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The Creation of Complexity in Chinese Garden

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Abstract. Chinese garden was designed to allow its owner to feel the beauty of nature in a congested city. Therefore, one of its main design principles is to make the space feel bigger than its real size, in other words, the creation of complexity. Former studies of traditional Chinese garden were mostly qualitative analysis. This paper applied the space syntax approach to study its spatial design. Two gardens (Guo's Villa in Hangzhou and Lion Grove Garden in Suzhou) with similar sizes were selected as comparative case studies. To analyze the effect of spatial complexity to human's behavior and cognition, movement tracing and questionnaire were used to collect behavioral and cognitive data. To analyze the spatial complexity in two gardens quantitatively, VGA analysis in the Depthmap software was used. By putting the spatial attributes of the gardens and the visitors' activities in them together, the authors find out that: firstly, by different ways of partition and composition, sites with similar size could result to dissimilar feelings; secondly, create a mismatched system of walkability and visibility is an effective way for the creation of complexity.

Introduction

Chinese garden was designed to allow its owner (usually literati) to feel the beauty of nature in a congested city. Therefore, one of its main design principles is to make the space feel bigger than its real size[1]. This kind of spatial logic is quite different from the one in urban space. Therefore, Chinese garden is worthy to study as a special type of spatial structure.

Former studies of traditional Chinese garden were mostly qualitative analysis. This paper aims at helping the designers understand the complex spatial design explicitly by the application of space syntax approach. Space syntax, both as a method and as a theory of space, is now widely used to support architects and urban designers in solving complex spatial design problems by quantitative analysis in computer programs. Cases studies from cities overall the world proved that various measures such as connectivity, step depth, and integration have profound influence on humans behavior and cognition in the complex space system[2].

This study chose two gardens with similar size as comparative case studies. The first is Guo's Villa in Hangzhou and the second is Lion Grove Garden in Suzhou (fig. 1). Guo's Villa was built in 1907 and renovated in 1991. The total area of the garden is 0.97 hectare, 29.3% of it is water. Lion Grove Garden was built in 1342 and renovated in 1917. The total area of this garden is 1.1 hectare. It is constituted by hills, buildings, ponds and bridges. The hill in the south-west side has two levels in terms of through movement.

The total areas of the two gardens are more or less the similar. However, the level of complexity in these two gardens feels quite differently from authors' site survey. Guo's Villa is relatively easy in terms of way-finding. A visitor can quickly understand its spatial structure: ponds in the north and buildings in its south. West Lake in its east part helps people to orient themselves. In contract, it is very easy to get lost in Lion Grove Garden, especially in the hills. We found many visitors lost their patience after disorientation and ended up by climbing barriers to find the right way. Many of them feel this garden like a maze. The trickiest situation is that where you can see through do not means it is where you can walk through. The authors made a conjecture here: it is the mismatched of visual access and walkable access increase the spatial complexity of the garden.

