

# An introductory short course in design thinking for undergraduate and graduate students

*Sujata K. Bhatia<sup>1</sup>, Brad Crane<sup>2</sup>, David Goligorsky<sup>3</sup>, Joseph P. Zinter<sup>4</sup>, Gu-Yeon Wei<sup>1</sup>*

In order to attract and retain undergraduate students in engineering programs, it is critical to inspire and encourage students to study engineering. An undergraduate engineering education is a rigorous and challenging program, which conventionally consists of intense mathematics and science courses in early academic years, followed by applied courses, such as engineering design in later years. The true essence of engineering is realized in these applied courses; integration of applied engineering and design-based activities throughout the academic curriculum is necessary to motivate and enable students to make informed decisions. With these considerations in mind, Harvard University introduced an on-campus, week-long intensive hands-on course on design thinking. The course won an award from the 2012 Harvard President's Innovation Fund for Faculty, and was held during winter break.

The course was intended to provide a concise and complete exposure to engineering and design, in a way that would be accessible to students with no prior technical background. The course was also developed with the goal of broadening the problem-solving approach conventionally used by engineers, through incorporation of techniques and methods used by designers – a process known as design thinking. The design process is characterized by periods of strategic thinking, conceptualization, and abstraction, followed by prototyping, testing, and on-the-fly problem solving. Application of the design process to engineering can improve the way engineers evaluate and address human needs. Finally, the course was developed with the goal of giving students an appreciation for human factors, user worldview, social implications, and environmental considerations. The workshop was compartmentalized into morning and afternoon sessions. Morning lecture sessions discussed the various stages of the design process; lecture topics included design improvisation, human-centric design, visual thinking, and work-mapping. Afternoon experiential sessions allowed students to apply these new tools and insights; activities included brainstorming, role-playing, user interviews, physical rapid prototyping, digital rapid prototyping, and design exercises. Each student was also given an Arduino pack, an open-source electronic prototyping platform that allows users at all skill levels to create interactive electronic objects. The course enrolled 40 students, who were distributed into seven teams. A common theme pervaded the workshop, so that students could apply each phase of the design process toward a unified end goal. Specifically, student teams were tasked with creating a “starter kit” for an individual with some definite need. The workshop culminated in student presentations of their designs and prototypes for “starter kits” in an open, constructively criticized venue. One team of students created a toolbox for a high school graduate transitioning to college. Another team of students created a tool for selecting a college major.

At the conclusion of the course, students completed an anonymous survey which assessed attitudes and motivation to solve open-ended problems, address societal needs, and pursue further study in engineering; the results are shown in Figure 1. The results suggest that the design thinking workshop positively reinforced student motivations to solve open-ended problems; students were in strong agreement with statements regarding enjoyment of problem-solving. The short course also positively reinforced student perceptions and enthusiasm for studying engineering. Students were in strong agreement with statements regarding the creativity, innovation, and societal impact of engineering.

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<sup>1</sup> Harvard University, School of Engineering and Applied Sciences, Cambridge, Massachusetts, USA 02138, email: sbhatia@seas.harvard.edu

<sup>2</sup> Harvard University, Graduate School of Design, Cambridge, Massachusetts, USA 02138, email: bcrane@gsd.harvard.edu

<sup>3</sup> IDEO, Cambridge, Massachusetts, USA 02138, email: d.goligorsky@gmail.com

<sup>4</sup> Yale University, School of Engineering and Applied Sciences, New Haven, Connecticut, USA 06520, email: jzinter@gmail.com

Students additionally demonstrated a strong excitement regarding future studies of engineering, and future careers in engineering. Importantly, students strongly agreed that “Technology plays an important role in solving society’s problems,” and that “Engineers have contributed greatly to fixing problems of the world.” Students displayed overall excitement for the future. Further, students’ comments revealed the positive impact of the course. One freshman student stated, “It was awesome to see that there’s this whole world out there just meant to empower people to build stuff. I really like that we had ideas and made them right away.” Another commented that “I’ve been given tools to know how to approach problems by considering human factors—putting humans at the center, and also really asking myself questions about the day-to-day things that we do...learning about humans throughout the design process taught me how to design *in* the world.” Students clearly came away from the course with a sense of the possibility of design and engineering. This work demonstrates the success of a week-long course in design thinking, held during winter break at Harvard University. The course incorporated both engineering and design. In the future, it will be important to assess whether this course affects student performance and student retention in engineering and design degree programs, as well as students’ future choice of careers in engineering and design.

