Meeting new institutional goals by renovating a 20-year-old industry-sponsored capstone design course

Sindia Rivera-Jiménez, Ph.D and R. Keith Stanfill, PhD. P.E.

Engineering Innovation Institute, University of Florida

Abstract

The following work in progress summarizes the efforts of the Integrated Product and Process Design (IPPD) Program in the Herbert Wertheim College of Engineering at the University of Florida (UF). Since 1995, IPPD provides an outstanding opportunity for engineering students to work in multidisciplinary teams to solve real-world challenges of interest to sponsor companies with the guidance of a faculty member and staff. UF expects IPPD to increase 30% in the number of students and projects for the upcoming year. Growing IPPD's enrollment will bring many challenges for capstone design instruction, development of assessment tools, faculty performance evaluations, and multidisciplinary team management. The current work will share the findings of 9 years of collected data and examples of instructional design strategies such as lesson plans, online environment, active learning, and assessment tools. Finally, this will lead to a discussion about the new strategies and efforts needed to improve course delivery, management, and assessment.

Keywords

Blended, flipped, design, capstone, industry, multidisciplinary

Introduction

The Herbert Wertheim College of Engineering at the University of Florida (UF) recently formulated its strategic plan to transform the education of the New Engineer. Based on a survey administered to major engineering-focused industries, UF created a list of attributes for the New Engineer that every graduate must have to overcome the many challenges that the 21st century will bring. To achieve this, engineering students must have meaningful experiences in leadership, innovation, and interdisciplinary practice during their time at UF. The Integrated Product and Process Design (IPPD) Program at UF has prepared engineering students to meet these demands due to its close relationship with industrial sponsors. IPPD offers a unique educational model that provides students with the opportunity to experience the develop the attributes of the New Engineer.

Since, 1995, the program has impacted over 2,800 students from 15 disciplines, participating in 517 projects sponsored by over 120 different companies. So far, 80 faculty coaches that are experts in their engineering fields have served as project mentors in IPPD. Projects are classified according to the company's major requirements into categories such as software, hardware, process oriented, and entrepreneurial. Because all projects are different, the two-semester course provides students with "authentic involvement" by working together in multidisciplinary teams to solve real-world challenges [1]. Each year, the projects are formed by creating a Scope of Work (SOW) before the Fall semester starts. The SOW guides the student teams and faculty mentors on the "needs and wants" of the sponsor company. Students apply to the program and are accepted based on how many disciplines are required to execute the SOW successfully.

During the first week of class, faculty mentors do a 3-minute elevator pitch of the projects to all the students with the aim of recruiting students to their teams. Students submit a Project Form ranking at least ten projects and explaining why they want to be part of these projects. Afterwards, all faculty mentors meet to draft the teams based on discipline requirements for the projects, student ranking and motivations, and student's experience detailed in the application. At the end of the week, students are notified through the IPPD webpage.

The core of the curriculum in the program utilizes systems engineering design fundamentals in parallel with the team's project development [2]. During the two-semester course, IPPD course deliverables, professional development, and activities guide students on project management to increase their chances of success. In 21 years, IPPD has shown a consistent project success of 90% as defined by the total customer requirements the teams met at the end of the year and the feedback from sponsoring companies.

Scope of work in progress

For the academic year of 2016-2017, IPPD has 131 senior students working on a total of 23 projects from 21 sponsor companies in a two-semester course. Figure 1 shows the gender distribution for the current year. Numbers are given in percentage. IPPD has 31% females and 69% males, a higher proportion of females than for the undergraduate student population in engineering at UF as a whole. These figures represent a 21% increase from previous years. Figure 2 shows the ethnicity distribution for the current year at IPPD. Minority groups constitute 44% of the student population in IPPD this academic year.

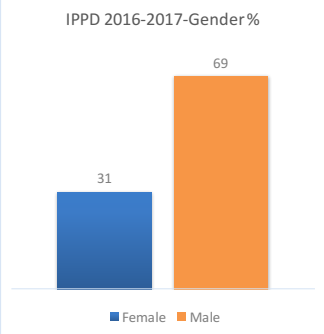

Figure 1.Gender percent distribution for 2016-2017

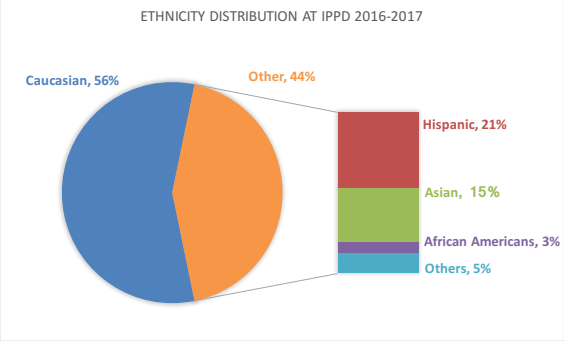

Figure 2. Ethnicity percent distribution for IPPD 2016-2017

Figure 3 shows the distribution of student disciplines in IPPD this academic year. The three disciplines contributing the most students are mechanical, electrical, and chemical engineering. The yearly discipline distribution is directly impacted by company recruiting efforts of the program and the resulting SOW.

