Non-Euclidian Methods to Characterize the Masters of the
Nets Garden, Suzhou, China

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Abstract: - Planners and designers are interested methods and procedures to create and replicate environments. One style that has defied quantifiable replication has been the Chinese garden’s organic/naturalistic style configuration, as the plan of the Chinese traditional garden is not defined by Euclidian geometry. Recently scholars have begun to develop and explore methods to define and replicate complicated shapes with fractal analytic methods. We applied the fractal box2counting method to the Masters of the Nets garden in Suzhou, Jiangsu, China by determining the fractal number of the “turning points” along the garden’s pathway system (1.577) and calculating the fractal number of the center points of polygons (1.305) formed by the pathway system. By applying the reverse box-counting method, we were able the replicate the general compositional style of this garden.

Key-Words: landscape architecture, environmental design, landscape metrics, garden history, landscape gardening

1 Introduction

Historians and scholars of landscape designs are often interested in studying the design principles driving the creation of space and built form, especially across cultures. In the West, design can be characterized as a search for individual expressions of ideas where each design attempts to find a unique solution to derive meaning, expression, and content as illustrated by Jellicoe ([1]. However, in the East, at times the task was to create a landscape that was centered around an expected norm and to not deviate to much from this expected form.

Western designers may use a special and unique concept may drive the design as noted in the United States of America plus other examples from gardens in Italy, France, Portugal, and the United Kingdom [2 & 3]. In contemporary China, the Dalian World Peace Park, designed by a French team is an example of this approach, where the design has a unique concept [4]. Today, many Eastern designers accept this approach to make unique statements. But in the past, in places like China, only the nobility and emperor could make such individualist statements such as the Ming Tomb in Nanjing, Jiangsu Province [3]. Nevertheless there was still a certain amount of predictability in the design of Ming tombs in both Nanjing and near Beijing, following precedents for cloud adorned archways, tablets carried by the Dragon’s son describing the merits of the deceased, sacred ways (pairs of stone statues along a walkway), and many more similar features. Meanwhile, the small gardens, such as the gardens around the city of Suzhou in Jiangsu Province seem to closely resemble each other. Many of the gardens do have concepts and ideas, but they are subtly presented as opposed to boldly stated by Western garden design traditions.

To describe the spatial features of Western design, Euclidian geometry is often employed. The designs such as the Italian garden of Villa Lante can be described with bilateral symmetry, rectangular and circular shapes, and discrete measurements [3]. In contrast many traditional Eastern landscape designs defy Euclidian geometry tools of description because they are naturalistic/organic in configuration.

Knowledge about Chinese gardens has been slow in forthcoming. Western scholars have known much more about Japanese gardens for a much
longer period than Chinese gardens. Publications by Valder and by Keswick have assisted in understanding the breadth and depth of Chinese gardens [5 & 6]. In addition, the publication of professors Congzhou’s, (the late professor of architecture at Tongji University in Shanghai, China) essays about Chinese gardens, written in 1978 to 1982, the essays offer tremendous insight into the philosophical and theoretical design considerations of these gardens [7]. In addition Congzhou’s Garden Synthesis book and Tong’s Garden Discussion book offer other viable insights concerning the planning and design of the Chinese garden [8 & 9]. Valder also provides insight into the symbolism and use of vegetation in the Chinese garden [10]. Knowledge about the Chinese garden continues to grow and expand as illustrated by the recent works of Xiaofeng, a professor from Tsinghua, University in China, plus Zongwei, and Xingxi [11 12, & 13]. However, each of these expositions and studies are unable to quantify the physical pattern of the Chinese garden. Consequently, we were interested in attempting to see if we could quantify the spatial pattern of a Chinese garden with a relatively new method barrowed from a French team of investigators to describe more organic shapes.

For the past decade, a French team has been exploring the descriptions of landscapes through the use of fractals [14]). They have been able to measure naturalistic patterns and through the development of the Inverse-Box Counting method replicate naturalistic patterns that Euclidian geometry was unable to characterize. In 2009, Fleurant (et al.) illustrated how to use this approach to replicate a stand of trees for surface mining reclamation [14].

Since Euclidian geometry would not suffice to describe traditional Chinese gardens, we were interested in applying the Inverse-Box Counting method to study the pattern for a garden a Suzhou. Plus in the future we were interested in employing the application of geographical prediction methods to aid in the understanding of the placement and features of the Suzhou garden.

