THE RELATIONSHIP BETWEEN PROBLEM-FINDING AND COMPUTING MEDIA IN DESIGN CREATIVITY

YUAN-JANG LEE
Graduate School of Applied Arts
National Chiao Tung University
Hsinchu, 30050,Taiwan
zone@iaa.nctu.edu.tw

Abstract. Designing is defined as a process of problem-finding and problem-solving. According to studies, the problem-finding during the early period of designing is the key point for influencing creativity, and the study also indicates that the computer originally used for presenting during the late period of designing can also be used during the early stage, but now we lack studies about creativity and computers. This study uses protocol analysis as an experimental methodology. We hope to clarify the relationship between computers and problem-solving, and to compare the differences between traditional materials and computers when used to discover problems.

1. Introduction

The process of designing is an extremely complicated mental activity, and in the field of designing it is considered a process of problem-finding and problem solving. However, most of the scholars of this research field put their emphasis on problem-solving but rarely on problem-finding. On the other hand, Guilford, a psychologist, who had an article about creativity, thinks that it is absolutely not ordinary intelligence, and begins to view creativity from a scientific point of view. It was considered the first formal contemporary research of creativity. After then, Gazels did a research from an artistic point of view, indicating that problem-finding is highly related with creativity. And then, a research about architectural designing by Chen further indicates that problem-solving in the early process of problem-finding is the key point for creativity.

The presence of computers has had a certain extent of impact on designing. But during the past, computers have always been playing a role of presenting in the late designing process. It is discovered that, in the early of designing, discussion of materials is mainly on traditional sketch, and the explorations of visual thoughts are also based on sketch. All the early stages of designing are constructed on the base of traditional sketch analysis. But in the thesis of Won,

by the comparative experiment of traditional /computer materials, it is made sure that computers can be used as   a tool of creating concepts in the early steps of designing.

In the field of computer-aided designing, a lot of people have been working on AI and behaviors, in order to understand the modes of human cognition and thinking process better. Through the mutual connection of human cognition and computer calculation, computers begin to play a very important role on creativity.

The researches above indicate that computers can be used in the early steps of designing, also the creative actions. Most studies aiming at the development of computer systems or computer-aided tools don't 0have direct evidences showing the relationship between the computers and the early steps of designing, nor is it between computers and creativity.

What on earth are the influences of computer involvements in the problem-finding during the early steps of designing and if it's the key point? What are the differences of problem-finding styles between traditional materials and computers and what are their characteristics? Based on the above questions, this research wants to explore the relationship between problem-finding and the use of computer materials in the early steps of designing, and the differences from traditional materials.

2. Review

2.1. THE DEVELOPMENT OF DESIGN THINKING

In early twentieth century, the behaviorism and gestalt view designing as a black box. Until 1960, the development of cognitive psychology and AI has made designing thinking a unique research area.

From the point of science, Einstein proposed his ideas. He emphasized that finding problems is no less important than solving them. Tracing back the development of designing process, Pena thinks that the whole designing process is divided into stages, and "only when you recognize what the problems are can you solve them". He thinks that the process of designing can be viewed as process of problem-finding and problem-solving.

2.2. CREATIVITY

In the field of science, there are people continuously trying to explore the creative part of human thoughts and behaviors. Psychologist Guilford first published an article about creativity and saw it from a scientific point of view. In his opinion, creativity is not ordinary intelligence, and he was the pacemaker of creativity researches by leading a series of creating measuring scales. Later,

Guilford proposed his advanced ideas about creative behavior of ordinary people. This behavior has three characteristics: variability, uniqueness and fluency. Following this research, he also added divergent and convergent thinking. The ability of divergent thinking and transforming activity is closely related to creativity. Simon had a research aiming at personal creativity and character. Simon pointed out that during creating, the process from making sure what the problems are to problem solving is the key point. In his research, he didn't view problem-finding as equally important. However, Csikszentmihalyi put it in different way. He thinks that creative thinking is produced in the process of problem-finding, and he objected Simon's theory.

In 1988, he mentioned clearly that problem-finding is a promise of good creating. The thinking process of problem-finding makes it possible for creativity to be carried out. The earliest creative actions of designing were promoted by Jones, who followed Guilford's opinions of general creativity. He pointed out there are three essential steps during designing: divergence, transformation, and convergence. Jones put it further that a divergent step is at which the designer continuously tries to expand the problem limit in order to search for enough space, so to produce enough methods. In this stage, the target is to try, rather than judging beforehand, so we can avoid expected answers and consider more possibilities. His opinions have noted the importance of problem-finding to a creative designing! Later, the studies done by Cross and Goel also supported this idea. Liu also promoted a dual geurateaul test model of creativity to combine these two theories. But according to Liu's study, problem solving is still the most important.

But, according to the studies of Csikszentmihalyi and Getzels, who tend to view creativity form a problem-finding point of view, creative artists would spend more time on problem-finding. Getzals even makes the serial thinking processes of creativity divergent, including expressive problem solving, and explorative problem solving. The explorative problem solving is especially for Ill-defined problems, which have unknown definitions, solutions and answers. Here, Getzals describes the characteristics of Ill-defined problems and creative actions. These results have been powerful evidences for Jone's theory.

