The ASU College of Technology and Innovation Capstone Program

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The multi-disciplinary capstone program in the College of Technology and Innovation at Arizona State University was designed to provide a learning experience that is based on open-ended relevant problems and one that enhances a student's connection to industry, government, and graduate education. The capstone experience brings together students from different disciplines as well as students that have learned through different pedagogical models. All students in the engineering program are engaged in multidisciplinary capstone projects. The engineering program is grounded on a unique project-based curriculum that prepares student to continue learning in a multi-disciplinary team structure. Students are assessed in the program through oral presentations, oral examinations, presentation of a portfolio, on capstone reports, and by the capstone sponsor. Assessment is based on four dimensions of development in eight areas. In the first year of implementation 12 multi-disciplinary capstone projects were conducted. This will be expanded to approximately 20 projects next year. Most of these projects are sponsored by industry. Currently there are students from five different degree programs working on the capstone teams. Next year this will also be expanded. Early evaluation of the multi-disciplinary capstones are very positive.

Introduction

The Engineering Program at the Polytechnic campus of Arizona State University is a nontraditional multidisciplinary engineering program that offers students a unique educational opportunity. Its core values of engaged learning, agility, and focus on the individual are realized using a creative curricular and pedagogical structure befitting a program housed within the College of Technology and Innovation. The capstone program is anchored by a two-semester multidisciplinary comprehensive project experience based on cumulative knowledge and skills gained in earlier course work. A primary objective of the capstone sequence is to demonstrate in a project setting that students have attained the academic program outcome at a level of proficiency required for ABET accreditation. A secondary outcome is to provide an educational experience that is consistent with professional practice.

The Enabling Curricular Structure

The engineering program in the College of Technology and Innovation has been uniquely designed to emphasize engineering practice through a project-based curriculum. The engineering program curriculum offers a project course every semester for each academic level (freshman, sophomore, junior, senior). The project courses are the primary avenue for engaging in realistic problems. This design is consistent with recommendations from several reports as follows.

Recommendations from Sheppard, S. et al. [1] include:
1. "Provide a Professional Spine"

The professional spine would be the engineering equivalent of the clinical dimension of medical preparation. Students would have increasingly practice-like experiences as a central feature of engineering education, pointing toward both analysis and design, with attention to ethical and professional development through an integrated approach.

2. "Integrate identity, knowledge, and skills through approximation of practice"
Faculty need to make clear what expert practice looks like, modeling or otherwise making visible both thinking and doing. Faculty need to provide students timely and informative feedback through formative means. All these efforts should move in a common rhythm, starting from more distant and moving toward closer approximations of the full complexity of practice.

Duderstadt [2] recommends: "Offer Practice-based Degrees"

"Working closely with industry and professional societies, higher education should establish graduate professional schools of engineering that would offer practice-based degrees at the post-baccalaureate level as the entry degree into the engineering profession." This speaks to the need for a capstone like structure at both the undergraduate and graduate level.

Recommendations from "Educating the Engineer of 2020" [3] include: "Adopt a Pedagogical Approach Similar to Medicine and Law"

"In a world characterized by rapidly accelerating

technologies and increasing complexity, it is essential that the engineering profession adopt a structured approach to lifelong learning for practicing engineers similar to those in medicine and law. This will require not only a significant commitment by educators, employers, and professional societies but possibly also additional licensing requirements in some fields."

Consistent with these recommendations, the multidisciplinary B.S. Engineering program was carefully crafted, through an innovative redesign of the traditional bachelor's program in engineering. In our program much of the learning takes place in *engineering studios*, not lecture halls, where we work on increasingly realistic projects every semester, providing a professional spine for students. The program provides a flexible curriculum, with many different potential pathways. The students build on an interdisciplinary engineering foundation by selecting two focus areas of study, and one of the concentrations does not need to be engineering. However, students may also select a primary and secondary focus in the same area providing a degree that is more traditional. All students have faculty mentors who guide them throughout their education, participate in an oral exam each semester, and develop portfolios to document individual accomplishments.

The Capstone Structure and Value

As part of our desired outcome of providing an educational experience that is consistent with professional practice we have developed an industry sponsored professional practice capstone program. Working with industry project sponsors we solicit design problems that are real open-ended problem. We have found that projects sponsors have varied interests in participating. For some, the opportunity to work with students for a full academic year provides a cost effective venue for evaluating talent. In addition to the project team, the sponsor will have additional opportunities to interface with top students such as through our project day, our design briefings, and through industry days on campus. Some sponsors use the project as a mechanism to evaluate potential new technologies and applications. Yet others explore new markets by using their technologies in new applications. And for a few, projects represent an opportunity to invest in higher education.

Each project has a team of 3-6 students working on designing and implementing a solution. Each student will work from 10 to 12 hours per week on the project for the full August - May academic year. A faculty advisor will be involved as will the sponsor's liaison, but the conduct of the project is the responsibility of the student team.

The College of Technology and Innovation has programs in engineering, engineering technology, business and entrepreneurship, aviation, computing, biology, math, and psychology. Multidisciplinary project teams are composed to address the specific skills needed to successfully complete the projects.

We ask each sponsor to provide a key stakeholder that functions as the project liaison and that the liaison meet with the team weekly (face to face or through virtual meetings). Students do best and receive the most educational benefits when they are working with a real customer and are working to meet the needs and demands of that customer.

Initial Results

At this point we have some anecdotal evidence that the multi-disciplinary structure is highly valuable. We surveyed the students and more than 90% indicated that they found a learning benefit in working on multidisciplinary teams. All corporate sponsors are continuing their relationship with ASU including more projects. Many of the team members were directly offered employment from a sponsoring company. We plan on a more detailed evaluation of the program this year.

Schedule

1. Sheppard, S. D., Macatangay, K., Colby, A. and Sullivan, W. (2009) "Educating Engineers, Designing for the Future of the Field, Sheppard, The Carnegie Foundation for the Advancement of Teaching, Jossey-Bass.

2. Duderstadt, J. (2008) "Engineering for a Changing World, A Roadmap to the Future of Engineering Practice, Research, and Education, The Millennium Project, The University of Michigan

3. The National Academy of Engineering, (2005), "Educating the Engineer of 2020"