ROLES OF REFERRING-SKETCHING ACTION FOR THE DESIGN IDEATION

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Abstract: The study mainly explored the behavioural flow and the linkage relationship between the searched content and the transformed ideas in designers' ideation process through the methods of in-situ observation of four practicing graphic designers. This paper proposes a two-stage S-R behavioural flow within a designer's ideation process. And the main findings show that first, designers tend to generate more different directions of ideas in the "S-R for WI" stage period and combine different ideas or combine them with their imagination in the "S-R for CNS" stage period. Second, the visual stimuli with more concrete features that designers found was utilized to combine with others to form a complete idea while the visual stimuli with more abstract features seem to be combined with the designer's imagination to form some ideas that differed from the previous ideas. Moreover, the study should be regarded as a pilot study for proposing an analytic method to the related research in the design field and other possible methods should be utilized to in the future for interpreting the deep linkage between the content they searched for and the ideas they generated.

Keywords: *Searching-retrieving behaviour, Ideation process, Graphic design*

1. Introduction

Designing is regarded as a particular kind of search process [1] in which a designer has to find an optimum solution to meet the initial design problem. Hence, a key issue in the design related research is realizing how a designer faces the design problem and generates the appropriate approaches to solve the problem in the ideation process, especially focusing on the transforming procedure and condition of the ideas. For this reason, many researchers have studied how designers utilize their own sketches and how such sketches help them think up ideas and concepts [2-5], by which researchers explore their behaviours and thinking procedures in the ideation period to catch the designers' thinking path through analyzing the designers' external representations. Therefore, a designer's designing is described as the well known interactive structure of "seeing-moving-seeing" [3] based on the designer's "reflection". Designers' seeing action may include both the designer's active searching intention and the content they are seeing.

In terms of the content, visual stimuli may become the trigger that draws out the designer's reflection which then influences the designers' actions within the ideation process.

Therefore, many researchers believe that more visual clues trigger designers' mental images in their ideation process [3, 6-12]. On the other hand, Gero and Kannengiesser [13] utilized the interactive relationship among the three worlds, "external world", "interpreted world" and "expected world", to illustrate the situated designing (Figure 1) that may interpret the designers' intention of their active searching behaviour. That is, a designer's searching-retrieving (S-R) behaviour could be regarded as the external presentation of his/her expected world, and the targets that a designer is searching for or retrieving on-line therefore are predicted according to current goals and interpretations of the current state. Moreover, Cheng and Yen [14] have found that most designers spend about one-third of their ideation time to search for relevant reference materials and the behaviour absolutely is essential in the designing procedure. However, what kind of stimuli the designers referred to connects with which type of idea they generated has not been discussed so frequently in the literature. Thus, in this study, the authors attempted to address the relationship between the visual stimuli they were referring to and the sketches they were creating in the ideation process through focusing on their S-R behaviour.
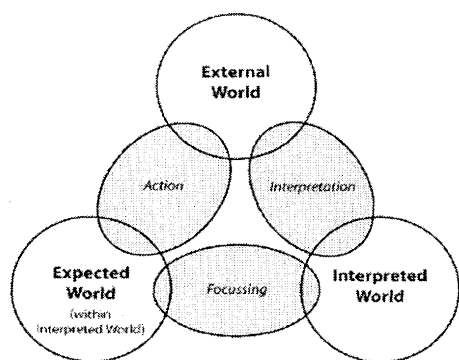
Figure1. Situatedness as the Interaction of Three Worlds [13]

(a) participant A   (b) participant B

(c) participant C   (d) participant D

Figure2. Monitoring Method in This Experiment

Due to most related research about the designers' thinking process or behaviour has concentrated on the area of product, engineering or architectural design, as well as the related experiments were mostly carried out with the subjects of such design areas [15-18]. It is very important to explore the features of graphic designers' ideation process for further comparing with the product, engineering and architectural design area in the future research. Therefore, in this study, we focused on the linkage relationship between the searched content and the transformed ideas within the graphic designers' ideation processes. And our observations on the designers' sketches aim at tracing the interlinking of their ideas as far as possible, in which the sketches could be regarded as a means of providing clues to trace the transformation of the designer's ideas.

