INNOVATIONS 2010

World Innovations in Engineering Education and Research

INNOVATIONS 2010

World Innovations in Engineering Education and Research

Edited by

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

Jerzy Moscinski
Silesian University of Technology
Gliwice, Poland

James Uhomoibhi
University of Ulster
Newtownabbey, UK

Wei-Chung Wang
National Tsing-Hua University
Hsinchu, Taiwan

Books in the iNEER Innovations Series:

Engineering Education and Research – 2001, ISBN 1-5670018-6-6
Innovations 2003, ISBN 0-9741252-0-2
Innovations 2004, ISBN 0-9741252-1-0
Innovations 2005, ISBN 0-9741252-2-9
Innovations 2005 – Special Edition, ISBN 0-9741252-4-5
Innovations 2006, ISBN 0-9741252-5-3
Innovations 2007, ISBN 978-0-9741252-6-8
Innovations 2008, ISBN 978-0-9741252-8-2
Innovations 2009, ISBN 978-0-9741252-9-9
Innovations 2010, ISBN 978-0-9818868-1-7

INNOVATIONS 2010: World Innovations in Engineering Education and Research

iNEER
P.O. Box 5229
Preston King Station
Arlington, VA 22205, USA
ineer@ineer.org

Library of Congress Control Number 2004215784

ISSN 1553-9911

ISBN 978-0-9818868-1-7

Printed in the United States of America

CONTENTS

PREFACE

The 2010 edition of the special volume of the International Network for Engineering Education and Research is the tenth book in the series, known also as the Innovations Series. Like its predecessors, the present volume provides a forum archiving seminal accomplishments and developments worldwide. The principal goal of disseminating the information is to help promote further progress in education and research through international cooperation. The papers are grouped under several major themes. Each paper has been selected by the Board of Editors following peer review. As briefly described in this Preface, the twenty-six papers included in this book are testimony to the exciting advancement in engineering education and research that are being conceived, developed, assessed, and implemented at diverse education and research institutions around the world.

ASSESSMENT AS A TOOL TO PROMOTE LEARNING

In Chapter 1, Win Aung describes the formative evaluation process for determining the future model for the International Research and Education in Engineering (IREE) initiative, by which engineering students and faculty are supported for extended-stay research-abroad visits, with all expenses paid by the U.S. National Science Foundation. IREE is aimed primarily at addressing the growing interest of U.S. students in gaining an international perspective while engaging in collaborative research. In Chapter 2, Furukawa et al. deal with the use of two different peer-evaluation methods to investigate student team contributions in project based learning. The two methods are applied to 27 classes, with close to 2,000 total samples from almost 1,000 university 1st and 2nd year students. The results suggest specific ways that the results of different peer-evaluation methods could best be used.

From Portugal, Viegas et al. (Chap. 3) discuss the application of formative assessment to improve students' learning and performance. They compare three types of feedback provided to students: general feedback provided in class, individual feedback provided in class, and individual feedback provided through an e-learning platform. They show that individual feedback, if properly used, could be a powerful tool to enrich learning and improve academic success.

At the Universiti Teknologi Petronas in Malaysia, Abidin (4) is providing in-house training, mandatory for new faculty, to introduce them to the education delivery and assessment culture that enables them to meet the standards set by the university. Delivered in the format of a workshop, the training is conducted by the university's

trained facilitators who are senior faculty members with consistently good teaching track record. The work of Hariz and Mohtar (5) at the University of South Australia is focused on the effectiveness of the remote laboratory in microelectronics fabrication. A newly-designed and built remote laboratory in Microelectronics has been tested. The research tools used to determine the effectiveness of such an e-learning tool are described, and the learning outcomes of students using the remote version of the lab and of those using the traditional laboratory are compared.

Outcomes assessment in Robotics classes for non-engineering students at Holyoke Community College includes a survey conducted for students (6). Results indicate a very successful program initiative for transfer purpose at a community college, with an encouraging trend of more female students attracted to engineering. The majority of students took Robotics as their first engineering course. The present study results would help enable faculty to upgrade the Robotics curriculum to meet student needs in the future.

