time, but because that an open side can be kept for the house by the farm, to get good ventilation.

. Road: As transportation instruments the roads have brought about economic gain, so the villagers now prefer to build their houses along the roads.

The environment factors as expounded above are the environment orientation in selecting dwelling places by the villagers, and they only express the relations between the people and environment. In our investigation, a village is the outcome of living together, the result of relations between houses.

. Relationship between the houses: There are many differences in the position between the existing houses and new one, which combination of houses fully
reflect the social relations between people, as well as the influence of the ethical view and concept of geomancy.

Village generation process fully reflected the sense of domain in the course of living together was stronger than the sense of form structure of the village. If we say that the form structure of a village is the unintended consequences of the behavior of villagers to build their houses according to their personal experience in life, then the establishment of sense of domain is an intended behavior of the villagers.

2.3. GRID FEATURE OF VILLAGES

Giving site grids means making natural land certain rules, which is one of conventional methods in architectural design and staring computer work as well. We have found that in the village, all houses in ZJG could be divided into two classes, 3-bay houses and 2-bay houses so that the minimum unit is the bay. In any period, the size and volume of all houses tend to identity. So it is possible to use the basic housing sites as an elementary grid and establishes a coordinate system.

Also villagers treat those natural environmental elements – river and road also as a measure reference. Regardless of the width of the river or road, villagers just consider it as one unit. When a house locates on one side of a river and another house locates on the other side of the river, villagers consider a unit of river between two houses, which means that environmental elements also could be transformed into grids.

If the arrangement pattern could combine the coordinate system, that could describe the distance between the houses and indicate the house position. So a plan of a village could be transformed into a grid system. For example:
3. Computer-aided Forming Village

We have known that possible to use the basic housing sites as an elementary grid and establishes a coordinate system. And the possibility of being chosen for one piece of land is quantifiable. So the method is to calculate the value of every piece of land and chose the most valuable one. With the help of computer, these works could be completed easily and satisfactorily.

Before we start the programming the computer, there are three things have to be down, they are if the site could be formatting, if the all elements mentioned before could be dated and if the mathematical language could be built. Then we could operate.

3.1. SITE FORMATTING

With the coordinate system the site could be defined piece by piece so that village could be transformed topologically to a square mesh, and each grid of the mesh could be given different environmental attribute: river, road, farm, existing houses or void land. When we define the top left corner as the origin (0,0), every coordinate could be described as NODE (X, Y). Then we could assign attribute to the node. At last we could describe whole site of village by computer language. For example:

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Figure 2. Grid model

Figure 2 shows a village that there is a road in the east, a river in the north, some pieces of farms in the south and west, and just two houses in the center. They also could be described as:

