Advances in Engineering Education

SUMMER 2011

Guest Editorial: NSF Sponsored Department-Level Reform Initiative

MANDAR M. DEWOOLKAR
School of Engineering
The University of Vermont
Burlington, VT 05405

Our infrastructure, economy, health, safety and indeed our entire environment are dependent on scientific and technological innovation, which is directly supported by engineering education. The changing demographics and socio-economic landscapes worldwide, globalization, and rapidly evolving technologies have increased the importance of engineering in the 21st century and the need for innovative and sustainable solutions. Engineering educators, therefore, are challenged to adapt their courses, programs and pedagogies to address these changes. For example, several excellent studies have been published related to the needs of undergraduate education in the United States (e.g. Boyer Commission Report, 1998), science and technology needs (e.g. NAE, 2007), and on engineering education (e.g. NAE 2004, 2005; NSB 2007; Duderstadt, 2008). Engineering organizations have also assessed specific educational needs to prepare the engineer of the 21st century (e.g. American Society of Civil Engineers (ASCE), 2006, 2008), and the Accreditation Board for Engineering and Technology (ABET) criteria (commonly referred to as "a-k") have also been adjusted to address the challenges facing engineering education (ABET, 2007).

The National Science Foundation (NSF) has supported engineering education efforts in the United States for decades. One recent NSF initiative was the Department-Level Reform (DLR) program. Between 2002 and 2005, NSF awarded about 80 one-year long planning grants, of which 20 were subsequently awarded three to four-year "Implementation" or DLR grants between 2003 and 2005. The majority of these DLR projects concluded by 2009. This Special Issue on NSF's Department Level Reform program presents highlights and findings of eleven DLR projects. The principal investigators of all twenty DLR projects were invited to submit a manuscript; however, not all project teams are represented in this peer-reviewed special edition. The readers can find brief summaries of all twenty projects in a review of the outcomes and impacts of the DLR program conducted by the Science and Technology Policy Institute of the Institute for Defense Analyses (STPI/IDA, 2009). Most DLR projects have also created individual websites where additional information can be found.

The first paper in this special issue presents an overview of the DLR effort from the eyes of NSF personnel including a brief summary of NSF's Engineering Education Coalitions effort and how it

led to the DLR initiative. It also provides a brief summary of all twenty DLR projects. The remaining eleven papers describe individual DLR projects.

This special issue should be of great value for engineering and technology-related programs worldwide who are thinking about curricular reform. The issue includes examples from civil, environmental, mechanical, electrical, computer, chemical, bio, and plastics engineering. Some DLR projects impacted individual engineering degree programs whereas others impacted many engineering programs across departments and colleges. The eleven papers also provide examples from existing programs as well as newly created degree programs as a result of the DLR effort. Nearly all of the DLR projects created new course content, new courses, or new sequencing of material. Hands-on learning, inquiry-based practices, service-learning, just-in-time learning, spiral curriculum, block scheduling and the use of innovative technology are some of the pedagogical techniques used for implementation. Most papers present the motivation and objectives of the reform, highlights of the reform, and some assessment results. Many papers also discuss sustainability of the reform beyond the award period, transferability to other programs, alignment with ABET criteria, challenges and benefits. Some authors have been quite candid and critical of their efforts and have tried to outline best practices and identify pitfalls. It is clear that meaningful curricular reform is an ambitious task and affects many agents beyond the students and instructors. It is a major educational and cultural change that needs to be supported by stake holders at all levels from K-12 to the upper administration of universities. Although the journey might be difficult, it is also clear from these papers that the reforms have also been very rewarding to those involved and have helped the programs overhaul their curricula in efforts to better educate engineers who are capable of tackling the needs of the 21st century.

REFERENCES

Accreditation Board for Engineering and Technology ABET (2007), 2008–2009 Criteria for Accrediting Engineering Programs, available at: http://www.abet.org/Linked%20Documents-UPDATE/Criteria%20and%20PP/E001%2008-09%20EAC%20Criteria%2011-30-07.pdf

ASCE (2006), The Vision for Civil Engineering in 2025, prepared by the ASCE Steering Committee to Plan a Summit on the Future of the Civil Engineering Profession in 2025, available at: http://www.asce.org/uploadedFiles/Vision_2025_-_New/TheVisionforCivilEngineeringin2025_ASCE.pdf

ASCE (2008), Civil Engineering Body of Knowledge for the 21st Century Preparing the Civil Engineer for the Future, prepared by the Body of Knowledge Committee of the Committee on Academic Prerequisites for Professional Practice, American Society of Civil Engineers, Second Edition, available

at: http://www.asce.org/uploadedFiles/Leadership_Training_-_New/BOK2E_%28ASCE_2008%29_ebook.pdf

Boyer Commission (1998), Reinventing Undergraduate Education: a Blueprint for America's Research Universities, The Boyer Commission on Educating Undergraduates in the Research University. Kenny, S. S. (chair), available at: http://naples.cc.sunysb.edu/pres/boyer.nsf/673918d46fbf653e852565ec0056ff3e/d955b61ffddd590a852565ec005717ae/$FILE/boyer.pdf

Duderstadt, J. J. (2008) Engineering for a Changing World, A Roadmap to the Future of Engineering Practice, Re- search, and Education, The Millenium Project, The University of Michigan, available at: http://milproj.ummu.umich.edu/publications/EngFlex_report/download/EngFlex%20Report.pdf

NAE (2004), The Engineer of 2020: Visions of Engineering in the New Century, National Academy of Engineering, Clough, G. Wayne (chair), Washington, DC: National Press, available at: http://www.nae.edu/Publications/Reports/25876.aspx

NAE (2005), Educating the Engineer of 2020: Adapting Engineering Education to the New Century, National Academy of Engineering, Clough, G. Wayne (chair), Washington, DC: National Press, available at: http://www.nap.edu/catalog.php?record_id=11338

AUTHOR

Mandar Dewoolkar (PE), Associate Professor, School of Engineering. Dr. Dewoolkar has been at UVM since Fall 2003 and has worked on incorporating educational modules on laboratory and computational research into undergraduate engineering courses as well as service learning in the curricula. He was actively involved in the department level reform of civil and environmental engineering programs at the University of Vermont supported by the planning and implementation grants from the NSF. His other interests are in applying experimental and analytical methods to address geotechnical and geoenvironmental engineering problems. Dr. Dewoolkar's Bachelor's and Master's degrees are from Mumbai, India and his Ph.D. is from the University of Colorado at Boulder, all in Civil Engineering.