NEW CURRICULUM AND METHODS

The hands-on approach continues to be integrated into the engineering curriculum in precision automatic control engineering through industrial and international collaborations in a collaborative project between the University of North Florida and the Cologne University of Applied Sciences (7). The objectives are to use, develop, and enhance the RLab Remote Laboratory System developed at CUAS, porting the RLab capability to UNF, and expanding the scope of experiments. At the University of Pittsburgh, a ne*w* course has been developed to infuse the curriculum for future engineers with learning in nanoscale science and technology (8). To lay the foundation for this multi-year, multifaceted educational project, the following two methods were used: (a) development of an undergraduate elective in nanoscale science and engineering; and (b) provision of hands-on research and international research experiences.

In Finland, the ageing population is presenting challenges to the field of healthcare. The challenge must be met by specialists who understand information systems and the special characteristics of healthcare. Kontio et al. (9) describe a development process for a novel engineering curriculum in healthcare informatics that is based on descriptive case study research. The first batch of students with new expertise is scheduled for graduation in 2011. Hirama and Melnikoff (10) describe a Maturity Environment employed in support of software engineering education in Brazil. Based on the ISO/IEC 12207 standard, the Maturity Environment make it possible to apply different teaching approaches in undergraduate, graduate and extension continued education courses, develop education and research projects in an integrated environment, and evaluate the performance of disciplines and improving communications among students, professors and researchers.

The design and development of course modules in nano manufacturing for undergraduate and graduate engineering students at Oklahoma State University are outlined by Cecil (11). The curriculum is designed for undergraduate and graduate industrial and mechanical engineering students. There is an information-centric emphasis in these modules involving the use of information intensive process models as well as virtual engineering tools.

At Northern Illinois University (NIU), a new curriculum for a nanotechnology undergraduate certificate program has been developed by an interdisciplinary team of faculty members from engineering, sciences, and business. A problem-based pedagogical approach is employed to increase content retention of undergraduate students in science, technology, engineering and mathematics (12). Also at NIU, faculty from the College of Engineering and Engineering Technology has formed an alliance with the Society of Women Engineers and two Girl Scouts Councils to teach engineering to middle and high school students (13). The underlying framework features engineering design through hands-on activities, teamwork and mentoring.

GLOBAL DEVELOPMENT TO ENHANCE INNOVATION AND CREATIVITY

In many countries, the engineering community continue to widen their focus on enhancing innovation, creativity and productivity through bilateral and multi-national collaboration. In Chapter 14, Barry and Kanematsu provide the results of eight years of U.S.-Japan collaboration on creative education in which advances originating from the U.S. were adapted into Japanese higher education. In Europe, the diverse communities in several leading institutions have joined to form the Network of Excellence in Technology Enhanced Learning (15). Called STELLAR (Sustaining Technology Enhanced Learning Large-scale Multidisciplinary Research) and supported by the European Union, the Network is motivated by the need for European research on technology–enhanced learning.

In Denmark, as in many other parts of the world, public policies are increasingly tied to integrating scientists and engineers into the discourse on the global economy, leading to an ongoing strategic transformation process at the Copenhagen University College of Engineering (16). Central to the continuing transformation process is the vision of becoming an engineering school of world class by 2013.

Taiwan's economy is based heavily in semiconductor manufacturing and, to promote interest, capability and creativity in design among undergraduate students, universities are using a design contest centered on an education version of the field programmable gate array (17). The challenging task of training student for entrepreneurship in Taiwan is being addressed through a virtual reality learning system, in which learners are engaged in the process of entrepreneurship through a project management approach (18). In Brazil, an Innovation Law has been passed, creating a legal framework for knowledge transfer that requires scientific and technological institutions to establish offices responsible for innovation policy (19).

From South Africa, a country with many cultures, Winzker and Pretorius (20) present a teaching/facilitation/research model with case studies, providing qualitative trends for collaboration between two culturally different academic institutions. A system dynamics model is developed to supplement the integrated teaching and research management model, emphasizing that cultural exchange, collaboration and research are dynamically interlinked. In western Africa, Moaveni and his students from Minnesota State University are collaborating with Antonio of the Kwame Nkrumah University of Science and Technology in Ghana on a solar project involving teams of mechanical engineering students. This helps to develop the students' ability to function on multi-cultural teams,

and broaden the students' education necessary to understand sustainability issues and the impact of engineering solutions in a global and societal context (21).

