Creativity through design heuristics: A case study of expert product design

Seda Yilmaz, Iowa State University, Industrial Design Program,
156 College of Design, Ames, IA 50011, USA
Colleen M. Seifert, University of Michigan, Department of Psychology,
530 Church Street, Ann Arbor, MI 48109, USA

Research has shown that cognition often relies on simplified heuristics; however, few studies have explored the role of heuristics in design. We propose that designers utilize specific heuristics to explore the problem space of potential concepts, leading to the generation of novel and creative solutions. Design heuristic use in the early stages of product conception was examined through a case study of an expert industrial designer working on a real-world project. Sequences of exploratory concept sketches were analyzed for evidence of design heuristic use in generating concepts. This case study uncovers design heuristics that promote variation in concepts and alter existing solutions, supporting the claim that expertise incorporates the use of heuristics to maximize creativity and diversity in designs.

Keywords: product design, creative process, design strategy, case study/studies, design heuristics

What is the nature of expertise in design? Expertise in cognitive science is defined as the skilled execution of highly practiced sequences of procedures (Anderson, 1982; Ericsson et al., 2006). Several decades of research has shown that experts have acquired a variety of cognitive structures that contribute to their performance (Ericsson, 1996; Sternberg and Grigorenko, 2003), such as, access to previous solutions (Logan, 1988), and better representations that capture the more important features of the domain (Chi et al., 1981). One general finding is the use of strategies (Schunn et al., 2005). Lemaire and Siegler (1995) have proposed a four-layered account of expertise from a strategies perspective, the adaptive strategy model (ASM). In this model, experts have better strategies (strategy existence), tend to use strategies that are better overall more often (strategy base rate), are better able to select the circumstances to which a strategy best applies (strategy choice), and are better able to execute a given strategy (strategy execution).

Corresponding author:
Seda Yilmaz
seda@iastate.edu

Within the domain of design, what heuristics do expert designers use to generate concepts? And how do heuristics impact the creation of multiple, diverse

www.elsevier.com/locate/destud
0142-694X $ - see front matter *Design Studies* **32** (2011) 384–415
doi:10.1016/j.destud.2011.01.003

candidate designs? In studies of designers, Ahmed et al. (2003) found that novices (graduates) used 'trial and error' techniques in generating a single design modification, implementing it, evaluating it, and then generating another, and so on, through multiple iterations. Experienced engineers were observed to make a preliminary evaluation of multiple proposed solutions before beginning implementing and evaluating them. Kruger and Cross (2006) identified different cognitive strategies employed by designers: Solution-driven design, where the focus is on generating solutions, tended to produce the best results compared to a problem-driven strategy, which consists of gathering data and identifying constraints to define the problem. However, these strategies are not specific to the initial concept generation phase of design tasks, especially when there are a relatively low number of constraints and the possibility of many alternative design concepts.

Lloyd and Scott (1994) found that this solution-focused approach appeared to be related to the level and nature of previous experience of the designers. More experienced designers used more 'generative' reasoning by bringing something new to the design situation, in contrast to 'deductive' reasoning on the design problem. In particular, experienced designers approached the design task using general discipline knowledge, rather than through problem analysis. So, becoming an expert may not be a matter of getting faster or more accurate, but of learning alternative ways of doing design. One of the key principles behind the development of high levels of expertise seems to involve a change from a conscious struggle to effortless, even automatic, performance (Lawson and Dorst, 2009).

Understanding successful concept generation is the key to uncovering experts' strategies for design, and for improving design education and practice. Schon and Wiggins (1992) found that designers proceed through cycles of 'seeing-moving-seeing', (*re*)interpreting shapes and relationships, and transforming these (*re*)interpreted shapes. During creative periods, expert designers alternate quickly in shifts of attention between different aspects of their task or between different modes of cognitive activity (Park et al., 2008). These findings suggest that continuously exploring new perspectives on solutions results in uncovering a wider variety of designs. However, many questions remain surrounding the use of cognitive strategies.

In previous work, we found evidence for specific 'design heuristics' that supported designers in exploring the space of potential designs, leading to the generation of varied and creative solutions (Yilmaz et al., 2010a). The term 'heuristic' has commonly referred to strategies that make use of readily accessible information to guide problem-solving (Pearl, 1984). Some heuristics provide ways to search systematically (such as 'depth-first search'), and some use evaluation functions to make 'best guesses' about which areas within the space are most promising. The term 'heuristic' implies that it: 1) does not guarantee