Digital Method of Green Building Design in Higher Education

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Abstract. Digital technology in green building design not only offers convenient representation method, but also provides participates in the design of all parties with a platform of communication, thus it should be widely spread in higher education. Based on urban design specific examples of a City Hall in Tong City China, we analyzed and showed whole process of digital technology application. Through digital technology, architects can not only enhance the design efficiency, but also assess the rationality of the spatial structure in the urban design. Results beyond what the traditional design method could ever achieve have been gained through this digital process.

Introduction

The so-called “digitization” is the conversion of all information into digital signals, stored and processed in a computer, which can be viewed in the form of images [1]. Digitization has subverted the traditional design methods of performance. Meanwhile, it has also significantly changed the human thought process and lifestyle. This has had a broad and profound impact on architectural development.

The Digitization’s Impact on Urban Planning and Design

The concept of digitization contains many aspects. First of all, it has completely changed our way of expression. Utilizing computer and information technology allows for the ability to express the invisible things in a visible way. It transforms the material carrier directly into the information carrier and can not only improve the efficiency of information exchange, but also reduce the consumption of material resources. Secondly, the deeper influence of the digitization is at the cultural level. Digitization changes people’s lifestyle, therefore it also affects the construction industry [2]. The Computer Aided Design (CAD) [3] is known as the Computer Aided Architectural Design Technology (CAAD) when applied to architectural design [4]. CAAD takes advantage of fast speed, large capacity, high precision and strong function of computers to help architects to deal with a large number of images, numerical and text information. This greatly improves the quality of architectural design, reduces the design cost, and shortens the design time [5]. The significance of digital technology is that it not only changes the traditional method of architectural design with its high efficiency but also alters the thought process of architectural design. The design development consisting of sketches and entities is reduced to being achieved through simple planes, facades and renderings [6]. Trying to combine space abstracts with spatial entities, research turns into wandering in the virtual space of a computer. It achieves the expression from which value design is converted to love of design. The most distinguished feature of digital technology is that there is no parameterized technology fully applied in the current planning and architectural design for the reason that parameterization is the core of digital technology and important means during the design [7]. During the planning and urban design process of Government Affairs Center region in a city, the author made full use of digital technology to finish a lot of design work, and conduct a multi-level analysis to the projects. The final achievement, which was displayed with a three-dimensional animation, was well received.
The Specific Process of Digital Design in Urban Planning

The basic intention of digitization for architectural design is using the digital method to complete the design more accurately. Now it is widely used in many areas including planning design and architectural design. Although the application is not exactly the same, process and methods are very similar.

The Change from Two Dimensions to Three Dimensions

The current digital application in planning design is limited to two dimensions, namely using the various kinds of CAD software to express the planning content. There is no specific image to show the performance of the overall effect of planning so this medium is not conducive to convey the thoughts and intentions [8]. Therefore, the visualized and dynamic expression of the planning achievement is very important [9]. The current three-dimensional modeling technique mainly relies on manual modeling [10]. For example, the commonly used modeling software, 3D Max, which establishes the model of the structure, needs a lot of manpower. Although this model technology application could get a 3D effect, it is a large workload and is hard to modify because it’s based on an artificial model [11]. During the process of urban planning and design, the plan needs to not only express the land utilization and function, but also to anticipate the effects after the completion of the establishment. During the design process, continuous fitting together, improvement and optimization is needed, which leads to much repeated work. Similar with the traditional method, the workload will be immense.

Figure 1(a) is the general layout of the Government Affairs Center Region. Figure 1(b) is the three-dimensional models established according to digital technology. When determining the planning index, the first thing noted from the map is the location of the various buildings based on the same coordinate system. Using the coordinate, the program will automatically generate the basic model of the building after its base setting, contour features, contour lines and height coordinates are entered. The defined table of each building is shown in the following Table 1.

*Figure 1. The plan and 3D model of City Hall.*

*Table 1. Location of building and coordinate of anchor point.*

<table>
<thead>
<tr>
<th>Building No.</th>
<th>Anchor point coordinate</th>
<th>Contour line number</th>
<th>Contour feature and coordinate</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(24, 26)</td>
<td>12</td>
<td>Line1, Line2, ……, Line12</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>(323, 209)</td>
<td>14</td>
<td>Arc1, Line1, Line2, ……, Line13</td>
<td>45</td>
</tr>
<tr>
<td>……</td>
<td>……</td>
<td>……</td>
<td>……</td>
<td>……</td>
</tr>
</tbody>
</table>
As shown in Figure 2, after finishing the general layout, we locate and define various buildings according to the above table. Then we will quantify and standardize the planning intention, and then express it with tables. This table is not artificial but automatically generated in accordance with the plan drew by CAD. Finally, the final height value will be input as an additional measure.

