

## **Professional Development for Engineers: A Certificate Program for 3D Undergraduate Experience in Engineering Education**

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### **Abstract**

Professional skills are critical in engineering practice and they are best cultivated in multiple communities of practice. We have created a certificate program for professional development of engineering students with the goal of organizing and documenting their co-curricular activities. We call our innovative structure the 3D Undergraduate Experience with dimensions of academic excellence, community creation and professional skills. Interested students will propose their plan of activities according to their career goals and document these activities in a web-based portfolio, which they can provide to potential employers or graduate schools. In this work-in-progress, we will present description of activities, rubrics for evaluation and preliminary results from a small group of students with whom we are piloting the certificate program.

### **Keywords**

Professional development, community creation, co-curricular

### **Background**

For the last two decades, improvements in academic training of engineering undergraduates have focused on changes in course offerings, course sequences and course content. This type of one-dimensional approach to engineering education has been tweaked, refined and optimized to the near limits of the benefit that can be offered within the confines of a four-year education. James Plummer, who is a pioneer in transforming engineering education and former Dean of Engineering at Stanford University, recently advocated broadening engineering education to include more liberal arts exposure and more life skills, with the aim of preparing future engineers for unpredictable careers. “Engineers will need communication skills, the ability to work in teams, global knowledge, and an entrepreneurial outlook as much as they will need technical depth<sup>1</sup>,” he said. We created our holistic program, which is both evolutionary and revolutionary, to address the needs of engineers of the future. For the last ten years, we have been collecting data on the co-curricular activities of the Biomedical Engineering students through qualitative inquiries such as exit interviews, award nominations, and journey maps to identify the need for the next innovation. A two-week strategic planning activity driven by the input from students and faculty combined with the critical lessons of the “A Whole New Engineer<sup>2</sup>” movement gave us the structure we call the 3D Undergraduate Experience<sup>3</sup>. The certificate program we are developing now provide interested students the opportunity to document their accomplishments as 3D Engineer.

## Certificate Program Description

For students who accept the challenge, the certificate program offers a unique opportunity to explore how a multi-year co-curricular initiative can foster confidence, particularly 1) in students who may have socially marginalized identities as they enter engineering and 2) in those for whom societal engagement is especially motivational<sup>4</sup>. The overarching goal of this certificate program is to create a hybrid “third space” to transform marginalizing educational experiences and to develop new narratives that expand the agency of our students<sup>5</sup>. The program also allows students who choose not to participate, nonetheless, to benefit from the insights and experiences of participating peers, and promotes a cultural transformation for all students.

When we saw the overlap between the student outcomes of the certificate program and the new ABET student outcomes, we decided to use the ABET versions of those statements for outcomes 3 and 4.

Students who complete the Certificate of Professional Development for Engineers will be able to:

1. Lead the way to address problems related to local and global challenges.
2. Pursue opportunities for innovation and entrepreneurship.
3. Communicate with a wide range of audiences.
4. Recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts.

The coursework requirement for the certificate program is nine credit hours of engineering design education. Design courses are strongly tied to the student outcomes of the certificate program and a common component of engineering disciplines in the college of engineering. Enrolled students are required to complete one semester long activity and two short-term activities per dimension. Figure 1 shows a list of sample activities for the Community dimension according to career goals. Figure 2 shows a list of sample activities for the Professional Development dimension. In the pilot study, there are nine students. Five of them are interested in industry jobs; four of them are interested in attending graduate school.

## Program Assessment

The certificate program has two deliverables: 1) development of an electronic portfolio, which would also serve as an augmented CV with reflective summaries of activities, and 2) a written proposal on the social and ethical impacts of their capstone project. We will evaluate the first component using the DEAL (Describe, Examine, and Articulate Learning) model for critical reflection<sup>6</sup>. It is in the Articulate Learning segment; students answer questions about themselves and integrate their academic learning with experiential learning. This year, students will write and submit the second component according to the guidelines given by the annual gender and equity symposium to be held at North Carolina State University.

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Semester-long activities		
<i>Required activity</i>	<i>Example for career goal</i>	
Internship	Co-op	Clinical Internship
	Research Experience	Internship or Research Experience
Short-term activities (2 per category)		
<i>Required activity</i>	<i>Example for career goal</i>	
Service Learning	Engineering World Health	Clinic Volunteer
	Helping Hands Project	Engineers without Borders
Community Service	Interact	Special Olympics
	Habitat for Humanity	Food Bank
Mentoring	Girls Engineering Change	STEM Camp Counselor
	Science Olympiad Volunteer	Tutor
Networking	Ambassador	Grand Rounds
	Research Conference	Networking Events

Figure 1: List of community creation activities for the Certificate Program according to career goals. Orange: Industry Blue: Graduate School Green: Medical School Grey: Other

Semester-long activity		
<i>Required activity</i>	<i>Example for career goal</i>	
Capstone Activity	Six Sigma Green Belt	EMT Basic
	Research Author	Design Competitor
Additional course	Regulatory Affairs	Microbiology
	Advanced Statistics	Advanced BME Elective
Short-term activities (2 per category)		
<i>Required activity</i>	<i>Example for career goal</i>	
Leadership Activity	Officer in Student Organization	Leadership Modules
	Lab Leader	Teaching Assistant
Global Engagement	Language Study	Medical Mission
	Study Abroad	Alternative Spring Break
Ethics Training	NAE Ethics Modules	IRB Ethics Module
	IACUC Ethics Module	Biomedical Ethics Course
Out of Class Learning	CNC Mill Training	Shadowing
	Seminar Attendance	Online Courses

Figure 2: List of professional development activities for the Certificate Program according to career goals. Orange: Industry Blue: Graduate School Green: Medical School Grey: Other

We are in the process of collecting reflective summaries from eight short-term activities per student that span the categories for the Community Creation and Professional Development dimensions. Students are also working on their proposals to submit to the gender and equity conference. We will share the summary of these results at the conference.

## References

1. <https://spectrum.ieee.org/view-from-the-valley/at-work/education/the-engineers-of-the-future-will-not-resemble-the-engineers-of-the-past>
2. Goldberg, D.E. and Somerville, M. *A Whole New Engineer: The Coming Revolution in Engineering Education*, ThreeJoy Associates, Inc. Douglas, MI, 2014
3. Cartee, L.A., H.O. Ozturk, and F.S. Ligler, “3D curriculum: an innovative structure to model the co-curricular experience in biomedical engineering,” Proceedings of the 2018 ASEE Annual Conference, Salt Lake City, Utah, 2018.
4. Meyer, M. and Marx S., “Engineering Dropouts: A Qualitative Examination of Why Undergraduates Leave Engineering,” *American Journal of Engineering Education*, Vol. 103, No.4, Oct. 2014, pp. 525-548.
5. Secules, S., Gupta A., Elby, A. and Tanu, E., “Supporting the Narrative Agency of a Marginalized Engineering Student,” *Journal of Engineering Education*, Vol. 107, No.2, April 2018, pp. 186-218.
6. Ash, S.L, Clayton, P.H., & Moses, M.G. (2009). *Learning through critical reflection: A tutorial for service-learning students (instructor version)*. Raleigh, NC.

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**Frances S. Ligler**, currently the Lampe Distinguished Professor of Biomedical Engineering, has had over 40 years research experience in academia, industry and government and mentored ~200 undergraduate and 55 postdoctoral fellows in her lab. With 11 commercial products and over 450 publications/patents, she has been named to the US Inventors Hall of Fame and elected a Councilor of the National Academy of Engineering.