

Experiential Learning for Professional Skill Development Across an Engineering Undergraduate Program

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Abstract—This innovative practice work-in-progress paper will describe the emergence of structured programming for experiential learning pathways in an engineering program in a private institution in the US Northeast region. This will include planning for professional skill development to be embedded throughout the first- and second-year curriculum and support for co-curricular experiences. In addition, the new structure will embed a design portfolio practice within the engineering curriculum. This work is guided by an organizational change model, and the initial results of the plan are shared through the steps of the model.

Index Terms—experiential learning, co-curricular, professional skills, institutional change, change models

I. INTRODUCTION

Engineering students must learn both technical and professional skills. Both skill sets are needed for industry, and student must develop professional skills to be successful practicing engineers. The National Academy of Engineering 2004 report, *The Engineer of 2020*, outlines the needed attributes for future engineers, which include non-technical professional skills such as communication, creativity, leadership, management, and flexibility [1]. Researchers have found that oral and written communication were among the top five most important skills identified by employers for engineering graduates. Employers noted, however, the largest difference in satisfaction with those skills [2]. Professional skills are also necessary for future multidisciplinary, globally engaged engineering projects and challenges. Engineering educators have emphasized that professional skills are critical for addressing globalization of the engineering profession [3]. Others have called for the electrical and computer engineers of the 21st century to develop a variety of interpersonal and intrapersonal skills including teamwork, collaboration, and global competence [4].

In order to best teach these skills, engineering schools have implemented curricular reform through a variety of methods. However, few engineering schools have taken a holistic approach to implementing experiential learning for professional and technical skill development through a combined, concerted co-curricular and curricular initiative. Previous studies have

indicated positive outcomes in student well-being and support programs through partnerships between engineering departments and administrative support programs such as students affairs and advising [5]- [6]. This study builds on those previous collaborations by building a coalition between several administrative support programs and all of the engineering departments within a school of engineering. This innovative work in progress paper will explore the early stages of change at an institution to embed co-curricular and curricular experiential learning for professional skill development throughout the undergraduate experience. This will be explored through the lens of Kotter's change model [7].

II. BACKGROUND

Kotter's 8-step change model was developed from observations of leaders and organizations. The steps are:

- 1) "Establishing a sense of urgency
- 2) Forming a powerful guiding coalition
- 3) Creating a vision
- 4) Communication the vision
- 5) Empowering others to act on the vision
- 6) Planning for and creating short-term wins
- 7) Consolidating improvements and producing still more change
- 8) Institutionalizing new approaches" [7]

This model has been utilized in several recent higher education studies, such as the implementation of a new student evaluation system and an academic library reorganization [8]- [9].

Building on the work of Henderson, Beach, and Finkelstein to identify and review change in undergraduate STEM instructional practices, Borrego and Henderson identified Kotter's change model as a potential change strategy to guide engineering educators [10]- [11]. Recently, this model has been utilized to study changes within an engineering department, funded through the NSF's Revolutionizing Engineering Departments (RED) program [12]. The authors found that the initial steps of the model and change were straightforward. They highlighted the importance of short-term wins in supporting the change,

and they stressed that the process overall was iterative and non-linear [12].

III. METHODS

A. Setting

The change model was applied at a large, private Northeastern US university. The school of engineering is approximately 6,000 students, split almost evenly between undergraduate and graduate students. This work builds on curriculum updates from the past 8 years. In 2016, the school also opened a large, 10,000 sq-ft makerspace in the main engineering building. This is equipped with a range of 3D printers, laser cutters, vinyl cutters, sewing and embroidery, CNC milling machines, soldering and electrical bench test equipment, and shop tools. The administrative staff who manage the space have worked closely with faculty from the school of engineering to embed use of the makerspace in project-based courses.

The steps from early curricular change to the creation of this committee are outlined below through the lens of the change model.

IV. RESULTS

Kotter's change model describes eight steps to support long term change in an organization.

A. Establishing a sense of urgency

A general culture of curricular improvement and change was slowly built upon with input from faculty, the creation of the makerspace, and an understanding of updated industry and technological needs over the last ten years. The main starting point for this step was really established in 2018, with the arrival of a new dean for the school of engineering. She fostered and championed a push for additional flexibility in the engineering curriculum, supporting all engineering departments to open up at least 15 free electives in their strict credit requirements.

As part of the strategic plan, the dean included a strong student first initiative to support the undergraduate experience. A new assistant dean of academics was also appointed to support curricular innovation.

In Spring 2021, the dean's office led a series of virtual "blue sky" idea retreats to discuss long term, large-scale vision and change. One of the breakout sessions focused on experiential learning. While the school does not have a historical co-op or internship program that places students in specific experiential learning opportunities in industry, there was a strong desire and brainstorming session to implement accessible, potentially required, assortment of experiences based on student interest and options at the school. These included but were not limited to industry experience, global/study away, multidisciplinary project-based courses, multidisciplinary capstone, service learning, leadership in student clubs and organizations, teaching opportunities, and undergraduate research programs.

B. Creating a guiding coalition

Over Fall 2021 an experiential learning supervisory committee was created with approval from the school's dean with the long term goal to create accessible experiential learning opportunities with supporting professional skill development for all undergraduate students. The committee includes:

- the first-year program director;
- assistant deans of advising and academics;
- administrators from admissions and enrollment, student life and leadership;
- engineering career services; and
- the director of the makerspace.

In addition, each degree granting department at the school has identified specific faculty and advisors who will participate in the committee to provide input and direction for the needs of their students. There are one to three representatives from each department, depending on size and interest. The committee is co-chaired by two administrative staff members, the makerspace director and the director of undergraduate enrollment, who led the development of the vision and strategy.

