INNOVATIONS 2009

World Innovations in Engineering Education and Research

INNOVATIONS 2009

World Innovations in Engineering Education and Research

Edited by

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

Kwang-Sun Kim
Korea University of Technology and Education Chonan, South Korea

Josef Mecsi
University of Pécs Pécs, Hungary

Jerzy Moscinski
Silesian University of Technology Gliwice, Poland

Ian Rouse
Victoria University Melbourne, Australia

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 2009: 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 978-0-9741252-9-9

Printed in the United States of America

CONTENTS

PREFACE

In this volume we present the ninth edition of the iNEER Innovations Series. The articles illustrate approaches that have been demonstrated as useful in the education of engineers for the globalized society of the 21st century.

It is hoped that the chapters to follow will stimulate the readers' interest to launch further pursuits either on their own or through collaborative teaming. Experience has shown that innovations can be the cornerstone for further innovations when cooperative partnerships are involved. Partnering with experts also allows one to save time and money and avoid unnecessary repetitions.

The authors in the chapters of the book are the leading experts in the respective fields being discussed. These authors describe work being pursued in a wide range of institutions from around the world. The seventy-six experts who have contributed their work in the thirty-two peer-reviewed articles in this volume are from Australia, Austria, Czech Republic, Canada, Ireland, Malaysia, Norway, Poland, Portugal, Puerto Rico, Russia, Slovak Republic, South Africa, USA and Venezuela.

Their subjects deal with recent advances in tools and methods for engineering education, computer-based learning, assessment, industry-academia cooperation, and phenomena and processes that affect teaching at technical universities all over the world.

DEVELOPMENT OF TOOLS AND METHODS

Several of the chapters in this book deal with harnessing technology in advanced engineering programs and modules. In Chapter 1, Gerhard Hillmer of the Management Center Innsbruck (MCI) in Austria describes education innovations that link engineering with management. He outlines an integrated study program offered for BSc and MSc studies in Engineering. The program is created in response to a growing demand for engineers who have not only excellent technical competence in their field of specialization but also a general understanding of business administration, management and the issue of leadership.

Valdez et al. (2) explain how cooperative learning concepts are implemented in Portugal and how they help students to work with electric power systems security problems.

Education in electric circuits at the University of the Witwatersrand in South Africa is covered by Gibbon (3) with emphasis on an inductive learning style that, when combined with the addition of two laboratory tasks, led to an improved learning environment for students, resulting in a 28% improvement in the pass rate from 2006 to 2007.

At the Universiti Putra Malaysia in Selangor, Malaysia, Azau et al. (4) have developed a method that they call continuous-grouped-self-learning. Using a mock teaching oriented assessment, the method promotes group work, and a better understanding and appreciation of engineering courses by students, and gives them an increased sense of responsibility, self-confidence, and competitiveness.

From the U.S., the Colorado School of Mines, an institution known internationally for leadership in engineering education, the team of Munoz and Skokan (5) outline a long-term study to understand issues such as what motivates students in an engineering design setting and how leadership contributes to it. The study is motivated by the need to address the broad variation of performance among student teams in solving open-ended design problems.

Also from the U.S., Glenn et al. at Texas A&M University employ multidisciplinary, freshman-senior multilevel applied research projects to promote retention of students and to prepare them better for their careers. Their work is based on a testbed of interacting robots outfitted with actuators and sensors (6).

In Chapter 7, Jerzy Moscinski, a member of the Department of Automatic Control, Electronics and Telecommunications and Computer Science at Silesian University of Technology in Poland, analyses the general trends in the application of tools and methods in engineering education, and discusses their effects on the quality of engineering education.

COMPUTER BASED LEARNING IN HIGHER EDUCATION

From the University of Ulster in Northern Ireland, UK, Uhomoibhi (8) gives an analysis of pedagogical issues, student engagement, and assessment with respect to the implementation of e-learning in engineering education. Relating pedagogy to existing strategy and policy, he shows that what leads to a successful implementation of e-learning in engineering education are creative learning design and learning activities that enable students to collaborate online, avoid being isolated, share information with others, and solve problems.

Illarionov et al. (9) present an interesting example of a remote laboratory for engineering education and research in Russia. Known as the Remote Access Laboratory for Robotics, the system is available for use by students at N.E. Bauman Moscow State Technical University and other Russian universities, by use of modern remote access technology. In addition to practical education in robotics, theoretical issues are also considered.

Schauer et al. (10) describe a collaborative effort between universities in Czech Republic and Slovak Republic on computer-based laboratory teaching in physics. This was implemented in the original Internet School Experimental System in Czech Republic.

