Cambridge Handbook of Engineering Education Research

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Cambridge Handbook of Engineering Education Research

Edited by Aditya Johri, Virginia Tech, and
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The *Cambridge Handbook of Engineering Education Research* (*CHEER*) will be an important reference source for the growing field of engineering education research (EER). EER has become an increasingly important field internationally, as evidenced by the growing prestige and subscriber base of its key journal, the *Journal of Engineering Education (JEE)*, the founding of several Ph.D.-granting engineering education departments at prestigious institutions, and the growth of an international community of engineering education researchers who hold global meetings and have a variety of publication venues. Despite the tremendous growth of the field, there is currently no book that provides an overview of EER. Thus we believe *CHEER* will fill an important gap internationally in the EER field and will be used as a textbook for graduate courses, a reference book by engineering faculty in disciplinary engineering areas, and a resource by policy makers, K–12 engineering curriculum designers, informal science educators, and others.

Cambridge Handbook of Engineering Education Research

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We dedicate this volume to our esteemed colleagues
Dr. Kamyar Haghighi and Dr. David Jonassen.

Dr. Haghighi was founding head of the School of Engineering Education (2004–10) at Purdue University. He was a national force for engineering education reform based on research and scholarship, and under his leadership, the School of Engineering Education (ENE) at Purdue launched the world's first Ph.D. program in engineering education; attracted a critical mass of nationally and internationally recognized faculty; created INSPIRE, the Institute for P–12 Engineering Research and Learning (the first such institute to combine research on childhood learning of engineering with outreach to teachers); saw the ABET accreditation of the undergraduate Multidisciplinary Engineering Program; and transformed the first-year engineering program with a design-focused curriculum – aligned with the "Purdue Engineer of 2020" paradigm – that integrates seamlessly with the new Ideas to Innovation (i2i) Learning Laboratory. In 2009, the American Society for Engineering Education honored Dr. Haghighi with the Chester F. Carlson Award, which recognizes an individual innovator in engineering education who, by motivation and ability to reach beyond the accepted traditions, has made a significant contribution to the profession.

Dr. David H. Jonassen, who has contributed a chapter to this volume, passed away in December 2012, at his home in Columbia, Missouri, after living life fully, the last two years with advanced-stage lung cancer. David had been a professor of learning technologies and educational psychology at the University of Missouri since 2000. In 2010, he was named curators' professor – the University of Missouri's highest honor for world-renowned scholars. Previously, he held professorships at Penn State University; the University of Colorado, Denver; and the University of North Carolina, Greensboro. Over his nearly 40-year academic career, he wrote 37 books, 182 journal articles, and 67 book chapters, as well as numerous other types of publications. He made 400 presentations in the United States and 28 other countries. He also was an invited visiting scholar in countries such as Australia, Austria, The Netherlands, Norway, Singapore, and the United Kingdom. His work has attracted more than $12 million in external funding from sources such as the National Science Foundation, the U.S. Department of Education, the Australian Research Council, NATO, and the European Union. Dave was the recipient of more than 40 scholarly awards, including 19 awards for outstanding publications and books, the 2001 Presidential Service Award, and the Lifetime Achievement Award for Excellence in Research and Theory, both from the Association for Educational Communications and Technology.

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Foreword

Norman L. Fortenberry

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Although isolated individual engineering faculty members had pursued engineering education research (EER) for as long as long as there has been formalized instruction in engineering, EER has made noteworthy progress as a critically important discipline, particularly within the United States, during the last fifteen years. In the United States much of this change was driven or supported by the shift, in 1996, by the engineering accreditation agency ABET to an outcomes focus. This change mandated measurement of student learning outcomes, and the need to assess student learning outcomes fostered a demand for the research findings of EER as well as broader faculty interest in the field. I recall being involved in early EER efforts when as a National Science Foundation (NSF) program officer I managed the award to Richard Felder of North Carolina State University for the first National Science Foundation grant (in 1991) to examine student learning styles. I later had the privilege of being one of the three program officers who recommended the 1993 grants to Cynthia J. Atman (University of Washington) and Martin Ramirez (then of Johns Hopkins) for the first NSF National Young Investigator awards to be made in engineering education research.

Since those first prominent NSF awards, the field has matured in terms of its topical focus and the quality of the research. Of particular note are the contributions and the intellectual integration of the work from the global community of researchers. The first International Conference on Research in Engineering Education (now called the Research in Engineering Education Symposium – REES) was held in 2007 in Honolulu, Hawaii, with fewer than 25% of the participants from outside North America. The most recent REES meeting in Madrid still had a strong minority of North American representatives but drew the majority of participants from throughout the global community of EER scholars.

As with most new fields, EER has drawn extensively on lessons learned from a variety of other fields. It has drawn extensively from the social sciences, educational research, and the cognitive and learning sciences to create a unique synthesis with its own expanding scholarly base. Although EER

originally focused primarily on students and their learning, it rapidly expanded to encompass virtually all aspects of formal and informal learning systems including:

- Learners, instructors, administrators
- Teaching, learning, and assessment systems
- Curricula, laboratories, and instructional technologies
- Goal and objective systems for students, instructors, administrators, and external stakeholders
- Constraints (economic, social, political, etc.) inherent in the learning system

This volume reflects the richness and comprehensiveness of the emerging field of EER and will be of tremendous utility to students as well as those seeking an introductory overview. The editors have carefully selected authors who are leading, globally recognized scholars writing in their areas of expertise.

This volume comes at a particularly opportune time as the broad engineering education community seeks to define better the required elements of a twenty-first-century engineering education in an increasingly integrated global community where the solutions to a growing array of social, political, and economic challenges require access to engineering knowledge. The traditional image of the solitary engineer is no longer valid. Successful engineering research, innovation, and practice require collaboration with and integration of professionals from other fields. The engineering education system faces stresses from larger changes within education systems overall, especially political pressures to reduce costs, and stresses on engineering faculty to be increasingly effective in teaching, research, and service. There is a tremendous need for a robust research base to inform future practice in this unfamiliar environment. This volume serves as an important tool for accomplishing this goal.

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