INTERACTIONS BETWEEN SPACE AND DIGITAL DESIGN MEDIA: A Case Study of Physical Space

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Abstract. The rapid developments of digital design media have impacted many aspects of architecture design, such as design process, presentation and communication. This paper focuses on the study of interactions between physical space and digital design media, and proposes a preliminary interactive framework between them. This research proposes a preliminary sense-of-space oriented framework, which indicates the crucial interactive elements and properties of physical space and digital design media.

1. Introduction

With the rapid development in digital design media, such as computer-aided architecture design (CAAD), computer image processing, and network technologies, architecture design has encountered profound transformations. For instance, the integrated CAAD systems can assist architects' development of initial ideas, drafting, and analysis of design projects. Various techniques of computer image processing provide creative environments for stimulating design thinking and for making representational drawings. By utilizing network technologies such as World Wide Web and Internet, architects can request designers, consultants, and materials providers around the world to form a design team of the so-called collaborative design. In other words, digital design media has gradually dominated architectural designing process, from conceptual design to the construction stage.

This digitalized working process and the end results, which are different from the conventional ones, has been defined as digital architecture. The definition of digital architecture therefore attracts many researchers' attentions. For example, in contrast to architecture as a form of physical material, Bertol (1997) indicates that digital architecture is made of databases within the computer environment. In addition, Liu (2001) points out a broad meaning of digital architecture, which emphasizes the application of digital design media into any phase of designing and produce critical result in concept, form, or space. Furthermore, according to generative methods of architectural forms in the computer, Kolarevic (2001) divides digital architecture into six types: topological architecture, isomorphic architecture,

animated architecture, metamorphic architecture, parametric architecture, and evolutionary architecture.

The relationships between digital design media and architectural designing process can be separated into three types: representation tools, design thinking media, and supports of design developments (Liu, 2001). Greg Lynn (1998) also indicates that architects can utilize digital design media as new working technologies, rethinking of professions, discovery of new spatial forms, new presentation methods, and new communication modes. In general, design process of physical space consists of three major phases: schematic design, design development, and construction. In the schematic design phase, digital design media not only rapidly assists formation of design concepts and design alternatives, but improves creativity, processes and communications of design decision (Hanna and Barber, 2001; Huang and Liu, 2001; Liu and Bai, 2001). Computer model has been regarded as the most powerful presentation during design development stage. For example, simulations of lighting and design communications will be enhanced by computer models (Neto, 2001). In the course of construction phase, through applications of CAD/CAM system and digital construction methods, material components will be accurately produced in the factory and assembled on site (Mitchell and McCullough; LeCuyer, 1997; Kolarevic, 2001).

However, recent research has not focused on the relation between space and digital design media. Furthermore, physical space is also excluded from the studies. What are the relations between physical space and digital design media? What are the interactive phenomena, elements, and process between them? The objective of this research is to study the interactions between physical space and digital design media, and to propose a preliminary interactive framework between them.

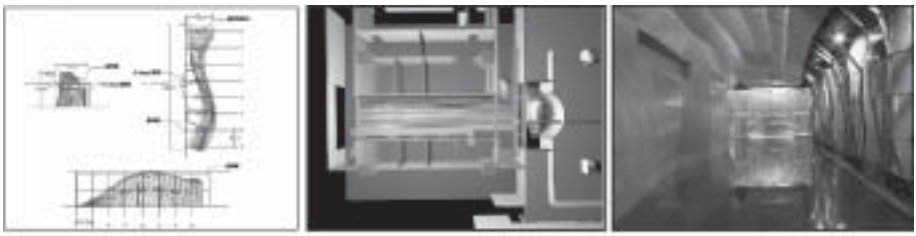
2. Methodology

In order to achieve the research objective, I conducted an empirical experiment. The object of this experiment is a built physical space: reception lobby, Bcom Corporation, Taipei, Taiwan (Figure 1). On the other hand, the subjects consist of two groups undergraduate students: architecture and non-architecture. There are ten students in each group.

The first step of the experiment was to represent three types of digital design media of the physical space to the subjects: 2D images and drawings, 3D model with rendering, and digital video tape (DV) after the project was completed. These digital design media presented the design process and the end results of the physical space.

After that, I asked the subjects to choose elements they recognized during the experiment. As shown in Table 1, it is a collection of properties of both space and digital design media, and they are divided into six categories : form, space, order,

aesthetics, cognition, body image; 2D images, 2D drawings, 3D model, animation, virtual reality, and net media. These elements resulted from an exhaustive review of literature. However, before the experiment started, I explained the meanings of each element to the subjects.



2D 3D DV

Figure 1. Reception lobby, Bcom Corporation, Aleppo Zone 2000-2001.

TABLE 1. Elements of space and digital design media.

Elements of space		Elements of digital design media.	
Object	Shape	Resolution	Map
Direction	Surface	Photomontage	Boolean
Human activities	Texture	Transparency	Polygon
Solid	Distance	Light	Light and dark
Void	Perspective	Material	Frame
Colour	Open	Colour	Rendering
Scale	Close	Filter	Editing
Sound	Horizontal and vertical elements	Camera	Information intensity
Location	Contrast	Layer	Information
Light and shade	Axis	Contrast	Real-time
Size	Repetition	Tone	Multimedia
Symmetry	Opening	Channel	Acoustic effect
Figure ground	Regular	Transformation:	
		move, rotate, scale	Interaction
Proportion	Boundary	Light source	Immersion
Time	Movement	Shadow	Hyperlink

3. Analysis and Results

3.1 ELEMENTS OF SPACE

In the architecture student group, the results can be separated into eight classes. The most important elements are object, human activities, solid, void, color, light and shade, shape, texture, and perspective. The second is scale, size, surface, open, axis, and opening. The third is direction, figure ground, distance, and horizontal and vertical elements. The fourth is location, proportion, repetition, and boundary. After that comes time, close, and contrast. The last three groups are regular, symmetry and movement, and sound. Notably, no subject selected sound.