In a related chapter, Schauer et al. extend the discussion on the teaching of physics (11) and concentrate on a new strategy using case studies of real world phenomena to explain generalized laws of physics and their consequences.

At Old Dominion University and East Carolina University in the U.S., Chaturvedi et al. (12) have successfully used computer-based active learning tools for simulating thermal performance of steam power generation cycles.

In Europe, a collaborative effort between Swedish and Norwegian institutions has led to development of an extensive internet based-learning program for geographical information, as reported by Ossiannilsson and Sponberg in Chapter 13.

INNOVATIVE CONCEPTS IN TEACHING AND ASSESSMENT

In Chapter 14, Tully deals with the teaching of mathematics by using the Infinity Project to stimulate interest in mathematics among students in Ireland. Joint work in Portugal at the Instituto Superior de Engenharia do Porto and the University of Trás-os-Montes e Alto Douro has led Viegas et al. (15) to employ contextualized and active learning to implement curriculum innovation in physics. Using an e-learning platform, the new approach allows students to monitor their own progress and maintain contact with the teachers.

Creative pursuits in engineering education can be both fun and professionally rewarding, as shown by the work of Derjani-Bayeh and Olivera-Fuentes at the Simón Bolívar University in Venezuela. In an article (16) that is informative and educational, these authors explain how they employ science fiction settings and ideas to teach chemical engineering principles and processes. They discuss the general implication of science fiction as a tool in education, with reference to the work of popular novelists such as Asimov, Clement, Verne, Clarke, and Sheffield.

In the U.S., Moaveni and Chou (17) at Minnesota State University use a holistic approach to introduce engineering mechanics to freshmen students. They stress the need for students to be exposed early to mechanics in a holistically, whereby concepts of statics, dynamics and strength of materials are combined in the same course.

As arbiters of student performance, few engineering faculty receive proper training on moving from raw test scores to assignment of final grades. This is precisely the topic covered in Chapter 18 by Ieta et al. (18). They discuss the results of a collaborative effort between U.S. and Canadian universities and present possible options and associated challenges in scaling raw scores in engineering education.

In a related chapter, Pioro (19) of North Carolina A&T University treats electronic assessment based on personal response devices commonly known as clickers. She concludes that computer-based tests employing clickers with MS Power Point presentations of multiple-choice questions may be used with success in place of traditional paper-and-pencil tests.

FOUNDATIONS FOR ACADEMIA – INDUSTRY PARTNERSHIP

Nichols and Evans (20) of the University of Texas – Austin describe a very interesting pilot program connecting the education of engineers and the commercialization of university technology – thus aiming at enhancing entrepreneurship among engineering students.

In Chapter 21, Dubikowsky and Goodrich (21) recount their experience in working with industry practices and design for safety, and preparing graduates for careers in aviation.

From Victoria University in Australia, Simcock et al. (22) share their experiences in implementing the problem based learning paradigm, focusing on the interaction between students and industry as well as with community organizations.

The emphasis by Norwegian technical universities on the teaching of entrepreneurship is highlighted by Gjengedal et al. (23), in which they provide an interesting analysis of the work at the University of Tromsø, where a course on the subject has been developed for the second year of engineering study.

At the University of Puerto Rico in Mayaguez, a similar program led to the Global Clinic in Biotechnology, a partnership between university and industry that is depicted by Bright et al. in Chapter 24. At Wayne State University in Detroit, the auto capital of the U.S., Liao et al. (25) focus on "green transportation" to create a link between engineering education and ecology. The center-piece there is an integrated learning system for hybrid vehicle technology.

GLOBAL TRENDS AND PHENOMENA IN ENGINEERING EDUCATION

Duan (26) presents an interesting case study in which the subject of a partnership between a state college and local high schools in the U.S. is described. The perspectives and expectations of high school students on their future careers in science, engineering and technology are explored and quantified.

Carpinelli et al. (27) follow with an analysis of the interest by higher education institutions to allow students to enrol in college courses while completing their high school studies. Simcock et al. (28) continue to pursue their interest in Problem Based Learning by developing academic staff awareness of learning styles, communication competency and assessment in PBL.

Confronting the problem involved in learning to design, Svihla et al. (29) chronicle the experiences of several design teams, dwelling on how they interact with their mentors and with each other within their teams.

In a second chapter from the Colorado School of Mines in Colorado in the U.S., the concern of Skokan et al. (30) is on a topic of increasing interest at many institutions, namely, a curriculum development in the field of energy. In this case the curriculum of interest at is intended for use by Native American tribal colleges. The said curriculum includes a land surveying class and a class on introduction to engineering, as well as classes in wind and solar energy, and energy resources.

