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Making Ideation Visible: An Early-Design Tool for Designers

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We investigated the effect of an idea generating tool, IDEATOR, on the performance of designers during early-design concept development. We also investigated behavioural differences between designers in the fields of graphic, product, and interior design. To investigate their behaviour when using IDEATOR and satisfaction with its core functions, we conducted behavioural observations on, and usability interviews with designers of those three fields. The results indicate that most designers thought IDEATOR to be user-friendly, and found its most useful feature to be the 'mind map'. Results were as expected, and they fulfilled the preliminary study 'creative concept app (IDEATOR)' requirement. In addition, IDEATOR functions as an effective recording tool for future research on the process of concept ideation.

Keywords: design-supporting tool, ideation, IDEATOR, usability interview

1. Introduction

Segers, de Vries, and Achten (2005) constructed an idea space system to facilitate architects' design thinking. The system's word–image connection inspired designers to think creatively, inhabit more perspectives, and thus, enhance their work efficiency. Siangliulue, Chan, Gajos, and Dow (2015) conducted an online experiment to explore the effects of being offered examples at the right moment. The authors observed that examples provided on demand assisted in the creation of novel ideas. By contrast, examples provided at the wrong moment suppress the generation of ideas. In addition, Ahmed (2005) observed that 24% of engineering designers spent most of their time searching for information. Thus, the author asserted that information searches are vital in the design process and developed a method that enabled the designers to index design knowledge. Westerman and Kaur (2007) examined the retrieval of images from computer databases meant to spark the creative generation of ideas. They propose that creative design tasks require the support through information systems for both convergent and divergent processes. In addition, the use of keywords is integral to finding resources on the Internet. Thus, a 'keyword' is an important concept for researchers to understanding design cognition.

This study focuses on the connection between keyword cognition and design concepts. Compared with the past designers who used books as a resource, the current designers use

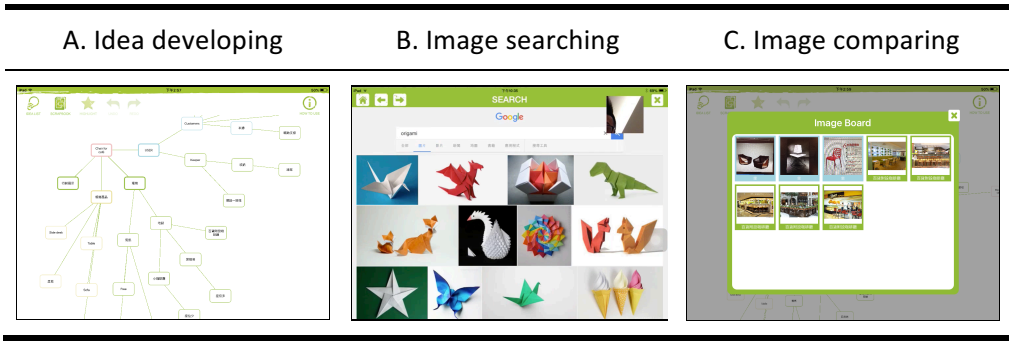
the Internet, resulting in a considerable shift in how they find resources. Specifically, in a 'thinking first' approach, designers must first identify keywords and require resources to that end. These keywords, necessary for finding the appropriate material, are used in a designer's visualisation. Designers can thus be inspired by numerous resources on the Internet.

Our preliminary research proposed 4 modes of association based on designer behaviour during ideation (Cheng, 2010; Cheng & Yen, 2008). We then developed a creative idea generation tool, 'IDEATOR' (Cheng, 2016, pp.89-95), to support designers during ideation. The main functions of the 'IDEATOR' (Figure 1) underlying designers' behavioural modes and resource searching needs in the ideation, support a designer's formulation of concepts by integrating image searches and stimulates design actions by displaying all the images on an image board. Unlike other studies on design thinking support systems, IDEATOR emphasises recording the designers' word thinking paths and processes (Function A in Figure 1). It assists designers in their repeated input, access, and storage of information. Our preliminary research results indicate that IDEATOR allows designers to add their own ideation sketches and brief descriptions while recording each concept, which made the results of their idea map similar to a designer's self-reports. In the process, keywords, ideation sketches, and images serve as a stimulus or as the object of 'seeing' in the 'seeing–moving–seeing' model (Schön & Wiggins, 1992).

