Engagement in Practice: Engineering for Social Change Course in Mechanical Engineering

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Engineering for Social Change in the Center for Engineering Concepts Development at the University of Maryland (UMD)

The Engineering for Social Change (ESC) Program was developed within the Center for Engineering Concepts Development (CECD) in the Mechanical Engineering Department in the University of Maryland (UMD). The course "Engineering for Social Change", developed in conjunction with the School of Public Policy, is one of five components of the ESC program that also includes ESC Fellows, ESC-DGI Interns, Community College Outreach and the Engineering for Social Change Book Series.

Engineering for Social Change Course

This unique undergraduate engineering course was developed during 2014 after several discussions between the director of CECD, Dr. Davinder Anand, faculty from both the Mechanical Engineering and Public Policy Departments at UMD, faculty from renowned international universities and key personnel in private and public institutions. Within the framework of "engineering is not just engineering", the course is an attempt to recognize the importance of the understanding that engineers are responsible for the social change that their profession creates. Traditional engineering courses typically focus on the development of technical skills but often fail to help students develop the professional or "soft" skills that engineers need today and to create a sense of social responsibility [1]. It was very important to the instructional team that students develop the needed cultural awareness and that they would be inspired to use their technical skills to practice social entrepreneurship with the intention of making a difference in their communities and society at large. Unlike many courses that engage engineering students in practical, hands-on activities to practice philanthropy, this course puts the students in control of real funds and emphasizes analysis, discussion, and group decision-making for real impact. Students in the course were expected to investigate, analyze and propose ways to mitigate the unintended consequences of engineering designs and to engage in and take ownership of the philanthropic efforts through the grant review process. In addition, it was intended that the course would contain a syllabus that could address some of the Grand Challenges presented by the National Academy of Engineering [2] and the student outcomes proposed by the ABET as part of their accreditation process [3].

The course was envisioned to have five major components: an introduction to the concept of non-profit organizations and philanthropy as catalysts for social change, a series of lectures connecting various technical areas of engineering to their social impact, a semester-long project that examines engineering successes and their unintended consequences, a student-driven proposal development and grant review process that would facilitate the selection of a non-profit organization to receive a $10,000 investment from the Neilom Foundation, and an end-of-the-semester celebration where students present their projects to guests from non-profit organizations and the local community. Throughout the offering of the course, the instructional team learned that students appreciate the opportunity to be engaged in philanthropic activities and that an early connection with non-profit organizations makes the process more meaningful for them, resulting in a better understanding of their role in the creation of unintended consequences and the efforts to mitigate them.

Course Offerings

Spring 2015 - The course was first offered in the Spring of 2015 to thirty-two Junior and Senior Mechanical Engineering students. The students completed a Virtual Non-Profit Challenge (VNC) project throughout the semester. This project required student groups to create a virtual non-profit organization that would address a well-defined problem in either the local community or the world with an initial budget of $1,000. At the end of the semester, one student group was selected to receive the $1,000 as seed money to initiate the actual organization.

Students were also involved in the $10,000 grant review process throughout the semester. The students had ownership of the funds, and were engaged in the role of grantor. First, the class selected a topic; this semester it was "Access to Healthy Food". The class as a whole wrote a Request For Proposals (RFP) that was sent to local non-profit organizations working on solving problems related to the selected topic. Fifteen organizations responded to the request and eight were selected for a phone interview. After the interviews, four organizations were visited by the entire class and at the end of the semester, the class selected the FRESHFARM Markets non-profit to receive the "Neilom Engineering for Social Change Grant". The development of the RFP and selection process were guided by the instructional team through a series of lectures that provide a framework for these processes.

The awarded grant was used to create a teaching garden and water management feature at the Ludlow Taylor Elementary School, a Title I school in Washington D.C. The money was also used to leverage an additional one-million-dollar investment by Washington D.C.'s Riversmart program. Figure 1 shows before and after pictures of the site and garden.

