HOW TO IMPROVE CREATIVITY

Can designers improve their design creativity by using conventional and digital media simultaneously?

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Abstract. From previous works, we know that the distinguishing characteristics of design media cause different influence on design creativity. However, the cognitive research about the application of conceptual sketches design by integrating both conventional and digital media simultaneously is absent. In this research, we would like to discuss that can it inspire more creative works if designers use conventional and digital media simultaneously as sketching media to generate conceptual sketches. The results show that using conventional and digital media simultaneously comparing with only using individual media can help arouse creative thinking, cognitive activity and design outcome in the stage of conceptual sketches design. The findings may suggest that the integration of various design media provides one feasible ways to inspire creativity, which can apply to the design training of creativity on education and to the designer's practical operation, but initiates more possibility of new media to assist design.

1. Introduction

1.1. CREATIVITY AND DESIGN CREATIVITY

Making variations on a theme is the crux of creativity (Minsky 1987). Creativity is to break former rules, and then make unexpected and valuable things and ideas (Gero 1996). In 1960's, Getzels and Csikszentmihalyi (1976) presented an important concept, which was the preliminary phase of discovering or devising problem, to added a new phase before Helmholtz's cumulative phase. As a result of the accumulation of previous research, we derive a rough structure of creating process, which is inspiration, accumulation, incubation, heuristic, and verification. Liu (2001) and Lynn's mentioned that someone has to concentrate on some system unceasingly, and

then creativity might just occur until he mastered the main points of the system.

However, Csikszentmihalyi (1988) thought *creativity* could not be only defined by itself, but must be generally consider "field", "domain", and "person". He brought up the concept of social/cultural creativity. Later, Liu (2000) combined the model of social/cultural creativity with personal creativity from Simon's problem-solving view (Newell, Shaw and Simon 1962), and then presented a dual generate-and-test model of creativity. Nevertheless, the research mainly discusses the relationship of creativity between personal and design media and therefore does not extend to think about the relation of society and culture.

Creativity is always interested in many fields. Particularly, creativity and design creativity have many interpretations (Boden 1991; Gero and Maher 1993; Kim 1990; Sternberg 1988). The design process is generally thought five stages, analysis, concept design, preliminary design, fine design, and production. Among the process, the stage of concept design is the behavior of conception of bringing up temporal solutions (Jones 1992). The Behavioral and Gestalt school take the mental careers of this stage as "black box" (Rowe 1987).

1.2. THE SIGNIFICANCE OF CONVENTIONAL AND DIGITAL MEDIA IN THE PROCESS OF CONCEPTUAL SKETCHES

In the early conceptual design process, designers use large number of sketches and drawings (Purcell and Gero 1998). Furthermore, the sketch as a design tool can inspire the designer while increasing the creativity of the designer's work (Goldschmidt 1994). Mitchell (1993) also indicated the image recognize of sketches behavior was the main origin of creativity. Design thinking is viewed as a creative thinking process that transforms designers' mind to its corresponding visual image (Nagai et al. 2003). The sketches were the start of creativity inspiration (Tversky 1999). Therefore, the drawing process of sketches included a lot of creative thinking and process, and previous work showed that the freehand sketches by conventional media have been believed to play an important role in processes of the creative design thinking (Goldschmidt 1991; Schön and Wiggins 1992; Goel 1995; Suwa et al. 1997; Verstijnen et al. 1998). Most of these studies have used freehand sketches as a media to analyze the design activity. Also, digital sketching as a media can be studied, as there is little research on comparing the traditional versus digital media (Bilda and Demirkan 2003).

Many studies have verified that using conventional media in the conceptual sketches arouse creativity (Goldschmidt 1991; Schön and Wiggins 1992; Goel 1995; Suwa et al. 1998). Furthermore, with the

emergence of digital media recently, there are more and more researches an increasing number of studies have investigated on the influence on creativity of digital media. After computer media stepped in to design activity, computer-aided-design made a lot of changes in all the design process. Recently, many design-based studied of creativity have investigated to the field of design operations and attempted to identify the possibility of combining creative activities with computer use (Gero and Maher 1993; Mitchell 1993; Gero 1995, 1996; Boden 1998). Consequently, digital media have been utilized to apply creative activities, which generated the unexpected discovery in early design processes (Boden 1998; Chen 2001; Gero and Maher 1992; Mitchell 1993). Additionally, Mitchell (2003) believed that there was the absolute correlation existed between media and and creativity, and that the tools used are important to art and design. Furthermore, Mitchell also argued that digital science and creativity can make up for deficiencies in human being's creative thinking. Most of previous research determined that conventional and digital media influence design creativity. Therefore, this study attempts to understand design creativity phenomena using conventional and digital media.