IDEATOR provides designers with copious visual stimulation in idea development (Functions B and C in Figure 1), which is in accordance with research demonstrating that a designer's mental imagery can be triggered by an abundance of visual stimuli (Dorst & Cross, 2001; Suwa, Gero, & Purcell, 2000; Verstijnem, Hennessey, Leeuwen, Hamel, & Goldschmidt, 1998; McGown, Green, & Rodgers, 1998; Goldschmidt, 1994; Herbert, 1993; Schön & Wiggins, 1992). Such mental imagery aids designers in creating new ideas.

Nonetheless, most research on design-supporting tools focus only on designers from a single design field. Thus, this study investigates differences between graphic, product, and interior designers.

Figure 1. Three main functions of IDEATOR (Screenshot sequences from left to right indicate the functions for 'idea developing-mind map', 'image searching', and 'image comparing').



2. Method

We explored how designers of different fields develop ideas with IDEATOR and the effect the app has on their ideation. We collected data using IDEATOR. Specifically, IDEATOR was adapted to record the designers' idea map, index reference content, concept words of association, and sketch development. Finally, we conducted one-on-one interviews with the designers. We aim to use this data for future revisions of IDEATOR.

2.1. Design Task, Process, and Participants

To ensure consistency, designers performed a design task assigned by us. Regardless of their field, all designers had an assigned task for the same café place. Specifically, they were required to design a logo, chair, and bar for a coffee shop named 'at Café'.

Before the design task was executed, task instructions, pieces of A4 paper for sketching, and an iPad Mini with the IDEATOR app were provided to each designer. Designers were taught how to operate IDEATOR and were informed that their behavioural data will be collected and analysed. The designers were free to work in an environment of their choice and could use the Internet in any way that they pleased.

Designers had 1 week to finish the task and were allowed to finish ahead of time. In addition, upon completion of the design task, participants were required to turn off the screen-recording app (Shou.TV mobile game streaming 0.7.13) on the received iPad and write down the drawing completion time point for each sketch on the paper (values in Figure 2).

Fifteen designers (10 male and 5 female), with an average of 3 years of experience, were invited to participate. Of them, 5 were graphic designers, 5 product designers, and 5 interior designers.

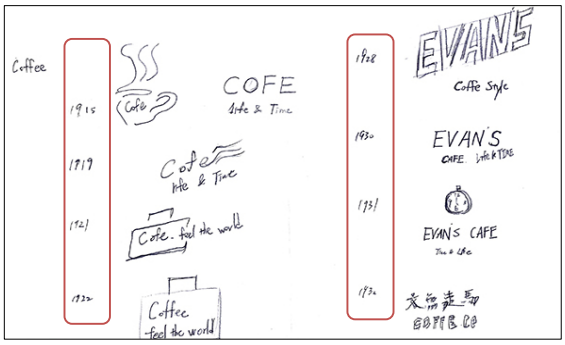


Figure 2. Idea sketches of participant G5 with time record (red rectangles show the time record)

2.2. Usability Interviews

After each designer completed the design task, we conducted one-on-one structured interviews on the user-friendliness of the IDEATOR interface, pertaining specifically to the 'image search', 'mind map', 'sketch pad', and 'image board' functions. Information from the interviews was used in an inductive analysis.

2.3. Data Analysis

For data analysis, each participant's IDEATOR data from the mobile device, screen capture recordings, and their developed idea sketches were collected. Video and protocol data analysis was conducted by the researcher and 2 coders, and the internal consistency of the coding results was tested.

The study used behaviour-recording software, The Observer XT, to collect and analyse video data. First, the researcher and 2 coders individually marked the change points of the videotaped behaviour of participants according to the behavioural definitions and coding scheme from our previous study (Cheng, 2016). Subsequently, the 2 coders listed clips that could not be categorised under any behavioural code. Thereafter, the researcher and 2 coders discussed possible revisions to the behavioural definitions and coding scheme.

Designers recorded the video data with IDEATOR to record their self-ideation process. Their operational behaviour has a bit different from the behavioural codes used in the previous study because of the app's revised interface and functions. For example, for sketching behaviour, the behavioural coding in the preliminary study comprised 'Creating new sketch' and 'Continuing to sketch.' The collection of research data was provided by designers, but the mobile screen-recording app (Shou.TV mobile game streaming 0.7.13) was unable to record the designers' sketching process on paper. Therefore, the sketch behaviour in this study was classified under 2 behavioural codes 'Sketching on paper (SOP)' and 'Drawing on sketch pad (DOSP)'.

