Infilling Time into Space - A Pedagogical Approach for Evolving Space Using Digital Media

Ih-Cheng Lai
Department of Architecture, Chaoyang University of Technology, Taiwan.
ihcheng@ arch.nctu.edu.tw

Abstract. *This paper presents a pedagogical approach to explore the relationships between time and space by using digital media. Based on a pedagogical model called e-Space proposed by Lai (2004), we apply motion as a spatial issue to approach this study. Through integrating with the characteristics of digital media, students are encouraged to evolve architectural space and form by decomposing, re-organizing, interpreting and realizing the spatial composition. Simultaneously, diverse digital media applications integrated with design thinking in a design process enables students to bridge two design spaces - physical and virtual. This process introduces the students to a new approach of design-creation and form finding. Finally, we use an advanced digital media course as an example to understand the impacts of the pedagogical approach. The students' outcomes are also reported in this paper.*

Keywords. *Digital media, pedagogy, motion, design space, design learning*

Introduction

In architectural design, time is an essential element in spatial composition (Giedion, 1967). Many design studio tutors inspired students' spatial exploration through exploring the relationships between time and space in design learning. For example, Wassily Kandinsky encouraged students to analyze the movement of dancers to express spatial tension and geometry. Josef Albers explored the assemblage of found objects, and transformed these materials into unexpected dynamic compositions. These pedagogical methods employed motion as a mediator to explore the relationships. During the design process, students used schematic diagrams to examine and analyze the implications of element movements in space (Bermudez and Neiman, 1997). By using various analogical media, these students transformed the relationships into the physical space (or called physical design space).

While digital media plays an essential role in current design education, the inspiration invoked by the digital means within the hand-on session of design studios creates an evolving spatial creature. In the design process, digital media provides diverse visual information and immediate visual feedback for students' design inspiration (Thomas

and Muller, 2004). Therefore, some researchers apply digital media to explore the motion issue in design learning. For examples, Schroth (2003) proposes a pedagogy called "pictures in motion" to stimulate students' concepts related to urban design through exploring moving images in the virtual space. By exploring the information flow within cyberspace (such as text, image and sound), students employ diverse digital media to represent space and form within motion (Engeli, 2002). These pedagogical approaches focus on using digital media to explore space and form in the virtual space (or called virtual design space).

Compared with design learning in the physical design space, digital media provides different dimensions for students to explore the new relationships between time and space. However, in current design education, using tangible means to get the real spatial sense and understanding in the physical design space still plays an important role in students' design learning. Therefore, the research intends to encourage students to use diverse digital media for exploring the new relationships between time and space. By bridging two design spaces, students are inspired to evolve architectural space and form. For understanding the evolving spatial creature in two design spaces, we employ a pedagogical model called e-Space (proposed by Lai, 2004) to approach this research.

A pedagogical model: e-Space

e-Space is a pedagogical model that is proposed for supporting design studio learning by overlapping two design spaces: physical design space and virtual design space (Lai, 2004). By implementing and thinking between two design spaces, students employ diverse digital media to investigate spatial composition in a design process. Basically, e-Space composes of three constituents to integrate architecture design with digital media. They are 1) generation of spatial issues, 2) operation of digital media and 3) representation of spatial compositions. The three constituents are connected together through the logical design thinking (Figure 1).

In this research, we intend to apply the three constituents to explore the relationships between time and space in two design spaces. The details are described in the following sections.

Motion as a spatial issue for exploring the relationships between time and space

Motion can considered as an object's transformation from one state to another state. In architectural design, many architects applied motion to explore the relationships between time and space (Antoniades, 1992). For example, Andrea Palladio used musical rhythm to create spatial order in the