2. Design of Experiment

This study conducted in-situ observation mainly to research the designers' searching-retrieving and to attempt to find the linkage relationship between the content they are searching for and the content they are sketching in the ideation process. Every participant in this experiment was allowed the greatest freedom and unrestricted searching for relevant data to perform an assigned task in his/her practicing space as the situated designing happened in everyday. Each participant was given the needed time to perform the assigned task in spite of the progress rate he/she achieved. We started recording after they read the task exposition the study provided while stopped recording when they thought that they have developed an expected idea to serve as the final representation. At the same time, in order to avoid interrupting the participants' ideation process, since designers might be reticent or unable to verbalize simultaneously whilst generating ideas [19], all their non-verbal behaviour and external representation throughout the period were monitored by a digital camera which was placed to right-back or left-back side of the designer (see Figure 2).
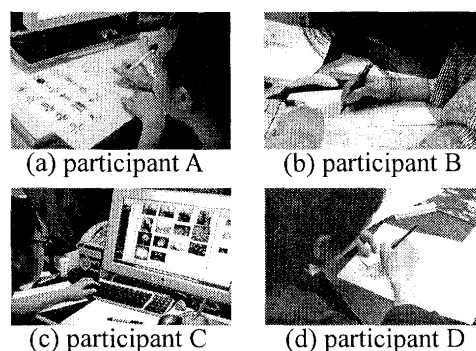
2.1. Participant and Task

In this study, four graphic designers participated in the experiment selected by judgment sampling method. All of them had at least one year of experience and were not aware of the purpose of the experiment. The four participants' personal information are presented in Table 1. The in-situ observation was executed in two individual studios, a clothing company and a design firm in Taiwan. Two participants were assigned the same task that was devised by the experimenter and the tasks in this study were as follows: 1) to design a mark for the Paralympics and 2) to design a DM for the New Year firework show (see Table 1).

2.2. Coding Scheme

The experimental data in this study was segmented according to a set of behavioural codes using the content analysis technique. The designer's behaviour coding scheme developed for the analysis were adjusted and shared the characteristics of Atman and Bursic's design activity coding scheme [20], Chusilp and Jin's cognitive activity model of conceptual design [21] and Cardella et al.'s representation coding scheme [22]. Moreover, the developed coding scheme was utilized to analyze the graphic designers' behavioural flow in Cheng and Yen's [14] and Cheng et al.'s research [23] as well. At the same time, the researchers also examined the whole film to ensure that each of the four participants' behaviours within the recorded data could be categorized into one of the behavioural codes. Therefore, the ten kinds of behavioural codes were the coding standards of this research (the ten behavioural codes with definition are shown in Table 2).

In the classifying process, two researchers cut the raw data, transcribed from the video part of the experiment, into many segments according to the time point of the changing behaviour. A segment is the behavioural unit, as well as the basic unit to explore the presenting order of the designers' S-R behaviour and the linkages between S-R behaviour and other behaviours during the participants' ideation process in

Table 1 Four Participants' Individual Information and the Design Task

Participant	Sex	Experience(years)	Type of company	Design task
A	Female	7	Individual studio	to design a mark for the Paralympics
B	Female	2	In-house designer	
C	male	6	Individual studio	to design a DM for the New Year firework show
D	male	1	Design firm	

Table 2 Behaviour Coding Scheme

Behaviour (code)	Definition
Analyzing task (AT)	Reading task exposition provided by the experimenter; understanding and analyzing problems
Writing down ideas (WI)	Writing down keywords as the ideas they generated to be used later; listing, adding or adjusting different alternatives
Reading own keywords (ROK)	Reading the keywords they have written down in advance
Looking at own sketches (LOS)	Looking at the sketches they have drawn in advance
Looking at relevant information (LRI)	Looking at the information they have searched for or retrieved in advance
Deciding conception (DC)	Selecting, combining or composing the alternatives they have written down in advance
Searching-retrieving information (S-R)	Searching for information in the reference material for capturing ideas, sketching or drawing; pasting memo stickers on reference; retrieving information on-line for capturing ideas, sketching or drawing; saving the retrieved information in the hard disc
Gathering information they searched for or retrieved (GISR)	Gathering relevant information they searched for; arranging relevant pictures or information by computer program and printing it out for later reference
Creating new sketches (CNS)	Creating the new pictures, labels or arrows
Continuing to sketch (CS)	Continuing to work on a sketch they have drawn by drawing the pictures, labels or arrows

this study. Each segment was put into one of the nine codes by two people, one researcher and a coder who directly classified all segments which had been cut in advance into the behavioural codes. Each categorized segment coded by the coder was compared to the researcher's for evaluating inter-coder reliability. Finally, we drew the connective relationship between the searched content and the transformed ideas in detail after discussing the exhibited order of the four graphic designers' all behaviours and their sketches.

