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# From the Editor

This entire issue is devoted to the National Science Foundation's Department Level Reform (DLR) Initiative. Mandar Dewoolkar, who was actively involved in the redesign of the civil and environmental engineering programs at the University of Vermont (see the Hayden, et al paper in this issue), has done an outstanding job of marshaling these dozen papers through a rigorous review, and in many cases, re-review process. As a collection, they describe an important NSF initiative, which as John Daniels, Sally Wood and Sue Kemnitzer point out in their paper, was greatly influenced by the NSF's Engineering Education Coalition program, which preceded the DLR program. In all, 80 DLR planning grants were awarded, followed by 20 implementation grants in the period between 2003 to 2005. The last of the implementation grants ended in 2009, but, as described in this issue, both implementation and assessment efforts continue at a cross-section of the country's engineering programs. As noted, we present papers describing twelve of these twenty programs, which were funded at levels between $400,000 to $1,500,000 each. Professor Dewoolkar provides a guest editorial to introduce the issue, followed by the Daniels, Wood and Kemnitzer paper, which provides an overview of all twenty projects, including a summary table of the issues that each addresses.

Nancy Hayden, Donna Rizzo, and Mandar Dewoolkar and their colleagues describe the transformation of the University of Vermont's Civil and Environmental Engineering curriculum by integrating systems thinking, inquiry-based learning and community service-learning projects. Their overall goal has been to have students acquire a systems approach for solving engineering problems that would lead to more sustainable solutions when they become practicing professionals. They describe how student work in five courses demonstrates that a systems approach is now being applying to engineering problem solving. Further, not only is this approach helping to address ABET outcomes, but the concept of sustainability is now being applied in senior design projects.

Gary Ybarra and thirteen colleagues describe how Duke's electrical and computer engineering department has used a combination of new developments and faculty research expertise to redesign the undergraduate curriculum around the theme of Integrated Sensing and Information Processing. They detail both their underlying philosophy and implementation strategy including elements of the new curriculum that are transferable to other engineering programs. They present evidence of increased student design ability and effective teamwork capability.

Oscar Garcia, Murali Varanasi, Miguel Acevedo and Parthasarathy Guturu at the University of North Texas document a different, cogniative-based approach to designing an electrical engineering curriculum. Here they utilize open-ended projects over the four-year program as both a pedagogical and motivational tool. Their curriculum is specifically designed to encourage a global-minded,

entrepreneurship approach, including early emphasis on ethics, professionalism and creativity, in addition to considering social and environmental issues as part of a life-long learning career.

Sushil Chaturvedi, Ramamurthy Prabhakaran, Jaewan Yoon and Tarek Abdel-Salam describe how faculty from Old Dominion University's departments of civil, electrical and mechanical engineering joined together to utilize web-based virtual laboratories to supplement physical laboratory experiments. They describe "eLIVE," (Engineering Laboratory Instruction in Virtual Environment)—a web-based tool which they developed as part of the DLR grant. Utilizing a comparison cohort, their statistical analysis in combination with student surveys suggest that "eLIVE" provides faculty with a very useful interactive learning tool.

Linda Vanasupa, a materials scientist at Cal Poly San Luis Obispo, has focused her DLR project on retention. Over the course of reform, the program has grown in size by 40% primarily due to retaining more students. Specifically the Cal Poly SLO program addressed introducing learning experiences that would accomplish two social imperatives: retaining women and other underrepresented groups in the engineering degree programs; and equipping engineers to solve the technical challenges in the context of our complex global society. Her paper takes a somewhat unique approach by focusing on the impact these reforms on the faculty. She chronicles the process of change, the agents of change, actions, and some results, reflecting on their meaning and providing thoughtful suggestions for faculty who may wish to continue this type of initiative.

John Duffy and four colleagues used their DLR grant to integrate service-learning (S-L) projects throughout core courses at the University of Massachusetts Lowell (UML). Their program—SLICE (Service Learning Integrated across the College of Engineering)—had a goal of including at least one S-L project each semester for all engineering students, in order to graduate better, more engaged engineers citizens. In fact, four of the degree programs have achieved this goal. More than fifty courses now have S-L components due to SLICE. Further, almost a quarter of entering students now cite S-L as one of the reasons for coming to UML, and more than two-thirds report that it has helped keep them in engineering. This UML program represent the largest experiment with S-L in mainstream engineering in the US.

Alan Cheville and Chuck Bunting describe a DLR project at Oklahoma State University that resulted in a ten-course sequence designed to help electrical and computer engineering students develop into "21st century engineers." These courses have been supported by engaging graduate students, building infrastructure to scaffold student development, as well as student self-reflection. They present four case studies to illustrate these on-going changes. They provide a taxonomy to help guide faculty in carrying out meaningful education reform.

Vinod Lohani and four Virginia Tech colleagues from the Engineering Education and Biological Systems Engineering departments have used a spiral curriculum approach to reformulate both general

engineering (i.e., freshman engineering) and bioprocess engineering programs. The concept builds upon the inherently recursive nature of learning in which students elaborate and strengthen earlier learning, correct misconceptions, develop a more holistic picture of their discipline, and become increasingly self-sufficient as learners. They describe lessons learned in three key words – patience, diligence, and awareness.

Joe McCarthy, Bob Parker and Mary Besterfield-Sacre along the PhD student Adetola Abatan, present the "pillars" chemical engineering curriculum they developed at the University of Pittsburgh. The result is a four-year, integrated curricula specifically designed to facilitate knowledge integration. This unique program also required a different type of assessment strategy. They address how they first measure the effectiveness of the new curricular structure for enhancing students' ability to engage in systems thinking (knowledge integration). Concomitantly, they also assess the impact of the pillars curriculum on students' conceptual understanding of (chemical) engineering principles. The paper outlines an overall assessment structure suitable for measuring the efficacy of multi-year integrated curricula. As with several other projects presented in this issue, results are preliminary with assessment still ongoing.

Lori Herz and six colleagues describe the undergraduate Bioengineering Program at Lehigh University, which was supported in part through the DLR initiative. Bioengineering at Lehigh was designed as an interdisciplinary program, with an emphasis on experiential learning, entrepreneurship, and innovation. The curriculum initially had three key components: a core of basic requirements, three tracks allowing for specialization, and experiential learning. The incorporation of Integrated Product Development (IPD), a hallmark program at Lehigh, into bioengineering, has enhanced the hands-on learning and innovation opportunities. Here again, assessment is still ongoing.

Feridun Delale and four colleagues address the systemic reform of the Mechanical Engineering program at The City College of New York. A major goal was incorporating emerging technologies (e.g., nanotechnology, biotechnology, micro-electro-mechanical systems, and intelligent systems) combined with new teaching methodologies (e.g., project based learning, hands-on laboratory experiences, inquiry based learning, and home experiments) into the curriculum. Here they describe modifications related to both emerging technology and pedagogy introduced in four courses - Mechatronics, Mechanics of Materials, Heat Transfer and System Modeling, Analysis and Control. The limited assessment data available to date suggests that students' confidence and overall academic performance has improved in some courses following the reform, with more improvement anticipated.

In summary, these papers provide a broad overview of the department level reform effort. Was it successful? It is too early to judge, but these projects when taken together suggest that the

results, at least for 20 institutions will be quite positive. Hopefully, this issue will help to disseminate their stories further.

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