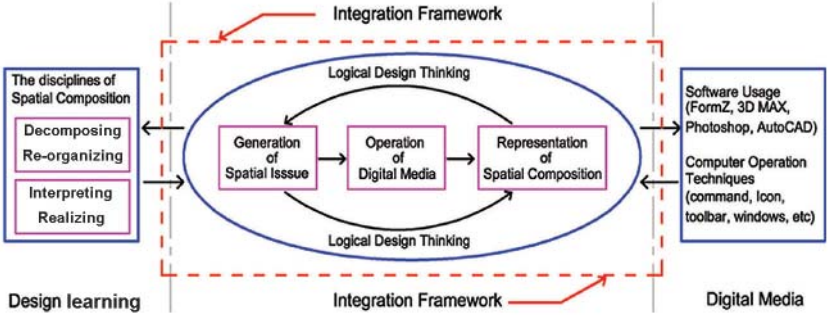

Figure 1. e-Space framework and its constituents

Figure 2. Two examples: San Carlino Church designed by Francesco Borromini and a toilet facility (Blow Out) designed by NOX (after Zellner, 1999)

Redentore Church. Francesco Borromini employed monads' movement to create a curve skin in the San Carlino Church (left figure in Figure 2). In modern era, Santiago Calatrava designed a sport pavilion in Berlin through exploring the movement of hand gesture. The different types of motion compose of various elements and transformation rules that motivate these architects to create innovative spatial composition (Lynn, 1998).

Digital media plays an important role for design inspiration in current architectural design. Moreover, motion always is considered as the key characteristic within such architecture design (Gao, 2004). For example, Greg Lynn exploited the movement among nodes to create the spatial fusion in the artist gallery design project. Besides, NOX explored the evolution of body gene to create a fluid architectural form in a toilet facility design project called Blow Out (Zellner, 1999) (right figure in Figure 2). Therefore motion, which is a motivating spatial issue, can provide different dimensions and possibilities for students to explore spatial composition related to time and space by using digital media.

The usage of digital media for motion exploration

Design is a visual process involving reflective behavior (Schon and Wiggins, 1992). Due to analogical media's lack of dynamic and simultaneous visual feedback, students are not easy to find the hidden tracks behind the motionless visual information, and then overlook some possibilities for spatial exploration. Besides, the generated form and space in the virtual design space is hard to be effectively realized in the physical design space. Such condition causes some limitations for motion exploration in students' design learning.

By conversation with digital media, diverse visual information can help students to communicate with time and space within motion efficiently. For example, the morphing process produces a sequence of "intermediate images" that provide students' inspiration in exploring new spatial compositions and relationships between time and space. In addition, simulating spatial reality and controlling dynamic viewpoints in the virtual design space are helpful for them to investigate and understand designed space and form (Lai, 2004).

While viewing motion composed with dynamic rules and elements (Lynn, 1998), the parameterized characteristic of digital media can facilitate

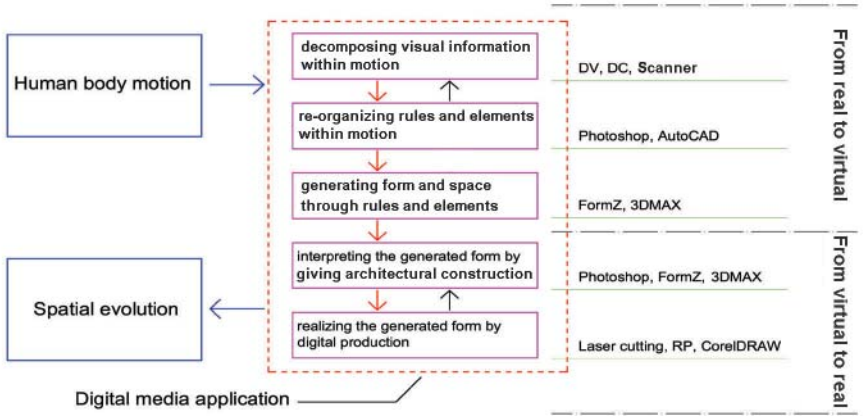

Figure 3. Different exercises and applied digital media in two phases

students to discover and define the elements and rules within motion. Furthermore, they can imaginatively generate architectural space and form in the virtual design space. Through input machines (such as a DV or a scanner) and output machines (such as a laser-cutting machine or a 3D Printer), students can produce physical and virtual results in two design spaces. Therefore, they can engage in repetitive interactions and reinterpretations of their design from real to virtual and back to real (Schnabel et al., 2004) during the process of motion exploration.