3. Results and Discussions

This study conducted in-situ observation mainly for researching the two participants' S-R behaviour and find the linkage between the searched content and the transformed ideas in their ideation processes. Analyses therefore concentrated on the designers' S-R behaviour that exhibited in their designing and the content they were searching for and their sketches in this study, including the presenting order of all their behaviours and the linkage between their searched visual images or written words and done sketches.

3.1. The Presenting Order of All Behaviours in Ideation Flow

The presenting order of the four participants' all behaviours after they read the task exposition during their tasks are shown in Figure 3. This figure indicates the order of ten kinds of behavioural codes that appeared during their ideation process. The numbers below the transverse axle of Figure 3 show the presenting order of the corresponding behavioural codes. That is, the first behavioural code of the four participants is S-R. Moreover, in order to clearly show the four participants' presenting order of their behaviours in a figure, the thin-black, bold-black, bold-gray and gray-dotted lines are individually utilized to indicate the behavioural flow of participant A, B, C and D. For instance, all behaviours of participant A in order are S-R, GISR, S-R, GISR, S-R, GISR, WI, GISR, WI, LRI, WI, S-R, WI, DC, CNS, S-R, CNS, S-R, CS, LOS, CNS, WI, CNS, DC, CNS, CS, S-R and CS. Additionally, each CNS behaviour segment of the four participants might not merely include a new created sketch. The amount of done sketches during a participant's CNS behaviour segment does not be shown in this figure, but will be slightly mentioned about later.

In terms of analyzing the results shown in figure 3, the study found a similar presenting order of a stream of behaviours appears in the four participants' ideation flow. In other words, we mainly obtained two noticeable stages of behavioural connection that focused on the S-R behaviour within their designing by analyzing the experimental data (see Table 3). First of all, the first stage is a set of majority behaviours in which the S-R, LRI and WI behaviours
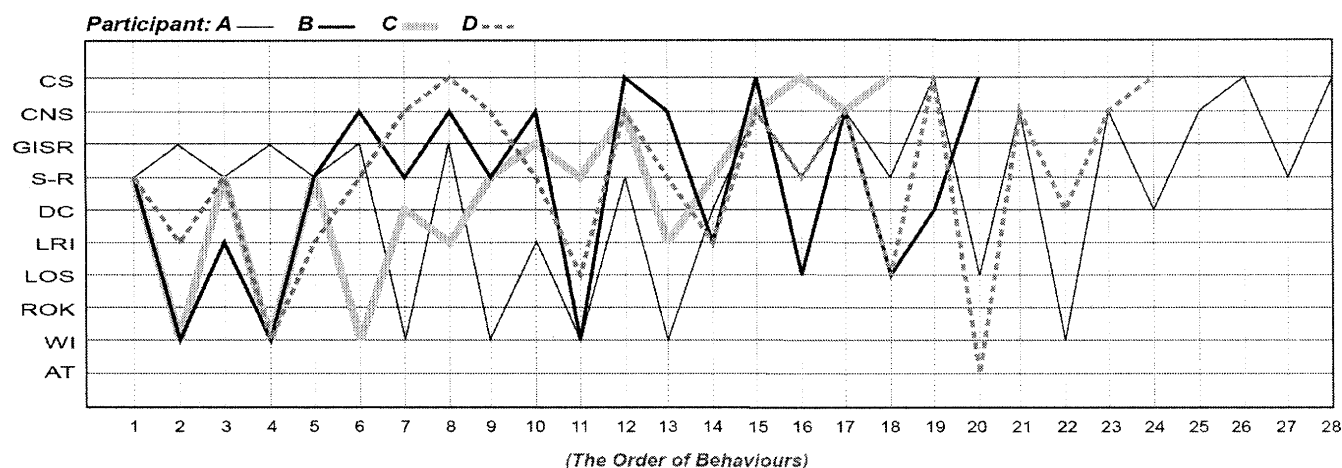
Figure3. The Presenting Order of the Four Participants' All Behaviours within Their Ideation Process