In one of the few single-author chapters in this volume, in Chapter 31, Simcock of Victoria University in Melbourne, Australia, shares his view on the role of accreditation bodies in creating and maintaining a global engineering identity. He explores in broad terms the whole meaning of such an identity and, indeed, on the future of globalization.

Closing out the chapters in this book is another single-author chapter on yet another timely topic. From the U.S., the epicentre of the current global economic downturn, Abata (32) examines its short- and long-term impact. He discusses the results of an informal survey of leading U.S. experts in engineering education, and concludes that the need for cooperation among engineering educators worldwide is more important than ever.

ACKNOWLEDGEMENTS

We wish to thank the authors and reviewers for their roles in making this book possible. The help rendered by many others, including Annie Aung and Robert Aung, is also gratefully acknowledged. In developing this book, it has been our pleasure and privilege to work with many thoughtful and creative educators from many different parts of the world. We have learned from each and every one of them, authors and reviewers alike. Our interaction with them has given us a sense of the common denominator for all of them – a keen sense of duty to the students, an uncommon love for their work, and a professional dedication to share in order to promote effective teaching and learning. They

have made our efforts worthwhile, and rendered painless and unimportant the countless hours we have spent working against deadlines to push this work out the door.

iNEER Board of Editors

May 11, 2009

[1] Since April, 2009, Ian Rouse has assumed the position of Dean of Fiji School of Medicine in Suva, Fiji Islands.

BOARD OF EDITORS

WIN AUNG
Win Aung completed baccalaureate studies in Burma (now Myanmar) and post-graduate studies at the University of Minnesota in Minneapolis, MN, USA. He was a Member of Technical Staff at Bell Laboratories, Whippany, NJ, USA and, since 1974 he has been at the U.S. National Science Foundation (NSF). He was appointed to the U.S. Senior Executive Service and awarded the first NSF Federal Engineer of the Year Award, both in 1985. During 1976-1996, he held adjunct and visiting professorships at several universities in the U.S. and abroad. He is a co-founder of the International Network for Engineering Education and Research (iNEER), and has served as its Secretary-General since 2000. He is also 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 received the *Doctorem Honoris Causa* (honorary doctorate) from VSB – Technical University of Ostrava, Czech Republic, in 1999, and from the University of Pécs, Hungary in 2008. In 2005 he was awarded the Medal of Merit by Silesian University of Technology in Poland. A Fellow of ASME, he served on its Board on Engineering Education as well as its Council on Education, and was an editor of Transactions of ASME, Journal of Heat Transfer.

KWANG-SUN KIM
Kwang Sun Kim received his Master and Ph.D. degrees from University of Kansas, USA, in Mechanical Engineering. After he graduated from KU, he was a research associate at Yale University, and worked for the Raytheon Incorporated as an engineer. He is presently the Honorary Chairman of Korea Society for Semiconductor/Display Equipment Technology and the Professor of School of Mechatronics Engineering, Korea University of Technology and Education (KUT). He initiated the founding of the Korea Society for Semiconductor Equipment Society and served as Chairman during 2003-2007. He is also the General Co-Chair of ICEE/ICEER2009, Seoul, Korea. He also served as a dean of planning affairs of KUT from 1996 to 2000, and as a dean of graduate school of KUT during 2000-2002 and 2004-2006. He served in the Ministry of Defense of Korea during 1978-1984 as a deputy section chief. He was awarded the National Medal by the President of Korea in 2006 for his contributions to scientific and technological fields. The University of Kansas has awarded him the Distinguished Engineering Service Award (DESA) in May, 2009.

JOSEF MECSI
Josef Mecsi received his BSc-MSc in Civil Engineering from the Technical University of Budapest in 1969, his CSc from the Hungarian Academy of Sciences in 1994, his PhD

and Dr. habil. from the University of Miskolc, the former in 1996 and the latter in 1998. Professor Mecsi was a fellow researcher at the Technical University of Budapest from 1970 to 1985, a technical advisor at Vízügyi Építő Vállalat from 1985 to 1992, a private professor at the University of Miskolc from 1991 to 2005. He has served as a full professor and was Dean of the University of Pécs, Pollack Mihály Faculty of Engineering during 2005-2009. He has been a member of the Hungarian Accreditation Committee (MAB) Board since 2000, a core member of the committees ISSMGE-TC-28 and TC-40 since 2002, a representative of Hungary at the European Committee of Civil Engineering (ECCE) since 2002 and president of the Section of Geotechnics of the Hungarian Chamber of Engineers since 1996. He has authored more than 125 scientific publications and made more than 600 geotechnical reports.

