WHAT DESIGNERS SEE FROM A CASE? A COGNITIVE APPROACH

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Abstract. In the behavior of human cognition, Schank, a cognitive researcher, claims that human frequently rely on past experience to solve new problems. The information and knowledge of well-trained designers was obtained from fundamental training courses in schools, from everyday experience, and importantly from several design cases. Acquiring knowledge by seeing cases is the most important activity in the design process. But, there are no related works from cognitive view to discuss what and how designers see from instances. Thus, this paper attempts to investigate what designers can see as some meaningful elements from instances, what relationships are among elements and knowledge which retrieved from designers’ long-term memory, and how new obtained knowledge influences the design outcomes.

1. Introduction

Design is one kind of ill-structured problem, in which some kinds of designing information and knowledge can only be applied to a specific design issue. The information and knowledge of well-trained designers was obtained from fundamental training courses in school, from everyday experiences, and, importantly, from many design instances (Purcell and Gero, 1991). In terms of human cognition, Schank (1986), a cognitive researcher, also claims that human frequently rely on past experiences to solve new problems.

Design can be regarded as a “seeing-moving-seeing” process, in which designers dialogize with all the design information which can be identified by designers (Schön and Wiggins, 1992). They will not only see sketches
which they generated continuously, but consult some related instances. As seeing design instances, designers will translate some parts, or elements, of cases into their design knowledge and, then, apply both new and original knowledge in new design projects. Moreover, in Christiaans and Andel’s (1993) paper, they propose that within the learning process students acquire much knowledge on a operational or procedural level by being exposed to a large number of examples of solutions.

In order to realize the decomposing process of the instances, this paper reviews some cognitive approaches about how human see a figure or a case. In visual cognitive research, Reed (1974) addresses that, while people saw a figure, they would decompose it into small, significant elements. Moreover, Kosslyn and his associates (1983) pointed out that the decomposition of these elements depended on the shapes which were meaningful to human and stored in his/her long-term memory (LTM). They also address that an image could be stored by separated elements with a significant schema. But the complicated shapes, which consisted of different sub-elements, will consume more time to store them. Then, human will use these sub-elements to recognize familiar elements, which were embodied in other shapes.

2. Problem and Objective

Acquiring knowledge by seeing cases is the most important activity in the design process. But, there are no related works from cognitive view to discuss what and how designers see from cases. Therefore, this paper attempts to investigate what designers can see as some meaningful elements from instances, what relationships are among elements and knowledge which retrieved from designers’ LTM, and how new obtained knowledge influences the design outcomes.

3. Cognitive Experiment

The cognitive experiment of this study is included two major parts: a analyzing and associating section, and a designing section. In the first section, the subjects were asked to analyze the instances to acquire design knowledge, and associate to the knowledge they have stored in LTM. Second, in the designing section, the subjects should develop some ideas from the instances and their expertise of design by sketching on papers. In order to explore the processes of how designers obtain design knowledge and link original knowledge, the subjects have to draw and/or think-aloud
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during the experiment. And whole processes are recorded by digital camera for protocol analysis.

3.1. DESIGN TASKS AND SUBJECTS

The purpose of this paper is to realize how the designers learn design knowledge from instances. To achieve this aim, the selection of design task should ensure that designers are not familiar with and have no experience about design topic. Thus, the knowledge of designing this topic will be acquired by designers from these instances provided by this study. The design task, which subjects analyze and design from instances, is an industrial product--a juicer, which is easier to deal with its function and form than any architecture design project.

Because of the different designing strategies among designers, this study invites two expert designers to be subjects of the cognitive experiment. The first subject, A, who now engages in designing the form of transportations, has 11 years for designing industrial products, while the other, B, has 13 years experience of related product design. Although neither subject A nor B has experiences for designing the design task, a juicer, they have had plentiful design knowledge which was accumulated by designers from past designing experiences and observations. It is impossible to examine all of their design knowledge in this paper. Therefore, this study only investigates the knowledge structure related to the design topic.

