INNOVATIONS 2011

World Innovations in Engineering Education and Research

Edited by

Win Aung
International Network for Engineering Education and Research, Potomac, MD, USA

Vojislav Ilic
University of Western Sydney
Penrith, New South Wales, Australia

Jerzy Moscinski
Silesian University of Technology
Gliwice, Poland

James Uhomoibhi
University of Ulster
Newtownabbey, Northern Ireland, UK

International Network for Engineering Education & Research
iNEER

CONTENTS

PREFACE

There is continuing interest on the part of many academic institutions around the world to inculcate global developments into their education programs. This has led to the continued emergence of creativity and innovations in engineering education in all its diverse aspects. Driven by strong institutional and government support, and helped by the ever more readily accessible high-speed internet, and opportunities for networking and dissemination available through professional publications and technical conferences, notable advances in teaching and learning paradigms are being reported at a rapid pace by educators from institutions in both matured and emerging economies.

New approaches are being developed and tested that would exploit new ideas in technology enhanced teaching, community services, law enforcement, linkage of engineering with K-12, assessment and evaluation, replication of cultural artifacts, and design and manufacturing. Also being presented are new ideas in physics education, international cooperation, remote access to unique instrumentation, and the teaching of soft-skills.

BROADENING ENGINEERING, INTERNATIONAL COLLABORATION

Significant advances have been made in the U.S. and abroad in efforts to broaden the participation in engineering and science education. While the U.S. arguably is still the leader in this area, notable steps are being taken elsewhere that are also drawing attention. An example is the work done in Japan by Takamata et al. (Chap. 1), who have developed a community lifelong learning program for science education with a collateral objective of facilitating increased interaction among community members. In Hungary and Portugal, the team of Carvalho et al. (2) are leading a cooperative project to forge interconnections among three higher education establishments in the two countries in which students from each institution are remotely accessing experimental facilities in the other institutions. In Korea, a particular model of university-industry cooperation, called the "co-prosperity" model, has been developed by Lee et al. (3); it builds on the interest of small-medium companies and major enterprises to develop the skills of practical engineers.

At the University of Ulster, Uhomoibhi et al. (4) are examining how emerging technologies are enabling e-learning to be used in education to create a major shift in the educational service paradigm. Collaborative efforts by three universities, two in Czech Republic and one in Slovakia, have led to development of the Internet Natural Science Remote e-Laboratory. As reported by Schauer et al. (5), the e-laboratory includes experiments from physics, chemistry and environment monitoring, with 13 experiments available for open access online.

The work of McIlroy et al. (6) deals with the use of a major research facility as a platform to join an institution in Germany with one in the U.S. in collaborative research and education. In their case, the facility is one based on the large matched-index-of-refraction technique which permits optical measurements for determining flow characteristics in complex passages and around objects without the need for intrusive measurement probes. In another project that links the U.S. and Germany, Moeller and Schrorer (7) develops remote traffic simulation scenario analysis for decision-making in future infrastructure development or response to acute situations like road closures.

Meanwhile, in the U.S., a 6-year study of the role of humanitarian engineering program on the retention and recruitment of women has been completed at the Colorado School of Mines, as reported by Skokan and Gosink (8). At the University of Alabama in Huntsville the focus of Leonard et al. (9) is on increasing the participation by female and minority students in civil and transportation engineering. Carpinelli et al. (10) are creating a linkage between engineering programs and K-12 by using robotics as a tool to enhance student understanding of, and interest in science, technology, engineering and mathematics in K-12 curricula.

Also in the U.S., Tanner and Dampier (11) are extending engineering education into the domain of law enforcement based on a concept mapping case domain modeling approach. They show that the concept mapping case domain modeling approach could be used by law enforcement to organize, search, identify, and analyze digital evidence in an examination.

INNOVATIONS IN TEACHING

The innovation pedagogy at Turku University of Applied Sciences in Finland is underpinned by an exceptional learning environment on campus, in which students tackle common development problems in a multidisciplinary setting (Putkonen et al., Chap. 12). At Virginia Tech in the U.S., Amelink and Scales (13) are employing instructional technology such as Tablet PCs and related educational software to encourage faculty-student collaboration and cover course content in an interactive educational setting. Also in the U.S., at Georgia Tech, Komerath and Smith (14) employ research seminars in an innovative program that aids underprivileged undergraduate students in gaining perspective and self-confidence in their professional fields.