Representation of spatial composition within motion

Spatial composition plays an important role for teaching students the sensibility and capability of making spaces (Lai, 2004). It constitutes architectural meaning and conditions by analyzing different combinations between architectural components and their relationships (Ching, 1996). Moreover, Alexander (1997) argued that these architectural components and their relationships could be combined according to some logical mechanisms. In the e-Space environment, students are encouraged to evolve architectural space and form through decomposing, re-organizing and interpreting the spatial composition in the virtual design space. Furthermore, the evolved spatial composition should be realized in the physical design space (seen in the left side of Figure 1). This discipline further encourages students to establish logicality of design thinking in a design process.

The outcomes as well as the possible impacts of this pedagogical approach are documented and evaluated through an experiment as described below.

An experiment: infilling time into space in two design spaces

Computer technologies are extensively used in teaching and in the student-centered learning in the Department of Architecture at Chaoyang University of Technology in Taiwan. An advanced digital media course, three hours a week during a period of one semester, is designed as an optional course for second year undergraduate students who have the basic skills of 2D drawing and 3D modeling. Therefore, this course provides students to learn the application within digital media towards the architectural design profession. Also, it provides students different dimensions of design exploration in the abstract spatial concepts through a specific spatial issue that is related to the characteristics of digital media.

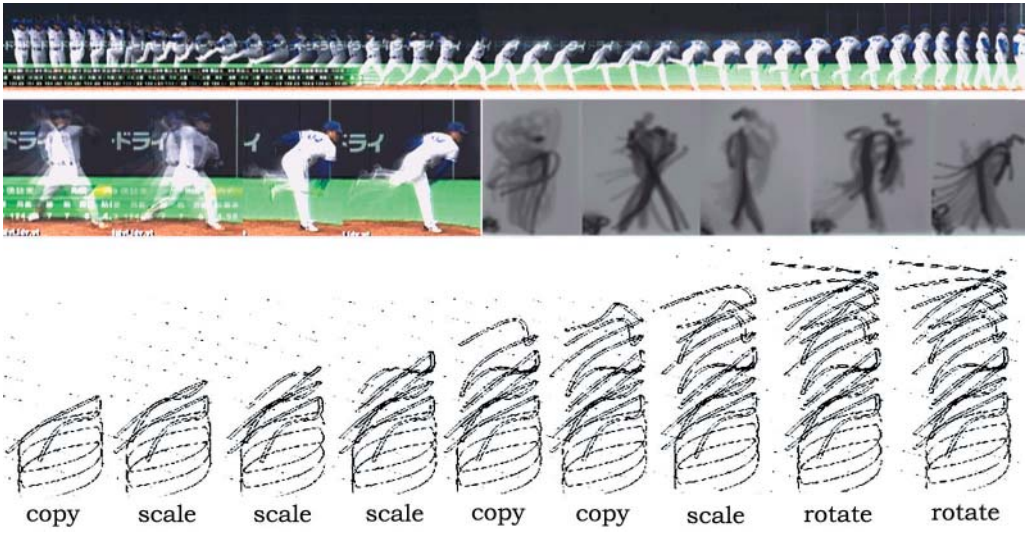

Figure 4. A team's decomposition of visual information within pitching motion

Based on the pedagogical approach described above, different types of motion (such as breaking, bowling, jumping rope etc) related to human body are applied to explore the relationships. Therefore, each team composed of three students should select one type of motion, and then use different digital media (including software and machines) to infill time into space in two phases (Figure 3). The two phases are 1) from real to virtual and 2) from virtual to real. Each phase is composed of different exercises, which are not formulated as separate but rather as a continuous development of the students' works.

From real to virtual

The phase focuses on infilling time into space from the physical design space to the virtual design space. There are two exercises involved in

