

A Preliminary Study of Computerized Design Process and Methods

A computer modeling approach

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The evolution of design media has kept a close relationship with the development of design methods in the history. Nowadays, different computer media have been used in different stages of the design process. It is to believe that computer media have great impact on the design process and methods. The objective of this paper is to realize the design process and methods when designers use computer modeling to tackle an architectural design problem. The methodologies are non-participant observation and retrospection. The findings of this research prove that media does contribute to the changes in design process and methods. Not only does its conclusion help to better understand properties of different media, but also benefit the development of computer media.

Keywords: design process and methods; computer media; computer modeling; design cognition.

Introduction

The evolution of design media has kept a close relationship with the development of design methods in the history (Liu, 1996). Herbert (1994) has indicated that design media has not only affected design development, sense of space and design communication directly, but also hinted out the possible progress direction. In addition, change of design media affects the design process and methods as well as the construction, design development and design communication of the architecture (Bermudez and King, 1998).

Although design is regarded as an ill-defined problem (Simon, 1973), we can still scrutinize the structure of design process by examining design activities. For example, many researchers have posed that the design process consists of several stages: programming, concept generation, design development, detail design, construction and post-

occupancy evaluation (Cross, 1994; Goel, 1995; Liu, 1996). Besides, designers are expected not only to develop concepts, but also to consider some important factors of architecture design during the entire design process. These factors include site organization, circulation, function, general form, structure and material, even economy etc (Rahman, 1992; Miller, 1995). Most of these methodological studies focus on the design process while using conventional media (pen, sketch, physical model, etc.). In addition to present various design methods as analytical frameworks in assisting design problem-solving (Pena, 1987; Goel, 1995), these researches also explore designers' cognition behaviors such as visual thinking, etc. while designing (Goldschmidt, 1991, 1994, 1994; Schon and Wiggins, 1992).

Nowadays, however, different computer media have been used in different stages of the design

process, such as computerized drafting, computer modeling, animations and virtual reality (VR), etc. Therefore, it is to believe that computer media have great impact on the design process and methods (Liu, 2001; Hanna and Barber, 2001). For instance, Bai and Liu (1998) propose an evaluation method to examine the visual impacts of computer media in the design process. They also point out that computer modeling can assist concept realization and design developments. In addition, Huang et al. (2001) compare the capabilities of animations and VR in representation and communication. Furthermore, computer graphics has been regarded as a useful media to generate and manipulate complex form (Osman, 2001).

Case Study and Research Problem

Case Study

In summary, these mentioned studies attempt to investigate the roles and functions of computer media during the computerized design process. In terms of the design process and methods, the conventional media has a well-established structure. Thus, since computer media have been widely used as design tools by designers, an overall structure, which is to realize how computer media impacts the design process and methods, is needed urgently. However, it is not easy to investigate this topic completely in one paper. This paper focuses on the concept generation stage and the design development stage. These two stages are the early stage of the design process. Most recent research has shown an emphasis on importance of use of conventional sketch and drawing in the design process and visual thinking (McKim, 1980; Goldschmidt, 1991; Schon and Wiggins, 1992). However, while computer became established as a new design tool in the 1990's, it arise widely discussions. The most important issue among them is the potential and limitation of the computer media as a design tool in assisting concept generation (Verstijnen et al, 1998; Kavakli et al, 1998). For example, Won (1999) com-

pared the traditional design media and computer media in industrial design. The result indicates that computer media can not only assist in concept generation but also differentiate the visual thinking. Wong (2000) further analyze the phenomena of lateral transformation of concept development while designers using computer as a media.

In practice, many architects have employed computer media in the early design stage. For example, Greg Lynn explored the design limitation by applying design concepts to the computer in order to search for unexpected discoveries (Liu, 2002). Besides, Frank Gehry also tried to reify the imagining concept to express freedom and curve fitting of the architecture through simultaneous transformation between physical model and computer modeling (Liu and Eisenman et al, 2001). The architect, Peter Eisenman, sets another famous example. His design method emphasized both the design process and actualization of his argumentation. However, when he began to make use of computer media as design tools, the design methods he used in the process was immediately changed. Such a transformation not only increased the complexity of design but influenced his design process (Liu and Eisenman et al, 2001).