2. Problem and Objective

This study first investigated the design behavior of practical designers familiar with both conventional and computer media. These designers utilize conventional and digital media simultaneously when producing conceptual sketches. Interestingly, designers are unaware of the correlation between creative thinking and design media in this process and don't pay close attention to it. Why designers choose two types of the media simultaneously when sketching conceptual processes, and then whether they can inspire more creative idea by using conventional and digital media simultaneously.

   Different design media have different affects on design creativity; however, because of different research problem and objective, previous works only discussed that the effect of the individual media on design creativity (e.g., Chen 2001; Coyne and Subrahmanian 1993; Goldschmidt 1991, Goel 1995; Liu 2001; Mitchell 1993; Verstijnen et al. 1998). Therefore, the author feels like adding to discuss using two types of the media simultaneously in the design process, and this study investigates whether it could inspire increased creativity when designers use conventional and digital media simultaneously as sketching media to generate conceptual sketches? This study also examines some phenomenon of combining both conventional and digital media on design creativities in the conceptual sketches and compares them with that when using an individual media. If designers using conventional and digital media simultaneously during conceptual processes have more creative ideas than

only using one media of them, it would follow that using diversified media can help enhance design creativity.

3. Methodology and Steps

Cross (1999) brought up for almost forty years the kinds of methods for researching the nature of design thinking that have been used have included *interviews with designers*, *observations and case studies*, *protocol studies*, *reflection and theorizing*, and *simulation trials*, and then interviews with designers, observations and case studies, and protocol studies all are suited to the interaction of designers and design tasks. The research mainly discusses the relationship of creativity between design media and conceptual sketches. However, when designers drew sketches by using design media at the concept generation stage of the design process, they don't usually take care of the conventional or digital media in hand. Therefore, if designers are expected to perceive and present explicitly the relationship of media and creativity, it may some of the following difficulties.

- In the design process, an expert designer's eyes, hands, and brain interact frequently himself and he usually takes no notice of his design tools in hand. Most of time he unconsciously changes a suitable design media for his drawing. Because designers commonly don't think more about the issue of design media in the design process, the author maybe not get multi-aspect and deep answers by directly interviewing with designers.

- When designers choose conventional media, digital media or both of them at the concept generation stage of the design process, the reason may be the convenience of situations at that time or the suitability of the design case. However, most of time designers themselves never think about the issue. If asking them to separate into three kinds of situations and to discuss them, it may make confuse and then can't reflect the problems correctly.

- Expert designers almost think the inspiration of creativity is affected by designers themselves. They usually are not conscious of the influence of design media on creativity, even not identify with it. So if to discuss the relationship of media and creativity with designers, the author may get unreal answers.

Because of previous phenomena, the author needed to design an experiment situation in order to get objective data. The author arranged a design task. Different participants individually finished the same task with different design media, and later proceed with a brief interview based on the previous design process. The research mainly observed the influence of creativity on conventional and digital media. Because the sketches in the concept generation stage are the most important and creative stage (Purcell

and Gero 1998; Goldschmidt 1994), the research concentrates the data on the stage of conceptual sketches to collect and analyze. The use of sketches is mainly at the early concept generation stage of the design process; therefore, the research defines sketches as all the conceptual drawings before deciding the final case.

The research consists of two parts. The part one also includes two stages. At stage one, there are three experiments in a protocol analysis of retrospective reports. Three participants individually worked on a design task while drawing sketches by skilled in conventional media, digital media, and both conventional and digital media simultaneously as design tools. At stage two, the author interviews the designers based on the precious process of experiments. After these three experiments are completed, the second part is the analysis of the reported verbal data and visual image from the stage of conceptual sketches during the design task. The data is discussed with two aspects, creative thinking processes and design results. Before the experiments, the warm-up experiments should be accomplished to prove that the chosen subjects are suitable for the experiments.

