SUMMER 2014

From the Editor

This issue of *Advances* features eight articles that touch a number of important areas currently facing engineering education. These include student innovation space, entrepreneurship education, "big data" analysis, multidisciplinary capstone design instruction and projects, problem solving and gender, and an innovative way of teaching pre-calculus to high school students. Papers also discuss using a low-cost haptic paddle to teach systems dynamics and an interactive simulator-based pedagogical approach for teaching microcontrollers.

Of note is the lead paper by Craig Forest and a team of colleagues from Georgia Tech that describes Tech's very creative Innovation Studio – a student run maker space that has developed its own culture. This 3000 ft^2 space was initially founded specifically for capstone design courses, but as the paper describes, the Invention Studio has taken on a life and culture of its own, far beyond just a capstone design prototyping lab. The paper describes the implementation process for the space, including its organization, funding, and challenges. The value of hands-on, design-build education to stimulate innovation, creativity, and entrepreneurship in engineering undergraduates is discussed in detail.

A second paper on entrepreneurship education comes from Spain. A team from the University of Cordoba addresses how to best equip graduates with a broad range of skills, including entrepreneurship, which they believe is now a critical part of engineering education. They discuss some of the lessons learned over a ten year period of running an entrepreneurship education program, which was incorporated within the curriculum. The paper describes how over this period they were able to develop an improved sense of entrepreneurial competence in their undergraduate students, overcoming a initial lack of institutional support and student interest. The authors also address how the traditional role of instructors as suppliers of information and knowledge had to be dramatically changed. The paper proposes that the intensity and enthusiasm of day-to-day work in entrepreneurship education can instill a degree of commitment and motivation in both students and instructors, inspiring them to tackle new challenges.

Krishna Madhavan (Purdue) and Aditya Johri (George Mason University) led a team who applied "big data" (data analytics) methodologies to determine engineering education networks. They describe the development of an Interactive Knowledge Networks for Engineering Education Research (iKNEER), which utilizes a combination of large-scale data mining techniques, social network mapping algorithms, and time-series analysis, to analyze and understand data about the engineering education community. The paper describes the algorithms, workflows, and the technical architecture used to combine archival publications, conference proceedings, NSF funding, and a range of products derived from engineering education research. Engineering education researchers and faculty can utilize iKNEER to visually identify potential collaborators, research patterns, topical trends, and closely related articles. Hence, while providing a detailed description of a data analytics approach, Madhavan and Johri have also provided the engineering education community with a very valuable tool. Jump online and try it out!

Jinny Rhee headed a multidisciplinary team from San Jose State University that documented how to effectively integrate an inherently multidisciplinary topic into the existing curricula. They did this through co-instructors for multidisciplinary senior capstone design projects. They tested their co-instruction model of multidisciplinary senior project administration to see if it could be used to effectively teach sustainability topics, achieve the known benefits of team-taught instruction, and overcome resource-intensiveness. The paper describes how this model was compared to more traditional approaches. What they learned in a pre- and post evaluation is that the students taking multidisciplinary projects outperformed those in traditional senior projects in four of five participating courses. However, the multidisciplinary project students rated their satisfaction with the experience lower on average than did those in the control group. Faculty found the convergence of disciplines on a topic of mutual interest to be interesting and illuminating. The paper provides a framework for other engineering educators who are interested in expanding capstone design beyond their own discipline/program.

Jennifer Bekki at Arizona State led a multidisciplinary team that examined improving interpersonal problem solving skills; i.e., those skills which enable engineers to navigate interpersonal difficulties and better manage conflict, two skills critical to successful team participation. Specifically, they describe how the *Career*WISE online learning environment can be used to improve these skills among women in engineering graduate programs. They document that the students who utilized the online environment had better knowledge of the interpersonal problem solving steps and were better able to describe how they would apply problem-solving skills to a relevant scenario compared to students who did not have the training.

Chelsea Sabo, Andrea Burrows, and Lois Childers describe in *Shaking Up Pre-Calculus* an inquiry based trigonometry lesson that is built around a study of earthquake engineering vibrations. Their module was successfully used in a Cincinnati high school classroom. It met Ohio educational standards, and, as documented, was positively received by the students.

Jenna Gorlewicz from Southern Illinois University and Louis Kratchman and Robert Webster from Vanderbilt describe how the haptic paddle (i.e., a force-feedback joystick) to teach System Dynamics, a core mechanical engineering undergraduate course focused on modeling dynamic systems in multiple domains. The authors note that prior assessments of learning enabled by the paddles have been qualitative - anecdotal case studies illustrating student and educator belief that they enhance learning and increase student enthusiasm. They describe haptic paddle design enhancements and provide a formal assessment of student learning when interacting with haptic paddles. Their design enhancements should enable broad dissemination and improve the student experience by making the paddle less expensive (less than $100 for a complete system including electronics) and easier to use. Their formal assessments demonstrate that well-designed, supplementary hands-on activities like haptic paddle laboratories enhance in-class material and significantly increase student conceptual understanding as measured by concept inventories.

Finally ShenshengTang (Missouri Western State University) introduces an interactive simulator-based pedagogical (ISP) approach for enhancing the teaching and learning process of microprocessors, without compromising the depth or breadth of course material. The paper analyzes the features of the traditional approach for teaching microprocessors and investigates two reasons that may hinder learning, It proposes a methodology for addressing these concerns – the ISP approach. The effectiveness of this approach is evaluated from both a questionnaire-based assessment and an outcome-based assessment. The assessment results indicated that the large majority of students were very positive about applying the ISP approach to teaching and learning. The ISP approach can be incorporated into a variety of educational settings, making it a valuable tool for faculty.