Since 2004, there has been a close collaboration between the Cyprus University of Technology and the University of Orleans in France in the area of tele-echography (22). With a hospital partner in each country, the project is centered on the development of a tele-echographic system with which a specialist doctor can examine a patient located in a remote place anywhere and under various conditions.

FOUNDATIONS FOR ACADEMIA – INDUSTRY PARTNERSHIP

In South Korea, the study of Choi et al. (23), University of Suwon, is directed at understanding the requirements of prospective employers for students. A survey was conducted for undergraduates, graduates and industry personnel who are prospective employers. Based on the responses, the university has started to offer new, industrially oriented programs such as a capstone design course.

The University of Ulsan was founded by industry in the metropolitan city of Ulsan in South Korea. Recently the University implemented a six-month Long-Term Ineternship Program (LTIP). In the chapter by Hwang and Yang (24), they emphasize the importance of "total management" of LTIP, which is equipped with well-defined support systems such as preliminary education, CEO professors, industry-adjunct professors, and a competitive conference. In another paper from South Korea, Kim of Dongguk University presents the formative assessment of capstone design courses (25). The author identified six basic phases with independent objectives and evaluation criteria, and designed a feedback structure that was used to provide feedback at each phase.

COMPUTER BASED LEARNING IN HIGHER EDUCATION

Ossiannilsson and Sponberg (26) describe the objectives and results of a Leonardo project, eGIS+, that developed and implemented course modules related to geographic information, facilitating the viewing, understanding, interpreting, requesting, and visualizing of information and data in many ways that reveal relationships, patterns and trends in the form of maps, globes, charts and reports. The effectiveness of learning through the use of web-based laboratories is investigated based on the experience of operating a solar energy e-learning laboratory (Solar e-lab) in Cyprus (27). The number of colleges and Universities that are using the solar e-lab as part of their training programme, and online student evaluation reports, all show that there is nearly excellent satisfaction by the users.

The contribution that an environmental engineering course makes towards supporting lifelong learning for "non-traditional" learners is described by Ziegler and Omar (28). The course employs the World Wide Web and is offered by the Cape Peninsula University of Technology (Bellville Campus) in Cape Town, South Africa, providing global access to knowledge and information sharing on critical environmental issues.

ACKNOWLEDGEMENTS

The authors of the articles in this book have taken great care in recording their work in the chapters presented herein. Everyone has conscientiously considered the reviewers' comments and revised the manuscript judiciously. They are the heroes of this volume. Next come the reviewers, all 122 of them, many responding to last minute calls from the editors for a review needed to resolve a conflicting issue or to fill in last minute for a third review. To all of these great people, we owe our gratitude.

iNEER Board of Editors

Win Aung
iNEER, Potomac, MD, USA
Jerzy Moscinski
Silesian University of Technology, Gliwice, Poland
James Uhomoibhi
University of Ulster, Newtownabbey, UK
Wei-Chung Wang
National Tsing-Hua University, Hsinchu, Taiwan

May 15, 2010

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. In 1974, he joined the U.S. National Science Foundation as Program Director of the Heat Transfer Program. He was appointed to the U.S. Senior Executive Service in 1985. He received 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 2004, established the International Conference on Engineering Education and Research (iCEER) series. He co-founded the International Network for Engineering Education and Research (iNEER) in 2000, and is serving as its Secretary-General. He is the principal editor of the iNEER Innovations Series. He has published over 120 technical papers, and has edited or co-edited more than 10 books. He is a Fellow and Life Member of the American Society of Mechanical Engineers. He was awarded the *Doctorem Honoris Causa* (honorary doctorate) by VSB – Technical University of Ostrava, Czech Republic, in 2005, and by the University of Pećs, Hungary in 2008. In 2005 he received the Medal of Merit from the Silesian University of Technology in Poland. He was 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. He was an editor of Transactions of ASME, Journal of Heat Transfer.

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.