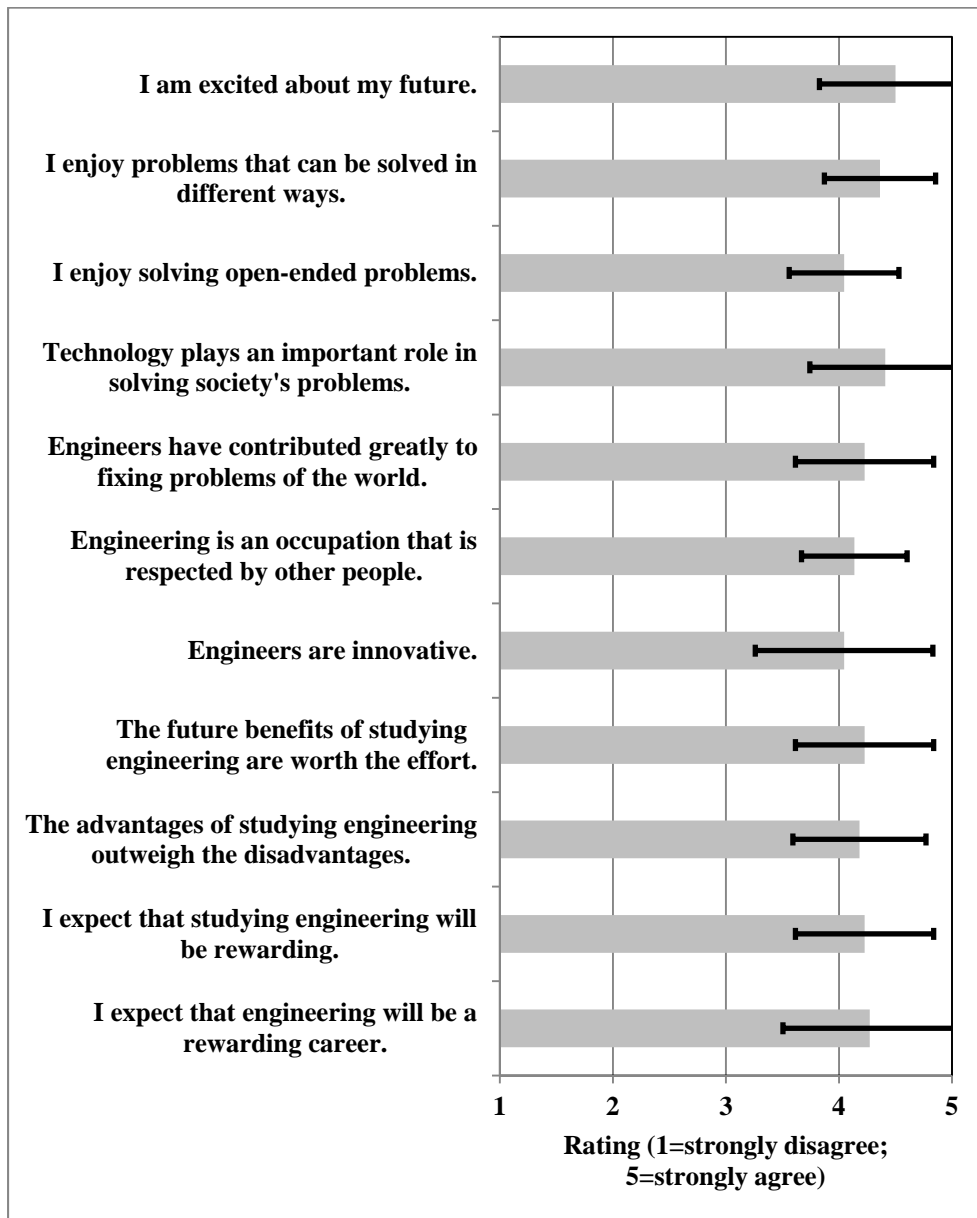


Figure 1: Student responses to engineering attitudes survey at conclusion of short course.

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