The selection of design instances is showed in figure 1. This study provides three instances for designers to analyze and learn. The first instance (figure 1a) is a normal juicer, which is without designing, but easy to use in functions. The second one (figure 1b) which designed by Alessi is to equally emphasize its form and function. A classical juicer (figure 1c), the last one, is designed by a famous France designer, Philippe Starck. His famed work integrated art and function.

Figure 1. The selection of design instances.
3.2. THE STEPS OF EXPERIMENT

The experiment is processed by following sequences: warm up, analyzing and associating task, and designing task. All procedures will be taped by a digital camera for protocol analysis.

Warming up: the warm-up task was used to accustom the subject to the methodology of think aloud while designing and the process of formal task. The topic of this warm-up task is a tea pot which designed by Philippe Starck. The section of warm-up is to ensure that the subject is suitable for protocol experiment.

Analyzing and associating task: the objective of this section is to reveal how the designer analyze cases and associate the knowledge, either expertise of design or common knowledge, which have been stored in the LTM. The instances will be sequentially viewed and analyzed one by one (figure 1a to 1c) by each subject. For each instance, the subject has to analyze it in terms of either forms or functions, respectively, or both of them, and then, associate the related knowledge. Finally, after analyzing and associating each instance, they develop an idea which derived from the instance. In this task, the subjects are asked to articulate and sketch what they saw and thought at the same time.

Designing task: After the analyzing and associating task, the two subjects should gain some design knowledge about a juicer from these three instances. In the designing task, they are requested to develop an idea to figure out how they applied knowledge from either instances or the original one which retrieved from their LTM.

4. The Coding System

The methodology of protocol analysis has been extensively used to scrutinize the design behavior (Eastman, 1970; Akin, 1978, Akin and Lin, 1995; Gero and Neill, 1998). After Akin’s (1978) study, there were numerous researchers to dedicate to methodology of protocol analysis in terms of the different scheme of coding system. The coding system is the most vital part of protocol analysis because different coding systems, which inspected the design processes from different point of view, will yield diverse results.

In Akin and Lin’s study (1995), they advance a coding scheme to investigate the activities that occurred during the process of design. Based on coding the activities of designers, they propose that these external activities could be relevant to the internal behavior of thinking. On the contrary, in terms of analyzing the problem domain and design strategy, Gero and Neill (1998) claim that when designers were solving design problems, they would analyze them in both macro and micro point of view. This point has
influenced the understanding of design action during design process. Moreover, they also advance that coding by level of abstract of what designers focus on could find that the attentions of designers may shift from macro to micro view or from micro to macro view. Therefore, the methodological researches of protocol analysis will present a variety of coding scheme. Because of the particular purposes of coding systems, there are a lot of limitations of each coding scheme, but I will not discuss the discrepancy among them. However, the coding scheme that encoded in terms of sketches and design knowledge was not presented yet. In order to interpret how designers consult design instances and associate with related knowledge, the paper proposes a preliminarily coding scheme, which could encode the sketches generated by designers and the knowledge they applied in the process of developing ideas.

In the cognitive experiment, the results by observing the design behavior can be divided into two main categories: designing actions and utilizing sketches and related knowledge. Accordingly, the coding system of designing actions will be based on examining-drawing-thinking (E-D-T) (Akin and Lin, 1995). Nevertheless, in order to record the action of viewing instances by designers, the coding system of this paper will extract the behavior of consulting instances from Akin and Lin’s coding scheme, examining (E). The consulting (C) will identify that the design knowledge was from instances. In addition, there are two new items of coding system: gesturing and associating. The gesturing (G) code intends that the gesturing action could be used to simulate the using of real products, while the associating (A) code shows the sources where was the design knowledge from: from instances (Ai), from expertise of design (Ae), and from common knowledge (Ac) (table 1).