In the non-architecture student group, the results can be separated into nine classes. The most important elements are object, direction, human activities, solid, light and shade, shape, texture, and perspective. The second is scale, size, proportion, and close. The third is axis, opening, and movement. The fourth and fifth groups consist of void, colour, location, opening, and, figure ground, time, and surface. The following two classes are horizontal and vertical elements, repetition, and, regular and boundary. The last two groups are symmetry, contrast, and sound.

The responses of students of architecture are more concentrated on the first four categories, while the other student group is more even. The professional training causes this result. By comparing the two student groups, there are seven identical elements in the highest-ranking category: object, human activities, solid, light and shade, shape, texture, and perspective. The second highest class also has two similar element : scale and size. These two categories are easier to be perceived during the experiment. In other words, these elements are more important than the others in the sense of the physical space. However, all subjects paid little attentions to the elements of contrast, regular, symmetry, and sound. These elements are difficult to identify in the physical space.

3.2 ELEMENTS OF DIGITAL DESIGN MEDIA

In the architecture student group, the results can be separated into nine classes. The most important elements are material, colour, light source, polygon, and light and dark. The second is light. The third is photomontage, transparency, shadow, map, and rendering. The fourth and fifth groups comprise Boolean, as well as layer, transformation, and multimedia. The following two classes are resolution, camera, information, and, filter, contrast, channel, frame, and interaction. The last two are information intensity, real-time, immersion, and, tone, editing, acoustic effect, and hyperlink. No subjects chose the last class.

In the non-architecture student group, the results can be separated into eight classes. The most important elements are transparency, material, colour, light source, polygon, and light and dark. The second is light, tone, shadow, and map. The third is resolution, photomontage, and rendering. The fourth and fifth groups comprise

of contrast, channel, transformation, and, Boolean, editing, and information. The following two classes are filter, camera, layer, frame, and, information intensity, real-time, and multimedia. The last is acoustic effect, interaction, immersion, and hyperlink. No subjects selected the last category.

The replies of both student groups are more even in each element category. This is due to the ability to utilize digital design media. By comparing the two student groups, there are five identical elements in the highest-ranking category: material, colour, light source, polygon, and light and dark. The second and third classes also have two similar elements: light and photomontage. These elements are more important than the others in the representation of the physical space. On the contrary, the elements of the last two categories in each student groups are not significant in the physical space, such as tone, editing, information intensity, acoustic effect, interaction, immersion, and hyperlink. These elements are neither too technical in the use of digital design media, nor irrelevant to the representation of the physical space.

3.3 A COMPARATIVE ANALYSIS

The most important elements of space are object, human activities, solid, light and shade, shape, texture, perspective, scale, and size. These properties belong to the scope of architectural form and space. On the other hand, the critical elements of digital design media are material, colour, light source, polygon, light and dark, light and photomontage. All of which relate to the properties of 2D image and 3D rendering model. By comparison, the most distinctive element is the properties of light, which has the highest rank, such as light and shade, light source, light and dark, and light. The surface natures of physical space are also important, such as solid, shape, texture, material, and color. Object and human activities are also critical elements, which can be presented by the techniques of photomontage. These important elements shape the foundation of sense of space of human. Therefore, this research proposes a preliminary sense-of-space oriented interactive framework (Figure 2).

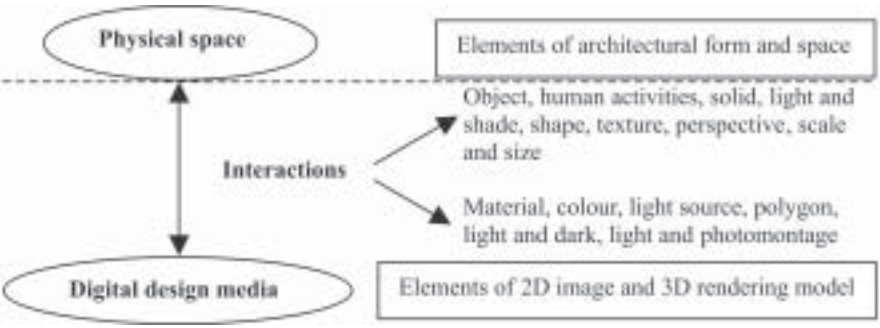


Figure 2. The interactive framework of physical space and digital design media.

4. Conclusion and Future Studies

The objective of this research is to study the interactions between physical space and digital design media, and to propose a preliminary interactive framework between them. The findings indicate that some distinct elements of space and characteristics of digital design media are interactive in the physical space. In the first place, although some minor differences exist, almost subjects of the experiment point out that the elements of architectural form and space are more important than that of order, aesthetics, cognition, and body image, such as object, human activities, solid, light and shade, shape, texture, perspective, scale and size. In addition, the essential characteristics of the digital design media are 2D image and 3D rendering model while subjects are watching the representation of the physical space, such as material, colour, light source, polygon, light and dark, light and photomontage. In other words, elements of sense of space in both physical space and digital design media activate the interactive mechanism. As a result, this research proposes a preliminary sense-of-space oriented interactive framework.

In summary, there are many very close interactive relationships within physical space and digital design media. However, this research is only a preliminary study. Future studies will first further analyze the properties of interaction between space and digital design media. I will also focus on the same issue, the interactive framework, applying to other types of space, such as virtual and net spaces. Therefore, interactions between spaces and digital design media will be fully understood. These studies will eventually suggest new directions for architectural design.

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