The development and design of a curricular program to train engineers and technicians for work specific to advanced energy storage systems is reported by Liao et al. (15). The curricula targets engineering/engineering technology students at 4-year universities and community colleges, engineers and technicians in industries, and K-12 technology teachers. Viegas et al. (16) present the effort by two universities in Portugal to improve the teaching quality and learning outcomes of a physics curriculum for engineering students. Based on the idea of reflection on teacher’s practice using multimodal narratives as an instrument, the course curriculum, the learning tasks, and teachers’ mediation in the classroom are successively improved. It is shown that the teachers' multimodal narratives are useful instrument of reflection.

Cecil and Kak (17) outline the design of an interdisciplinary curriculum for engineering students at Oklahoma State University. Morgan and O’Gorman (18) present a new approach for enhancing students’ interpersonal and business management skills to fill skill-gaps identified by industry. Opportunities for developing key soft skills have been embedded across the whole curriculum and across all years of the mechanical and engineering management programmes. Ziegler (19) focuses on senior students' perspectives of the quality and value of experiential learning. Learners' feedback is described with particular focus on their ability to cope with responsibilities in the workplace.

In the context of teaching physics to engineering students, Beck and Braunstein (20) show that the calculation of electromagnetic field due to transient currents obtained by either solving Maxwell's equation or through Einstein's special theory of relativity is equivalent. They recommend using both methods of calculation in order to expand the depth of understanding of electromagnetic fields.

ASSESSMENT AND EVALUATION

There has been an increasing recognition of assessment and evaluation as an effective tool for improving engineering and computer science education. In Spain, Araujo et al. (21) are investigating the impact of a new assessment approach in which 90% of a student's grade is guaranteed upfront with the remaining 10% based on a presentation by the student. At the Universiti Teknologi PETRONAS in Malaysia, Abidin et al. (22) apply e-portfolios in large classes in which students are required to work collaboratively. In Australia, Kim (23) quantifies thesis assessment using a mathematical formula, thereby substituting what is usually subjective assessment with an objective approach. At Ohio State in the U.S., Czocher and Baker (24) compare two textbooks on differential equations according to criteria developed through research in mathematics education. In Japan, Murai et al. (25) are developing an onboard training program for cadets in ship navigation using salivary amylase activity (SSA) as a physiological indicator of mental stress induced during navigation.

Why has the number of students in the U.S. who choose to major in computer science been decreasing in a job market where computer science graduates are in high demand? To answer the question, Lauriski-Karriker et al. (26) have conducted a computer science attitude survey that measures five constructs. The results of the survey are described along with plans to validate the survey instrument with a broader population.

CREATIVITY, INTERDISCIPLINARITY, AND DESIGN EDUCATION

Addressing the challenges in the teaching of manufacturing, Bzymek (27) describes the Manufacturing Automation course offered at the University of Connecticut dealing with integration of problem solving and design. Yang et al. (28) propose a personalized suggesting system for use in the selection of hardware platform employed in embedded systems education.

Luna-Sandoval et al. (29) show that reverse engineering procedures can encourage creativity among engineering students, especially for product improvement and innovation. They argue that the methodology of reverse engineering should be taught formally and systematically in classrooms.

Glakpe et al. (30) trace the historical evolution of the capstone design course at Howard University with emphasis on the transition from individual student design projects to a more structured one including student design team projects and participation by industry partners. Sabag and Trotskovsky (31), defining “engineering thinking” as comprising creative and algorithmic routine thinking, they discuss its characteristics and, based on the results of interviews with industry experts and students, they show engineering thinking characteristics described by the experts are consistent with those expressed by students.

The emerging and integrative field of Biomedical Engineering (BME) is the subject of study by Rodriguez et al. (32). Their work relate to the experience of BME students with various teaching approaches, such as lectures, computer simulation and practical sessions at both the university and the collaborating hospital. The combination of traditional methods and practical activities is shown to be a successful strategy for the field of biomedical engineering.

ACKNOWLEDGEMENTS

We thank all the authors for submitting their papers to *Innovations 2011* and for painstakingly revising and refining their manuscripts when requested to do so. We also thank all the reviewers for giving us their incisive comments that guided us throughout our work. Robert Aung and Linnea Hasegawa helped with all phases of editing and book production.

iNEER Board of Editors

Win Aung
iNEER, Potomac, MD, USA
Vojislav Ilic
University of Western Sydney, Penrith, NSW, Australia
Jerzy Moscinski
Silesian University of Technology, Gliwice, Poland
James Uhomoibhi
University of Ulster, Newtownabbey, Northern Ireland, UK

