附錄 C　有趣又有創意的學習－
一個數位設計課程的先期模型

PLAYFUL AND CREATIVE learning

A Preliminary Model for Digital Design Studio

PEI-LING WU
Graduate Institute of Architecture, National Chiao Tung University
Hsinchu, 30050, Taiwan
vivian@arch.nctu.edu.tw

Abstract. Hutt (1966) demonstrated that familiarity, clarity, simplicity, and congruity are four stimulus characteristics eliciting play. When the participant reaches this status of an activity, in which is at this point that the playfulness element enters into play, and play is an important ingredient of the creative process. Correspondently, the characteristics in digital design studios which are rapid and broad exploration, systematic design process, the use of suitable digital media, and problem solving system reveal the analogical qualities with play. Since creativity is crucial in design processes, it is worthwhile to study relationships between play and digital design studio to discover possible means to benefit and facilitate digital design learning.

1. Introduction

Architectural education is consuming the phenomenon of digital technologies in its own distinctive manner. Schools have become experimental laboratories for creating digital design tools, promoting a new architectural imagination and treatment of new materials (Wright and Parks 1990; Andia 2002). Some of the architectural schools have taken a more critical position and have used digital technology to reconstitute the scope of the profession. They are evolving in a context of transforming values, media, research methods and professional practices. Furthermore, the digital technology has changed the architectural profession, and the knowledge and skills required by the students (Loy 2001; De Paoli and Leglise 2002). It also forms part of a larger phenomenon, one that may ultimately change the design/build processes, organizational structures, and design culture (Neiman and Do 1999; Liu 2001; De Paoli and Leglise 2002).

Play is a powerful metaphor to interpret the nature of design (Archea 1987; Woodbury, Shannon and Radford 2001; Caillois 2001; Coyne 2003; Wu 2003), and it possesses several different characteristics that can be put into analogies with design in many ways. Researchers in psychology and related disciplines pointed out that combinational play is the important element in the creative process (Deutsch 1958). Griffith (1935) described that there is the rational conclusion shows elements in play contributing to later creativity might be identified and measured at an age level. In the design field, creativity is not solely a matter of individual abilities or behavior. Creativity implies an innovative outcome (Heath 1992), and it is one of the most important ways that design distinguishes itself from other human activities.

First of all, the analytical reviews of play and creativity, which are relevant to studying relationships between them, are depicted and evaluated so that the characteristics of play and creativity can be demonstrated. Then, the reflection of the digital media in design education is reviewed and analyzed chronologically to learn the traits of digital design studios so that the analogies between play and digital design studio can be established. Finally, a preliminary model of playful and creative learning process for digital design studios is presented, and the components of the model are clarified and explained.

Effective learning has much to do with taking risks (Lieberman 1977). Even the inviting atmosphere can encourage experimentations. This paper hypothesizes that the engagement of digital media in all stages of design will not only construct a more playful learning process, but also acquires the more creative design outcomes. It is also the attempt of this paper to propose a preliminary model of playful and creative learning process that can be flexibly applied to digital design studios.

2. Analysis of Play and Creativity

2.1. RELATIONSHIPS BETWEEN PLAY AND CREATIVITY

Piaget (1945) noted that play enters every activity. Woodbury (2001) proposed that play and design can be put into metaphorical relation, and to do so is to let each inform the other. Play is generally an open-ended activity with unique and ephemeral results. Psychologists have confirmed that a playful attitude gives a person the chance to experiment by reducing associated penalties. Dewey (1913) gave the definition of playfulness: “It is the capacity to draw satisfaction from the immediate intellectual development of a topic, irrespective of any ulterior motive” (p.727). This social philosopher and educator further described playfulness in 1933 as follows: “Playfulness is an attitude of mind; a passing outward manifestation of this attitude” (p. 210).

Lieberman (1977), a psychologist and a scholar, had great interests in the special characteristics of play relating to imagination and creativity. She indicated in her conceptualization of playfulness in play that these qualities or traits would be sense of humor, manifest joy, and spontaneity, and this was confirmed in her studies with young children, adolescents, and adults. The diagram of this theoretical model is shown in figure 1.

