CONTENTS

PREFACE

The purpose of the iNEER Innovations Series, of which the present book is the latest edition, always has been to stimulate mutual progress through international collaboration. This book concerns innovations in teaching and learning in engineering education. Authors hail from several different countries and provide accounts of changes stimulated by technological progress. New technology has provided teachers and students with new opportunities. New directions are being opened in curricula and in teaching methods. The authors in this volume describe their ideas and practices in pursuit of these new directions.

From the Turku University of Applied Sciences, home to the recently convened and highly popular ICEE 2012 conference in Finland, Rector Professor Juha Kettunen (Chapter 1) outlines his ideas on the different types of learning and knowledge that are important today for promoting innovation in professional higher education. He asserts that expertise is achieved as a result of professional growth when students take more and more demanding challenges, and when the study program integrates different kinds of learning elements into a coherent whole. Collaborative and networked learning, and reflection on experiences in interdisciplinary situations, are themselves valuable for promoting professional growth; and interdisciplinary learning is to be taken into account in curricula, since it is required at the workplace.

From Northern Illinois University in the United States, Taherenzhadi, Hayman, Seaver, and Vohra (2) present a planning framework for academic support programs with research-based practices. These programs seek to maximize student retention and graduation rates. The key components of the framework include a summer pre-college bridge program for under-prepared students including: clustering students in STEM courses with supplemental instruction, providing research opportunities for faculty and students, enhancing research apprenticeships and faculty development.

Tague, Czocher and Baker (3), from Ohio State University, consider competencies that might be used in developing a first year mathematics course aimed at fostering mathematics literacy amongst engineering students. Ultimately, a fundamental issue that needs to be resolved is deciding on which mathematical competencies must form the basis of instruction. Beneficial changes cannot be accomplished through instructional modifications, but must entail building instruction, curriculum, and connectivity around mathematical literacy.

Dabipi and Burrows-McElwaun (4) discuss freshman engineering design using experiences from five years of multidisciplinary partnership. Their work is based on a study of lessons gleaned from facilitation of and participation in a freshman engineering design course. The perspectives of the course facilitator and project client are individually explored with an emphasis on unique experiences that influence and shape the evolution of course objectives, project scope, leadership selection and outcome expectations.

In an overview of cyber technologies that have already impacted engineering education, Cecil (5) of the Oklahoma State University holds that we are on the cusp of the next revolution, with the potential to dramatically change the face of education. His focus is on next generation internet networks based on cloud technologies, and 3-D virtual prototyping and Haptic technologies. The impact of such technologies on teaching engineering courses is discussed using manufacturing and space systems engineering as examples. The challenges facing the adoption of such technologies are also discussed.

A bi-national study has been carried out with potential impact on e-learning and other internet-based learning environments. The results of the collaboration are reported by Mhamdi, Saliah-Hassane and Braham (6). They examine the use of educational intranet and e-learning environments. Solutions are presented based on 3D languages such as VRML and Java3d. A model is presented for a 3D generic environment for remote practical instruction on embedded automated systems. The features and characteristics of this environment, and activities for teachers and students, are outlined.

For some time now, there has been concern by brain scientists about students in higher education who are ubiquitously exposed to new technologies. The concern is that these students may lose some of their abilities to perform successfully certain professional engineering tasks, particularly in research and development. Banky (7) examines this issue in a case study on first-year undergraduate students, with the aim of introducing and reinforcing the sequential nature of the research and development process as practiced by professional engineers. Student feedback and practitioner reflections are used. The results indicate that students who are required to carry out the sequential process of "engineering thinking" are able to successfully perform the tasks, even though they may have been previously exposed to new technologies. A clinical study of this issue, however, is needed.

Online education has been given a special emphasis ever since the adoption of the Bologna Declaration, as educators place increasing attention on the student and on hands-on laboratory experiments. In a collaborative effort between Czech Republic and Slovak Republic, Krbeček, Schauer and Lustig (8) develop the Internet School Experimental System (ISES) and EASY REMOTE ISES, the latter for the plug and play compiling of the control program and communicating web page without the need for programming. Addressing distance education at the University of Trnava in the Slovak Republic, Tkáč and Schauer (9) introduce an e-laboratory composed of remote real, interactive experiments running round the clock, covering the fields of dc and ac currents, and electromagnetic induction for a basic course on Electricity and Magnetism. The facility is based on hardware and software from the Internet School Experimental System (ISES). Courses are delivered using the methodology known as Integrated e-Learning (INTe-L). The authors describe the use of the remote experiments are used by students.

From South Africa, Gibbon (10) presents the evolution of a first year course on Electric Circuits, which is designed to develop conceptual thinking and engineering problem solving. He discusses the special measures used to change the students' mindset, including the requirement to pass all the knowledge areas in the course, and induce them to become more deductive in seeking solutions for problems.