appear frequently from the 1st to the 14th behaviour of participant A's ideation flow, from the 1st to the 5th behaviour of participant B's, from the 1st to the 8th behaviour of C's and from the 1st to the 6th behaviour of D's. However, we also found participant A frequently arranged the retrieved data (GISR) by computer while other three participants seldom or had no this behaviour within the same stage. For this reason, GISR behaviour does not be regarded as the one of the main behavioural codes in this stage. The second stage is also a set of majority behaviours in which the CS, CNS, S-R and LOS behaviours appear frequently from the 15th to the 20th behaviour of participant A's ideation flow, from the 5th to the 10th behaviour of participant B's, from the 9th to the 14th behaviour of participant C's and from the 6th to the 19th behaviour of participant D's.

The two noticeable behavioural stages related to the S-R behaviour in the four participants' ideation process are shown in Table 3 and interpreted as follows. In the first stage, participant A, B and C all started to retrieve relevant information on-line through keying some keywords on the websites of search engineers after they read the task exposition while participant D searched for relevant visual stimuli from a reference book. Then the four participants were writing down some ideas they have gotten on the paper while they were searching for some data from a reference book or retrieving relevant information on-line by computer (S-R) and looking at relevant data (LRI). Among them, participants A particularly printed out the well arranged visual image she retrieved on-line as the reference material for stimulating herself to generate some ideas and write them down. The main behaviours they are presenting in this stage are searching for or retrieving relevant information (S-R), looking at relevant information (LRI) and writing down their ideas (WI). Therefore, the major
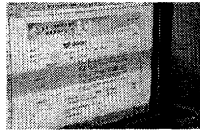
intention of the participants when they are presenting the S-R behaviour in this stage is "to write down the generated ideas". For this reason, the stage is termed as "S-R for WI" stage in this study.

After the "S-R for WI" stage, participant A and D searched for some visual stimuli from the reference book (S-R) mainly for creating new sketches (CNS). At the same stage, participant B and C were retrieving some visual information on-line through keying in some keywords on the website by computer to create new representations similar to participant A and D's intention. In particular, a large number of more complete sketches were done by the four participants in this period: participant A created 7 sketches (totally 11 sketches had been created), participant B 16 (totally 20), participant C 5 (totally 7) and participant D 10 (totally 16). The chief behaviours they are showing in this stage are searching for or retrieving relevant information (S-R), looking at own sketches (LOS), creating new sketches (CNS) and continuing to sketch (CS). And the major intention of the participants when they are presenting the S-R behaviour in this stage is "to create new sketches". The stage therefore is termed as "S-R for CNS" stage in this study. After this stage, most of them seemed to continually revise and adjust the sketches, adding some elements to the previous figures or drawing clear-cut outlines of the previous designs they have accomplished (CS).

3.2. The Linkage between the Searched Content and the Done Sketches

In order to find the linkage relationship between the content they were searching for and the content they were sketching in the ideation process this study mainly analyzed the experimental data of the four participants' "S-R for CNS" stage in which they are searching for some specific stimuli obviously while creating the new sketches. For