JERZY MOSCINSKI

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 in the field of Control, Signal Processing, Identification and Estimation, Computer Controlled Systems and Computer Networks at SUT, Gliwice, Poland. Since 1993 he has been involved in international co-operation at SUT as the Rector's Representative for International Collaboration. Dr. Moscinski has coordinated at the University level the international exchange of students and teachers, and international vocational training programs as well as international collaboration in the field of research and development as head of the Regional 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.

IAN ROUSE

A Professor and the Executive Dean of the Faculty of Health, Engineering and Sciences at Victoria University since 2005, Ian Rouse formerly served as a Professor of Health Sciences at Curtin University of Technology where he held the positions of Dean of Research and Enterprise and Acting Head of the School of Public Health. He graduated with first class honours in Biochemistry from the University of Western Australia in 1975 and completed a Doctorate in Epidemiology in the Department of Medicine of the University of Western Australia in 1986. He also completed with distinction a Graduate Diploma in Health Sciences from the Western Australian Institute of Technology in 1983. He worked in the fields of medical research, public health, epidemiology and health informatics in Western Australia, South Australia and at Harvard University. He held several prestigious fellowships including the Wyn Spence Medical Research Fellowship in 1983 and the CSIRO Division of Human Nutrition Research Fellowship at in Adelaide from 1986-1987. He was the General Manager of the Health Information Centre during 1995 – 1997, Chief Information Officer in the Department of Human Services in South Australia during 1997 – 1998, and Acting Chief Information Officer at Curtin University of Technology, 2000 - 2003. He has authored or co-authored more than 100 refereed papers, review articles and book chapters and have been associated with approximately 40 presentations at scientific meetings.

REVIEWERS

Anne Nortcliffe, *UK*
A. Chatterjee, *India*
António Dias de Figueiredo, *Portugal*
Anna Friesel, *Denmark*
Alex Stojcevski, *Australia*
Andrew Lau, *USA*
Anastasia S. Safigianni, *Greece*
Bhaskar Choubey, *UK*
Elisabeth McGrath, *USA*
Barbara M. Moskal, *USA*
Claire Davis, *UK*
John Carpinelli, *USA*
Cristina Alonso-Tristán, *Spain*
L.R. Chevalier, *USA*
Clara Amelia de Oliveira, *Brazil*
Cornelia Connolly, *Ireland*
Gary Downey, *USA*
Duane Abata, *USA*
Enrique Arce-Medina, *Mexico*
Edward E. Anderson, *USA*
Elena Mereuta, *Romania*
Eduardo Montero, *Spain*
Frode-Eika Sandnes, *Norway*
Guillaume Alinier, *UK*
Greg Peters, *Australia*
Gloria Rogers, *USA*
Suchi Guha, *USA*
H.K. Versteeg, *UK*
Heiko Rudolph, *Australia*
Heinz Luegenbiehl, *USA*
David C. Ingram, *USA*
Ingvar Gustavsson, *Sweden*
J.A.Rossiter, *UK*
Jasmine Henry, *Australia*
Jerzy Moscinski, *Poland*
Julie Schoenung, *USA*
John Hoddinott, *Canada*
John Ringwood, *Ireland*
John W. Prados, *USA*
John Sutherland, *USA*
Julio L. Rivera, *USA*
Kathy Schmidt, *USA*
Krzysztof Czyż, *Poland*
Keith Sheppard, *USA*
Costas Tzafestas, *Greece*
Subha K. Kumpaty, *USA*
Lisar R. Lattuca, *USA*
Kathleen Leonard, *USA*
Loren Schwiebert, *USA*
Alexander M. Zimin, *Russia*
Mauricio Duque, *Colombia*
Malgorzata I. Michalczyk, *Poland*
Maria Lúcia Pereira da Silva, *Brazil*
Maria Helena Braz, *Portugal*
Peter Moson, *Hungary*
Miroslava Ozvoldova, *Slovak Republic*
Andrew Nafalski, *Australia*
Sameer Naik, *USA*
Sameer Naik, *USA*
Nancy Healy, *USA*
Pamela M. Norris, *USA*
Radim Farana, *Czech Republic*
Raija Tuohi, *Finland*
Bob Ribando, *USA*
Robin King, *Australia*
Rosemary Tomkinson, *UK*
Sergey Dubikovsky, *USA*
Shirley J Dyke, *USA*
Vojislav Ilic, *Australia*
Vinod K. Lohani, *USA*
Wolfgang Losert, *USA*
Zoltan Nagy, *UK*