Advances in Engineering Education

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From the Editor

With this second issue of *Advances in Engineering Education*, we have attempted to demonstrate the wide breadth of subject areas that encompass engineering education and that we are interested in presenting to our readers. The five papers presented here include two examples of virtual reality; a middle school design module as part of the national Future Cities Competition; a review paper that describes a promising new construct for engineering education—Model Eliciting Activities—originally developed by math education researchers; and a novel proof of a fundamental theorem for improving understanding and learning of electromagnetic fields principles that can be used directly in the classroom. Specifically:

A team of Australian engineering educators presents an innovative education resource that is applicable for both engineering students and those in the process industries in "Development and Deployment of a Library of Industrially Focused Advanced Immersive VR [Virtual Reality] Learning Environments." Their virtual reality learning tool combines a proven instructional framework with graphics from actual operating plants and embedded interactive content. The authors' have used video and graphics in a creative manner to enhance the paper's readability. The paper is fully documented with references to the various relevant pedagogy, specifically constructivism, interactivity, cognitive load and learner-centered design.

In the second virtual example, Prashant Jain, Yuxiang Gu and Rizwan-uddin in "Broadcasting Engineering Laboratories—Audio/Video and Data—in Real-Time over the Internet," demonstrate how engineering educators can utilize today's technology to extend laboratory and training infrastructure to students located almost anywhere. Their well designed, web-based digital laboratory provides additional benefits that typically may not be available in the conventional lab, especially if it involves a radiation environment with such expensive, rarely accessible equipment as nuclear research reactors. The real-time, distance lab module described here is being implemented within the Department of Nuclear, Plasma and Radiological Engineering at the University of Illinois. It is part of an internet-based system that allows remote students and faculty to watch the experiment as it is being performed, acquire data, and interact (via audio and/or video) with the on-site personnel. By using LabVIEW's *remote front panel* the local lab and remote client are able to communicate and, if permitted, the remote clients can assume either part or full control of the experiment.

Camille McCue, a teacher at the Alexander Dawson School, and David James, an engineering professor at the University of Nevada, Las Vegas, describe their pre-college research in "Future Cities

Engineering: Early Engineering Interventions in the Middle Grades." They offer their insights relative to both affective and cognitive changes that they observed during a one semester schedule of activities in which students focused on creating models of a city 150 years in the future. Students depict their vision by both creating a computer simulation using *SimCity 3000 Unlimited*, and constructing a physical scale model. McCue and James "ground-truthed" the *SimCity* system by comparing its simulated dimensions to those for analogous real world objects (e.g., roads and water pipes) in order to determine its efficacy as a realistic modeling tool, noting the deficiencies that they have found. In addition, the authors have surveyed the participating students' attitudes towards the engineering profession and have attempted to measure the student learning that has occurred.

In what may be considered a novel publication for an engineering education journal, we have included Ezzat Bakhoum's description of "Thomson's Theorem of Electrostatics: its Applications and Mathematical Verification." Professor Bakhoum addresses this 100 years-old formula that has recently found numerous applications in computational electrostatics and electromagnetics. His innovative proof avoids a dependence on Differential Geometry (which is beyond the majority of engineering students) by utilizing the concept of "curvature" instead. We publish it here, because of the emerging applications of Thomson's theorem in computational field problems, some of which are also discussed in the paper, and the consequent value to those engineering educators who teach these concepts that have traditionally challenged students.

A team of mathematics educators, Eric Hamilton, Richard Lesh, Frank Lester and Michael Brilleslyper present an in-depth overview of a promising construct in "Model-Eliciting Activities (MEAs) as a Bridge between Engineering Education Research and Mathematics Education Research." Here they introduce Model-Eliciting Activities as a form of case study team problem solving. The MEA design focuses on eliciting from students the conceptual models that they iteratively revise in problem-solving. While MEAs were originally developed by mathematics education researchers to study the evolution of mathematical problem-solving expertise in middle school students, they are increasingly being used in undergraduate engineering at a number of levels beginning with introductory, first-year courses. Recently, MEAs have been the subject of several NSF grants focused on expanding the construct's implementation across the various engineering fields. The authors describe the challenges involved in implementing MEA within engineering curricula, including finding the appropriate blend of MEAs with other pedagogies. In addition to a focus on better understanding and learning problem solving, engineering education researchers are also using MEAs to tease out misconceptions, address ethical issues, integrate concepts learned in earlier coursework and incorporate laboratory experimentation as part of the problem solving process, hence, further enhancing their classroom value as both a learning and assessment tool.

From the Editor

We hope that you will find this issue of interest and value. We continue to seek your advice, suggestions and critiques, and, of course your papers. We anticipate in the near future to begin publishing educational briefs in addition to the fully peer-reviewed papers (that we have included in this issue). We look forward to hearing from you.

Sincerely,
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