THE PROCESS OF MAKING 3D-VECTOR SCENOGRAPH OF ANCIENT BUILDING WITH LARGE QUANTITIES OF DATA

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KEY WORDS: Block, Layer, Orthograph, Scenograph.

ABSTRACT

This paper offers an introduction of the making process of 3D-vector scenograph of an ancient building with large quantities of data with the aid of AutoCAD, which display the effect of scenery drawings. The vital skills and technique involved are illustrated through the example of Pagoda of Thousands of Buddha in Chi Lin Nunnery in HongKong. Which was started in the year of 1996 and finished in 1999 with the concrete structure internal and wood external, imitating the style of buildings in Tang Dynasty. Thus, 3D-vector scenograph become available to users.

1 INTRODUCTION

Ancient buildings, as the essence of ancient Chinese culture, characterized by its complex and antique shape, delicate structure, compact combination and graceful sculpture, is welcomed globally. Some ancient buildings made of wood endure long because of its solid structure. For example, the existent Nanchan Temple and Foguang Temple on Wutai Mountain in Shanxi Province of China can be traced back to Tang Dynasty. Nowadays, the building techniques have been constantly renovated due to the integration of both old and new ones. Before the birth of computer, the available drawings and internal structure drawings were all made by hand. The scenery effect of the building perceived by human eyes was demonstrated in the drawings made by building artist. The popularity of the technology of CAD provides sufficient hardware and software environment for the making of 3D scenery effect drawings of shape and internal structure drawings. It is with the aid of computer technology that the delicacy and meticulousness of ancient buildings have been represented accurately and perfectly, and that the abstract technology has been simplified.

2 THE MAKING PROCESS

Collection of original data □ Making of separate parts of the building □ Combination of part structure drawings □ Combination of the whole building □ making of 3D scenograph.

2.1 Collection of original data

There are four methods of collection required by different practical conditions.

2.1.1 On the practically measure. The original data of the example of Pagoda of Thousands of Buddha is obtained by measuring the actual parts of the building.

2.1.2 Making of 3D drawings based on plane figure. Under the condition that no processed actual part has been made, the 2d data can be transformed into 3d data according to the design drawings.

2.1.3 Obtaining 3D data of parts with complex surface by converting the results from PhotoModeler into AutoCAD.

2.1.4 Making of 3D according to designs directly in case of lacking plane figure

2.2 Making of drawings of separate parts of the building

The establishment of 3D models starts from the individual part reasonably in response to the property of ancient buildings that the whole body is occluded compactly through rabbets and mortises of each single part.
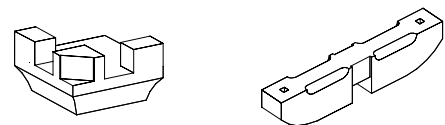

Figure 1

A closed and independent 3D drawings, its shape, direction, size total

consistent with its equivalent actual object reflect each model of the part. Such as Figure 1 is the 3D-drawing of Dou and Gong.

2.3 Combination of one floor

In view of the fact that the wood ancient building is combined through rabbets and mortises of many sub-parts, it is usually divide into Columns, Dougong Layer, Roof frame, Eave Layer and Tile. The simulating process manipulated by AutoCAD must stick to the principle of compact combination. Only in this way can the drawings reflect the exterior appearance and internal structure truly. After the 3D drawings of each part have been made, computers begin the organization layer by layer. Figure 2 shows the organization of part of the Dougong; Figure 3 shows the organization of the whole body of Dougong; Figure 4 shows the organization of the floor 1.
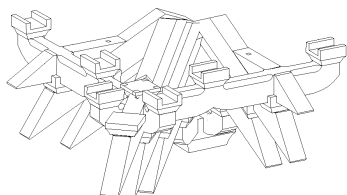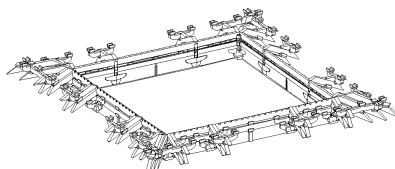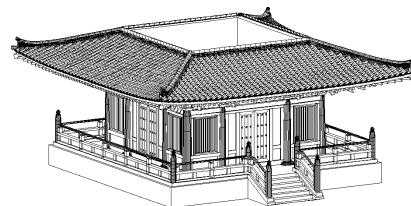