Table 3 Two Stages S-R Behavioural Flow of the Four Participants

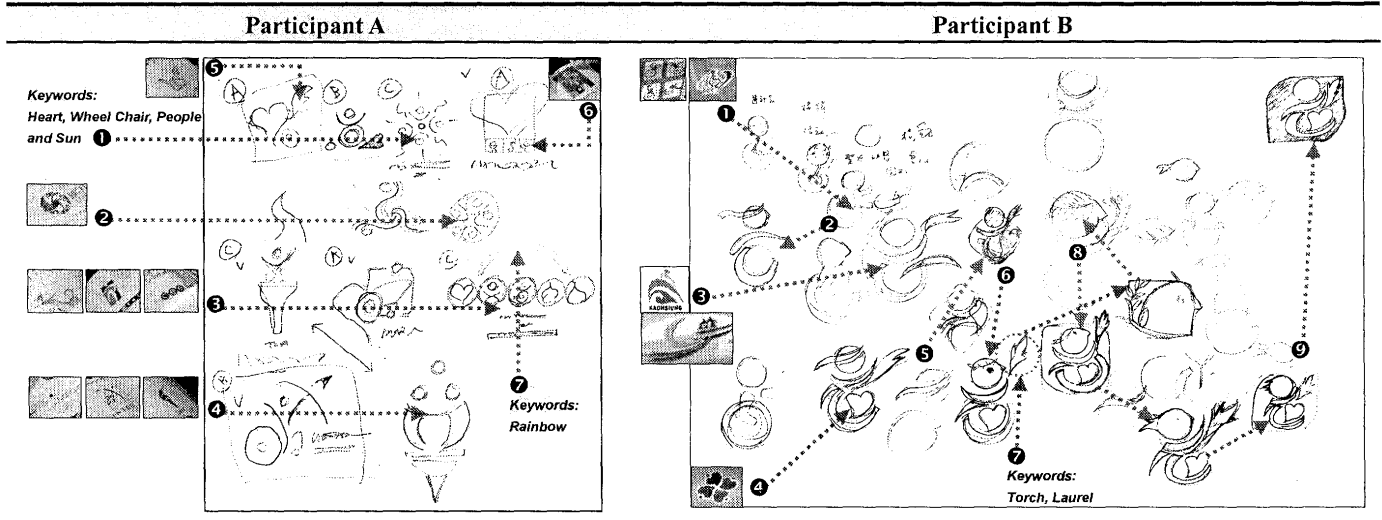| Behavioural Stage	Main Behavioural Codes	Participant A	Participant B	Participant C	Participant D
S-R for WI	S-R, LRI and WI	$1^{st} \sim 14^{th}$ behaviour	$1^{st} \sim 5^{th}$ behaviour	$1^{st} \sim 8^{th}$ behaviour	$1^{st} \sim 6^{th}$ behaviour
S-R for CNS	CS, CNS, S-R and LOS	$15^{th} \sim 20^{th}$ behaviour	$5^{th} \sim 10^{th}$ behaviour	$9^{th} \sim 14^{th}$ behaviour	$6^{th} \sim 19^{th}$ behaviour

Figure4. The Participants' Searched or Retrieved Content and Sketches

illustrating the linkage between the type of visual stimuli and the transformation of ideas in detail, the experimental data of participants A and B that shows the clear path of targets-searching and monitored by a proper visual angle, left-back side of them, was selected in this study. For this reason, the experimental data we utilized in this section were the segments from the 15th to the 20th behaviour of participant A's behavioural flow and from the 5th to the 10th behaviour of participant B's. The searched or retrieved content and done sketches of the two participants in their ideation process are shown in Figure 4. And the dotted arrows with digits in Figure 4 show the order that the two participants carried out the sketches in this period. Moreover, we place the pictures outside the participants' main sketches in sequence through examining the searched or retrieved content in the experimental data.

The sketching procedure of participant A is shown in the left side of Figure 4 and interpreted it in sequence as follows. First of all, before her "S-R for CNS" stage period, she had keyed in six keywords to retrieve some information

on-line in order to generate ideas, which included "Olympic", "disabled-people icon", "Paralympics" and so on. Then she had written down 27 words on a piece of paper by referring the retrieved data in the "S-R for WI" stage period. The 27 words as the ideas were utilized later on, which included "heart", "wheel chair", "people", "sun", "circle", "rainbow" and so on. After that, she started to search for some visual stimuli from a reference book and pasted memory stickers on the targets she needed as reference materials. And then, she continued by writing down five words which include "wings", "lines", "colorful", "silhouette" and "movement".

Next, she simultaneously drew some sketches as the first arrow shows and referred to the visual stimuli she had marked after having pasted memory stickers by or by looking at the words she has written down before. This period therefore transferred "S-R for WI" into "S-R for CNS" stage at this point. However, the four sketches obviously were influenced by the written down words, such as "heart", "wheel chair", "people" and "sun". Then she did

another three designs by referring to an abstract form as the picture shows which is placed to the left of the second arrow. We then found the three sketches that participant A had done differed from the others from which we conjecture that she was inspired by the abstract form.