As a result of completing two-dimensional graphics, it will be very convenient to generate the three-dimensional models after. Then we are able to see the overall architectural form and effect, and conduct the analysis of visual angle, building dimension and sunshine [12]. During the process of modifications and adjustments, we can directly amend the plan contour, numbers in the table, and height value so that we are able to quickly get a new three-dimensional model. The three-dimensional model produced from this process does not represent the architectural design because the design ideas and concepts in the architectural design cannot be expressed here. This method is needed when analyzing large-area urban planning and design. Especially in the analysis process of the initial conceptual design, these models will play an important role in displaying the visual effects and providing an initial platform. We can conduct specific architectural and landscape design according to the models, after determining the specifics, to allow effectiveness and efficiency to be significantly improved. After the establishment and improvement of the three-dimensional models, we can then visualize the external structure and the surrounding environment structure of local buildings in the partial or overall visual views. Figure 3 (a) is the partial effect design based on the three-dimensional models [13].

**The Transformation from Digitization to Parameterization**

The basic intention of digitization is to express the tangible or intangible contents in a digital way with digital recording. However, only digitization is not enough in the process of application, we also have to conduct parameterized design which goes further into digitization as well. Parameterization is used by assigning the value according to the need. At present, digitization is widely applied in various designs, but the parameterized design still not exists. Only parameterization can truly reflect the design process, therefore parameterization is conducted on the basis of digitization to intensify and expand the desired result. During the design process of this project, all variables are defined by the parameterization. Therefore, it only needs to modify the related parameters when the project is changed or improved. The contents in Table 1 are all defined as parameters, which will be very convenient to modify.

**The Whole Effect Quickly Generated**

After defining digitization and parameterization, we can quickly get the whole effect of the planning and buildings. After being continuously analyzed, discussed and amended, the needed overall design contents are also gained. Then we are able to see the desired effect after we are immediately able to change the two-dimensional half stretching models. Figure 3(b) shows the quickly generated elevation effect drew along the street through using this method.
Using Digital Technology to Test the Rationality of the Project

CAAD not only can transform the project into visual images quickly, but it can also test its rationality [14]. In contrast, the traditional method of urban planning can only assess the rationality of the functions and the aesthetics of the space configuration. However, demand for ecological and low-carbon requirements in the city is growing stronger with the deterioration of urban ecological environment and the seriousness of urban pollution in recent years [15]. How to evaluate a city whether it is ecological, low-carbon and livable or not? Now we can do analysis through CAAD. The deterioration of urban air quality, intensity of urban pollution, and the increasing energy consumption of air-conditioners are mainly related to the urban wind and thermal environment. The development of a city will lead to change of the city’s underlying surface nature, the atmospheric pollution, and the discharge of waste heat generated by energy usage, which will make the temperature of the city higher than the surrounding areas. This is the urban heat island [16].

Urban heat island [17] provides a potential threat to the daily life of urban residents. As urban heat island is characterized by increased temperature, it can potentially increase the magnitude and duration of heat waves in cities. Another consequence of urban heat island is the increased energy requirement for air conditioning and refrigeration in cities with relatively hot climates.

Although there are various reasons for the urban heat island and the deterioration of urban ecological environment, the rational planning of the urban space and well-organized wind and thermal environment would aim to provide solutions to these urban problems [18]. CAAD can conduct all-around, multi-angle simulation to the wind environment and thermal environment after the city has been built. We can use Air-pak simulation, belonging to CCAD, to model the urban natural ventilation. Moreover, we can optimize the elements of urban ventilation channels, such as main urban streets, open space, ecological green areas, water systems, considering building height and dimension, through the simulation of Air-pak. As a result, we can allow the natural and clean wind to blow through the city, removing air-pollution and heat [19]. Figure 4 is the simulation of the wind speed, temperature, and specific wind streamline at different heights of the city.

The Ecotect software belonging to CAAD can accurately simulate the noise pollution and thermal radiation intensity in the city. The simulation results of Ecotect shows us where we must conduct the noise reduction, the site selection of small activity areas, and the urban landscape planting. For example, we set sun-shading facilities or plant evergreen trees in places which have strong average annual solar radiation intensity. Places where the average annual solar radiation intensity is average,
in order to ensure the shade of summer and winter heating, we should plant deciduous trees [20]. When the annual average sunshine radiation is weak, it’s more appropriate to plant some sciophilous plants. Figure 5 are the simulation analysis of the whole year’s solar radiation intensity in this project.

Figure 5. Solar radiation sun path diagram.

Conclusions

Modern CAD technology has already been widely used in urban and architectural design. However, most of the applications are limited to be alternative tools of the previous drawing board because there has not been a lot of research done about the benefits. In fact, use of digital technology is not only a tool but also a method which can change the design process and thinking patterns. Using digital technology, we can provide impactful new methods for planning and architectural design. Combining with the practical project, this paper not only uses the digital technology but attempts to show aspects of parameterization. Whether planning or creating architectural design, as well as the broader urban design, the most important aspect is the thought, the concept and the wisdom of the designer. As computer technology has increasingly developed, the new digital expression method will certainly change the process of our design and thinking.

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References