After that, in Chen's thesis, a comparative study is done between two groups which have same designing abilities. It is found that the group which is better at problem-finding has stronger creativity, and vice versa. He points out that it is problem-finding that influences creativity best.

2.3.   THE CREATIVITY OF COMPUTER MEDIA AND DESIGNING

The presence of computers has had a great impact on designing process. Many related studies are produced, and there are topics talking about computer-aided design. There has been a lot of discussions in the field of computer designing, like shape-grammar , knowledge-based system, expert system, and the different designing styles between traditional and computer media. However, most studies are talking about late stages of designing. There are not many researches about early stages of designing. But now there are more. For example, Lipson and Shptitakni have proposed the techniques of transforming sketch to 3D modes. Gross also create a drawing environment. They both break the point of Tovey that computer-associated designing can't support sketch. Also lots of people are studying another field of computer- associated creativity –AI. Margaret A. Boden proposed three kinds of creativity related with computers :

    1. New combinations of familiar ideas
    2. Discovering potential conception space
    3. Transforming thoughts originally considered impossible

She also notes that computers have made good progresses on the 2nd creative actions. Other studies include Binsted studies about Jape's system. But these studies all aim at general creativity rather than involving the influences of computer media on creativity during designing.

The studies above have indicated that computer media can be used in the early stage of designing, also the creative actions. However, most studies discuss the development of computer system and computer-aided tools, and there are no direct evidences showing the influences of computers for early designing. In Won's thesis, Tovey's view is objected—computers can be used in the stage of conception thoughts of designing.

3.   Methodology

The method of study design is originated from cognitive psychology, like retrospection , introspection , human personality。 Among them, the "think loud" method from protocol analysis is more effective for analyzing human inward thinking processes. As a result, this study will use "think loud" method to obtain the data of protocol analysis.

3.1.   EXAMINATION

3.1.1. TOPIC
The reconstruction of architectural design studio

3.1.2. THE SELECTIONS OF PARTICIPANTS

The research emphasizes the practice of computers in the early stage of designing and the influences of traditional materials during the thinking processes of conception making—that is, what's the characteristics and differences on problem-finding when computers are involved? So we have to divide the participants into A and B, and they must have same expertise. Group A is very good at using computers and is used to have it as a tool of designing；Group B is used to analyzing thoughts by traditional materials.

There are two steps of screening for participants. First, we screen from a group of specialized people. So we choose a class of graduates in architecture department in a university. The screening standard is the grades of a computer-associated course. The second step is to screen through the masterpieces of them. At last, we use warm-up to decide if they are suitable for "think loud" experiment.

3.2.   BASIC RESULTS OF THE EXPERIMENT

Because the participants using computer media can't design in details and we want to avoid prolong experiment time and invalid oral data, in the manifestations of experiments , participants were required to what the relationship between blocks is and where the windows and movement is. It means that the designing is in half way, and we analyze all oral data.

The participants using traditional materials have much time to do their work, and their work are highly completed. The late steps of designing are not the keys for influencing creativity, so we only choose the data of first 40 minutes. We can recognize that participants of this group have a long and sustained problem-finding stage. It happened to make clear the more problems are found in the early stages of designing, the higher creativity is.

The participants using computer media are found to have some phenomenon below :The verbal data of the participants describes the operation of computer commands sometimes, for example : *And then an action of cutting, I will make a square for Boolean later…..*or when working on a problem solution, not saying a word until the orders he works have the same results with the status he mentioned before. No matter what kind of situation is, "think loud" of the traditional protocol analysis is not enough to show the thinking processes of designers using computer media, it even blocks the expression of participants during the thinking process of designing.

4. Encoding and Analysis

This experiment hopes to find out the relationship between computer media and creativity, and tries to discover if computer can help participants to recognize more problems, and the different styles of problem-finding by computers.

According to a lot of studies, creativity is closely related to the early stage of designing. So, the encoding and analysis of this experiment begin form the early stage of designing, and they include three major systems : problem-finding, problem-solving, and others. What below are the definitions of encoding system and experiments.

4.1. THE EARLY STAGE OF DESIGNING

The designing progresses to obtain related concepts, like entire space, blocks shape and more divergent related, unrelated thoughts.

PS: According to the rules of the topic, or the targets we want to reach during the designing process, using known methods to develop designing in order to meet the requirement.

PF: Designers discover rules and problems not given by the topic, and method or angles different from before, and develop designing.