Figure 1: Before and After pictures of Teaching Garden at Ludlow Taylor Elementary School

Fall 2015 - The second course offering was again open to only Mechanical Engineering majors. Forty-one students enrolled in the class. During this semester, students worked on a new Ideas for Social Change Challenge (ISCC), designed as a semester long project to replace the VNC from the previous semester. The project consisted of identifying a local or global problem and then using the ideas of empathy and co-design to design a sustainable solution in conjunction with members of the target community. The central idea, presented by guest speakers from the United States Agency for International Development (USAID) and the Academy of Innovation and Entrepreneurship at the University of Maryland, was that community members should be recognized as important participants of an effective design process.

The topic selected by the students for the grant process was "Access to Clean Water". This semester the class received ten proposals responding to the RFP, six organizations were selected for a phone interview and three received site visits by the class. At the end of the semester, the class selected the organization Bread and Water for Africa of Alexandria, VA to receive the grant award. The organization matched an additional $5,000 to dig a manual hand-pump well in Freetown, Sierra Leone to provide fresh water to 2,500 residents for the next 15-20 years. Figure 2 shows school children in the community using the new well.

Figure 2: Manual hand-pump well in Freetown, Sierra Leone

Fall 2016 - For this course offering, enrollment was opened to all engineering majors, and the requirement of a one-page application was put in place. A total of forty-three students enrolled in the course, limited to thirty-three from Mechanical Engineering and the remaining from multiple engineering departments. A significant difference this semester was that instead of a design project, the students worked in groups on a semester-long scholarly paper on the unintended consequences of engineering successes. The primary motivation for this change was to provide students with the experience of creating a well-researched, high-quality document that theoretically could be published with minimal alteration.

During this offering, students chose the topic of "Assistive Technology" for the grant process from a choice of four options. The class received five proposals from local nonprofits, students visited two organizations and representatives from a third organization came to speak to the class. At the end of the semester, the class chose the Baltimore, MD non-profit organization V-Linc to receive the award. This organization works with engineering students and professional volunteers to develop custom assistive technology solutions for young people with mobility limitations. Figure 3 shows students and professional volunteers during one of their bike clinics.

Figure 3: V-Linc student and professional volunteers

Lessons Learned

During the first three offerings, the instructional team received feedback from students, guest speakers and faculty. The main lessons learned were:

- Allowing students to choose the voting method to select the organization that receives the grant did not provide significant benefit. After the first offering, it was decided that the instructional team will provide the voting method at the beginning of the semester.
- Students felt rushed during the development of the RFP process, especially since time constraints require that this process is finalized early in the semester. The new process, used in the 4th semester, will be explained in subsequent sections of the paper.
- Topic selection and site visits required too much of the class meeting time. Student's schedule conflicts did not allow for site visits outside regular class time.
- Depending on the topic selected, the number of proposals received could be very low, limiting the diversity of projects for grant consideration by the students.
- The administrative time dedicated to personally contacting organizations to encourage them to apply and then to following up with them was very high, and the results unpredictable.
- Students did not feel engaged with the organizations until the phone interviews and site visits, occurring towards the end of the semester.

Fall 2017 - In an attempt to address several of the issues raised in previous semesters, the instructional team decided to make several changes for the fourth offering of the course. First, the topic for the grant proposal was preselected for the students at the start of the semester. The topic chosen for this semester was "Waste" as it is one of the most important unintended consequences created by technology. Within this general topic, student groups selected a type of waste from a list presented to the class during the first meeting of the semester. Second, instead of requesting the students to create an RFP, the groups were tasked with investigating the field, identifying possible non-profits to work with, and reaching out to organizations working on the mitigation of such waste. Students were then required to schedule meetings, including site visits, with representatives from the organizations to co-develop a proposal directed at solving a specific problem. The student groups presented their projects and proposals to the rest of the class, the instructional team selected the top three proposals, and representatives of each of the finalist organizations visited and spoke to the whole class. At the end of the semester the class selected one non-profit organization to receive the $10,000 grant from the Neilom Foundation, the Oyster Recovery Partnership of Baltimore, MD. This non-profit organization works in oyster restoration to improve water quality in the areas of the Chesapeake Bay affected by the pollution created by agricultural runoff waste in the area. In particular, the funds awarded will be directed to the purchase and installation of a larger oyster processing hopper to improve their initial processing of used oyster shells. Figure 4 shows the winning student group with the representative of the organization and a schematic of the hopper.

