Concept blending and dissimilarity: factors for creative concept generation process

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We approached the concept generation stage in design within the framework of a concept-synthesizing process from two base concepts. We analyzed the concept generation process by comparing it with the linguistic interpretation process, from the viewpoints of thought types (property mapping, blending, *and* thematic relation) *and recognition types* (commonalities *and* alignable *and* nonalignable differences). *Subjects interpreted a novel noun–noun phrase, designed a new concept from it, and listed the similarities and dissimilarities between the nouns. Blending (i.e. generating a new concept that is not included in the two base concepts but that inherits certain characteristics of the concepts) and nonalignable differences (i.e. the recognized differences that are unrelated to the common structure) characterize the creative concept generation process.*

Keywords: generation, design cognition, creativity, conceptual design, design process

Numerous studies have investigated the nature of the design process, and many significant empirical ones have sought to identify its creative features within a problem solving framework (Cross, 2001). Cross discovered that the cognitive features of outstanding designers' thinking processes were related to problem finding. He categorized these cognitive processes into taking a broad 'systems approach', 'framing' the problem and designing from 'first principles' (Cross, 2006) in order to investigate how designers solved problems on the basis of strategic knowledge. Thus, the 'creative problem solving' framework (Holyoak and Thagard, 1995; Ball et al., 2004) has given rise to rich arguments on the features distinguishing the design activities of expert and novice designers (Casakin and Goldschmidt, 1999). These studies have highlighted the concept of analogizing by 'structure mapping' (Gentner, 1989), in other words, 'mental leap' (Holyoak and Thagard, 1995), as an important factor that enhances solution finding ('creative' solution by Dorst and Cross, 2001; 'creative design solution' by Gero, 1994) in the design process. Ball et al distinguished between 'schema-driven analogizing

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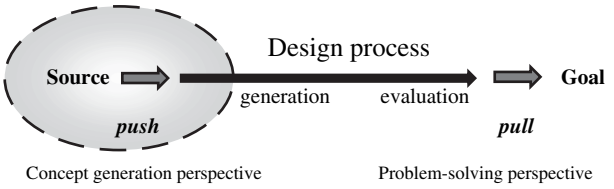

Figure 1 A design process model comprising generation and problem solving perspectives

(i.e. the recognition and application of abstract experiential knowledge that could afford a design solution to a familiar problem type) and case-driven analogizing (i.e. the invocation of a concrete prior design problem whose solution elements could be mapped onto the current problem)', and reported that 'expert designers exhibit more schema-driven analogizing than case-driven analogizing, whilst novices show the reverse pattern of analogy use'. Their findings concerning schematic reasoning supported the assumption of work on analogical relationships between problem—solution in design as addressed by Visser (1992, 2006) and the differences between the cognitive processes of experts and novices as addressed in empirical studies of engineering design. These studies have primarily discussed the role and functions of analogy in the design process (Christensen and Schunn, 2007). The issues raised by these studies included the relations between base and target domains and the types of analogy (i.e. 'within' or 'between' the domain) in design in a problem solving framework. However, these views were goal-oriented and their focus was limited to the problem solving process. Another important aspect of the process, namely, 'generation', has yet been clarified. Figure 1 illustrates the design process, which involves two aspects: the problem solving aspect, wherein the process begins with the given goal, and the concept generation aspect, wherein the process begins even in the absence of a goal (Taura and Nagai, in press).

1 *Concept generation stage in creative design*

In our study, we focused on the concept generation stage in order to understand the creative features of the design process, as this stage can be considered when formulating a novel design idea on the basis of the following reasons. As it is widely known, 'new ideas evolve from generated ideas that are invoked from old ideas' (Finke et al., 1992). A number of design studies have also addressed the roles of generation in the formation of ideas (namely, concept generation) related to the original design (Pahl and Beitz, 1984; Liu et al., 2003; Chiu and Shu, 2007). However, it is possible that the concept generation process occurs suddenly in the design process, which makes it difficult to capture it in the framework of a problem solving process.

Few studies have actually examined the concept generation process. (In this study, we use the term 'concept generation', which, according to Ulrich and Eppinger (2004), includes 'idea generation' to represent a formulated design idea that is a 'product concept'. The term 'concept' is used to represent not only the