In order to gain a clearer understanding of the influences of computer media on the process of design, the author further compares two of Eisenman's works, the Universtiy Art Museum of California State University, Long Beach (1986) and Hsinchu Museum of Digital Art, Taiwan (2000). The choice here is made not merely because of their similarity in attribute, but also because of their resemblance in spatial functions and demands; moreover, these two projects both initiate from historical context and approaches with "superposition" methods. However, in the first case traditional media such as sketches and physical models are adopted, and in the second computer media is adopted extensively. The purpose of comparison is to achieve preliminary comprehension about the

manner different media are used and the transformation of design process and methods that the change of media has influence on.

In terms of the concept generation process, there are four phases to the design process of the University Art Museum of the California State University, the first is to collect historical information of the site, and to find a set of relative scale relation through diagram while the layering maps of different time that becomes a basic principal to transformation. Furthermore, in the second phase, the designer starts to focus on the layout of buildings, utilizing the Jefferson Grid as precise framework which proceeds site dig into the development framework of form and volume. This is the phase where the physical models are introduced. At the beginning of phase three, the designer uses sketches on paper in attempt to systematize the procedures. The objective of this phase not only aims to obtain accurate layout of buildings, but also implies the future form will be generated. In the last phase the diagrams are simplified into basic interior functional plan, which studies circulation and mass form through section and physical models, and specific areas such as the entrance or hallways through perspective drawings.

In the case of the design process of the Museum of Digital Art, although there are no obvious phases to its procedure, the transformations of its operation and content are subjectively used by the author as parting points in order to follow up further comparison, in which four phases are determined. The first initiate with collecting historic information using computer diagrams, after establishing four sets of urban axis, it is adopted as guide lines to transform the grid by using the computer media. Various deformational tendencies of grids are generated through different relationships between axes, which further layers up into a new graphic system of interlacing grids. Mirror reflection method is adopted in the second phase, using one set of axes to overlap grids from three eras. Then from the

basis of these two grids generated from phase one and two, the design tactic of analysis on spatial function is directed into phase three, while also focusing on the site for the layout and organization of function which possesses the relationship of the man made and natural landscape included in each other, and the problem of linking the circulation systems. Finally, when architectural functions have been quantified, research concentrates on the plan of function and partition. Physical models are used to study how form gradually overlaps on architectural space after landscape and circulation is dent into topographical grids.

The author conducted an analysis by comparing media, operating methods and formation of volumes after a general understanding of the product operating process of both. First, in the former case, he employs conventional 2D diagrams to construct site plan and makes use of physical model to inspect the circulation and form of the building. On the other hand, in the latter one, he used computer media to construct diagram of site plan. Such an effort not only contributes to organization of geographical information but also supplies the foundation for future building volumes and space utilization. In the latter period of concept development, the physical model also serves as a tool to inspect function and building composition. As a result, physical models seem to play an important role in assisting design thinking, especially in the design process of conventional media. The adoption of physical models in the early stage of design process concludes that it is a major media in leading 3D thinking.

Problem Statement

After comparing two Eisenman's projects, it can be found that when he use different media in concept design, the process and methods he used to approach design task are changed. Besides, physical models are found useful in assisting concept design, especially in conventional design process. However, these findings are not sufficient for us to

understand the interaction between designers's thinking and the media they use. Accordingly, the major problem of this paper is that when designers use computer modeling in generating concept and developing design, what differences can be identified from the design process and methods by contrast to conventional media (sketch and physical model)? The objective of this paper is to realize the design process and methods when designers use computer media to tackle an architectural design problem. With respect to media, I chose computer modeling because designers have increasingly used them in these two design stages recently.

Methodology and Steps

The author adopts non-participant observation as a basic method and makes use of retrospection protocols as a means of collecting verbal data. In this study, a competent architectural designer with abilities for applying computer modeling and conventional media was observed while preceding the final project for his master's degree. The methodology therefore is divided into two stages. First of all, the author videotaped the design process when the subject approaching the design task A: an exhibition center, with conventional media (sketch and physical). Every time when the design process was break off, the subject is asked to retrospect what he was done before and record these statements as verbal data. Then, after 2 weeks, the subject approached the design task B: auditorim, with computer modeling. In this stage, the author used the same methods with the first stage to collect visual and verbal data of the process in design B.

Analysis and Results

The author uses three kinds of coding schemes (Table 1) to analyze the reporting verbal data. The first scheme comes from the background review, which includes 5 types of architecture design factors – C, SR, FU, CIR and SM. The second scheme modifies form Suwa(1997), which includes two types of segment – NS and CS. The other is the

deduction about “total” and “partial” of operation from the author. “C-SR-FU-CIR-SM” represents “concept – spatial relation- function – circulation-structure/ material”, “NS-CS” represents “new segment- continuing segment” while “T-P” represents “total- partial”.