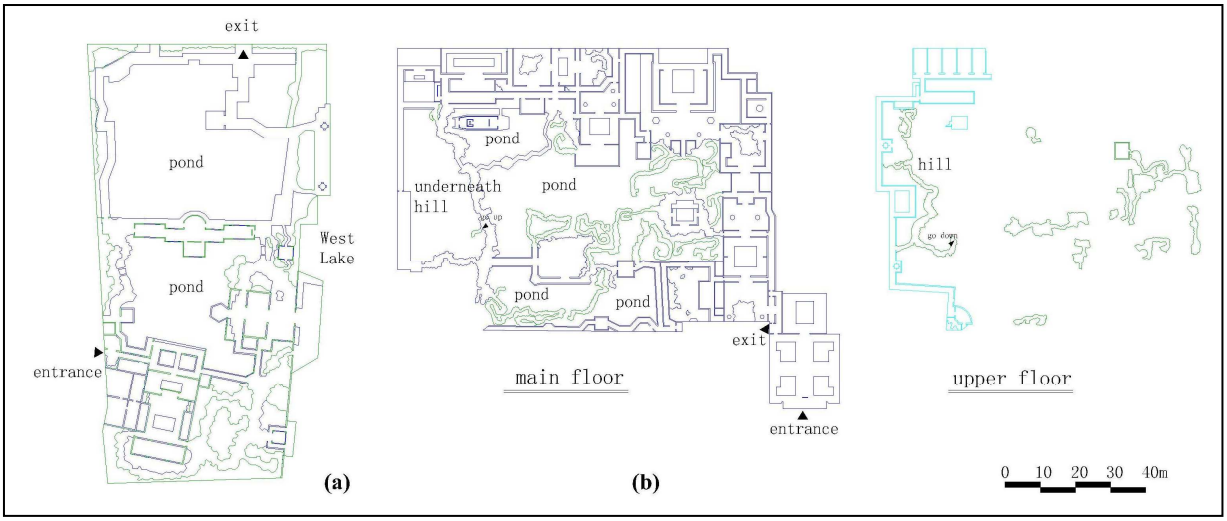

Figure 1: (a) plan of Guo's Villa (b) plan of Lion Grove Garden

Visitors' Cognition and Behavior

To analyze the effect of spatial complexity to humans' behavior and cognition, the authors selected two investigation methods. The first one is questionnaire. In each Garden, fifty questionnaires were collected [3]. As both gardens are famous, in this 100 samples, there were 67 people had visited both of the gardens. Interestingly, 66 people thought Lion Grove Garden is bigger than Guo's Villa. Only one person had the reversed feeling. In the questionnaire, there are four questions related with orientation (table 1). The results of visitors' survey proved that the researcher's intuition is right: the orientation and way-finding in Guo's Villa is much easier than in Lion Grove Garden. For example, when ask the visitor to point out the place where he/she was on the map provided by the interviewer, in Guo's Villa 84% of the visitors successfully completed the task but in Lion Grove Garden only 20% of the visitors can tell where their are.

Table 1 Summary of Orientation Survey

	Question	Guo's Villa		Lion Grove Garden	
		number	%	number	%
1	can find the way easily	48	96	7	14
2	can tell the north direction	36	72	16	32
3	can tell direction of the entrance	43	86	11	22
4	can point out the correct place where he/she was on the map	42	84	10	20

The second investigation method is movement tracing. In each Garden, fifty tracing had been recorded on the map and much other information was written down in the same time. These data allowed the authors to compare "average total length", "average duration", and "average speed" of visitors' behavior pattern in the two gardens (table 2). The result is quick striking. It showed that the average total length of trips in Lion Grove Garden is 1.7 times of Guo's Villa; the average total time is 4.3 times of Guo's Villa. These data give a reasonable explanation for the cognition results we just found. It is because people spent longer time and walk longer distance in Lion Grove Garden that made them think this garden is bigger than Guo's Villa, regardless the fact that two of them have similar mathematic size.

Table 2 Summary of Movement Tracing

	Total Length (m)	Duration (min)	Speed (m / min)
Guo's Villa	290.6	9.9	36.3
Lion Grove Garden	494.0	42.6	11.7

Quantitative Analysis of Spatial Complexity

The next question the researchers asked is why two gardens in similar mathematic size led to different length of visiting trips and durations? We will use the quantitative tool of space syntax to answer the question. VGA analysis in the Depthmap software was applied to examine the two gardens. As the visual access and walkable access always not match, for each garden we set up two models to represent the situation of visibility and walkability.

The first measure we discussed is Mean Step Depth (MSD). It is a simple measure for the whole system, which can tell us how deep the system is: how many steps is it from every single point to reach all the others. From table 3, we found the MSD of Lion Grove Garden is always about two times of Guo's Villa, no matter walkability model or visibility model. This is a concrete evidence for us to judge their spatial complexity level.

Table 3 Mean depth Comparison

Mean Step Depth (MSD)	Guo's Villa	Lion Grove Garden
walkability model	5.84	10.65
visibility model	2.42	4.06

From table 3, we can also found there is a striking contract of the MSD value for a same garden in its two models. The value from walkability model is more than two times of the visibility model which means the visibility model is much shallower than the walkability model, in another words, there is a real situation of "can see through but not walk through". It is actually a result of the design principle of Chinese Garden: make the space feel bigger than its real size.

Here we can propose that the spatial logic of Chinese garden is very different from the one in urban tissue. In cities, where you can see through is always corresponded to when you can walk through. This spatial law is useful for the efficiency of the city, make the urban area intelligible for its inhabitants. In contrast, Chinese Garden was designed to serve one family. As the family members use the space everyday therefore familiar with it, it will not cause functional problem by making a complex spatial system to realize the principle of "make the space feel bigger than its real size". And this principle is very important for the owner to imagine himself living in the wild nature while still sit in the crowded downtown.