O: Those can't be classified into the first two categories.
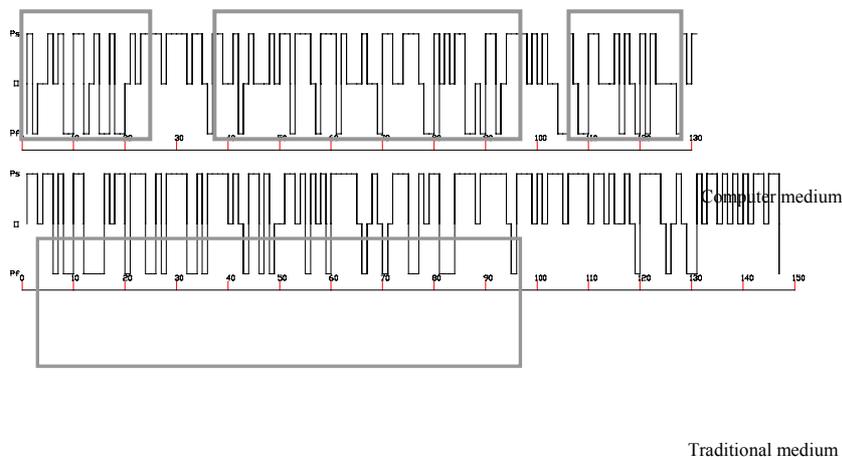
4.2. ENCODING RESULTS

Figure 1.   The coding comparing of computer media and traditional media.

The two participants are the more creative under screening. Their frequency of problem-finding is higher. But, according to the encoding, we can see the

participant using traditional materials have a period of time finding out problems easily after the designing begins. On the contrary, the participant using computer media doesn't detect problems as often as the one using traditional materials, but the duration of problem-finding is longer.

Now we analyze the reason why the participant using computer media find out problems less frequently. First, in the process of experiment, we found that the participant was silent or described his steps to reach the target when a concept was under constructing.

> *Mmm….Oh yeah,(remind him of talking) wait a minute, because I am doing what I just said, I can't keep talking about the same thing.*
> *I want to…cut a piece off here….*
> *And then an action of cutting, I will make a square for Boolean later….*
> *Now let's move to the window in front, we out the square in the correct height, O.K….almost there.*

This phenomenon is due to the software formZ that was used. This software is characterized by precise locations and snap, which is very different from traditional ones. The participant has to carry out certain amount of orders to finish his idea, and there is no instant feedback. Therefore, the frequency of judging result is lower, and problem-finding is not as often and quick.

The duration of problem-finding in participants using computers is longer. The participants using computers are scattered on problem finding. When the problem-finding proportion is the same, it takes longer than using traditional materials. Because of the different style of materials, it takes longer for computers to find out problems.
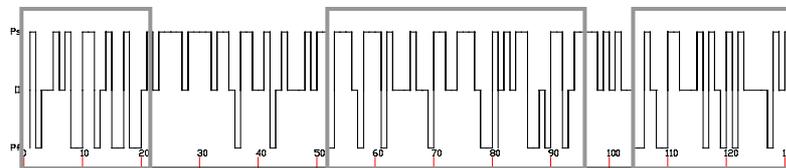

Figure 2.   The characteristic of using computer media.

There is another phenomenon. The participants using computers turn their attention to problem-solving soon after finding out problems as frequently as those using traditional materials for a period of time. And after that, they jump between problem-finding and problem-solving fairly.

The concepts in computers have to be expressed by a series of orders. So the participants using computers can't have several ideas at the same time. Traditional materials allow quick sketch production as to screen and asses problem-solving. As a result, traditional materials have the priority when it comes to exploring concepts. Computers make it less possible for divergent thinking and are better for deep thought. After the expression of concepts, computers will make it easier for designers to solve the problems they have while observing concepts but not to think two (or several) ideas at the same time. So, participants using computers tend to solve problems.

There is another phenomenon. As the graph above, from line 56 to 92, and line 103 to 127,when the participants do the defined O, there are accompanying PFs .

Examine the protocol data here, we can find that the participant is checking the designing from another angle.

Now let's see the space feeling ….
Now it's the main space, then….see what we can make?
Oh…..let me check the situation of blocks   now…..
O.K, I will check again….Right!! the height is 5.5 m, and if it's the stair. .Let's make a stair….o.k , it should be like this.

This phenomenon tells us that participants using computers can examine a problems from different point of view and thus producing new problems, so the open quality of problem-solving can be kept.

5.   Conclusions

This study hopes to discuss the relationship between using computers and problem-finding in the early stage of designing, and the differences from using traditional materials. The result showed designers using computers tend to solve problems. On the other hand, because of the differences of materials, the problem-finding styles are obviously not the same. The problem-finding process in computers last longer and the frequency is more scattered. But, although the problem-finding process is longer, we can't say it's helpful for inducing creativity because of the different qualities on problem-finding. We need further studies.

6.   Limitation

Traditional materials, besides general sketch, also include a designing model called object-making. Object-making provides a totally 3-dimensional visual mode, and it's very different from the traditional materials mentioned in this study. It deserves further studies.

Computers designed for aiding designing can be classified as instinct type (like painter) or precise type(like Autocad). The computers we talk about in this study is restricted to precise type. Other instinct types of materials are studied later.

The process and standards we screen participants are still under discussed because right now there is no efficient way to judge creativity. But this is not the point of our study.

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