How engineering teams select design concepts: A view through the lens of creativity

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While concept selection is recognized as a crucial component of the engineering design process, little is known about how concepts are selected during this process or what factors affect the selection of creative concepts. To fill this void, content analysis was performed on student engineering design team discussions during a concept selection task. Our results indicate that student design teams typically focus on the technical feasibility of concepts during the selection process. However, teams that identified useful elements of ideas or continued to generate new ideas during this process had a tendency towards selecting creative ideas. These results add to our understanding of team-based decision-making during concept selection and highlight the need for encouraging creativity throughout the concept selection process.

Keywords: collaborative design, decision making, design education, engineering design, teamwork

Creativity is regarded as an essential component of the design process and is required throughout the product development process in order to translate innovative ideas into successful products (Roy, 1993). As such, engineering design research has long sought to develop methods to enhance creative idea development in the early phases of design through the study of ideation tools (see for example Altshuller, 1984; Eberle, 1996; Kulkarni, Dow, & Klemmer, 2012; Osborn, 1957). While the goal of these methods is to help designers generate a large quantity of effective solutions and explore a larger solution space (Shah, Vargas-Hernandez, & Smith, 2003), the creative ideas developed through these methods are often rapidly filtered out during the concept selection process (Rietzchel, Nijstad, & Stroebe, 2006) with few making it to commercialization. Since the evaluation process dictates which products to develop and which to abandon (Kijkuit & van der Ende, 2007), the concept selection process can be seen as the 'gate keeper' of creative ideas.

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The process of selecting concepts that satisfy design goals has been regarded by researchers as one of the most difficult and elusive challenges of successful engineering design (Pugh, 1996) because of the impact this process has on the

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direction of the final design (Hambali, Supuan, Ismail, & Nukman, 2009; King & Sivaloganathan, 1999). Individuals and companies who select high quality and highly innovative concepts during this process increase their likelihood of product success and radical innovation, while those who select poor concepts have larger expenses including redesign costs and production postponement (Huang, Liu, Li, Xue, & Wang, 2013). These additional costs can greatly damage companies that are trying to survive in the fast-growing market that demands product innovations (Ayağ & Özdemir, 2009). In other words, for innovation to occur, creative ideas must be identified and selected through the concept selection process (Rietzchel et al., 2006). However, individuals often select conventional or previously successful options during this process instead of novel ones (Ford & Gioia, 2000) due to their inadvertent bias against creative ideas (Rietzschel, Nijstad, & Stroebe, 2010). Specifically, researchers found that when left to their own devices, participants tended to select ideas based on feasibility to the detriment of creativity even though creativity did not necessarily lead to less feasible ideas (Rietzschel et al., 2010). Therefore, even though creativity is emphasized in idea generation, due to people's deep-seeded desire to maintain a sense of certainty and preserve the familiar (Sorrentino & Roney, 2000), individuals may prematurely filter out novel ideas during the concept selection process regardless of merit in order to reduce risk. Thus, it is important that the field of engineering design shift its focus from identifying how to generate creative ideas, to identifying the factors that contribute to the filtering and promotion of creative ideas through the design process in order to increase the likelihood of innovation, which is crucial for long-term economic success (Ayağ & Özdemir, 2009).

Therefore, the goal of this research paper is to explore the team decision-making process during early-stage concept selection as well as the factors that impact the selection of creative ideas during this process. In order to accomplish this, an empirical study was conducted with 37 engineering students who performed a concept selection activity in design teams. The results from this study add to our understanding of the factors and themes that impact team decision-making and creative concept selection and outline new opportunities for increasing the effectiveness of concept selection methods and techniques in design education and research.

1 Background & motivation

1.1 Design considerations during concept selection

Concept selection is described as a convergent process that includes both the evaluation and selection of candidate ideas (Nikander, Liikkanen, & Laakso, 2014). Specifically, the first stage of the concept selection process occurs directly after concept generation when the design team is tasked with quickly evaluating dozens of concepts and selecting the ideas with most promise to move forward in the design process (Kudrowitz & Wallace, 2013).