3.1. EXPERIMENTS

The most typical method for analyzing subjects' cognitive processes is and has been concurrent thinking-aloud verbal reports (Ericsson and Simon 1993). The method is extensively applied to the research of design activities. However, previous works indicated that talking aloud may adversely interfere with participants' perceptions during their sketching activities (Ericsson and Simon 1993; Lloyd 1995; Suwa and Tversky 1997). Edwards (1986) also mentioned that there are two cognitive modes in human's brain, the L-mode of vocabulary and the R-mode of vision. If people draw and talk at the time, there will be conflict between L-mode and R-mode. So they can't work simultaneously. Therefore, participants were not asked to report concurrently what was going on in their minds, nor were they interrupted by the experimenter during the design task. Their sketching activity was videotaped and the author did not participate in it. Following the design task was the report task which watched their own videotape. Participants were asked to remember and report what they were thinking as they drew each portion of each sketch.

The object of research results expected to suit to all novice designers and students in design schools in order to be the reference of design training of creativity. The study selected participants are from a pool of designers with creative potential, and are not generally acknowledged as creative designers in the world. Thus, all of the participants have already been awarded some design prizes.

In the design task, each participant worked on designing a logo of theater and concert hall through successive for 45 min. The logo included National Theater and Concert Hall of Chinese and English name and presented the human characteristic of performing arts in Taiwan. Because Logo design is the groundwork for various field of design and not the fixed rules and criterions, it is very suitable for the subject of conceptual thinking. It can also be applied extensively later.

3.1.1. The Preparation of Pre-experiment

Due to the difference of design discipline, experience, and background, each participant showed various creative thinking and ideas. In order to reduce the diversity, the author chose ten pieces of the most general but different pictures which were related to the design task and then the pictures would be the start of each participant's conceptual thinking. After participants received the same visual stimulants, immediately they worked on designing the task by using different media.

3.1.2. Experiment One: Conventional Media

The experiment is with respect to the behavior that designers generate sketches while using conventional media in the concept generation stage. It is done according to the traditional sketching method, not concerning about computers. The objective is to discuss the creative thinking of designers generating concepts in his traditional way.

1. Subject A: An expert designer is one who has an excellent ability to generate conceptual sketches using conventional media, and has more than three years of design-based education.
2. Topic: The logo of National Theater and Concert Hall.
3. Tools: Papers, pens, rubbers and rules.
4. Process: Subject A was asked to generate 8-10 idea sketched fitted the demand of the experiment and then selected 2-3 satisfied conceptual ideas and say why.

After the experiment, Subject A was asked a brief interview about his sketches. After experiment one finished, the cognitive behavior of the designer while using conventional media generating concepts was studied.

3.1.3. Experiment Two: Digital Media

The experiment is with respect to the behavior that designers generate sketches while using digital media in the concept generation stage. It is done according to the computer-aided sketching method, not concerning with the conventional media. The objective is to discuss the creative thinking of designers generating concepts in the computer-aided aspect.

1. Subject B: An expert designer is one who has an excellent ability to generate conceptual sketches using digital media, and has more than three years of design-based education.
2. Topic: the same as Experiment one.
3. Tools: Hardware (Pentium D computer, 19inch monitor, keyboard, and mouse), Software (Illustrator CS2).
4. Process: The same as Experiment one.

3.1.4. Experiment Three: Conventional Media and Digital Media

1. Subject C: An expert designer is one who has an excellent ability to generate conceptual sketches using both conventional media and digital media, and has more than three years of design-based education.
2. Topic: the same as Experiment one.
3. Tools: Conventional media: papers, pens, rubbers and rules; Digital media: hardware (Pentium D computer, 19inch monitor, keyboard, mouse, and scanner), software (Illustrator CS2).
4. Process: the same as Experiment one.

Figure 1. The process of experiment one and experiment two

3.2. BRIEF INTERVIEWS

After a participant finished the first stage, the author interviewed with him at once. There are two parts in the interviews. In part one, according to the used design media of the design task, the participants would discuss it more deeply. In part two, according to each sketch in sequence, the participants of experiment one and experiment two would try to compare with the difference between the use of original media and the added other type of media; and further, the participants of experiment three would try to think what different from only using one of both the media.

3.3. ANALYSIS

After these three experiments are completed, the second part of the method was the analysis of the results from those experiments. The major analytical source was the retrospective data, and the supporting data was the verbal data of the interviews that subjects were asked after the experiments. The verbal protocols of the retrospective data were the main target of my analysis.