NODE (0,0).attrib = water
NODE(4,0).attrib = road
NODE(0,2).attrib = farm
```
3.2. MAKING DATA STRUCTURE

After formatting the site of village, we could define all environmental parameters to make data structure to describe the topography. The possibility of building house for one site could be quantified, which is called as value. Such a value is the weight value of a node when expressed by a computer language. Weight value is an argument, and can be described as: NODE(X,Y).value

The value of one node is decided by environmental elements, these factors are parameters that could influence the value. All parameters could be divided to two classes: E-code and S-code. E-code means natural environmental factors, such as:

NODE(X,Y).water means the influence of water factor to this node.
NODE(X,Y).road means the influence of road factor to this node.
NODE(X,Y).farm means the influence of farm factor to this node.
NODE(X,Y).orient means the influence of orient factor to this node.

S-code means social ideological factors, include the influence of an existing house to its surrounding, such as:

NODE(X,Y).east means the influence of the house to the east node.
NODE(X,Y).south means the influence of the house to the south node.
NODE(X,Y).west means the influence of the house to the west node.
NODE(X,Y).north means the influence of the house to the north node.
Figure 3. Influence of E-code and S-code.

From figure 3, we could easily find the difference between influence of E-code and S-code.

3.3. BUILD MATHEMATICAL FUNCTION

Because the value was influenced by every environmental factor, it is the sequence of summation. So through following function the each value can be calculated if an appropriate data for each parameter is set:

\[
\text{NODE}(X,Y).\text{value} = \text{NODE}(X,Y).\text{water} + \text{NODE}(X,Y).\text{road} \\
+ \text{NODE}(X,Y).\text{farm} + \text{NODE}(X,Y).\text{orient} \\
+ \text{NODE}(X,Y).\text{east} + \text{NODE}(X,Y).\text{south} \\
+ \text{NODE}(X,Y).\text{west} + \text{NODE}(X,Y).\text{north}
\]

The more amount for the NODE(X,Y).value will be the more suitable result for building. An according to the result the computer will automatically sign this piece as built land. Once the void piece was signed as build land the property of the adjacent piece was also changed in the same time, and then the computer returned to new calculation for the next NODE(X,Y).value. Step by step, we could choose all the lands most suitable for the housing, and the whole process is simulating the housing process.

3.4. OPERATING

Program flow chat will start with inputting the size of site (x,y), setting the attribute of mesh, setting the parameters, calculating the value of each grid, comparing all values, and finding the maximum. Then the computer will chose one mesh randomly from grids that have maximum and display the result of choice.

If there are no buildable grid then ends the program and if there are buildable grid then computer will find all grids that are suitable to build house again back to step the fifth.

The meaning for running this program is let computer imitated a man who want to build house in the village, and all the factors which man wanted has to be put in to the computer. The computer does the calculation with the
environmental codes, to build one house it has to calculate whole site and for the next one it has to re-calculate whole again with last one as existing building.

4. Application of the Program

4.1. SIMULATE A VILLAGE

Figure 4 a is the typical site in the north of ZJG, in order to prove our method we have to format the site to Figure 4b, and then the initial E-code and S-code will be given. Normally, the initial codes were not suited to generate proper village and we have to try different data based on our investigation, and finally we could find such code group that could simulate a village (Figure 4c). We could describe the village by this code group, which could be called one of properties of the village:

<table>
<thead>
<tr>
<th>E-code</th>
<th>S-code</th>
</tr>
</thead>
<tbody>
<tr>
<td>water</td>
<td>2</td>
</tr>
<tr>
<td>Road</td>
<td>0</td>
</tr>
<tr>
<td>Farm</td>
<td>1</td>
</tr>
<tr>
<td>Orientation</td>
<td>0</td>
</tr>
</tbody>
</table>

a. Site plan
4.2. DEVELOP A VILLAGE

When some new houses need to be built in an old village, what normally architects do is using the reference lines in 2D or 3D, which come from the exiting houses and will be also used as the edges of the new. But the village does not only mean concrete form and space, and we should comprehend that reference line is not complete. The method that we used is parameter, which comes from the environment, villagers and their relations. With help of the program, the village will generate follow the old structure. (Figure 5)
4.3. BUILD A NEW VILLAGE

In order to build a new village with our method one has to start to format the site first and build site attribute second (Figure 5a,b,c). Then we could simulate a village near by the site and get the code of the village, which could be used for generating the new settlement (Figure 5d,e).
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a. Site plan  
b. Site format  
c. Build site attribute

d. Consequence of computing  
e. Transform to plan
Figure 6. Process of building.

5. Conclusion

Our new method for structuring the rural settlement is using the computer to generate natural village with its environmental factors. In the whole process the environmental elements and their relation with the land for housing are the first and the building itself becomes the second normally it was not.

The process of computing is the process of justifying and re-justifying, in which the quality of land has been shown up. These qualities do not mean the quality of environment, but it means the quality of relations between environment and human being, and relationship between human society. The difference of our method is instead of using physical elements by using codes and data, which could display the relation and quality very precisely.

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References