2 Study Area and Methodology

The traditional Chinese gardens have been mysteries for a long time. Each visitor will be surprised that so many pleasant environments can be designed in such a small garden. The unrevealed secrets to the design of such gardens remain hidden, partly because we do not have the right tools to describe them. Possibly, fractal approaches might be suitable to describe the complex organic forms in these gardens. These gardens all have a simple boundary composited of many similar units in some irregular way (Figures 1, 2, 3, 4, 5, 6, and 7). This common character of spatial form is similar to what fractal analysis can qualitatively describe. Is it possible for the traditional Chinese garden can be described with fractal geometry?

Figure 1. A view of the central pond area of the Masters of the Nets garden, Suzhou, Jiangsu, P.R. of China (copyright © 2009 Jon Bryan Burley, all rights reserved, used by permission).

Figure 2. A view looking in the reverse direction of Figure 1 (copyright © 2009 Jon Bryan Burley, all rights reserved, used by permission).

We chose the Masters of the Nets garden (網師園; Wǎngshī Yuán) in Suzhou, Jiangsu Province, in China for our study. It is a relatively small garden and a UNESCO World Heritage site. The garden originated in the Song Dynasty, around 1140 AD and continued to evolve into the 1790s and 1800s during the Qing Dynasty, with restoration in the 1940s. The garden is essentially a metaphor for “going fishing” as experienced in a counter-
clockwise fashion around a pond with plants and landscape features that symbolize the fishing experience. We chose the pathway system in the garden to form the fractal analysis. We chose the pathway system because it was a form-giver to the arrangement of planting areas, water features, landforms, and pavilions. We attempted to describe the pathway system with two types of pathway related variables: the fractal number for turning points along the pathway and the fractal number for the center of polygons formed by the pathway segments. We started with a 110 m by 110m grid.

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3 Results
Figure 8 illustrates the box counting method and its procedure of counting route turning points along the pathway. The box sizes pertinent to calculating the fractal dimension are 27.5m to 3.4375m. For the center points of the polygon generation box sizes starting with 27.5 and ending with 0.859375 (Figure 9). Tables 1 and 2 represent the pairs of values necessary to compute the fractal dimensions with regression analysis. Regression analysis revealed the fractal dimensions of $D_{tp}=1.577$, with a standard error as 0.135 for the pathway turning points and $D_{cp}=1.305$, with a standard error as 0.098 for the center points of the polygons.
Figure 8 The box counting method and its procedure of counting route turning points. Figure 8.1 Illustrates the location of the turning points in the pathways. Figures 8.2 to 8.6 Present the process of reduction in box sizes until all boxes with points contain one and only one point.
Figure 9. The box counting method and its procedure of counting space center points of polygons. Figure 9.2 illustrates the location of the center points. Figures 9.2 to 9.7 present the process of reduction in box sizes until all boxes with points contain one and only one point.

Table 1. Values for regression analysis of path.

<table>
<thead>
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<th>Pair</th>
<th>Grid size (meters)</th>
<th>Filled Boxes</th>
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<td>1</td>
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<td>12</td>
</tr>
<tr>
<td>2</td>
<td>13.75</td>
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<td>6.875</td>
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Table 2. Values of regression analysis of polygons.

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<tr>
<td>6</td>
<td>0.859375</td>
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4 Results and Conclusion

With fractal numbers calculated, we were interested in attempting a replication of the garden. The replication would not be an exact copy but rather a design with the same general character of the original garden. Thus we replicated the garden, employing a method more fully described by Fleurant et al., to establish routing turning points and center points of polygons [14]. With the points plotted, we used some general rules about creating the pathways and polygons:

1. To make the pathway make sure all of the turning points have a connection to some other turning point. In route turning point maps, try connecting all points.
2. In routing the pathways, the center of the garden should contain an enclosure shape that forms the pond.
3. In routing the pathway, connect the pathway around the pond to pathways beyond the pond at the proposed turning point maps.

The result is a general design as illustrated in figure 10. The design fills the space with turning points for pathways and defines the spaces for the polygons.

The results do not mean that all Chinese gardens are represented by these fractal numbers, but rather it is possible to ascertain the fractal pattern of one garden and replicated this pattern. Investigators are invited to determine the factual numbers of other gardens in China and to study the similarities and differences.

Figure 10. A Fractal generated design for the space of the Masters of the Nets Garden.

References