A conceptual sketch of the entire design process in one experiment is regarded as a section and then each section would be encoded. After coded, each encoded data of sections are put together to integrate and compare with three experiments. The method of segmentation based on the shift of subject's intention, of the contents of their thoughts, or of their action (Suwa et al. 1998, 2000). Furthermore, the entire design process includes many blocks of contiguous segments. Suwa (1997) brought up a concept of 'dependency chunk'. Each block is a *chunk*. For each segment, it would be simply coded cognitive actions of designers into four categories. They are physical, perceptual, functional and conceptual (Suwa et al. 1998). The entire process of analysis is briefly showed in Figure 2.
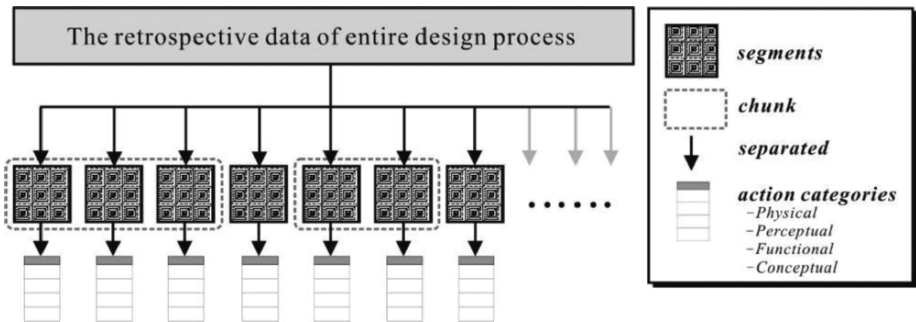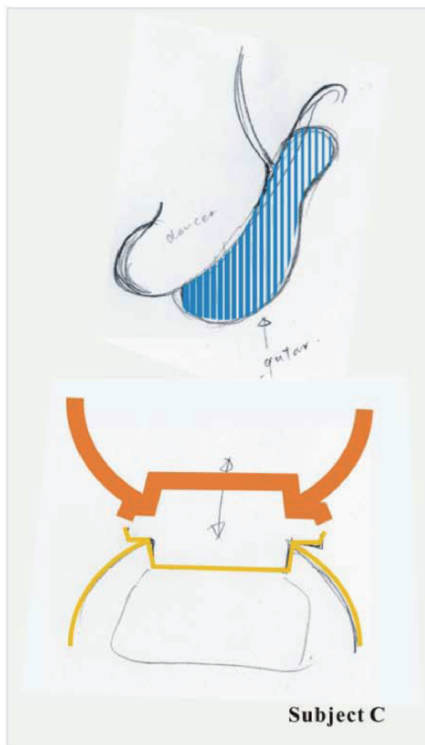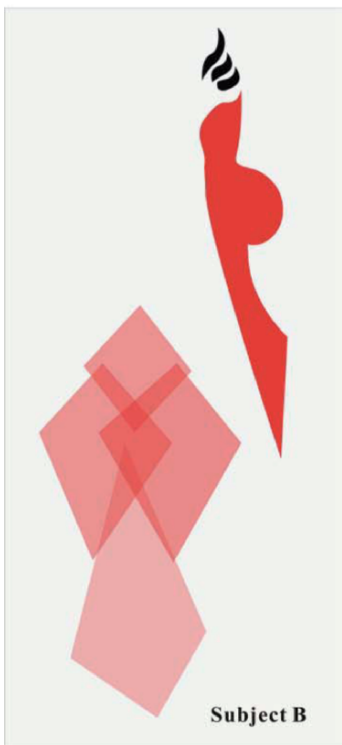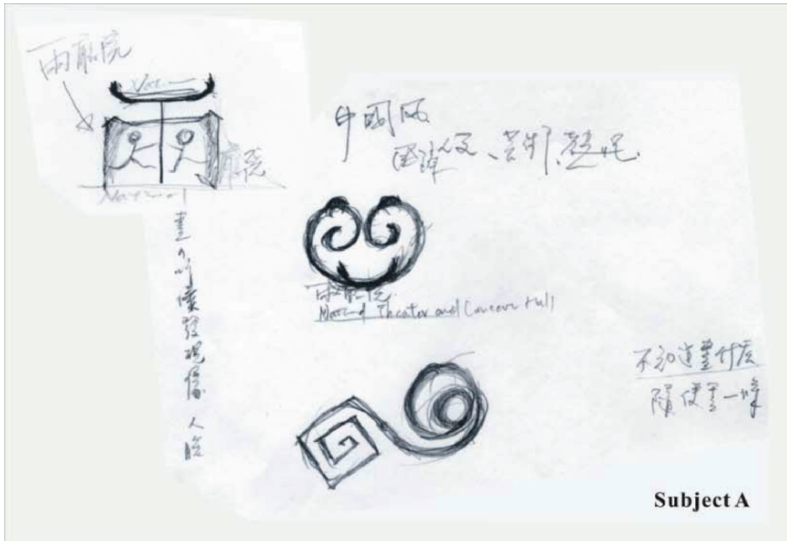