In the process of design A, the subject took 8.5 hours in 8 days to complete the concept design. The retrospection report of this design took 72 minutes to accomplish. . On the other hand, In the process of design B, the subject took 14 hours in 10 days to complete the concept design. The retrospection report of this design took 72 minutes to accomplish.

Table 1. Three coding scheme

Coding scheme	Clarification	Source
C-SR-FU-CIR-SM	C: concept	Rahman, 1992;
	SR: spatial relation	Sam Miller, 1995
	FU: function	
	CIR: circulation	
	SM: structure/ function	
NS - CS	NS: new segment	Suwa, 1997
	CS: continuing segment	
T-P	T: total	The author's deduction
	P: partial	

In the process of design A, the subject first compared the site photos with the physical model to gain an understanding of the site. Later, the subject inspected the physical model back and forth and then sketched the site in the drawing. After comparing the present site with the historical axis, the deviation is the major source of the object. At this moment, he already have rough idea of the possible outcome in the beginning of the design process. Then, he use “wall” as elements by comparing with the existing axis to construct the physical model. The model is corrected constantly by reviewing and installing total or partial circulation and function.

In the process of design B:auditorim, the subject began with studying the relation of speed and renewal frequency as abstract concepts. The pru-

pose of this study is to explore human visual boundaries through space relation by using polarisers. Therefore, the early stage of this design is to build a space through variation relation on the surface. Meanwhile, in the process of beginning with spacial relation, form and volume of the building is partially and passively determined. The next step was to edit with the exisintng volume and to review the appearance and circulation of different block through functaionl installment

As a result, the same design block usually contains a lot of transformation of different issues when conventional media is in use. On the other hand, computer media demonstrate a deeper exploration of the same block. However, they don't arouse transformation as frequently as conventional media. Therefore, conventional media is seemed have more advantages than computer media in the aspect of triggering design.

From the second coding scheme, we discover that every new segment clusters in the different issues during the conventional media design process. Not only are concepts but also special relation, circulation and function are taken into consideration. As compared to the former, computer media design process puts more emphasis on concept. It begins with an active idea or evaluation of design form or concept. This signals that designer has an active part in utilizing computer media. Therefore, designers emphasize the inspiration and exploration of the concept. On the contrary, conventional media bring a high interaction between visual presentation and thinking. Designers can easily discover different level of topics through physical models or sketches, but they also set a form of thinking and measuring models in the early stage of design.

The introduction of the third coding scheme, we discover that there is transformation of topics as well as total or partial variation within transformation in the same block during the conventional media design process. That is, partial topics may

raise total consideration during design process or raise another block consideration. However, we are able to distinguish that designer completes the structure first and then continues with detailed design for each section during a computer media design process. Therefore, there is no transformation as the conventional media.

Conclusion

In conclusion, the design process of conventional media is under partial and total transformation after we generalize coding phenomenon. The reason is that conventional media provides a visual display, which extends and inspires. These characteristics enable designers to discover concept from visual clues and construct objects through imaging in the early stage of the design. Form the aspect of design content, thought designers obtain inspiration from visual display frequently, however, As a result, development of concept is not emphasized as much as practical functions.

The compute media is under a balanced phase and demonstrates a design procedure from total concept to partial development. The space portion is partial. Therefore, space or circulation have partial consideration phenomenon. The probable cause may be from computer modeling software. Although most software achieves functions such as viewpoint, zoom in or zoom out, their presentation of the design is limited. The designers cannot obtain detailed information. Computers do not show a extending characteristic like the conventional media. As a result, it is more difficult to inspire and transform. Nevertheless, computer presents a conceptual stimulation to designers. Designers take great advantage of computer's display characteristic to calculate the interaction between time and distance by means of animation and transfer logistic concept to architectural space. From this point of view, designers are actively raise question or present evaluation.

This research proves that media does contribute to the changes in design process and methods. Not only does its conclusion help to better understand properties of different media, but also benefit the development of computer media. In addition, the meaning of computer media in exploring concepts shall not be overlooked upon. Such may serve the future direction of creativity. Nevertheless, the use of a single designer as a subject has limited this research to gain insight of different design background and experience.

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