

Proposed EELI Project Olin College

September 13, 2005

Background

There is an increasing recognition of the “pipeline” issue in American engineering education. High school students are, in general, less interested in pursuing engineering than other options (e.g., medicine, business, or law). Particularly among underrepresented groups, engineering is not generally viewed as a viable career option.

Although there are many possible causes for these phenomena, two stand out. First, there are significant discrepancies between public perception of the engineering profession and the realities of engineering today (see figure 1). As most people in the engineering profession would agree, engineering is not just about mathematics and physics, and it is not only about determining the best way to meet a set of specifications. As *The Engineer of 2020* outlines, engineers in the next decade must deal with the social, cultural, natural, and economic contexts of engineering. Engineering is becoming a profession that requires synthesis of a wide range of disciplines.

Our nation’s teachers and high school students are largely unaware of these contextual aspects of engineering. Students and teachers in K12 often think of engineering as nominally equivalent to mathematics and physics – consider, for example, the number of engineering students who have commented, “I chose engineering because I was good at math.” Even when students do not think of engineering as equivalent to science and mathematics, their conception of engineering is commonly focused on the narrow “specification to prototype” definition of engineering.

These beliefs – that engineering is the same as math and science, or that engineering is all about building widgets in a social vacuum – certainly attract some students, but they also create a significant entry barrier for many students, particularly in underrepresented groups. We particularly believe that it is important for students and teachers to understand that engineering is, at its core, about solving problems for people. Indeed, while the narrow definition of engineering shown in Figure 1 appeals to the “traditional” engineering demographic, the broader definition has the potential to appeal to many groups that currently do not seriously consider engineering as a career option.

Compounding this problem is a lack of knowledge and skills in the teaching workforce to introduce engineering at the middle school and high school level. While many teachers have at least some science or math background, virtually none have been exposed to engineering.

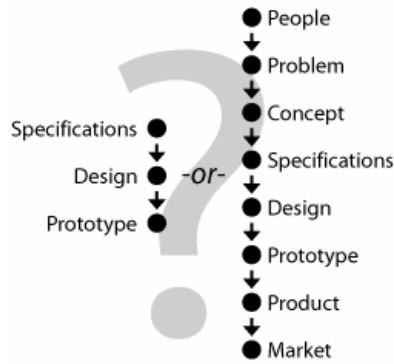


Figure 1: Two conceptions of engineering

Public pressure to make American high school graduates more literate about engineering is rising. For example, Massachusetts recently implemented a new, state-wide curriculum framework that includes technology/engineering as one of the core competency areas in science/technology for high school graduates. To date, relatively few students have been able to meet this requirement (approximately 1-2% per year).

At Olin College, we have worked over the past two years to develop a curricular structure that emphasizes these contexts. In particular, we have developed a sophomore-level course in user-oriented collaborative design (UOCD) which introduces students to formal ethnographic methods, methods of idea generation, and methods of collaboration in design. The course is not highly technical – indeed, we have successfully delivered the course to business students and liberal arts students from neighboring institutions – but it is fundamentally about an important part of engineering.

Proposed Project

We believe that there is a significant opportunity to use these curricular materials to introduce teachers to *engineering in a social context*. We envision a program which would: i) give teachers a much better sense of what engineering is, especially the social aspects of the profession; and ii) provide teachers with tools to help them introduce engineering to their students.

The program we envision would bring teachers to the Olin College campus for a two to three week collaborative summer workshop. Major components of the workshop would include:

- **Introduction of teachers to user-oriented design methodology (appx. 5 days):** With guidance from faculty, teams of 3-4 middle-school teachers would use the UOCD process to develop one or more product concepts. This portion of the workshop gives teachers hands-on experience in this approach to design, providing them with a context for subsequent workshop activities.
- **Collaborative development of materials (appx. 5 days):** Teachers and faculty would work collaboratively to adapt portions of the UOCD process to the middle-school environment. Such collaborative design would (1) provide teachers with

another opportunity to practice the design process, and (2) ensure that the developed materials took full advantage of the expertise of the teachers.

