LEAP OF IMAGINATION

Design Heuristics help students think outside the box and devise novel, more diverse solutions.

By Julia Kramer, Shanna Daly, Seda Yilmaz, Colleen Seifert, and Richard Gonzalez

Innovations depend on creative-concept generation, but engineering students often struggle to come up with ideas. They typically proffer a handful and fixate either on their first idea or existing solutions. As a result, students explore only a narrow subset of possible solutions.

Techniques to support concept generation include a tool called Design Heuristics, a collection of strategies for exploring variations in product designs (*www.designheuristics.com*). The tool was developed through empirical studies of industrial and engineering product designers and has been shown in prior research to assist students in creating new and diverse concepts.


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In this study, we explored how students developed their initial ideas into final designs within a team project. We investigated whether initial ideas created using Design Heuristics led to successful, practical outcomes. At the beginning of the semester, undergraduate mechanical engineering students in a design project course learned the Design Heuristics tool. Each student used the tool to generate concepts for a remote-controlled machine to compete in a final challenge. The students then worked in teams to develop their ideas into a final design, which they built using traditional machining materials and techniques. Data collected included the initial concepts generated by individual students, team designs presented at the midterm review, and final designs presented by the teams at the end-of-term competition.

The results show that Design Heuristics were used to develop 91 percent of the students' initial concepts and 78 percent of the final team designs. These findings suggest that the student teams found Design Heuristics to be applicable and practical for generating usable concepts and developing final designs. In addition, we found that almost half the teams synthesized components of several independent ideas into their team designs, using one or more of their Design Heuristics-inspired concepts.

These findings suggest several guidelines for engineering education. Instructors can provide tools for generating ideas and encourage students to use these methods to explore more initial design concepts. Engineering educators can also encourage their students to use Design Heuristics at several subsequent points in their design processes, and to engage in multiple divergent and convergent concept-development cycles. Revisiting the Design Heuristics tool throughout the design process may also support improvements in concept development by student teams. In particular, concept synthesis – combining the best ideas into one concept – is important for maximizing the impact of creative initial concepts.

Instructors can implement these goals through the structures of their project deliverables. First, instructors may be able to alleviate their students' tendency to settle on a concept too quickly by setting a minimum number of individual initial concepts, along with multiple initial team concepts. The Design Heuristics tool can be offered to help students reach this required number of concepts. Next, instructors could require student teams to demonstrate their concept development through divergent exploration, convergence, and synthesis throughout the design process. Requiring explicit documentation of these stages will help students learn to attend to concept development throughout their own developing design processes.

The assignment of appropriate deliverables must strike a balance between concept exploration and practical design outcomes. Our study offers support for Design Heuristics as a useful tool for encouraging students to consider a variety of ideas without sacrificing practical outcomes. As a result, students may learn to create practical and innovative design concepts for their projects.

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