Figure 2   Figure 3   Figure 4

2.4 Combination of the whole

The pagoda is as high as 7 floors. With combination of each floor finished, AutoCAD begins the combination of the model of the whole building

2.5 Creating of 3D vector scenograph

The above stated process from making drawings of parts, combination of parts, combination of floors to combination of the whole is based on 3-Axis reference frame namely Cartesian System. The problem with 3-Axis reference frame is that when the vision point is changed, the 3d model can only be rotated paralleling with the axis (referring to Figure 5,6) Obviously, graph 6 shows that the drawing made from Orthograph is inconsistent with the sights perceived by human eye. Hence, it is hard to access the overall effect of the design of the building. To achieve the similar effect of 3D-scenery sight perceived by human, it is necessary to
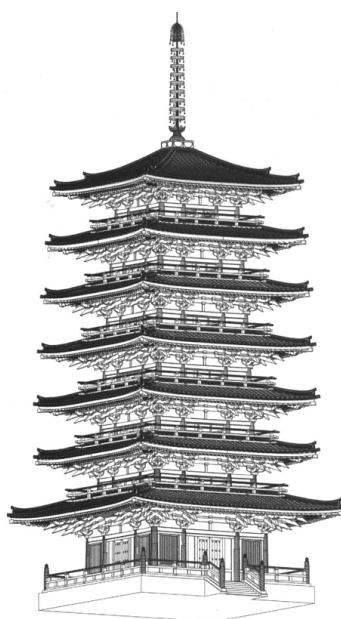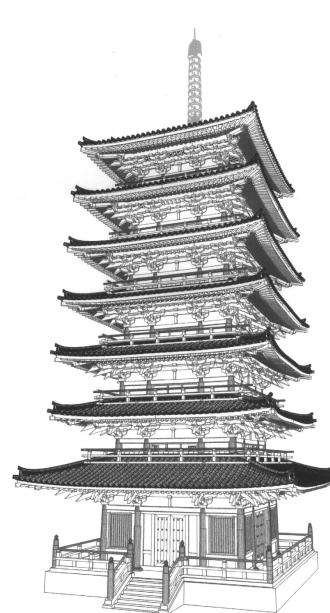

Figure 5   Figure 6   Figure 7

convert from Cartesian System to Central Projection System. This conversion involves several procedures in the process of imitating photographing in AutoCAD as follows:

2.5.1 The choice of zoom

The choice of zoom depends on the practical requirements and it determines the view angle. The short zoom should be chosen when the model has to be observed within short distance through wide view angle. By contrast, the long zoom is preferred when the model is to be observed within farther distance through narrow view angle.   Therefor, the short zoom is preferable to the long one when the graph is intended to display primarily the grander and height of the building, and vice verse.

2.5.2 Choice of camera distance

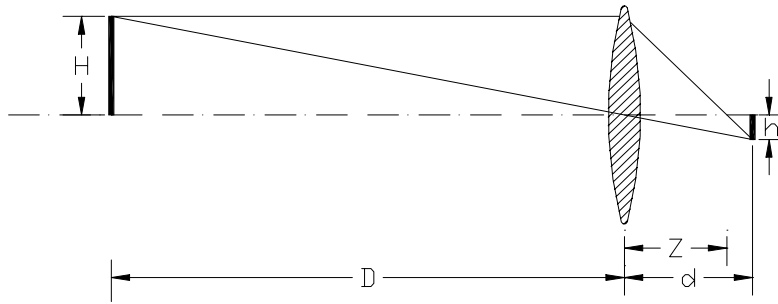Figure 8 shows the theory of scenograph; Camera can be calculated when zoom has been chosen.

Figure 8

$$\left.\begin{array}{l} \dfrac{H}{D} = \dfrac{h}{d} \\[2mm] d = \dfrac{(H+h)}{H} \cdot Z \end{array}\right\} \Rightarrow D = \dfrac{H}{h} \cdot d = \dfrac{(H+h)}{h} \cdot Z$$

Where: □is the height of model, Such as the height of Pagoda of Thousands of   Buddha is 32685mm□
h is the height of photo. In AutoCAD□ h is about 30mm.
Z is the Zoom is select

2.5.3 Choice of view line

In the process of modeling photographing to make perspective drawings in AutoCAD, the proper vision point and the view line is determined by the location of the parts to be observed. The downview is proper for observation of the shape of tile, while the upview is proper for the observation of the structure of Dougong and rafter under the eaves. The outlooking perceived from different angle can be obtained by choosing different horizontal angles. There are two methods of choosing view line, the first of which is to settle down the target and camera. The second method is to fix the angle between view line and the plane, also the angle between view line and the axis X. In practical operation; the second method is often used immediately after the first one because different parts of the model are targeted.