May 1, 2011

BOARD OF EDITORS

WIN AUNG received his M.S. and Ph.D. degrees in Mechanical Engineering from the University of Minnesota. He was a Member of Technical Staff at Bell Laboratories, Whippany, NJ, USA during 1969-1974. From 1974 to 2010, he served at the U.S. National Science Foundation in various programmatic and senior executive capacities. From 1985 until he retired in 2010 he was a member of the U.S. Senior Executive Service. He won the first NSF Federal Engineer of the Year Award in 1985. During 1976-1996, he held adjunct and visiting professorships at several universities in the U.S. and abroad. In 1994, he founded the International Conference on Engineering Education (ICEE) series and, in 2000, he co-founded the International Network for Engineering Education and Research (iNEER), serving as its Secretary-General since the beginning. In 2004, he established the International Conference on Engineering Education and Research (iCEER) series. In addition, he: is the principal editor of the iNEER *Innovations Series*; has published over 120 technical papers and edited or co-edited more than 10 books; is a Fellow and Life Member of the American Society of Mechanical Engineers (ASME); was awarded the *Doctorem Honoris Causa* (honorary doctorate) by VSB – Technical University of Ostrava, Czech Republic, in 1999, and by the University of Pećs, Hungary, in 2008; received the Medal of Merit from the Silesian University of Technology, Poland, in 2005; served as a member of the Standing Committee on Theory and Fundamental Research of the ASME Heat Transfer Division, the ASME Board on Engineering Education, and the ASME Council on Education; and is a past editor of Transactions of ASME, Journal of Heat Transfer.

VOJISLAV ILIC came to the University of Western Sydney (UWS) from the University of Sydney in Sydney, Australia where he obtained his PhD in 1994. He obtained a Master of Engineering Science Degree and his undergraduate degree in Mechanical Engineering at the University of New South Wales and a Diploma in Mechanical Engineering from the Royal Melbourne Institute of Technology. Prior to Vojislav's engagement at the University of Sydney, he was a Research Engineer with the Commonwealth Scientific and Industrial Research Organization in the Division of Energy Technology where he led a Research Team into applications of multi-phase flow technology to petroleum metering from oil wells and vapour generation in parabolic trough solar concentrators. He spent two years in the U.S. (while on leave of absence from the Australian Atomic Energy Commission, AAEC) working as a Research Fellow in the Thayer School of Engineering, Dartmouth College (Hanover, NH) and University of California (Santa Barbara, CA) on problems associated with multi-phase choked flow in pipes as a part of a wider study of a loss of coolant accident scenarios in nuclear reactor operations he had been researching at the AAEC. He was also a visiting scholar (focusing on cavitation research) at the

University of Belgrade in 2007 while on leave from UWS. Vojislav is the elected Leader of the Asia-Pacific District of the American Society of Mechanical Engineers (ASME), a Board Member of the Engineers Australia College of Mechanical Engineers and of iNEER. Applications of magneto-rheological fluids, hypo- and hyper-thermal ablation of tissues and cavitation of submerged water jets are of his current research interests and activities. He is also particularly interested in all aspects of education of engineers with a special focus on introducing humanities into the engineering curriculum and technology into the humanities curriculum. He has published over 110 technical papers.

JERZY MOSCINSKI received the M.Sc. and Ph.D. degrees in Automation and Robotics from Silesian University of Technology, Gliwice, Poland, in 1982 and 1990 respectively. He has taught several courses in the field of Control, Signal Processing, Identification and Estimation, Computer Controlled Systems and Computer Networks in the Faculty of Automatic Control, Electronics and Computer Science, SUT, Gliwice. Dr. Moscinski has been involved in the organization of international co-operation at the Silesian University of Technology, as Rector's Representative for International Collaboration during 1993-2008 and heading the International Cooperation in Science and Technology Division from 2008. Dr. Moscinski has coordinated at the University level the international exchange of students and teachers, international vocational training programs as well as international collaboration in the field of research and development on regional level as head of the contact point in Gliwice. He is an iNEER member and is involved in the organization of ICEE conferences. His main areas of interest include advanced control and signal processing, computer networks and their role in computer controlled systems and computer based education, Internet and multimedia technologies, international collaboration in education and research.