After that, she accomplished another three sketches by referring to the left picture near the third arrow, which includes figures of people, a running person and several circles, and the ideas she has used in the figures of the first arrow. Subsequently, she finished the two sketches below by referring to the picture near by the fourth arrow. She obviously combined a moving figure and the archery. Following this, she added wings on the first sketch which resulted in the left picture near the fifth arrow. Then she added a square with three figures beneath on the fourth sketch of the first line that was influenced by the picture near by the sixth arrow. Lastly, she added a semicircle above the third sketch of the third line that was affected by the word, "rainbow".

In addition, participant B's sketching procedure is also shown in the right side of Figure 4 and describe it in sequence as follows. Before her "S-R for CNS" stage period, she had keyed in "defectives" and "gymkhana" to retrieve some information on-line to generate ideas. Then she had written down eight words on a piece of paper as the generated ideas like "gymkhana", "a relay baton", "activity", "people", "posture", "torch", "moving" and "circle". And she tried to draw an incomplete sketch. Afterward she started to draw a more complete sketch as the first arrow shows accompanied with S-R behaviour and referred to the marks of defective and Paralympics she retrieved on-line which near by the fist arrow. This period therefore transferred "S-R for WI" into "S-R for CNS" at this point. After this, she carried out the second and third sketches by referring to the two abstract figures as the picture shows that are placed to the left of the third arrow. And we also found the sketch as the third arrow directs is different from previous sketches from which we may conjecture that she was inspired by the two abstract forms.

After that, she carried out the fourth sketch which is composed of the third sketch and a heart figure. Then she tried to transfer the form of the fourth sketch into the fifth sketch by adjusting the position of the heart figure. Subsequently, she carried out the sixth sketch by changing the colored ribbon to the fire form by referring to the word she has written down, "torch". And then, she tried to draw some new sketches indicated by the seventh arrow which were affected by the word, "laurel". Then she gave up the idea of laurel and kept on adjusting or revising the sixth

sketch into another three sketches which are indicated by as the eighth arrow. Lastly, she accomplished a mark through clearly drawing the outline of the figure as the ninth arrow shows and adding black tone to it.

3.3. Discussions

In this study, the desingers' S-R behavioural flow in the ideation process is divided into two main stages by analyzing the connective relationship between all designers' S-R behaviour and other behaviours and exploring the intentions of different stages during their ideation process. That is "S-R for WI" stage and "S-R for CNS" stage. The behavioural chain of "S-R for WI" stage includes the behaviours of searching for or retrieving relevant information (S-R), looking at relevant information (LRI), and writing down generated ideas (WI). Designers in "S-R for WI" stage period may appear the "analysis" and "generation" activities. And the main intention of this stage is to generate ideas and write or note them down. However, the behavioural chain of "S-R for CNS" stage includes the behaviours of searching for or retrieving relevant information (S-R), creating new sketches (CNS), continuing to sketch (CS) and looking at own sketches (LOS). Designers in "S-R for CNS" stage period may appear the "generation" and "evaluation" activities. And the main intention of this stage is to create new sketches as the representation of their generated ideas.

According to Howard et al.'s comparison of creative process [24], the phases of analysis, generation, evaluation and communication / implementation are included. They mentioned about more recent research psychologists have thought of the creative process could be interpreted as the design process and thus combined the phases of analysis, generation and evaluation with engineering design process to form a creative design process. Therefore, the activities of analysis, generation and evaluation within the graphic designers' "S-R for WI" and "S-R for CNS" stages we mentioned above obviously shows the similar feature to the engineering designers' design process. Accordingly, the graphic designers' ideation process may be analogous to the ideation process of the product, engineering or architectural design area.

In addition, two significant phenomena could be drawn in the observation of participant A and B's "S-R for WI" period and "S-R for CNS" period. First, the two designers tend to generate more different directions of ideas in the "S-R for WI" period than in the "S-R for CNS" period. However, the designers combined different ideas or combined them with their imagination to form the main
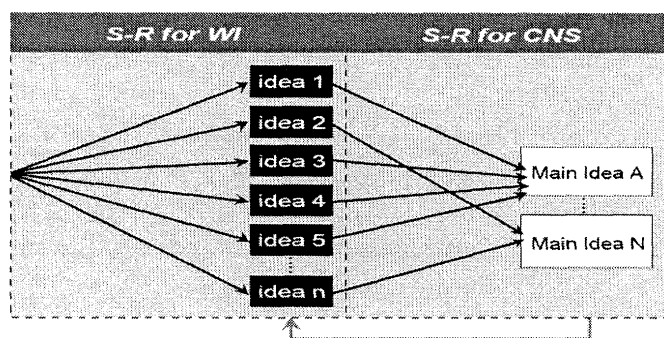
Figure5. Two-stage S-R Behavioural Flow in Designers' Ideation

