McCormick
Northwestern Engineering
Northwestern Center for Engineering Education Research

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News

➢ The NCEER website has undergone a through revision, including reorganized pages, updated information, better curated links and resources, and a refined statement of what are all about. If you haven't been there in a while, you might take a look (if only to see that we have you properly listed as an NCEER Scholar). As always, upcoming events are posted to the Events page. If you miss an event, the slides or a paper from the talk will usually be posted there within a few days of the event. The most recent NCEER seminar was with David Gatchell and Wei Chen on Product Archaeology on April 24, and slides from that talk are posted there.

Also, NCEER has a new email address. If you should need to refer to us publicly, tell someone how to sign up for the mailing list, or if you just want to reach us but don't know who to contact, feel free to use nceer@northwestern.edu.

➢ On the conference front, ASEE 2013 is coming up rapidly in June. While the program is set, it's not too late to register to attend if you have not already. ASEE is in Atlanta this year, and a little later in the month than usual, on June 23-26. Purdue's School of Engineering Education and the CELT center at Washington University have graciously made shared booth space available to us, so NCEER will be manning a table to help raise our profile in the engineering education community. Stop by if you are there.

➢ The Center for Advancing Engineering Education (CAEE) was an NSF-funded center at Washington University in St. Louis which wrapped-up in 2010. Subsequent to its conclusion, several useful publications, including a guide to the resources it produced and a comprehensive final report, were issued. These are now available in the Publications section of the NCEER website.

- Finally, as many of you know Ann McKenna from her days at Northwestern and the founding of NCEER, we thought we would mention that she's recently been promoted to chair of the Engineering and Engineering Technology Departments at ASU's College of Technology and Innovation (CTI).

Now onto the longer articles; the first of our two main articles covers perhaps the biggest ongoing development: Northwestern's membership in the Center for the Integration of Research, Teaching and Learning, CIRTL. The second is about an important ongoing project researching how best to teach engineering students in different disciplines to apply mathematical models to their design projects.

Update on CIRTL Activities at Northwestern

As many of you know, Northwestern has joined the Center for the Integration of Teaching Research and Learning (CIRTL), a national NSF-funded teaching and learning center. CIRTL member institutions work to advance the teaching of science, technology, engineering, and mathematics (STEM) disciplines in higher education, particularly by providing programs for future faculty professional development. In CIRTL, STEM includes social sciences. We officially joined the CIRTL Network in 2012, and as of this year we are a full dues-paying member. Rob Linsenmeier is the leader at Northwestern and Nancy Ruggeri, Associate Director of the Searle Center, is the co-leader.

As a result, a range of CIRTL programs, events and materials are now available to us, targeted primarily to graduate students and post-docs. The Northwestern STEM community is encouraged to participate in the CIRTL Coffee Hour Series (online discussions facilitated by STEM faculty and staff across the CIRTL Network institutions) and the CIRTLCast Series (webinars to discuss issues in STEM teaching and learning). While the CIRTL Coffee Hour and CIRTLCast programs are concluded for the academic year, they will start up again next fall.

In addition, we are beginning to offer CIRTL materials and events of our own to the network. The first of these programs is now underway, initiated in Spring, 2013 with about 20 STEM graduate students and postdocs, and 8 faculty members. It pairs graduate students and post-docs to with faculty in a teaching mentorship in order to generate discussions about teaching. Graduate students or postdocs are observing faculty teaching in a small number of undergraduate or early graduate classes, with an eye towards pedagogy rather than content. Mentors and students will then meet (perhaps over coffee) to discuss their observations and other aspects of teaching methods. The program is meant to be a low-key, resource-minimal introduction for graduate students and post-docs to begin thinking about teaching.

More local CIRTL activities will follow as the program builds. Northwestern's CIRTL program is co-sponsored by the Searle Center for Advancing Teaching and Learning, The Graduate School, the Weinberg College of Arts & Sciences, the Feinberg School of Medicine, and the McCormick School of Engineering and Applied Sciences.

Read more about CIRTL Network activities at Northwestern here: http://www.northwestern.edu/searle/programs/graduateandpostdoctoral/CIRTL%20at%20Northwestern.html

Teaching Mathematical Modeling in Senior Design

Much of the undergraduate engineering curriculum is math intensive, both pure and applied. Yet what defines engineering as opposed to science is the practice of *design*. Yet despite extensive training in mathematical methods in undergraduate engineering education, there is a gap between mathematics-intensive analysis and using math in the practice of design, even in senior design courses. While engineers in industry are often expected to model their designs – or at least its critical elements – before undertaking the time-consuming and potentially expensive act of prototyping them, undergraduates in design courses often resist this step. In design courses, students frequently proceed directly from idea to mock-up, skipping the step where they test whether their assumptions about the physical system they intend to build are valid and will result in the optimal effect they seek.

This omission is due in part to the need to fit the entire design process into a single academic term – particularly at Northwestern, with our brief 10 week quarters, but modeling is a complex process, and we hypothesized that there were also skills that students did not have. Over the past few years, one project at Northwestern has sought to change that in biomedical engineering senior design. This effort to began in 2009 as a component of the NSF-funded CADEX, or Computational Adaptive Expertise project, of which Ann McKenna, Rob Linsenmeier, Matthew Glucksberg, and Uri Wilensky were co-PIs.. When CADEX moved to Arizona State along with PI Ann McKenna in its final year, the work was continued by Jennifer Cole, a postdoc at the time, with the assistance of Rob Linsenmeier and Matt Glucksberg of BME. Work was done over the course of three years, continuing when Jennifer Cole became Assistant Chair of Chemical and Biological Engineering (ChBE). Students also worked on this project under the Bioengineering Education Research REU in 2011 and 2012.

Mathematical modeling means more than a 3-D CAD model, which students often do produce as part of the design process. It means distilling the core relationships of the design in such a way that their behavior can be calculated, and design elements optimized, by understanding how the parameters of those

elements, and the relationships among the elements, affect the system's output. For example, the case chosen for students to practice on is the design of a light-emitting blanket intended to treat jaundice in newborns. While simple in principle (a grid of LEDs on a flexible substrate), any such design must ensure a uniform level of illumination at sufficient intensity within the relevant range of distances to the skin while using a minimum number of light-emitting elements (LEDs). Only by exploring these relationships in a rigorous mathematical model will students be able to understand them and thereby optimize the performance of the design without difficult data collection and prolonged experimentation.

In the first intervention, student mathematical modeling ability was studied in BME capstone design in 2009 over several weeks. It was found that without specific instruction, students generally failed to make a convincing start on a mathematical model of the light-blanket problem. As a result, lectures on modeling were supplied in 2010 and 2011, which resulted in a substantial increase in the ability of students to model the sample problem, and to include modeling in their own design projects. The modeling project was presented at ASEE in 2010, 2011 and 2012. For copies of the papers, please contact NCEER or Jennifer Cole directly.

More recently, this project was expanded under the auspices of a Murphy Society grant to the ChBE capstone design course as well. Unlike in BME, where the project is typically to design a device, design in Chemical Engineering usually involves an industrial process. Some issues in modeling are the same in both fields, but some are different. This diversity provides the opportunity to study mathematical modeling in two very different contexts.

If you have any engineering education news to share please send it to Mark Bourgeois at m-bourgeois@northwestern.edu for inclusion in the next NCEER newsletter. We are always interested in learning more about any awards you have received, projects that have been funded, results from your research, or any other news that would be of interest to the community.

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