The Scenograph is completed after the above three procedures are finished.

3 SOME VITAL SKILLS AND TECHNIQUES

Due to the large quantities of data, the improper choice of method will slow the process, even prevent it.

3.1 The making of 3D drawing of basic parts

AutoCAD provides two methods of making of completely closed 3D drawings: the surface technique and the solid technique. The latter serves as an accurate reflection of the rapid procedures of processing wood parts: making of a practical unit object (choosing a piece of wood) □ incision, annexation, and subtraction (making rabbets and mortises) □ model of object (wood parts). Compared with the solid technique, the surface technique is less rapid and simple, which follows the procedures as follows: points □ lines □ frame □ surface model. It worth's mention that modifications of the data of wood parts are inevitable for the reason that the size of wood part, such as (rafter) is often determined by its location in the on-the-spot organization. Before necessary modification, the

wood parts are anything than the final products. The technique of solid thus meets the demand of modifications more facilely. Despite the above advantages, the technique of solid is disadvantaged by the large quantities of data produced by the solid model with information about the internal structure. Thus, currently, the technique of solid is only applicable to organization of buildings in a relatively small scale. For example, the total quantity of data of Pagoda of Thousands of Buddhas with approximately 9,980 pieces of individual wood parts and 12,000 pieces of tile produced, by the solid technique is as many as 120Mb,ten times as that produced by the surface technique. It is impossible for the present PC technology to deal with that.

In conclusion, the solid technique is employed only to a small number of parts with large quantities of data in order to meet the demand of modification such as rafter. The other parts are finished with the help of the surface technique.

3.2 The technique of block and layer

The primary techniques employed in organization are the technique of block and layer.

The technique of block requires that each part in the graph of organization be in the form of a whole body, that is, a block. A block refers to not only a single piece of part but also a compounded part, such as the larger parts of the door and the window consisting of smaller sub-parts. Figure 3 shows Dougong Layer of the floor 1, which belongs to a larger block of the whole floor 1 shown in graph 4. The concept of block facilitated the separate operation of move, copy, rotation and mirroring.

The technique of layer manipulates each layer separately by putting different parts into different layers. Some merits lies in the fact that layers set with distinct colors facilitates differentiation so that some layers can be closed or freeze in certain conditions.

The frequent use of the technique of layer is required by the peculiar structure of the pagoda. As is mentioned above, the structure of ancient buildings usually can be divided into the layers of Columns, Dougong Layer, and Roof frame. The Pagoda of Thousands of Buddhas with the steel-concrete structure and frame structure internal can be further divided into internal frame. For each layer, for example, the layer of Dougong can be dividend into Dou, Gong, Fang, Ang and so on. Each layer had its equivalent 3D drawing; thus, it is necessary to process each layer separately to avoid mutual interference. Figure 9 shows the layer structure of The Pagoda
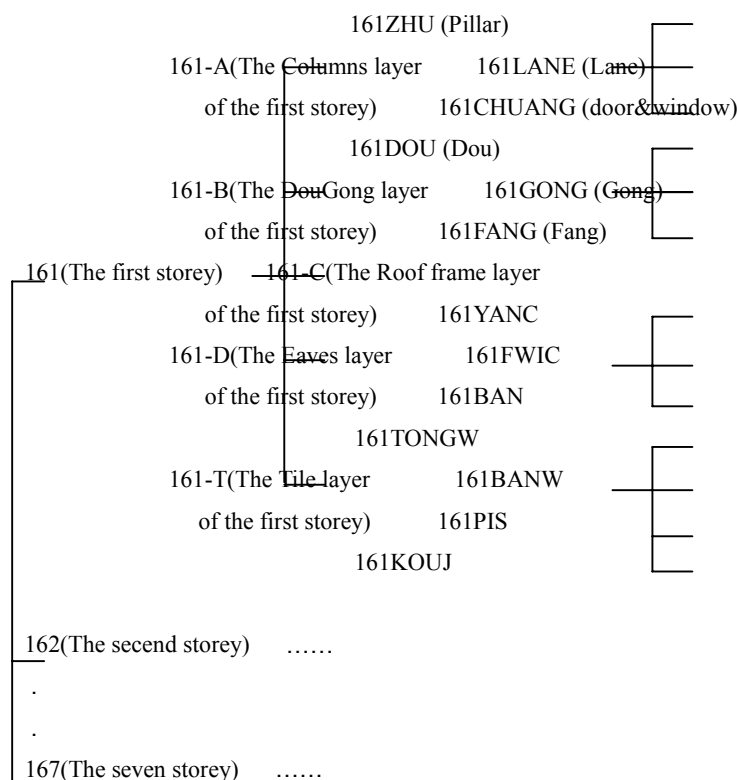
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                              161ZHU (Pillar)              ─
          161-A(The Columns layer       161LANE (Lane)     ──
             of the first storey)    161CHUANG (door&window)
                              161DOU (Dou)                 ─
          161-B(The DouGong layer       161GONG (Gong)     ──
             of the first storey)    161FANG (Fang)        └─
   161(The first storey)    161-C(The Roof frame layer
             of the first storey)    161YANC               ─
          161-D(The Eaves layer        161FWIC             ─┤
             of the first storey)    161BAN                └─
                              161TONGW                     ─┐
          161-T(The Tile layer         161BANW             ─┤
             of the first storey)    161PIS                ─┤
                              161KOUJ                      └─