Our modified behavioural coding scheme is as follows (Table 1). There are 3 behavioural modes. The 'Gathering information (GA)' mode includes the 3 behaviours of 'Retrieving information (RI)', 'Referring to relevant information', and 'Referring to the saved data (RSD)'. The 'Generating ideas (GI)' mode includes the 3 behaviours of SOP, DOSP, and 'Adding a new branch idea (ANI)'. The 'Thinking' mode includes 'Revising a branch idea (RBI)', 'Highlighting a branch idea (HBI)', and 'Purposeless action (PA)'. In addition, participants, in their unfamiliarity with the interface, may have performed an 'Error action', an action that belongs to none of the 3 modes.

Table 1 Behavioural coding scheme (revised from the behaviour codes in previous research [Cheng, 2016])

Behavior mode	Behavior (code)	Definition
Gathering information (GA)	Retrieving information (RI)	Retrieving information on-line for capturing ideas, sketching or drawing; saving the retrieved information in the hard disc to be the reference later.
	Referring to relevant information (RRI)	Referring to the information they have retrieved on-line in advance. Retrieving action is not included in the behavior.
	Referring to the saved data (RSD)	Referring to some saved data that have been retrieved on-line by them in advance.
Generating ideas (GI)	Sketching on paper (SOP)	Creating the new shapes, labels or lines.
	Drawing on sketch pad (DOSP)	Drawing the new shapes, labels or lines on sketch pad.
	Adding a new branch idea (ANI)	Adding an idea in the mind map area of IDEATOR as the new branch to be used or further thinking later.
Thinking (TH)	Revising a branch idea (RBI)	Revising the idea, fixing the words of an idea, adjusting the level of an idea in the mind map area of IDEATOR.
	Highlighting a branch idea (HBI)	Applying different color to a branch idea for highlighting its important or using several colors to those ideas for separating them from each other.
	Purposeless action (PA)	Making a move purposively, such as touching and moving working area back and forth.
None	Error action (EA)	Making a move incorrectly or not accordance with the operational rules of IDEATOR.

3. Results, Discussions and Conclusion

To explore whether the effect of IDEATOR on the design process differs by a designer's field, the data of the graphic, product and interior designers were denoted G1–G5, D1–D5, and I1–I5, respectively. Each designer had a complete set of data comprising screen capture data, hand-drawn sketches, and IDEATOR data.

3.1. Analysis and Comparison of the IDEATOR Operation Records Segment Encoding in 3 Fields of Design

According to our analysis using Observer XT, the mean duration of each designer's ideation was 1873 s (or 31 min). Video Data on the designers' interface operations were divided into 767 segments according to the behavioural coding scheme (Table 1), and the coding results of all the segments are detailed in Table 2. During ideation, the product designers had the most number of segments (M) using IDEATOR (M = 75), whereas graphic designers used IDEATOR the least (M = 33).

ANI had the most segments (M = 288, 37.5%) coded under it, followed by PA (M = 127, 16.6%), and RI (M = 85, 11.1%). The least prevalent types of behaviour were DOSP (M = 12, 1.6%), followed by SOP (M = 17, 2.2%). For the interior designers in particular, the RSD behavioural segment was more prevalent, even more so than PA and RI; DOSP is also more common than SOP.

The designers in our study also spend more than a third of their time generating ideas. GI occurred 41.3% of the time, followed by GA, which occurred 21.5% of the time.

However, when observing differences between the designers of different fields, graphic and product designers spend most of their time on GI. In particular, graphic designers spend 50% of their time on GI, whereas product designers spend more than 40% of their time on GI. However, in the 3 fields, among graphic designers, gathering information (GA) behaviour occurred least frequently, whereas among interior designers, the frequency of the 'gathering information (GA)' behaviour was highest among the 3 modes.

3.2. Usability Interview Results

Participants gave the following feedback during the interview.

1) The most user-friendly part of the interface was the 'interface icon (ICON)', followed by the 'mind map' ideation model. However, users experienced minor difficulties using the 'picture searching' function.

2) The most helpful function for concept ideation was the 'mind map'. Most of the designers believed that this function aided their management of their own ideation-thinking path. In particular, the image searches integrated with the mind map, so that the concept of the development context could be visualised and then the HBI function so that designers could sort out and classify the thinking path on mind map.

3) With the 'image board' function, designers recognised that the relevant images could be presented at the same time as a source of inspiration stimulates the designers. Moreover, they found the function of HBI and 'picture searching' advantageous.