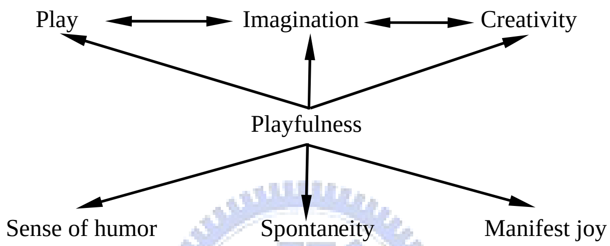

Figure 1. Model of relationships among play, imagination, and creativity, and playfulness. (Lieberman 1977)

According to the model, the relationship between play, imagination, and creativity is offered as first-order elements, and playfulness, divided into sense of humor, manifest joy, and spontaneity, as second-order elements. The labeling has no statistical connotation, but is to be considered figurative. Put differently, we might look at playfulness as the factor common to play, imagination, and creativity. Playfulness, itself, however, may not be a unitary trait, and this can be caused either developmentally or situationally, as illustrated in Lieberman’s studies.

2.2. CHARACTERISTICS OF PLAY AND CREATIVITY

One of the major pointers in understanding the relationship between play and creativity on a cognitive basis is the differentiation between exploration and play. Hutt (1966) demonstrated that familiarity, clarity, simplicity, and congruity are stimulus characteristics eliciting play, while novelty, ambiguity, complexity, and incongruity spark exploratory behavior. It may be that when the child feels that he or she is in control of the environment or that he or she feels competent to deal with the environment, the “function pleasure” becomes part of his or her approach (Buehler 1918; Piaget 1945).

Studies of exploratory behavior (Berlyne 1963; Fowler 1965; Hutt 1966) illustrate that curiosity leads to the seeking of novelty; information gained through novelty seeking becomes incorporated into the existing schema making for familiarity; familiarity, in turn, triggers the kind of activity called play, with the individual in charge of direction and selection of activities. In Lieberman's analysis (1977), it is at this point that the playfulness element enters into play.

When we fantasize and create, more often than not, we start from what we know and the embellishments we add to make it something different also may come from a pool of knowledge already there. This is not to say that the novel and original must be left out of a consideration of imagination, but the humble known is sometimes given short shrift in theoretical discussion (Elkind 1969). Rearranging of known connections and relationships through imagination either concretely or in the abstract may lead to a unique and original product, one of the hallmarks of creativity.

3. Analysis of Digital Media in Design Education

New technologies have had great impact on both design education and practice. Digital media have the potential to radically change three fundamental ingredients in the classroom: students, instructions, and instructors. It is obvious that changes of this kind spell out a commensurate change in design pedagogy (Akin 1990). In architectural practice, the application of digital media has also changed the design method (Liu 2001). Many famous architects such as, Frank Gehry, Peter Eisenman, Daniel Libeskind, Greg Lynn, Tom Mayne, Eric Owen Moss and so on, have created amazing spaces through the assistance of computer technologies. Those methods are changing the way that buildings will be designed in the future.

3.1. BEFORE 1980

Since the late 1950s, there have been attempts to bring architecture and computer science together. Most of these pioneering efforts were taken places in schools such as *problem-solving* (Simon 1996) and *systematic methods* tradition that dominated the computer science community at that time. In the Spring Joint Computer Conference of 1963, *Sketchpad*- a convincing working prototype running on the TX-2 computer developed at MIT's Lincoln Laboratory was introduced by Ivan Sutherland (1963). He also produced a memorable film sequence showing a designer (himself) manipulating an interactive graphic display with a light pen (Mitchell 1990). At Cambridge University, the *sketchpad-like* systems with an architectural flavor were developed further by Newman (1963) who implemented one that allowed an architect to select and assemble elements from an industrialized component building system. Other intensive research on the computerability of architectural design was also engaged in the architectural academic community in the sixties and the early seventies.

The movement of design methods then emerged. Among the most celebrated were Alexander's (1977) *pattern languages*, Asimow's (1962) *design elements,* Jones' (1970) *factors,* Archer's *sub-problems*, Cross' (1977) *automated architect,* and Rittle's (1972) *issue based information systems.* However, only a few design methods theories retreated to a small number of courses in architectural schools, and were survived to become the foundation for some of the first commercial CAD (computer-aided design) system.

3.2. THE 1980S AND THE EARLY 1990S

Increased productivity was the first purpose when computers entered new fields. During this period, CAD was proven to be an important tool for project documentation and visualization. Nevertheless, both architecture and computer science academia decried the simplistic nature of commercial CAD. Design computing researchers considered commercial CAD a frivolous instrument, one that ignored the informational potential of software design, while a great number of studio instructors banned commercial CAD from their design studio because they concerned that students would not acquire traditional drafting and design skills (Andia 2002). At that time, computers were occasionally used to back up support courses, for example, in energy analysis or design economics. It was neither used as a truly new medium, nor was the nature of design affected in any substantial way (Flemming, Akin and Woodbury 1985).