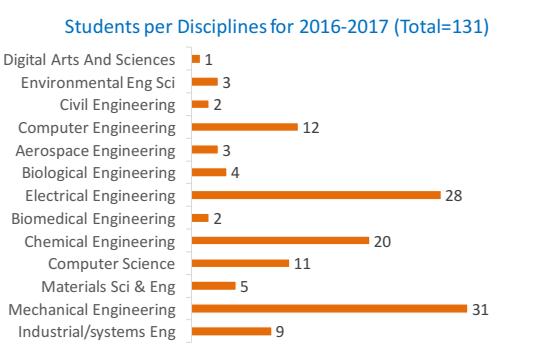

Figure 3. Discipline distribution for IPPD 2016-2017

Understanding student academic, gender and demographic backgrounds provides opportunities to learn about the role of diversity on project innovation, team management, recruitment efforts, and educational strategies. All of this data shows IPPD efforts of promoting a multidisciplinary environment for our students. However, the University of Florida expects IPPD to increase 30% in the number of students and projects for the upcoming year. Growing IPPD's enrollment will bring challenges to the way IPPD offers instruction, multidisciplinary team management, and assessment.

In parallel, the Herbert Wertheim College of Engineering is looking into ways of assessing the attributes of the New Engineer for the 21st century. Evaluation of the attributes of the New Engineer should be done at different stages of a student's career. IPPD offers a unique opportunity to participating senior students for a full immersion in an environment that merges interdisciplinary experiences, leadership, and innovation. The proposed redesign of the two-semester course will allow for new strategies and efforts to improve the course delivery, management, and assessment. Assessment tools developed and validated at IPPD will serve as insight for the evaluation of the attributes of the New Engineer at the end their engineering career at UF. Findings on program outcomes can be extended further to the rest of the academic community and other institutions.

Research questions

Preliminary research questions are:

1. What are the strengths and weaknesses of the program's experiences in leadership, teamwork, communication, innovation, and interdisciplinary practice?
2. How do we assess/measure the impact of IPPD on the attributes of the New Engineer?
3. What are the strengths and weaknesses of current assessment methods used in IPDD?
4. What is the effect of using blended instructional methods in reaching out to the growing population of students in the program?

Practices to be implemented

IPPD is currently revamping its course delivery, educational experience, and assessment strategies. The main goal is to better meet the expectations of our major stakeholders: the college of engineering, its students and faculty, and sponsor companies.

The current work in progress describes IPPD's current instructional format and intended implementation practices to create a flipped classroom experience. Implementation practices will cover examples of the current and proposed blended instruction strategies [3]. In addition, we will highlight the use of a systems engineering teaching approach, and the significance of collaboration between teams and industry.

To answer some of the research questions we will use 9 years of collected data at the IPPD program. Available data includes pre- and post- course assessment, team member evaluations, course management surveys, coach evaluations, industry engineer evaluation, and student demographics. Using this data as a reference, different strategies for the design and implementation of a flip classroom using blended instruction will be proposed. Finally, examples of instructional design strategies such as lesson plans, online environment, active learning, and assessment tools will be shared.

References

1 Dutson, Alan j., Todd, Robert H., Magleby, Spencer P., and Sorensen, Carl D., "A Review of Literature on Teaching Engineering Design Through Project- Oriented Capstone Courses", Journal of Engineering, Education, January 1997, p.17-28.

2 Farr, John V., Lee, Marc A. , Metro, Richard A., and Sutton, James P, "Using a Systematic Engineering Design Process to Conduct Undergraduate Engineering Management Capstone Projects", Journal of Engineering Education, April 2001, p 193-197.

3. Bailey, Reid, and Smith, Michael C, "Implementation and Assessment of a Blended Learning Environment as an Approach to Better Engage Students in a Large Systems Design Class", 120th ASEE Annual Conference & Exposition, June 2013, Page 23.692.1-13.

Dr. Sindia Rivera-Jiménez

Dr. Sindia Rivera-Jiménez is the Assistant Director for the Integrated Product and Process Design (IPPD) program at UF. At the IPPD, Dr. Rivera currently serves as a coach for two industry-sponsored team projects, works directly with industry to improve the program and to increase the number of projects in the program, and leads several educational efforts within the IPPD. She received her B.S. and Ph.D. degrees in chemical engineering from the University of Puerto Rico at Mayaguez. Before joining the IPPD, she worked as a chemistry faculty and as an assistant professor of food science and technology. She is a member of the Society of Women in Engineering, Society of Hispanic Professional Engineers, the American Chemical Society, and the American Institute of Chemical Engineers.

R. Keith Stanfill

R. Keith Stanfill is the Director of the Integrated Product and Process Design Program for the Industrial and Systems Engineering Department at the University of Florida. He received his B.S., M.E., and Ph.D. degrees in mechanical engineering from the University of Florida in 1985, 1991 and 1995, respectively. Dr. Stanfill has over ten years' industrial experience and served as a key resource to the New Product Development Council Steering Committee. His interests include technology transfer, product development, design education and DFx. He is a registered professional engineer in the state of Florida and is a member of the American Society of Mechanical Engineers and the American Society for Engineering Education.