WEI-CHUNG WANG received his B.S. and M.S. degrees in Mechanical Engineering from the National Cheng Kung University in Taiwan and Texas Tech University in 1976 and 1981, respectively, and his Ph.D. degree in Engineering Mechanics from Iowa State University in 1985. Since then he has served as an associate professor (1985-1990) and a professor (1990-present) in the Department of Power Mechanical Engineering of the National Tsing Hua University in Taiwan. His recent research interests include theoretical and experimental developments of the ESPI technique, plate vibrations and thermal residual stresses. He served as advisor (1987-1995) for the Ministry of Economic Affairs, Executive Director (1994-2002) for the Tze-Chiang Foundation of Science and Technology (TCFST) and Director General (2003-2004) of the Department of International Programs of the National Science Council (NSC). Professor Wang is an active member in the Society for Experimental Mechanics (SEM) as well as several professional societies in Taiwan. He was one of the SEM Executive Board members from 2001-2003. He is the current SEM President (2009-2010). He is a three-time recipient of the Excellent Research Award from the NSC. He received Outstanding Service Award and Outstanding Engineering Professor Award from Chinese Society of Mechanical Engineers in 2000 and 2001, respectively. In 2002, he received K. T. Lee Management Medal in recognition of his outstanding performance on managing the Tze-Chiang Foundation of Science and Technology. In June 2005, Professor Wang was elected a Fellow by SEM.

REVIEWERS

A. Manuel de Oliveira Duarte, *Portugal*
Abdel Salam Tarek, *USA*
Adrian Rusu, *USA*
Alcínia Zita Sampaio, *Portugal*
Alexander M. Zimin, *Russia*
Alfredo Soeiro, *Portugal*
Alonzo Vera, *USA*
Anabela Gomes, *Portugal*
Anastasia Safigianni, *Greece*
An-Bang Wang, *Taiwan*
Andrew Nafalski, *Australia*
Anlia Pretorius, *South Africa*
Anna Friesel, *Denmark*
Anne Donnelly, *USA*
Ante Munjiza, *UK*
Arne Gjengedal, *Norway*
Ashish Mani, *India*
Barbara T Pioro, *USA*
Bhaskar Choubey, *UK*
Brent Jesiek, *USA*
Catherine Skokan, *USA*
Che-Ho Wei, *Taiwan*
Clara Amelia de Oliveira, *Brazil*
Colin G. Johnson, *UK*
Cornelia Connolly, *Ireland*
Cristina Alonso-Tristán, *Spain*
Dariusz Bismor, *Poland*
David C. Ingram, *USA*
David Dampier, *USA*
David Edwards, *Australia*
David Munoz, *USA*
Dorin Patru, *USA*
E.K. Glakpe, *USA*
Ebba Ossiannilsson, *Sweden*
Eckart Meiburg, *USA*
Eduardo Montero, *Spain*
Edward E. Anderson, *USA*
Eli Fromm, *USA*
Eugene Coyle, *Ireland*
Ewa Bielinska, *Poland*
Fabiana Leta, *Brazil*
Frode-Eika Sandnes, *Norway*
Galeno José de Sena, *Brazil*
George Gibbon, *South Africa*
Graham Horton, *Germany*
Greg Peters, *Australia*
H.I. Atagana, *South Africa*
H.K. Versteeg, *UK*
Hamadou Saliah-Hassane, *Canada*
Heiko Rudolph, *Australia*
I. Omar, *South Africa*
Irina Radinschi, *Romania*
Ivan Esparragoza, *USA*
J. Andrew Yeh, *Taiwan*
Jale Akyurtlu, *USA*
James Uhomoibhi, *UK*
Jasmine Henry, *Australia*
Javier Irizarry, *USA*
Jean-Marc Thiriet, *France*
Jeffrey Connor, *USA*
Jenny Lo, *USA*
Jerzy Moscinski, *Poland*
Jie Wu, *USA*
João Luís de Miranda, *Portugal*
John Kian Tan, *UK*
John Paxton, *USA*
John Sutherland, *USA*
John W. Prados, *USA*
Juan C. Morales, *USA*
Juan Sillero, *Mexico*
Juan Villalvazo-Naranjo, *México*
Jukka Tuohi, *Finland*