   162(The secend storey)    ……
     .

     .

   167(The seven storey)     ……
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Figure 9

3.3 Reflection of the whole through parts

The technique of block and that of layer are complementary to each other, both of which play a full role in the making of Scenograph in AutoCAD. Generally, the Scenograph can be completed after choosing the zoom and vision line and then

calculating the distance. However, the inputs parameters designed according to the calculated values are inadequate to produce satisfactory results. The process of producing of satisfactory Scenograph is a process requiring gradual regulations.

The large quantity of data as well as the use of Central Projection System, with much time lost in computer calculating slow the process of dealing with data. Thus, the critical problem lies in how to reflect the whole body through parts. In view of the fact that different parts of the model belongs to different layers, layers indispensable to reflect the outlooking shape and size of the building are often picked out to be processed. All the layers of the model of pagoda are frozen expect the layers of Tacha, ridge, steel-concrete frame, base and railing. The layers will not be unfrozen until the intended effect of the chosen layers has been obtained. In this way, the model is displayed as what is expected. (referring to Figure 10)

3.4 The mutual exchange of paper space and model space

All the operation of above is finished in Floating Model space. After finished the scenograph, it can be fixed in the paper space in a form of paper; both the paper space and the Floating Model space need no more change. Conversion of drawings from paper space to model space can meet the need of modifications of 3D model without any change in scenograph.
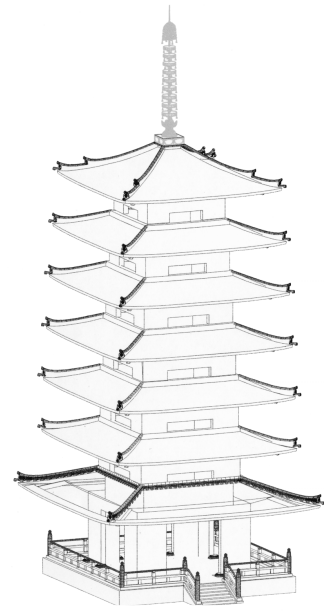
Figure 10

4 ADDENDUM

The list of using command in the process of making 3d-vector scenograph

Open   (Open the file of whole 3D-model drawing)
Layer   (Freeze the layers except Tacha, ridge and steel-concrete frame of each floor, base, and railing)
Tilemode 0   (Transform to Paper space)
Mview 1   (Creating one Paper space)
Mspace   (Using Floating Model space)
Dview   (Using Dynamic View)
  \Distance   33000 The camera distance is 33000mm
  \Zoom   30   The zoom is 30mm
  \Point   Input the target point (0,0,10000) and camera point (-10000, -30000,6000)
  \Camera   Input angel from XY plan −8 and angel from X Axis −115
  \Exit
Layer   (Unfreeze all the layers)
Pspace   (Change to Paper space)
Mview
  \On   (Select Hide print)

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