ideas in the "S-R for CNS" period. In the findings, we may consider Guilford's conception of divergence-convergence thinking within creative process [25]. That is, designers develop ideas during their "S-R for WI" stage with more divergence thinking while with more convergence thinking during their "S-R for CNS" stage in their ideation process as Figure 5 shows.

Second, in terms of the linkage relationship of the searched content or the written words and the condition of the participant A and B's idea transforming, we found that the visual stimuli with more concrete features that the designer found were utilized to combine with others to form a complete idea. And this kind of stimuli inspired them to develop many similar ideas. However, the visual stimuli with more abstract features seemed to be combined with the designer's imagination to form the different ideas that differed from the previous ideas. Therefore, we adopted the three interactive worlds in Gero and Kannengiesser's discourse [13] to interpret this part of the results in this study. That is, in designers' ideation process, they try to imagine what will be needed in their "expected world" to present the searching-retrieving (S-R) behaviour in their "external world". Once the reference they found has the concrete feature sought after it will be combined together to form an idea through the designers' interpretation in their "interpreted world" that interacts with their "external world", in which the individual reference may be treated as a component that is assembled with others to be a whole. On the other hand, the reference they found that has an abstract feature will be immersed in designers' "expected world" that is then combined with their imagination to form a different idea, in which the individual reference may be like a tractor for drawing out the designers' memory, experience or knowledge to interact with the abstract reference to create a new one.

However, the study also found two major differences in the whole ideation process among all participants. Firstly, in their task, most designers retrieved relevant information

on-line by computer for developing the ideas during their whole ideation process except participant D. It may raise the potentiality that the influence of the retrieving behaviour on designers' representation can be considered by design-related research in the future. Second, among all designers, only participant B seemed to continually create new sketches by referring to the previous realistic sketches she had done. Her tendency resulted in the amount of similar ideas she generated during the whole ideation process (see the sketches in the right side of Figure4).

4. Conclusions

The study mainly examined four professional graphic designers' ideation process and focused on their searching-retrieving behaviour (S-R) and described the connective relationship between the searched content and the transformed ideas of participant A and B. From the results we propose the designers' S-R behavioural flow in the ideation process is divided into the two main stages of "S-R for WI" and "S-R for CNS". Moreover, three main findings in the study were: first, the designers tend to generate more different directions of ideas in the "S-R for WI" stage period and combine different ideas or combine them with their imagination in the "S-R for CNS" stage period. Second, the visual stimuli with more concrete features that designers found was utilized to combine with others to form a complete idea while the visual stimuli with more abstract features seem to be combined with the designer's imagination to form some ideas that differed from the previous ideas. Third, designers tend to develop similar ideas when the references they searched for were more concrete. On the contrary, the abstract visual stimuli seem to give designers more different kinds of perspectives to form a greater diversity of ideas than the concrete visual stimuli did.

Finally, there are some restrictions and insufficiencies during our research that we should revise in any further study. They include the number of the participants, the monitoring angle and the results through in-situ observation are the limitations in this study. Because the observational data analysis itself is a time-consuming process, cooperation with the behavioural coding scheme makes it almost impossible to provide statistically enough number of subjects. Thus, for the number of the participants, the research might be regarded as a pilot study for proposing an analytical method to the related research. Besides, by examining the experimental data, we found the improper monitoring angle during participant C and D's task, right -back side of them, made the analysis of precisely tracing

the designers' sketches transforming process is difficult Therefore, it should be noticed and improved in further study. However, it is still insufficient to interpret the deep linkage relationship between the searched content and the transformed ideas in designer's ideation flow merely through the method of in-situ observation. Therefore, other possible methods, such as retrospective protocol analysis, should be utilized as future studies.

5. Acknowledgements

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