Figure 2. The process of analysis

Figure 3. The satisfied conceptual sketches selected by three participants

4. Results

This paragraph mainly discusses some phenomena associated with the design processes of the three participants' and their sketches during the early conceptual design phase. In the aspect of the design process, there are two parts. First, it has more *instants* when using conventional and digital media simultaneously than when just using either conventional or digital media. It is perceived that using conventional and digital media together generates more complex design thinking in the shift of cognitive actions of designers. In conceptual actions, the difference in numbers of *instants* for using conventional and digital media simultaneously and one of them is small. However, the contexts of conceptual actions in experiment three covers both contexts of experiment one by using conventional media and experiment two by using digital media. Second, for experiment three, when the participant changed from one media to the other, the participant could continue thinking about new possibilities and solutions based on existing conceptual drawings. Consequently, it would obtain the longer *chunks* than experiment one and experiment two; furthermore, there are some different styles before and after changes of media. In other words, when using conventional and digital media simultaneously, the designers would think more deeply and the creative thinking would be more flexibility. It would widen the thinking space. Therefore, after changing media, designers could refresh the old conceptual ideas which originally were ceased thinking or could not be thought.

In the aspect of the design results, in the experiment one, the freehand sketches had more ambiguous part and conventional media were easy to be noted. Ambiguous and vaguely defined properties of the design sketches came was recognized as a major influence on the creative process (Liu 1998). By using sketches and notes, the designers could arouse creative thinking. This is because of the characteristics of conventional media. In the experiment two, the designer could easily paint colors, and then consider color combinations. Furthermore, he could start to consider the possibility of overlapping colors; however, the sketches developed using digital media lacked the ambiguous characteristics. In the experiment three, the designer considered the conceptual ideas more deeply than in the other two experiments and continued thinking about others due to owing both properties of the conventional and digital media to operate. The latter sketches would be influenced by the former, such that the former sketches using both conventional and digital media owned two design styles and then affect the latter ones which were not likely to stimulate in the experiment one and two.

The experimental results demonstrate that using conventional and digital media simultaneously, as comparing with using only one media, helps

arouse creative thinking and cognitive activity and improves the design outcome in the stage of conceptual sketches design. Particularly, the interaction between two media promotes cognitive thinking to the broader field and find more complex mode of design thinking. The combination of conventional and digital design media not only provides diverse experiential association, but also has more opportunities than individual media to generate creative results. Therefore, the integrating design media may stimulate design creativity in the stage of generating concepts.

Designers can get diverse conceptual ideas and be guided into gradational thinking by using both media simultaneously. Designers generate two different results that can be combined when designing with the two media, thereby promoting creative thinking. All of them can help arouse creativity.

5. Conclusions

The objective of this research was to verify the hypothesis that using conventional and digital media simultaneously can improve designers' design creativity during the early conceptual design phase. However, the process of the experiment three identified the shift between conventional and digital media which mirrors the transformation from analog to digital data. That is time-consuming and inconvenient. Moreover, the research investigated the relationship between personal creativity and design media, but did not extend to discuss the relationship between society and culture. Using conventional and digital media simultaneously to improve designers' design creativity may be insufficient for obtaining socio-creativity results. To produce the socio-creativity must be integrated with numerous elements and efforts and then just will be possible to make it. Even though it is, the results of the research suggest a capable method for promoting design creativity. Furthermore, because only one invited participant using one media, study results are limited by insufficient sampling. This is one of the limitations in the research. If it can be applied in practical and observed quantitatively in the future, we can discuss the results further.

The research found that when using conventional and digital media in combination, designers can get more creative ideas during the stage of conceptual thinking than when just using conventional or digital media. These findings suggest that integrating various design media is one feasible method of inspiring creativity, and can be applied to the design training of creativity on education and to the designer's practical operation. Additionally, in the application of Computer-Aided Design, we have known digital media brought a new face in the world, and have stimulated the creative design thinking, especially during the stage of conceptual thinking. However, the use time of conventional media is longer than that of computer media. In the past, designers only used conventional media, but their creative

ideas have never brought to an end. Computer and conventional media have different advantages. If we can integrate these two media, we may be able to find some creative integrated idea or provide a new opportunity to initiates more possibility of new media to assist design. That supply a new way in the development of CAAD. Research into creativity can create a way to improve creativity forward and might help understand *what creativity is*.

Acknowledgements

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