Although the computerization began to take off in the mid seventies and grew explosively in the late seventies and early eighties as cheaper PCs and commercial CAD emerged (Mitchell 1986), computers in the early 1980s were far too low-powered to perform any useful CAD functions although they established the idea of personal computing. In the mid-1980s, IBM PC and Apple Macintosh computers displayed more speed and memory and provided fairly acceptable graphics performance. The Macintosh also introduced to a broad public the mouse-and-windows style of interaction (Mitchell 1990).

It was not until the late 1980s that CAD courses became widely accepted and joined the core curriculum of architectural education. For example, the Harvard Graduate School of Design has been engaged in incremental development of a CAD network to support teaching and research in architecture, landscape architecture, and urban design and planning since 1987. Once these tools were made available, they started to have more profound impact (Flemming, Akin and Woodbury 1985). Instructors of architectural schools started to discuss about the impact of computer technology on the way design is taught (Schodek 1987).

3.3. AFTER THE MID-1990S

CAD progressed from an exotic position in architectural education into the mainstream in the 1990's. The development of computer technologies not only provides new production methods such as rendering and modeling, but expands our abilities to create, to see, to express, to compose space, and to understand design in new ways (Neiman and Do 1999). Led by the School of Architecture at Columbia in the early 1990s, design studios began to eliminate traditional design processes and to work with a paperless format. The Columbia paperless studios were characterized by eliminating hand-drawn design as much as possible, and developing a strong dependency on high-end software (Cramer and Guiney 2000).

The emergence of the Internet brought a large increase in the person-to-person exchange of data and information (Schmit 2001). Advances in digital communication has fostered the growth of a new enabling technology that allows geographically displaced individuals to have the opportunity to interact (Rutherford 1995). As collaboration technologies evolved and became available to the masses, virtual collaborative studios using telecommunication technologies and the Internet began to explore how computers could be implemented in academia. University of British Columbia and MIT tested on the asynchronous and synchronous techniques of remote collaboration in studio exercises. Florida International University and Texas A & M fostered international consortiums of architectural schools (Andia 2001). University of California at Berkeley and CIFE at Stanford University engaged several interdisciplinary efforts in students from architecture, engineering, and building construction (Kalay 1995).

Architects and researchers started to address not only the issues of *form*, but also consider how human activity spans the real and virtual worlds. They proposed alternative ideas regarding architecture's implementation of digital media and claimed that architecture should be concerned with both designing analogue space and digital space (Mitchell 1995). The field of *Information Architecture* emerged and became a popular subject in the late 1990's. It even defined new departments and programs inside schools such as the CAAD (computer-aided architectural design) postgraduate programs at the Swiss Federal Institute of Technology Zurich (Engeli 2001), the inFARC program at Bauhaus-Weimar, the New Cybernetic Design program at Universidad Internacional de Cataluyna, and the Informatics Architecture program at Rensselaer Polytechnic Institute (Andia 2002).

4. A Preliminary Model of Playful and Creative Learning Process for Digital Design Studio

4.1. CHARACTERISTICS OF DIGITAL DESIGN STUDIO

The digital design studio discussed by the author here is to explore new digital approaches at all stages of design instead of the limited use of digital tools for presentation. Taking this point of view tends to recognize the potential of the computer technology to radically change the design process in a number of positive ways.

From the review on the 3rd section of this paper, I conclude some distinctions between the digital design studio and the traditional design studio. The 1st and also the basic difference is the media used in design process. The media used in the digital design studio are computer technologies and new digital approaches instead of manual techniques at all stages of design. The 2nd differentiation between the digital design studio and the traditional design studio is that a more rapid and broad exploration according to various criteria is made possible by technology advances, including aesthetic ones, and this approach can be extended to the evaluation and comparison of design alternatives. However, traditional design strategies aim at the generation of a single acceptable solution. They are constrained by the use of manual methods both for the creation of solutions and the prediction of their performance (Flemming, Akin and Woodbury 1985). The 3rd characteristic of the digital design studio is that the design process is explored in a systematic way. Studies (Radford and Gero 1980) suggest that the design process can indeed benefit from a systematic inquiry. The 4th issue the author brought up is the complexity of design problems. Simon (1996) proposed to construct hierarchic systems to decompose complex problems. Gagne's theory on condition of learning (Gagne 1985) suggested, through the process of task analysis, to organize a complex learning task into a hierarchy simple learning tasks. Recent learning theories, such as scaffolding, are incorporated in the structural knowledge learning to customize the software to facilitate learning.