Another significant difference from previous semesters was the linking of the scholarly paper on a specific unintended consequence of engineering to the grant proposal process. This was accomplished by directing the students to use their proposed projects and organizations as one mechanism by which to mitigate their chosen unintended consequence (waste).

Figure 4: Left: Fall 2017 Winning Student Team with Oyster Recovery Partnership Representative. Right: Proposed Hopper

Course Assessment

The assessment strategy of the course has been focused on assessment of the students' understanding of the lecture topics, peer assessment of presentations and team interactions, self-assessment of participation activities and direct feedback from students. Student knowledge of topics presented during the semester was assessed by traditional methods: a midterm, announced quizzes (in a group setting), a final exam and a scholarly paper. Students were also asked to submit lecture critiques twice during the semester. All students had the opportunity to assess their peers' presentations. Their input was factored into the final grade that each group received for their preliminary presentation. Participation was assessed by requesting the students to submit a participation log and engage in self-reflection of their contributions to class discussions twice during the semester (at the same time of the lecture critique). Finally, students participated in two open discussions about the class lectures and course dynamics and were asked to submit an individual public blog with their impression of the class at the end of the semester.

The instructional team will be working on the creation of an assessment plan to investigate the level of achievement of the class goals. Also, the team intends to adopt the CATME tool from Purdue University [4] to form teams and assess student interactions in their groups.

Student Feedback

Student feedback is requested multiple times and encouraged during the semester. As was mentioned previously, students are expected to submit lecture critiques twice during the semester and a blog at the end. In addition, three In-Class Feedback sessions are scheduled throughout the course. During these sessions, students seated in a semi-circle formation respond to questions posed by the instructors. Each student is allowed a limited amount of time to respond to the questions and to make comments or suggestions about the class. The following are some excerpts from the feedback sessions and student blogs:

- *This class humanized my engineering education.*
- *The course has bridged the gap between what I plan to do with my engineering degree, and why I'll be doing it.*
- *Overall, the class encouraged a form of engineering activism in me.*

- *During the stages of the course, I have learned how to embrace the concept of philanthropy while continue to remain relevant to the globally interconnected engineering landscape.*
- *This course stepped away from the traditional engineering curriculum, which is rigorous and technical, and instead focused on the bigger picture— what it means to be an engineer.*
- *This course is symbolic of the stepping stone all engineers in today's world need to base themselves on when solving problems.*

Conclusions

"Engineering for Social Change" is a unique undergraduate course that combines engineering and philanthropy and allows students to take a leadership role as both investigator and grantor of the Neilom Engineering for Social Change Grant. Throughout this course more than two hundred non-profit organizations have been contacted, and four grants have been awarded through the Neilom Foundation, totaling $40,000.

Across four iterations this course has successfully provided an opportunity to more than one hundred and sixty students to learn to identify responsibilities that engineers should bear in their profession in addition to the technical requirements that are the focus of conventional engineering courses. In the most recent offering, students were able to engage directly with non-profit organizations right from the beginning of the semester. This interaction seems to translate into a higher level of engagement of the students in devising creative solutions to existing problems in their communities.

It is important to note that another unique trait of this course is the diversity in the students that choose to take this elective. In all its offerings, the percentage of female enrollment in this course has been between 30 and 50 percent. For comparison, the total female enrollment in the Mechanical Engineering Department is around 15 percent. Also, a noticeable number of international students have chosen to take the class. The authors believe that offering courses similar to this one, could help in developing a new perspective of engineering professions among student groups that are not normally well represented.

References

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