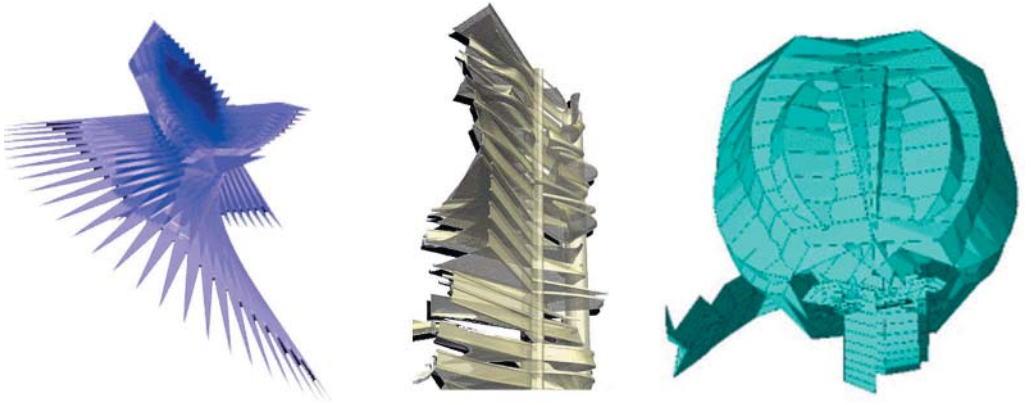

Figure 5. Three teams' evolving spatial creatures through different types of motion including breaking, pitching and jumping rope

Figure 6. Three teams' works about spatial interpretation: an urban sculpture (breaking), an observation tower (pitching) and a MRT station (jumping rope)

this phase. The purpose is to inspire students to discover the new possibilities of the relationships that are different from the relationships of using analogical media. Besides, they can create the evolving spatial creature in the virtual design space. The two exercises are detailed as follows:

1. Decomposing visual information within motion: students first used different input machines (such as DC, DV or scanner) to record the visual information within their selected types of motion in the physical design space. Through analyzing the visual information in the virtual design space, students were encouraged to decompose the visual information into different elements (such as line, surface, object or meta-ball) and transformation rules (such as copy, rotate, mirror, scale). These elements and their transformation rules should be presented through serial diagrams (Figure 4).

2. Re-organizing elements and rules within motion: students then re-organized these decomposed elements and transformation rules by integrating with the parameterized environment of used software. Through the operation interface within used software (such as transformation, deformation, derivative etc), the evolving spatial creatures were generated in the virtual design space. The evolved form and space imply the new relationships between time and space (Figure 5).

From virtual to real

In this phase, there are two exercises to infill time into space from the virtual design space to the physical design space. The purpose is to implement the evolved form and space, which is generated in the virtual design space, into the physical design space through proper software and output machines. The output machines mainly include a laser-cutting machine and a 3D Printer (or called rapid prototyping machine). The two exercises are detailed as follows:

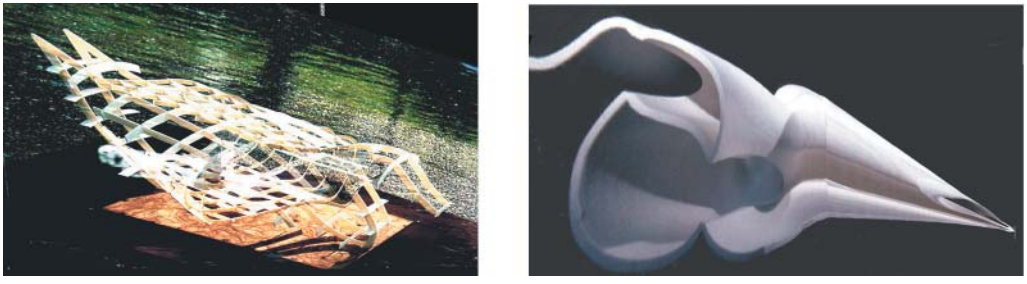

Figure 7. Two teams' works through two different kinds of output machines: a laser-cutting machine and a 3D Printer

3. Interpreting the evolved form and space: each team collaged some photo images within the generated form to express specific spatial events, and then to give the generated form an architectural construction (such as rain-screen, sculpture, observation tower etc) (Figure 6). Through controlling dynamic viewpoints, each team simulated the spatial reality not only to evaluate the architectural construction, but also to get the sense of spatial experiences. The interpretation process as a bridge to induce the evolved form and space into the architectural composition.

4. Realizing the architectural constructions: according to the spatial characteristics of the architectural constructions, each team selected one kind of output machines (a laser-cutting machine or a 3D Printer) to implement the architectural construction in the physical design space. For expressing the frame structure composition, one team used a laser- cutting machine to implement the work in the urban sculpture (right figure in Figure 7). Another team used a 3D Printer to implement the work in the MRT station in order to express its slab structure composition (right figure in Figure 7).

