Cognitive styles in design problem solving: Insights from network-based cognitive maps

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This study aims at understanding the cognitive styles of designers from the point of view of precedent utilization and idea generation. A protocol study was conducted with 24 masters students majoring in industrial design. To analyze verbal protocols, this study devised a new way of describing cognitive processes called 'cognitive map.' It supports intuitive interpretations of a cognitive process while visualizing its comprehensive structure with rich relationships among encoded items. Based on cognitive maps, three phases of the design process were identified, and the cognitive styles of each participant were derived through integrating the cognitive styles of each phase. As a result, four types of cognitive style − Focused probers, Treasure hunters, Selectors, and Explorers − were identified and described.

Keywords: cognitive styles, protocol analysis, design precedents, design behaviour, research methods

Prior knowledge and experience have been regarded as critical components of creative thinking processes aimed at the creation of the new (Hyman, 1961; Runco & Chand, 1995; Ward, 1995). In the design process, prior knowledge and experience play a pivotal role. Laxton (1969) mentions a reservoir of knowledge as a prerequisite for design ability. Suwa and Tversky (1997) found that background knowledge, especially the domain knowledge, makes a significant contribution to and has implications for designing.

In the field of design, domain knowledge has often been represented as precedents. As Goldschmidt (1998) stated, the role of precedents in design is quite different from precedents in the practice of law, which uses identical cases to adopt. The design precedents rather support the design activities as a reference which suggests ways to deal with design problems. Designers can refer to their pool of precedents in order to find problem solving elements which can be reused in a different design problem (Visser & Trousse, 1993). In addition to the solution generation phase, designers also utilize their episodic knowledge to understand the problem and evaluate its solutions (Visser, 1995).

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In Lawson's elaborated explanation of design expertise (2004a), precedents help designers to form their own schemata and are also utilized as gambits to recognize the design situation. Even in a group of students, the development of expertise changes the ways precedents are used, from geometric to symbolic referencing. This also suggests that precedents are actively engaged not only in the design process but also in the development of design expertise. As such, the level of dependency on prior knowledge and experience may vary depending on the designers' level of expertise. In addition, it may be different depending on the designers' own characteristics. The study by Kruger and Cross (2006) empirically shows that some designers often utilize their prior knowledge rather than other sources. In the case of these designers, the utilization of such knowledge has the potential to be developed into a design strategy (Kruger & Cross, 2006).

As many studies have expanded our understanding about the usage of prior knowledge and experience in designing, researchers engage in design activities in a variety of forms and ways. It seems likely that the engagement of these mental resources has a significant relationship with design ability. However, there have been limited attempts to elaborate the diverse characteristics in the usage of precedents, and its implications to designing. If the utilization of precedents is one of the most important aspects of the design problem solving process, how does it vary and differ depending on the designer? Is it possible to classify these variances into a limited number of cognitive styles that have distinctive features to each other? This research focused on these research questions, and attempted to investigate the design problem solving process of designers in terms of utilizing prior knowledge and experience. We viewed the design problem solving process as a cognitive process which progresses while utilizing various cognitive elements. In order to analyze a cognitive process, we conducted a protocol study, and devised a new graphical representation that visualizes cognitive elements and their relationships in order to support the analysis and interpretation of protocols. The new description method is also discussed thoroughly and compared to existing methods of interpreting protocols.

1 The known to the new – precedents in design

Previous studies in cognitive psychology indicate the significant role of prior knowledge and experience in creative thinking. Conceptual expansion, which was proposed by Ward, Smith, and Vaid (1997), is an example of how prior knowledge may influence the creative process. It refers to a cognitive activity whereby peoples' knowledge of familiar concepts is extended for creating, even to different domains. Other researchers have proposed conceptual combination and reorganization as a significant ability of human creativity (Baughman & Mumford, 1995; Mumford, Mobley, Reiter-Palmon, Uhlman, & Doares, 1991; G. M. Scott, Lonergan, & Mumford, 2005). These studies highlight the contribution of existing knowledge and experience in the creative