Thinking Like an Engineer
Proposed First Year Course for Fall 2016
Dan Flath and Diane Michelfelder, Macalester College

We propose a first-year course to be offered in the Fall of 2016 with the provisional title of Thinking Like an Engineer. The following represents our initial brainstorming about the course in terms of overall focus, justification, student participation, possible readings, and class activities.

Course focus: Our provisional title points to our desire to offer a course that would be welcoming to a broad spectrum of students, one reflecting the spirit of “Engineering for Everyone”: the introductory engineering course at Smith College. Of course, we wouldn’t be ignoring the fact that engineers bring new artifacts and systems into the world, far from it. But, by putting the primary emphasis on the process of thinking rather than the end result, we want to send the message that engineering is not just about the grand achievements of great minds but also about a way of reflection and a form of practice in which many can participate. We hope to expose students to the variety of types of knowledge involved in engineering design and, by so doing, help them to understand that engineering knowledge is at bottom interdisciplinary knowledge—knowledge involving ways of thinking that reflect a number of disciplines in the liberal arts and sciences. Students will learn to see that a design problem isn’t solely a technical problem, but is inseparable from ethical, social, political, and historical dimensions.

Why this course now? The environment into which our students will graduate, and the one that will continue to shape their lives, is an environment increasingly shaped by the thought processes and decisions of engineers. Driverless cars, the emerging Internet of Things, and the rise of additive manufacturing are just three examples of how this environment is engineering-saturated. But as the world has become saturated with engineering products and as life has been transformed as a result, many students still have a limited knowledge of how these products work and of the ethical, political, historical, and social dimensions connected with them. We could wonder if as a result their world is becoming more magical. In a recent essay in the National Academy of Sciences’ Issues in Science and Technology, philosopher Carl Mitcham asked:

By designing and constructing new structures, processes, and products, they [engineers] are influencing how we live as much as any laws enacted by politicians. Would we ever think it appropriate for legislators to pass laws that could transform our lives without critically reflecting on and assessing those laws?

While Mitcham’s concern here is with engineers, we could similarly raise the question of whether given the massive transformations to the lived human environment made by engineering, reflection on these changes should be included within the compass of a liberal arts education. Our response to this question is an unqualified yes. The engineered world needs to
take its place as a legitimate object of liberal arts inquiry alongside the longstanding objects of
the natural, social, and cultural worlds. It is with this in mind that we are interested in developing
this course. For those students who may be interested in pursuing a career in engineering, this
course will give them a window into the world of engineering. For all students, the course will
offer a window into the engineered world that will help to inspire their curiosity about how
things work and contribute to their ability to think more clearly about their relationships to
technology, whether as consumers, citizens, or simply as reflective human beings.

Student participation: We envision *Thinking Like an Engineer* would be comprised of
students whose interest in engineering design is supported by an interest in mathematics and the
natural sciences, as well as students whose interest in engineering design is infused with a liking
for inquiry in the humanities and in the arts. Optimally, working together with the Director of
Academic Programs, we would like the class to reflect a balance between these two groups of
students; and we hope the interests of at least some students would encompass both areas.

We have given some consideration to class size. Ideally we would like to team-teach a single
course of 16 students, but we realize that might not be possible. Based in part on comments from
Karen Saxe about her experience team-teaching a first year course of 32 students, we believe that
number is too large for the goals we have in mind of making the course as welcoming as possible
to all and building a sense of community. Given the fact that opportunities to participate in class
discussion decrease as a factor of class size, as well as our desire to have the course be
residential in order to help facilitate a sense of community among students with interests in
engineering, a class size of 20 or 22 students would be good.

Possible readings: At this point we have just started talking about possible readings for the
course. One volume that pops out, given our emphasis on the process of engineering design, is
Eugene Ferguson’s *Engineering and the Mind’s Eye* (MIT Press, 1992), in which he defends the
idea that (quoting here from the Amazon.com description) “good engineering is just as much a
matter of intuition and nonverbal thinking as equations.” Other possibilities for the course are
Walter Vicenti’s *To Engineer is Human: The Role of Failure in Successful Design*, Donald
Norman’s *The Design of Everyday Things*, Louis Bucchireli’s *Engineering Philosophy*, where
the author argues that the “synthesis of things and ideas” are central to engineering design, or his
*Designing Engineers*, an “in-the-field” study of the social and negotiation-infused aspects of
engineering decision-making. We also intend to incorporate readings on the responsibilities that
engineers have to the public beyond those reflected in professional codes, as well as readings
taking up matters of current controversy within engineering design—possibly driverless vehicles
or geoengineering. And, as we will look at the role that big data play in helping to identify
solutions to ethical problems associated with emerging engineering innovations, we will have
readings associated with this aspect of the course. No matter how our list of readings finally
develops, we would hope to Skype one or two authors into class to talk about their work and to
lead discussion.
**Potential class activities:**  Our aim is to have a variety of activities in the course, including some low-stakes, “makering” projects intended to bring out different dimensions of engineering thinking. For instance, we might ask students to build chairs out of cardboard, or to design something that could be 3D printed, or ask them to take something apart (say a solar light) and then write instructions for reassembling it. We envision a final, culminating design project for which students would work together in teams and for which they would keep a “decision log” in which they would reflect on their decision-making process; the exact nature of this project would be determined as we get further in to developing this course. Also, we anticipate that students might write an argumentative paper related to the discussion on the controversial engineering innovation that we integrate into the course. Another possible writing assignment would ask students to come up with a design plan for a small item that could make a big difference in addressing one of the NAE’s Grand Challenges, and to defend their design plan against other possible options. (One of Diane’s former philosophy students, soon to enter the Uméa Institute of Design, had to do a similar exercise on his application).

While most course activities/assignments would be common to all students, we would also like to include some options for some assignments where students could go more science heavy if they wished or stay more on the humanities/social science side if that is more to their taste.

We plan on putting in a request to GERC for a WA designation for this course, and perhaps for a Q1 designation as well.