Back at the Turku University of Applied Sciences in Finland, Luimula, Roslöf and Suominen (11) address the possibilities and challenges of ubiquitous computing and 3D virtual models. These subjects are a part of the process to update the curriculum on information technology. Game Development is presented as part of the curriculum structure for the B.Eng. Degree Program in Information Technology. A state-of-the-art review and a comparison of the core topics of Game Development at 48 universities are also presented, and the findings are analyzed.

In Taiwan, the National Chip Implementation Center (CIC) has been established to provide high quality IP design and implementation services for academia of Taiwan. One service introduced recently is *MorPACK*, a highly modularized and flexible platform for research and education. The experience of operating MorPACK during the last two years is reported by Huang, Yang, Wu, and Chien (12).

As discussed by Salmisto (13), a progressive inquiry learning-based Real Estate Business and Management course has been established since 2011 at Tampere University of Technology in Finland. The course is a part of the construction management and economics curriculum for engineering students. The course plan is developed based on student feedback and the experiences of teachers. The novelty of the course lies in transforming the theoretical learning approach into real learning situation and improving the course after one year, based on analyzed student feedback and experiences of the teachers. Although there are many articles written about progressive inquiry learning, this article is most likely the only one about the application of progressive inquiry learning in engineering education.

From South Africa, Alexander (14) presents a study of the efficacy of information and communication technologies (ICT) for development aimed at understanding the dynamics and interrelatedness of social, enterprise, and technology aspects of ICT deployment. The notion of efficacy is presented as a synthesized conception of the effectiveness of ICT deployment in promoting ICT adoption by the community and the improved efficiency of the production enterprise resulting from the deployment of ICT. The work has demonstrated a basic methodological approach that has the potential to impact practice in this emerging field.

The objective of the tri-national study by Abidin, Ziegler, and Tuohi (15) is to discover and compare the learning styles of undergraduates in Malaysia, Finland and England. Three universities are involved in the study with more than four hundred first year engineering and business students as participants. This study shows that most students prefer the social learning style and that it is the preference of both female and male students, with roughly every third student having the social style as his/her most favored learning style. Also, the findings show that amongst Engineering, Business and Information Computer Technology students, the most preferred is the social learning style and the least preferred being the verbal style.

López, Luna-Sandoval, Obregón, Velázquez, Moroyoqui, Molina, Velázquez, and Olivas (16) describe the collaborative work in industrial design of eight educators from six academic institutions in Mexico. They note that, in this field, it is very important to generate new or improve existing methods for the design of original equipment (forward design) or improving existing products by duplicating their parts or components (inverse or reverse engineering design). A methodology is presented with nine stages that incorporate the industrial experience of teachers and researchers. The methodology can be used by students in the forward design process, as well as in reverse engineering for duplicating parts and components. Both methodologies are described so that students and teachers can decide which one to use, according to the nature of the problem or project. The methods and procedures are based on a research program in reverse engineering and contribute to engineering education in fields such as machine design, metrology and manufacturing.

In the closing chapter of this volume, Blicblau (17), in Australia, looks at how the various technology applications can be used to optimize teaching and learning in an engineering materials science subject across a variety of engineering disciplines. The objective is to increase the effectiveness of delivery of the subject matter. Practical examples are given of delivery strategies, activities, and assessment protocols. The teaching approach adopted requires the development and implementation of an integrated technology and web-based teaching strategy for the provision of online lectures; audiovisual material; discovery based learning activities; and communication tools for the guidance of students in the self-management of their personal learning styles. The implementation of such an online initiative was considered novel, and led to an encouraging response from both students and staff. This was seen as pivotal in its contribution to the success of the overall learning strategy.

This then is a summary of what you see in this book. The articles are the fruits of the hard work by the authors, and by the reviewers each of whom has contributed immeasurably to the high quality of this volume through their efforts in the review process in which each paper is subjected to anonymous peer review by multiple experts. In our role as editors, we have strived to adhere to the principal goal of this volume by presenting examples of the exciting, innovative progress made around the world in engineering education and research.

We hope that the articles will help the readers understand a little better about innovations in engineering education in parts of the world different from their own. The authors are opening a window, large or small, to give us an insight into ideas and practices in education and research in their respective countries, institutions, classrooms and laboratories. They are the ambassadors in education that have given us, the editors, the honor of working with them. For this, we are grateful. To these authors, and the reviewers, go the credit for this book, and to them we dedicate our work and the book.