- **UOCD “summer camp” (1-5 days):** Following the development of materials, middle-school students would be invited to Olin college for a “camp”-style program at which teachers and faculty would act as instructors. This would allow teachers and faculty to test and refine the curricular materials, and would make the teacher’s future adoption of the materials much more likely.
- **Master Teachers:** In subsequent years, we imagine that teacher alumni of the program might return to campus to help deliver the program to new groups of teachers. Such a feature would allow those teachers to become local experts in their schools, and eventually to disseminate their practices to other teachers in their districts.
- **Funding Considerations:** We imagine that funding for this proposal would have to include appropriate stipends for teachers, as many teachers count on some form of summer income to supplement their teaching salaries. On the other hand, we believe that the “summer camp” aspect has the potential to be a revenue source, which could help defray the costs of the entire program. Naturally some form of outside funding will be necessary to undertake this program; we believe that a variety of funding sources might be appropriate.

Strengths of this proposal

The proposal leverages existing curricular materials and instructional techniques at Olin College.

Olin has been delivering the UOCD course to sophomores at Olin and students from neighboring institutions for two years. The course has consistently received strong reviews, and has been noted as particularly innovative by external constituents who have visited the college. Support materials for the course are well-developed and documented.

The proposal is financially and technically feasible for participants to bring back to their home schools.

The materials and infrastructure required to deliver the experience outlined in this proposal are common and inexpensive. No high-end equipment or supplies are required, nor is any special technical skill set.

The transfer of knowledge outlined in the proposal is demonstrably possible.

We have demonstrated the viability of the proposal both by running similar smaller scale workshops with instructors from other institutions (SyE3, ALE), and by involving non-engineers in the delivery of UOCD at Olin.

Opportunities addressed in this proposal

There is a demand for engineering-related educational materials for middle and high schools in Massachusetts and other states.

As this workshop addresses a specific need in the curriculum, we anticipate that interest from teachers will be high and that there will be a high rate of classroom adoption. This will provide us an opportunity to engage students in engineering at an earlier stage in their

education. Demonstrating this side of engineering may also help attract students and increase their motivation to continue with the more technically challenging courses in preparation for an engineering education.

There is a need for a change in the public understanding of engineering

The public perception of engineering is largely that of the technologically-focused, socially inept nerd. This workshop will help disseminate the idea that engineers are involved in listening to and interacting with users, and that they use these interactions as a basis for design.

The demonstration of the social aspects of engineering will help attract students to the field.

The UOCD course emphasizes a number of aspects of engineering education that are not prominent in the widespread perception of engineering. These include the skills of social interaction that are involved in working on a team and in collaborating with users. There is also a strong focus on creativity, as the process includes creative activities aimed at coming up with products that are appealing and functional for the user. By sharing this broader view of the engineering process with students as well as teachers, we have an opportunity to appeal to people who are not attracted by a view of engineering that is exclusively technical.

Weaknesses of this proposal

Public school curricula are often closely controlled or fixed.

In many public school districts, curricula have become rather rigidly controlled by centralized authority. This trend limits the flexibility of an individual teacher to introduce new material into the classroom. In this environment, it may be necessary to convince a school board or board committee to allow introduction of new course material. The burden resulting from increased administrative oversight of curricula is a potential barrier to implementation of the proposed new material in substantial numbers of classrooms.

Public school teachers may be afraid of new technology or unwilling to relinquish time from existing material to include new material.

Public school teachers may be guarded and somewhat unwilling to change existing curricula for a number of reasons. First there is the possibility that they may feel threatened by new, technical material; their insecurity may drive them to be a slow adopter of new material. They also may feel of sense of ownership of the existing material, having already invested time in learning how to teach it, and new material presents additional workload, with no particular benefit. They may feel unqualified to teach anything with the label “engineering” and reject it without careful consideration.

Course material that carries the label of engineering and is not rigorous in mathematics and science has the potential to misrepresent what engineering really is.

The program should acknowledge that the objective is to give students insight into an *aspect* of engineering that might give them an incentive to stick with a program of study that, unavoidably, will contain mathematics and science. We want to be careful to not give the impression that we are whitewashing the reality: qualified engineers must study a rigorous

regimen of technical courses that require significant maturity in mathematics and science. The potential risk, if this is not handled correctly, is that students will receive the misleading impression that engineering is *only* about the aspects that the UOCD course addresses. The goal of this program is to give students and teachers an insight into engineering, as well as a better glimpse of “the brass ring”, the exciting parts of engineering. After this, teachers need to be able to say: “Well, now that you are really excited about being able to design and build things, here is how you set your goals and plan to build the right background to be successful....”