<table>
<thead>
<tr>
<th>E</th>
<th>examining</th>
<th>Examining the sketches which he has drawn</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>drawing</td>
<td>Drawing on papers which could be taped in the digital camera</td>
</tr>
<tr>
<td>T</td>
<td>thinking</td>
<td>Without examining or drawing</td>
</tr>
<tr>
<td>C</td>
<td>consulting</td>
<td>Consulting the instance provided in this study.</td>
</tr>
<tr>
<td>G</td>
<td>gesturing</td>
<td>Using hands to simulate some actions.</td>
</tr>
<tr>
<td>A</td>
<td>associating</td>
<td>where was the design knowledge from</td>
</tr>
<tr>
<td>Ai</td>
<td>from instance</td>
<td></td>
</tr>
<tr>
<td>Ae</td>
<td>from expertise of design</td>
<td></td>
</tr>
<tr>
<td>Ac</td>
<td>from common knowledge</td>
<td></td>
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</tbody>
</table>

On the other hand, the coding system of utilizing sketches and related
knowledge follows the main idea from level of abstract (Gero and Neill, 1998). But, in the design process, designers will draw or associate elements which composed the product by sketching or linking to related knowledge. Each element also has its own properties for designing and associating. Thus, the coding system will aim at the elements of product and their properties to encode, precisely, each knowledge which be applied in the design process by designers (table 2).

<table>
<thead>
<tr>
<th>Elements of a juicer</th>
<th>Properties of elements</th>
</tr>
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<tbody>
<tr>
<td>a whole</td>
<td>Pm Material</td>
</tr>
<tr>
<td>b Head</td>
<td>Pa Axis</td>
</tr>
<tr>
<td>c Filter</td>
<td>Pu Use</td>
</tr>
<tr>
<td>d container</td>
<td>Pf Function</td>
</tr>
<tr>
<td>e Handle</td>
<td>Ps Shape</td>
</tr>
<tr>
<td>f Outlet</td>
<td></td>
</tr>
<tr>
<td>g Feet</td>
<td></td>
</tr>
</tbody>
</table>

Therefore, I represent level of abstract by using the coding system of utilizing sketching and related knowledge (table 3).

<table>
<thead>
<tr>
<th>level of abstract</th>
<th>sketching and related knowledge codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 System</td>
<td>a-Ps</td>
</tr>
<tr>
<td>1 Interactions</td>
<td>b &amp; c</td>
</tr>
<tr>
<td>2 Sub-system</td>
<td>b, c, d</td>
</tr>
<tr>
<td>3 Details</td>
<td>b- Pa, c- Pm</td>
</tr>
</tbody>
</table>

5. Results and Discussions

The consequence of the cognitive experiment shows that designer will consult instances by analyzing and learning their original concepts, and, then, break them out to avoid the similarities between new ideas and
instances. In the case of subject B, during his experiment of instance b (figure 1b) designed by Alessi, he has obtained the axis of non-vertical and horizontal (figure 2a). In the further designing action, he first draw the axis of new idea on the other side of vertical (figure 2b). In another case, subject A has learned a concept, gracefulness, from instance c (figure 1c). Then, he interprets this concept by his past expertise of design to generate an idea which is fulfill the concept of gracefulness. In addition, the major function of a juicer is from the head of this product. Because the function of extracting juice by pressing is well-developed by instances, designers will prefer not to re-design it.

In the designing process, designers will draw either front or perspective view to deal with the first part of idea. When they encounter the difficulty of describing concepts, they will draw another view with more details to indicate their ideas. In addition, the paper also find that the nomination of each element is not meaningful for designers because they use the words, “this” and “that”, to point what they see, consult, and, even, think when they were developing ideas.

This paper does not present entire coding results, but proposes some phenomena which found in the cognitive experiment. The further study will focus on completeness of coding system to encode the sketches and design knowledge. Moreover, by following the concept of preliminary coding system which is based on the design process of industrial products, the coding scheme for architecture design will be presented in the near future.
References