To sum up, the four traits of the digital design studio are the use of digital media and approaches, rapid and broad explorations, systematic design process, and problem solving system. Those are also the main distinctions between the digital design studio and the traditional design studio.

4.2. ANALOGIES BETWEEN PLAY AND DIGITAL DESIGN STUDIO

As the 2nd section of this paper outlined, the characteristics of play are familiar, clarity, simplicity, and congruity (Lieberman 1977). Play is an essential ingredient of creative thought (Deutsch 1958). The traits of play can be put into analogies with digital design studio as shown on table 1.

TABLE 1. Analogies between play and digital design studio.

The Characteristics of Play	The Characteristics of Digital Design Studio
Familiarity	Rapid and Broad Exploration
Clarity	Systematic Design Process
Simplicity	Problem Solving System
Congruity	The Use of Suitable Digital Media

4.3. THE PRELIMINARY MODEL

According to the characteristics and analogies of play and digital design studio, in figure 2, I offer a schematic model of relationships between eight components of play and digital design studio, which are familiarity, clarity, simplicity and congruity on the outer circle, and rapid and broad exploration, systematic design process, problem solving system and the use of suitable digital media on the inner circle.

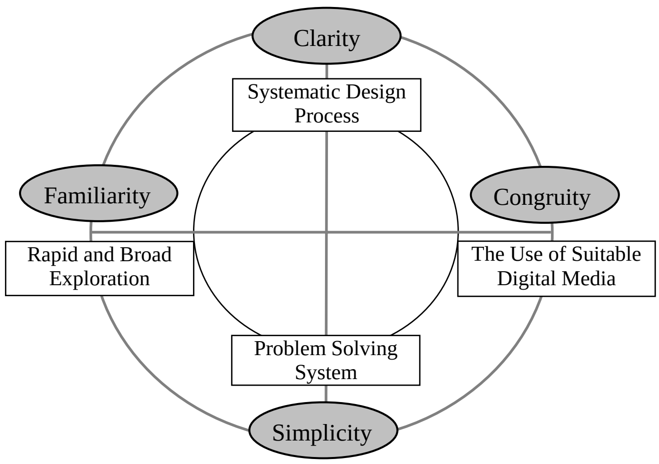

Figure 2. Model of playful and creative learning process for digital design studio.

4.3.1. Systematic Design Process Leads to Clarity

Design is a complex cultural activity. Design problems are usually ill-defined in respect of the domain of possibilities when new vocabulary elements and operators may be introduced at any time, so that there is no fixed set of design variables to consider (Mitchell 1992). The problem is ill-defined in respect of the solution criteria when the requirements are not predetermined, the nature of a solution is ambiguous or controversial, and there is no clear way of telling whether a given proposal is a solution.

There has existed a belief among design professionals, particularly in the area of architectural design, which attempts to formalize the design process in terms of logical operations or computational techniques. The burgeoning ability to model and implement design processes as reasoning systems, making use of artificial intelligence research and techniques, has given new impetus to the study of design theory and methodology (Gero and Maher 1992).

Over the past two decades research into systematic design processes utilizing ideas and models drawn from artificial intelligence has resulted in a better understanding of design as a process. For instance, the introduction of knowledge-based systems as an approach to developing computer programs that support or simulate design processes has provided insights into modeling creative design.

4.3.2. Rapid and Broad Exploration Leads to Familiarity

Creative design involves exploration, such as finding new goals, new states, and new state transition processes (Gero and Maher 1992), and vast and multiple explorations can quickly approach the state of familiarity. Studies of exploratory behavior (Berlyne 1963; Fowler 1965; Hutt 1966; Maw and Maw 1970; Switzky, Haywood and Isett 1974) illustrate that curiosity leads to the seeking of novelty; information gained through novelty seeking becomes incorporated into the existing schema making for familiarity; familiarity, in turn, triggers the kind of activity called play, with the individual in charge of direction and selection of activities.

The emphasis on the enumeration of designs becomes particularly important within the automated generation of designs which stresses the comparison of design alternatives (Flemming, Akin and Woodbury 1985). The design of expert systems deal specifically with problems solved by experts using knowledge that is internalized and based on the experience gained over years of practice is useful for architectural design profession.