4) IDEATOR's most notable disadvantage was the flexibility of dragging the mind map. Besides, it was less intuitive for them to see the relevant pictures of each concept immediately on the mind map, Followed by 'picture searching', and most of the designers recognised that as they searched for the relevant pictures, and then copied and saved them,

they must return to the search screen before they can copy the second picture, which made the operation less streamlined.

Table 2 Encoding of designers' behaviour segments in 3 fields

B-mode	GA			GI			TH			None	Total
B-Code	RI	RRI	RSD	SOP	DOSP	ANI	RBI	HBI	PA	EA	Segs.
G1				1		15		3	2		21
G2				1		12		2	3	2	20
G3	1			1		29	11		14	1	57
G4				1		11	1	3	2		18
G5	4		3	1		20	3		10	7	48
Total	5	0	3	5	0	87	15	8	31	10	164
D1	12		4	3		4	2			2	27
D2	14	5	6	1	2	49	7		38	7	129
D3	14	1	10	1		13	4		2	6	51
D4	2	4		1		50	7	11	16	20	111
D5	7	6		1		31	2		5	5	57
Total	49	16	20	7	2	147	22	11	61	40	375
I1	14	2	14	1	2	2	2		14	2	53
I2			10	1		15	10	7	2	1	46
I3	4	2	3	1	1	12	2	5	13	11	54
I4	6		2	1	1	5			3		18
I5	7	1	7	1	6	20		7	3	5	57
Total	31	5	36	5	10	54	14	19	35	19	228
Segs.	85	21	59	17	12	288	51	38	127	71	767
Pct.(%)	11.1	2.7	7.7	2.2	1.6	37.5	6.6	5.0	16.6	9.0	100
Order	3	8	5	9	10	1	6	7	2	4	

3.3. Conclusion

This study provided the expected results and fulfilled the preliminary study 'creative concept app (IDEATOR)' requirement. In addition, IDEATOR functions as an effective recording tool for future research on concept ideation process. The result shows that GI behaviour in graphic and product designers occurred more frequently than the other 2 types of behaviours. In particular, graphic designers' GI behaviour accounts for more than half of the total number of occurrences. Furthermore, most designers used IDEATOR thought it was understandable and found its most useful feature to be the mental map.

4. References

Ahmed, S. (2005). Encouraging reuse of design knowledge: a method to index knowledge. Design Studies, 26(6), 565-592.

Cheng, P.-J. (2010). A Study on Designers' Searching-retrieving Behavior in the Ideation Process, National Yunlin University of Science &Technology, Unpublished doctoral dissertation.

Cheng, P.-J. (2016). Development of a mobile app for generating creative ideas based on exploring designers' on-line resource searching and retrieval behavior. Design Studies, Vol.44C, 74-99.

Cheng, P.-J. and J. Yen (2008). Study on Searching-retrieving Behaviour in Designers' Ideation Process. Bulletin of Japanese Society for the Science of Design. Vol.55 No.3, 91-98.

Dorst, K. & Cross, N. (2001). Creativity in the design process: co evolution of problem-solution, Design Studies, 22(5), 425-437.

Goldschmidt, G. (1994). On visual design thinking: the vis kids of architecture, Design Studies, 15(2), 159-174.

Herbert, D. (1993). Architectural and study drawings, New York: John Wiley & Sons Inc.

McGown, A., Green, G. & Rodgers, P. (1998). Visible ideas: information patterns of conceptual sketch activity, Design Studies, 19(4), 431-453.

Schön, D. A., & Wiggins, G. (1992). Kinds of seeing and their function in designing. Design Studies, 13(2), 135-156.

Segers, N. M., de Vries, B., & Achten, H. H. (2005). Do word graphs stimulate design? Design Studies, 26(6), 625-647.

Siangliulue, P., Chan, J., Gajos, K. Z., & Dow, S. P. (2015). Providing Timely Examples Improves the Quantity and Quality of Generated Ideas. Paper presented at the Proceedings of the 2015 ACM SIGCHI Conference on Creativity and Cognition, Glasgow, United Kingdom.

Suwa, M., Gero, J. & Purcell, T. (2000). Unexpected discoveries and S-invention of design requirements: Important vehicles for a design process. Design Studies, 21(6), 539-567.

Verstijnem, I., Hennessey, J., Leeuwen, C., Hamel, R. & Goldschmidt, G. (1998). Sketching and Design creative discovery, Design Studies, 19(4), 519-546.

Westerman, S. J., & Kaur, S. (2007). Supporting creative product/commercial design with computer-based image retrieval. Paper presented at the Proceedings of the 14th European conference on Cognitive ergonomics: invent! explore!, London, United Kingdom.

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