C. Developing a vision and strategy

In this case, steps two and three were developed simultaneously. A second leadership retreat presentation on experiential learning was developed and presented by the makerspace director in March 2021. This spurred additional conversation about possibilities and goals at the school for change. The makerspace director and the director of undergraduate enrollment were interested in continuing to work on this as a potential proposal. Over Summer 2021, they developed and presented several visioning strategies. These were shared with the school of engineering dean's office and the engineering department chairs for feedback and guidance.

Finally, in early Fall 2021, the dean reviewed a final proposal which included establishing a guiding committee and an experiential learning center.

D. Communicating the change vision

An announcement was shared with the school leadership team which includes department chairs and center directors, in Fall 2021. Over the next few months, the committee co-chairs reached out to department chairs with recommendations for the departmental representatives. These were reviewed and approved, or edited as necessary, by the chairs. The committee co-chairs then set up listening sessions with each set of representatives. These were intended to guide the early change goals for the co-chairs and committee, as well as to build buy-in and support from the individual representatives. The questions included:

- How are your students currently involved in experiential opportunities?
- Which opportunities do your departments' students utilize the most?
- What gaps are there from your perspective?
- What department specific opportunities are there?

- What resources do you think you might need to better prepare your students for industry?
- Do you currently track student involvement in these activities? If so, how?

In addition to the listening sessions, the co-chairs also worked with the school's marketing and communications team to create a set of webpages for the center. The main page was designed to be a resource for students and faculty, gathering information about experiential learning opportunities at the school that had previously been disparate. Several new pages were also created and connected to the main page to support professional skill development. These included a guide for creating an engineering portfolio. The webpages were published in March 2022.

In April 2022, the dean announced the new center and initiatives to incoming admitted students at several live, virtual events.

E. Empowering broad-based change

Several barriers have been addressed as part of the early stages of this work. Establishing the experiential learning committee itself also helped to remove silos between administrative functions and departments. Based on feedback from several faculty on the committee and the director of student life and leadership, the importance of student professional conference attendance was highlighted. In the past, there have been multiple opportunities for students to request funding support for conference travel, but faculty did not know about the support from outside their department. Through the experiential learning committee, a budget was requested and approved by the dean's office to centralize student professional conference funding opportunities and make explicit how to apply for each opportunity.

F. Generating short-term wins

The establishment of the committee and center, and the design and creation of the website have all been initial wins. Budget approval, which includes the student professional conference support detailed above, funding for portfolio and teamwork platforms, and professional development training, has also been a win. CATME was identified as the desired teamwork platform identified by the first-year engineering program at the school. They plan to implement CATME in the curricular changes for Fall 2022. As part of the experiential learning center budget, enough license seats have been funded for the platform to be implemented by senior design and other design-based courses across the school. This is part of the committee's early discussions about implementing broader change across the curriculum and school in a cohesive and strategic manner.

The largest short-term win has been the approval by the faculty body of a planned change to the first-year engineering course. These changes are actively being developed over Spring and Summer 2022 and will be implemented in Fall 2022. This includes adding a credit hour to enable and support professional skill development and career preparation into the

course. In addition to labs, lectures, and a semester-long design project, the students in the course practiced presenting weekly in recitation and were guided through creation of a resume. The planned changes now include preparation for applying to an internship by creating a cover letter, resume, LinkedIn page, and starting a professional portfolio. The faculty also plan to implement CATME to support teamwork skills.

G. Consolidating gains and producing more change; Anchoring new approaches in the culture

Both of these steps are still future work for the school and guiding coalition. Long term goals include the creation of a second-year professional skills course. This would support career development goals and continue the changes in the first-year course to grow student professional skill development. Design of the course is planned for the next academic year.

V. DISCUSSION

As indicated by other studies, the application of the process is iterative and often non-linear [12]. In this case, several of the early steps were implemented concurrently. Empowering broad-based efforts and generating short term wins will likely need to be iterative, and the final two steps in the process are still planned work for Fall 2022 and onwards. Building from a mixed-method study surveying engineering faculty, chairs, and deans, developing a shared vision of change will be important as we move forward [13].

The guiding coalition in this work, the experiential learning committee, is unique in engineering education research as an example of a collaboration for change supported by administrators and faculty. Appointing the two co-chairs was important to empower several change agents who were interested in doing the work and had capacity to build momentum.

There were several important findings from the departmental listening sessions. All department committee members emphasized a lack of professional skill development and career preparation in their students. While two of the departments do offer a professional practice course, both are for students who are in their junior or senior year. Informally, students in those departments emphasized that they felt the courses were offered too late in their undergraduate experience to be helpful. Most of the department committee members also highlighted communication skills, both technical and professional communication, as a need for their students. Many members expressed confusion about the opportunities available to students and with the school's website. All members of the guiding coalition stressed the importance of student agency and ownership as they participate in these experiential learning opportunities.

VI. CONCLUSION AND FUTURE WORK

While change and curricular reform in engineering education have been implemented and studied over the last 20+ years, there is still ongoing change of engineering programs and the undergraduate educational experience to support professional skill development. This innovative practice paper details the successful implementation of the early and middle

stages of Kotter's change model for the creation of a sustained, transformative change for undergraduate engineering students at one institution. This work is unique in studies of change management in engineering education, as it details a collaboration between several different administrative support systems or staff and all of the engineering disciplines within the school.

Future work includes the implementation of the first-year engineering course changes to support additional professional skill development. And, the creation of a second-year professional skills course. These are both planned for the next academic year. Long term, the committee should continue to build momentum to produce change and anchor the institutional change. An empirical, qualitative study on the guiding coalition and change model are planned. Finally, long-term goals include implementing assessment of student professional skill development through the design portfolios, course evaluations, and a future research study focused on as these curricular changes are adopted and structured throughout the undergraduate experience [14]- [15].

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