

Student Engineers Learning to Become Designers

Micah Lande

Center for Design Research, Stanford University

micah@stanford.edu

ABSTRACT

My doctoral research explores how student mechanical engineers are taught, learn, and apply a design thinking process to routinely create and innovate in the context of training for industry practice. I am interested in the maturation of master's students with backgrounds in mechanical engineering adjusting to a project-based learning experience centered on design thinking methodology and processes. I use a combination of theoretical approaches from design research, engineering education and the learning sciences. My methodology draws on field observations in the classroom of a capstone-plus core mechanical engineer course on design innovation at Stanford University [1] as well as interviews, document analysis and other qualitative methods. I am gathering empirical evidence of what design learning looks like and how it changes over time and how students conceptualize design and engineering.

In order to characterize the transition that students make along the novice to expert design continuum, students' concept maps for their design processes and drawings of their notions of engineers and designers at work were collected. Students were asked to generate a concept map of their "typical design process" and to draw a designer at work and an engineer at work along the lines of the Draw-a-Scientist Test [2]. Initial findings from qualitative content analysis indicate that the concept maps of design process mature over time along a consistent learning trajectory. Students also have distinct but complimentary mental models of the roles of a designer and engineer mainly along two emerging themes: idea generation/implementation and human/tech-centerness.

A preliminary framework of "Ways of Thinking" [3] relating design thinking activities to engineering thinking activities and production and future thinking has been developed and is being used to analyze student project team design activity. Students in the design innovation course capture their work regularly on a wiki and in quarterly design documentation reports. By coding and analyzing the reports of each team, their design steps and order they take in their design processes can be noted. Preliminary analysis of project matched pairs shows that the more leaps around in their design process steps and prototyping activities a team makes a more novel project deliverable outcome as well as bettering the students' learning experience.

Additional observations of students have been done to capture the barriers and catalysts to them learning along the way. With field observations of regular team meetings, it's apparent students are hindered by a predisposition to plan and calculate repeatedly before taking action and making. The students' learnings are helped by a close proximity to other groups in a shared design space ("situative zeitgeist"), a series of front-loaded prototype milestone assignments ("scaffolded prototyping"), a practice of encouraging reflection on what is gained from prototyping ("cognitive iteration") and repeatedly stepping through the steps of the design process ("cognitive apprenticeship").

Data collection is complete and the analysis is ongoing.

Author Keywords

Design Learning, Design and Engineering Thinking.

ACM Classification Keywords

H.5.2. Information interfaces and presentation: User Interfaces – Theory and methods; H.1.2 Information Systems: User/Machine Systems – Human factors.

BIOGRAPHICAL SKETCH

Micah Lande is a Ph.D. Candidate in Mechanical Engineering and Design at the Center for Design Research at Stanford University. He is researching how engineers learn and apply a design process to their work. Micah is a co-Editor-in-Chief of *Ambidextrous*, Stanford University's Journal of Design. His academic interests include design and engineering education, design thinking, foresight thinking, creativity and innovation, and interdisciplinarity. He has a B.S. in Engineering from Stanford's Product Design program and has a M.A. in Education from the Stanford School of Education program in Learning, Design and Technology.

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