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WIN AUNG earned the B.Sc. in Mechanical Engineering from the Rangoon Institute of Technology in Rangoon (now Yangon), Burma (now Myanmar), and the M.S. and Ph.D. degrees in Mechanical Engineering from the University of Minnesota, Minneapolis, MN, USA. He was a Member of Technical Staff at Bell Laboratories, Whippany, NJ, USA from 1969 to 1974. From 1974 to 2010, he served at the U.S. National Science Foundation and was a member of the U.S. Senior Executive Service. Since 2000, he has served as the Secretary-General of iNEER which he co-founded. He is the principal editor of the iNEER *Innovations Series*. He was awarded the first NSF Federal Engineer of the Year Award in 1985. He has held visiting professorships at several universities in the U.S. and abroad, published over 120 technical papers and co-edited more than 10 books in heat and mass transfer, and engineering education. A Fellow and Life Member of the American Society of Mechanical Engineers, he served on the ASME Board on Engineering Education, the Council on Education, and was an editor of the Journal of Heat Transfer. He received the *Doctorem Honoris Causa* (honorary doctorate degree) from VSB – Technical University of Ostrava, Czech Republic in 1999, the University of Pećs, Hungary in 2008, and the Saratov State Technical University, Russia in 2012. In 2005 he received the Medal of Merit from the Silesian University of Technology in Poland.

BENNETT M. ALEXANDER is currently the head of the Department of Information Technology at the Cape Peninsula University of Technology (CPUT). As an Associate Professor he is extensively involved with the supervision and examination of postgraduate research. He received his BSc in Electrical Engineering from the University of Cape Town in 1980, his MSc in Technology and Human Resource Development from the Indiana State University in 1997, and his Doctor of Technology in Information Technology from CPUT in 2011. His current research interests relate to computational modelling of human behaviour using agent-based modelling techniques. He is a national role player in ICT curriculum development in South Africa. He has served as President of the Higher Education ICT Association (HEICTA) since 2005 – a consortium of South African universities focused on vocational ICT curriculum development and coordination, and the ICT sector responsiveness to national strategic imperatives. He has authored an Electrical Engineering textbook and has been involved with the instructional design of several others. He also holds two technology patents. He has been a community development activist and has supported several major Technology-for-Development projects. He has hosted several national and international conferences and also actively contributes to scholarly journals and peer-reviewed conferences.

HAMADOU SALIAH-HASSANE is a senior researcher at LICEF Research Center. He teaches informatics and computer networks at TELUQ, a Distance Education University of the Network of Universities of Quebec. He has a PhD in Electrical and Computer Engineering from McGill University in Montreal and a Master of Applied Science degree from École Polytechnique de Montréal, Canada. Saliah-Hassane has taught at the University of Niamey, Republic of Niger (1985-1987) and was Head of Electrical Engineering Department of The Engineering School of Mines, Industry and Geology (EMIG) of the former Economic Community of West Africa in Niamey, Niger (1989-1991). He is a member of Professional Engineers of Québec (OIQ); IEEE (Member of the Administrative Committee of IEEE Education Society; IEEE-SA P1876 Working Group Chair on "Standards for Smart Educational Learning Devices for Online Laboratories" and Chair of its Education Standards Committee); the American Society for Engineering Education (ASEE) and African Engineering Education Association (AEEA). In 2005 he received the "2005 Achievement Award" from the International Network for Engineering Education (iNEER) for "Research and Innovation on Online Laboratories and for the Advancement of International Collaboration". Other awards that he has received include: "Champion of Montreal's IEEE Teachers in Service Program" (2010); Volunteer Award of the President of IEEE Canada (2009); Certificate of Appreciation from the Vice Presidents of IEEE Technical and IEEE Geographic Activities. And recently, in 2012, Professor Saliah-Hassane was recognised with highest academic distinction of "Commander of the Order of Academic Palm" by Republic of Niger, his native country.

FRODE EIKA SANDNES received a B.Sc. in computer science from the University of Newcastle upon Tyne, U.K., and a Ph.D. in computer science from the University of Reading, U.K. He is currently the Pro-Rector for Research and Internationalization at Oslo and Akershus University College of Applied Sciences in Norway (formerly Oslo University College and now the 3rd largest higher education institution in Norway), and a full Professor in the Institute of Information Technology, Faculty of Technology, Art and Design (formerly Faculty of Engineering). His research interests include human computer interaction, multimedia processing and engineering education. Dr. Sandnes has published extensively in both technical and engineering education journals including the IEEE Transactions on Education, European Journal of Engineering Education, International Journal of Engineering Education, and Computer Assisted Learning Journal. He is an editorial member of several international journals including Journal of Systems and Software, Human-centric Computing and Information Sciences, International Journal of Communication, Consumer and Control, Journal of Information Technologies and Applications, The Open Cybernetics and Systemics Journal, International Journal of Smart Home, and International Journal of Computational Science and Engineering. He has chaired and been involved in the organization of nearly 50 international conferences including the steering committees of several ICEE conferences. Sandnes has also served on the national panel of evaluators for quality assurance in higher education and participated in several audits and chaired the evaluation committees for two institutional evaluations. Sandnes has also been an evaluator for the accreditation of a Ph.D. programme in Computer Science.

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