JAMES UHOMOIBHI is the E-learning Coordinator for the Faculty of Computing and Engineering at the University of Ulster where he oversees the development and delivery of online teaching and research involving the use of VLEs (virtual learning environments) and VREs (virtual research environments). He received his undergraduate honours degrees in Physics, Education and Philosophy. He obtained MSc in Optoelectronics and Optical Information processing and a PhD in Laser and Plasma Physics from Queen's University Belfast. His current research area is Laser Engineering Applications and Photonics (LEAP) and engineering education. He heads the LEAP Research Group whose focus is on nanoscale studies of the structure and dynamics of complex systems using novel laser light scattering and allied diagnostic techniques. His group is also involved in the development of computational techniques and software for studying hydrophobic environments. He is a Chartered Physicist, a Chartered IT Professional and a Fellow of the British Computer Society. He is a member of the European Physical Society (EPS) and the European Optical Society (EOS). He is Chairman of the National BCS E-Learning Specialist Group and was Chairman of ScienceNI (Northern Ireland Branch of the British Science Association, formerly known as the British Association for the Advancement of Science) from 2007-2009. James Uhomoibhi is the Northern Ireland Regional Co-ordinator for the UK-wide African-Caribbean Representation in Science and Technology (ACRISAT) project, an initiative of National Endowment for Science, Technology and the Arts (NESTA). He is an active member of SEFI (European society for engineering education), iNEER (international network of engineering education and research) and serves on the editorial boards of several journals. James Uhomoibhi presently serves on the editorial boards of several publishers. He is a registered UK Science and Engineering Ambassador.

REVIEWERS

Adrian Melling, *Germany*
Adrian Rusu, *USA*
Alex Hariz, *Australia*
Alexander Zimin, *Russia*
Amy Moll, *USA*
Andrew Nafalski, *Australia*
Anne Donnelly, *USA*
António Dias de Figueiredo, *Portugal*
Arne Gjengedal, *Norway*
Barbara T. Pioro, *USA*
Brent Jesiek, *USA*
Carlos Miguel Tobar Toledo, *Brazil*
Carsten Wulff, *Norway*
Catherine Skokan, *USA*
Claire Davis, *UK*
Clara Amelia de Oliveira, *Brazil*
Clara Viegas, *Portugal*
Cristina Alonso, *Spain*
D. T. Rover, *USA*
David C. Ingram, *USA*
David Edwards, *Australia*
David Holifield, *UK*
Donald Day, *USA*
Dorin Patru, *USA*
Duane Abata, *USA*
Edmund Palaszynski, *USA*
Eduardo Montero, *Spain*
Edward E. Anderson, *USA*
Ephraim Sparrow, *USA*
Eugene Coyle, *Ireland*
Frank Kulacki, *USA*
Frode-Eika Sandnes, *Norway*
Galeno José de Sena, *Brazil*
Gary C. Kessler, *USA*
George Gibbon, *South Africa*
Hamadou Saliah-Hassane, *Canada*
Heiko Rudolph, *Australia*
Heinz Luegenbiehl, *USA*
Hylke van der Schaaf, *Netherlands*
I. Omar, *South Africa*
Irina Radinschi, *Romania*
J. Cecil, *USA*
Janis Swan, *New Zealand*
Jean-Marc Thiriet, *France*
Jerzy Moscinski, *Poland*
Jerzy Swiatek, *Poland*
John Hoddinott, *Canada*
John W. Prados, *USA*
Joseph O. Arumala, *USA*
Julie Schoenung, *USA*
Karl Riedling, *Austria*
Krzysztof Czyż, *Poland*
Loren Schwiebert, *USA*
M. Bredol, *Germany*
Malgorzata I. Michalczyk, *Poland*
Maria Helena Braz, *Portugal*
María Jesus Gonzalez, *Spain*
Maria José Marcelino, *Portugal*
Marios Kassinopoulos, *Cyprus*
Michael Mehalick, *USA*
Milan Simic, *Australia*
Muhammad S. Khan, *Switzerland*

Newlin Rajkumar, *India*
Olga V. Mudraya, *UK*
Pat Connolly, *Ireland*
Peter Knottenbelt, *South Africa*
Pritpal Singh, *USA*
Raija Tuohi, *Finland*
Raquel Dormido Canto, *Spain*
Richard Wysk, *USA*
Rosetta Ziegler, *South Africa*
Sameer Naik, *USA*
Scott Socolofsky, *USA*
Secil Satir, *Turkey*
Sergey Dubikovsky, *USA*
Sew Ming Low, *Malaysia*
Shirley J Dyke, *USA*
Shlomo Carmi, *USA*
Sigmond Singer, *Israel*
Stelian Brad, *Romania*
Subha K. Kumpaty, *USA*
Suchi Guha, *USA*
Vanessa Svihla, *USA*
Vojislav Ilic, *Australia*
Weidong Zhu, *USA*
Zbigniew Bzymek, *USA*