The second measure we discussed here is Integration (Rn). Likewise, each garden has two values from walkability and visibility model. The Integration measure can tell us the most accessible place of the whole system and this place is called "integration core" and colored by red (fig. 2/3) .

Figure 2: (a) walkability Rn (b) visibility Rn (c) movement tracing

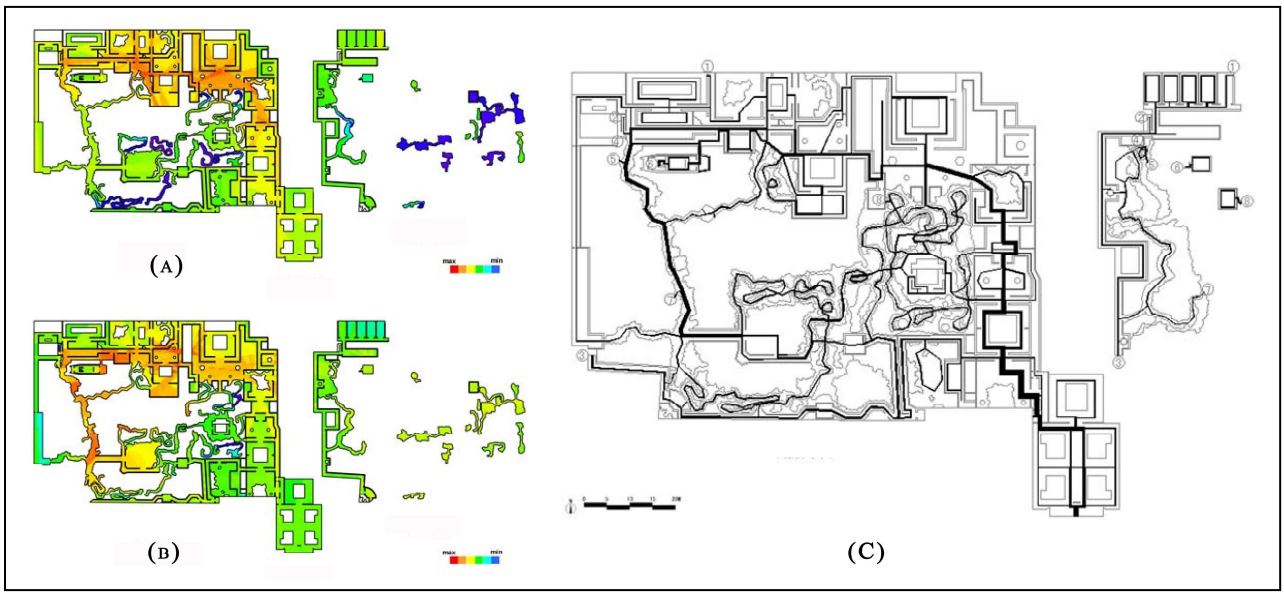

Figure 3: (a) walkability Rn (b) visibility Rn (c) movement tracing

Again, we found the integration cores of the two models for the same garden are in different position. A visual examination of the correlation between the integration core of the gardens and the overlapping of fifty tracings can be done by putting the figures together. And we found the observed tracing hot routes have a certain level of similarity with the integration core. The warmer the color, the possibility of attracting more people passing by also increasing. However, the attraction of entrances is also very strong uncovered by both results.

Conclusions

This study examined two Chinese Gardens with similar mathematic size. By the help of Space syntax tool, we uncovered the two gardens have distinct levels of spatial complexity. It is this spatial difference which led to the striking differentiations in terms of visitors' cognition and behavior. Overall speaking, it is the design strategy of creating an mismatched system of walkability and visibility that create an situation of "can see through but not walk through", and finally realize the design goal of "make the space feel bigger than its real size",

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References

[1] Yi-gang Peng, Analysis of the traditional Chinese garden (in Chinese). China Architectural Industry Press (1986)

[2] Bill Hillier, *Space is the Machine - a configurational theory of architecture*. Cambridge: Cambridge University Press (1996)

[3] Ye Chen, A Comparison Study of Guo's Villa in Hangzhou and Lion Grove Garden in Suzhou (In Chinese), Bachelors Dissertation, Zhejiang University (2007)