4.3.3. The Use of Suitable Digital Media Leads to Congruity

Tools have played a major role for human beings in scientific discoveries, problem solving capabilities and in the power to design and create. In architectural design domain, the preferred tools or so called media, underwent a change through time from delicate watercolors and metal-point pencil to photographs, quick sketches with a soft #2 pencil (Wright and Parks 1990) and then digital media today. The computer has been seen by many as the ultimate tools to support creativity (Fischer 1992) and to dramatically change architectural profession.

Before computers were easily accessible, design could be practiced only by those who had mastered the difficult skill of drawing fluently and accurately and gain extensive specialized expertise about relevant class of artifacts. Mitchell (1986) explained that, "it was just as writing and scholarship were once the domain of a few literate priests and scribes. Computer-Aided Design changed this in much the same way that the printing press, and subsequent mass literacy, changed literature. Capacity to describe and manipulate complex designs, to make sophisticated analyses of them, and to generate images will become increasingly widely available, at diminishing cost, through the computers."

Digital media now is ubiquitous. It is likely that the future human spaces are *mixed-reality* environments which will be deeply affected by the next digital technology trends, such as the liberation of cyberspace from computer monitors and virtual reality glasses, and the use of universally accessible networks with high level of bandwidth. There will be more and more options of congruous digital media available for us to choose from in order to elicit more creative designs.

4.3.4. Problem Solving System Leads to Simplicity

The complexity of the design problems must be acknowledged. More generally, design is a broad field of multifaceted goal-directed endeavors that is both a way acquiring and utilizing knowledge. One of the most influential theories of problem solving in the design literature is Newell and Simon's Information Processing Theory (Newell and Simon 1972). The 1st major component of this theory is the characterization of problem solvers as production system. The 2nd is the distinction between short-term memory and long-term memory. The last and the most important one is the description of problem solving as search through a problem space.

Simon (1996) explained that," the central task of a natural science is to make the wonderful commonplace: to show that complexity, correctly viewed, is only a mask for simplicity; to find pattern hidden in apparent chaos." Complex problems might be constructed in a hierarchy of levels, or in a boxes-within-boxes form. The basic idea is that the several components in any complex system will perform particular sub-functions that contribute to the overall function.

Decomposition is a powerful technique to design such a complex structure. It is to discover viable ways of decomposing it into semi-independent components corresponding to its many functional parts. The design of each component can then be carried out with some degree of independence of the design of others, since each will affect the others largely through its function and independently of the details of the mechanisms that accomplish the function. Much of classical organization theory in fact was concerned precisely with decompositions of a collection of interrelated tasks.

5. Conclusion

In response to the hypothesis the author proposed in the 1st section of this paper that the engagement of digital media in all stages of design will not only construct a more playful learning process, but also acquires the more creative design outcomes, there are questions needed to be clarified. Are play and creativity strongly related? Are there analogical qualities and characteristics between play and digital design studio?

The answer to the 1st question is straightforward thanks to the abundant researches on play and creativity in domains of psychology and social philosophy. Although it has been analyzed in the 2nd section of this paper, I would like to quote Lieberman's expression about play and creativity in her book *Playfulness* to strengthen the answer here. "Because of playfulness, the playing child and the playing adult may become more alike. Incorporating the element of playfulness into imagination can lead to unique and creative products." (p. 149)

Through the analytical review and comparison presented in this paper, the answer to the 2nd question is yes. However, the answer is only true under certain consequences. The four characteristics of digital design studio presented in this research do not represent the whole picture of digital design studio but just the crucial qualities of it. Therefore, it is important to recognize that since design itself is a complex problem, the deductive process used in this research is just a means to refine the structure underneath. Meanwhile, the analogies between play and digital design studio can also be acquired through the analytic process.

One of the major insights that emerged from my analysis of play and digital design studio is that elements in the preliminary model of playful and creative learning process are closely related and have great potentials and flexibilities to be applied to digital design studios. However, the model is still in the conceptual stage and needs to be verified by conducting several experiments.

No medium in the history had ever done such a dramatic impact on architecture tradition like computer technologies are doing now. We now appear to be at significant crossroads in the architectural history. It is to be expected that the history of our profession is continually laden with changes in all kinds of forms, so that develop the coherent new pedagogies and contents (Demirbas 2003) at schools to equip the students, the future architects with new visions to the future diversities will be one of the major tasks I intend to pursue.

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