Through integrating the four exercises, each team should apply the dynamic and interactive characteristics of used digital media (such as Flash MX) to re-represent the relationships between time and space.

Conclusion and discussion

Through these exercises, students have different dimensions at operating architectural designs by applying different digital media. During the process of motion exploration, digital media provides diverse visual information for students to logically generate sequential emergent digital diagrams that are composed with elements and rules. Through these digital diagrams, students can discover new relationships between time and space, and then evolve architectural space and form. By exploring different types of motion, some design concepts related to the relationships between time and space are developed, such as infusion instead of binary, compositing instead of collage, liquid instead of solid etc. These concepts can instigate these students for exploring further spatial possibilities in their design studio learning.

By implementing the evolved space and form in two design space interactively, digital media not only can bridge two design spaces effectively, but also can provide a seamless cooperation for students' design learning in different stages of design process. In addition, how to identify a spatial issue is the key for students' digital design learning. In this research, we find that the issue should be effectively integrated with the characteristics of digital media. Besides learning the application and technique of digital media, they also can learn the integration between design thinking and digital media. Through making design thinking transparent and logical, each student can further develop an individual design methodology for his/her design works.

However, we find some limitations in motion exploration by using digital media. For examples, some complex mechanisms within motion can't be performed due to the restriction of algorithms within used software. Also, the evolved form and space cannot be put into practice effectively due to the limitation of output machines, such as working size, output material and cost. Such limitations cause students' difficulties to explore the relationships between time and space in two design spaces. Besides improving the capability of digital media (including software and machines), two concerns should be studied more in-depth in our future research: 1) integrating computation learning with design learning to explore complex mechanisms within motion, and 2) framing an appropriate spatial issue that is corresponded to the characteristics of digital media.

Acknowledgements

My greatest gratitude is extended to Jun-Hong Lin, who has offered me valuable suggestions. I am also thankful to my CAAD students who participated in my experiments. With all their assistance, I am able to complete this paper successfully.

References

Alexander, C.: 1979, The Timeless Way of Building, Oxford University Press, New York Book.

Antoniades, A.C.: 1992, Poetics of Architecture: Theory of Design, Van Nostrand Reinhold press.

Bermudez and Meiman: 1997, Between Analog and Digital Civilization, The Spatial Manipulation Media Workshop, Association of computer Aided Design in Architecture (ACADIA) 97, Cincinnati, U.S.A..

Engeli, M.: 2002, "From within" Revealing architectonic ideas in virtual reality, a+a arquitecturanimacion, Massad, F. and Guerrero A. (ed.), pp. 210-227, COAC press.

Fowler, T. and Muller, B.: 2004, Establishing a Physical-Digital Media Framework Using Bauhas Principles for Integrating Building Technology into Studio Design Projects, 2004 Design Symposium. Taipei (Taiwan), pp. 81-92

Gao, W. P.: 2004, Tectonics? A case study for digital free-form architecture, 9th CAADRIA Conference Proceeding, Seoul (Korea), pp. 519-534.

Giedion, S.: 1967, Space, Time and Architecture-the growth of a new tradition. Cambrideg: Harvard University press.

Lai, I. C.: 2004, A Teaching Model for Integrating Conventional Design Curriculum with Digital Media, 9th CAADRIA Conference Proceeding, Seoul (Korea), pp. 467-476

Lynn, G.: 1998, Folds, Bodies and Blobs: Collected Essays, Brussles: La :Lettre Volee.

Schnabel, M.A., Kuan, S. K. and Li, W.: 2004, 3D Transformations - 3D Scanning, Digital Modelling, Rapid Prototyping and Physical Depiction, 9th CAADRIA Conference Proceeding, Seoul (Korea), pp. 227-238.

Schon D.A. and Wiggins G.: 1992, Kinds of seeing and their structures in designing, Design Studies, 13, pp. 135-156.

Schroth, J. K.: 2003, Pictures in Motion- Using moving images to approach urban tasks, 21th eCAADe conference proceeding, pp. 505-507.

Zellner, P.: 1999, Hybrid Space: New Forms in Digital Architecture, Thames & Hudson press.