INNOVATIONS 2006

World Innovations in Engineering Education and Research
INNOVATIONS 2006

World Innovations in Engineering Education and Research

Edited by

Win Aung
International Network for Engineering Education and Research, Potomac, MD, USA
National Science Foundation, Arlington, VA, USA

Caroline Crosthwaite
The University of Queensland
Brisbane, Australia

Ramon Vasquez Espinosa
University of Puerto Rico
Mayaguez, Puerto Rico

Jerzy Moscinski
Silesian University of Technology
Gliwice, Poland

Shan-Hwei Ou
National Cheng-Kung University
Tainan, Taiwan, R.O.C.

Luis Manuel Sanchez Ruiz
Universidad Politécnica de Valencia
Valencia, Spain
# CONTENTS

PREFACE TO INNOVATIONS 2006
Win Aung, Caroline Crosthwaite, Ramon Vasquez Espinosa, Jerzy Moscinski, Shan-Hwei Ou and Luis Manuel Sanchez Ruiz xi

BOARD OF EDITORS xvii

REVIEWERS xxi

1 A SOCIETAL RESPONSIBILITY OF ENGINEERING EDUCATORS AND RESEARCHERS
G. Gilbert Cloyd 1

2 MOVING ENGINEERING STUDENTS ACROSS THE SINO-EUROPEAN DIVIDE: TAIWAN-NORWAY EXCHANGES AND COLLABORATION
Yo-Ping Huang and Frode Eika Sandnes 9

3 INTEGRATION OF RUSSIAN HIGHER EDUCATION INTO THE REALM OF GLOBAL ACADEMIA
Vladimir A. Ignatiev and Lidia I. Khorzova 19

4 SHIFTING THE RESPONSIBILITY OF LEARNING IN FIRST-YEAR ELECTRICAL ENGINEERING STUDENTS
George Gibbon, Ian Jandrell and David Rubin 27

5 COMMUNICATION AND TEAMWORK TRAINING USING AN ENGINEERING SIMULATION GAME
Steve E. Watkins, Ray Luechtefeld and Vijay Rajappa 39

6 TEACHING IN A DIVERSE CLASS: A STRUCTURED PROJECT-BASED APPROACH
S. M. Aziz 51

7 A STRATEGY TO LESSEN COMPUTER ANXIETY AND THEREBY IMPACT STUDENT RETENTION RATES ON COMPUTING COURSES
Cornelia Connolly, Eamonn Murphy and Sarah Moore 63

8 PERFORMANCE ON COMPUTER PROGRAMMING TESTS: COMMENTS, ACADEMIC MAJOR AND GENDER
Barbara T. Pioro 75

9 PROJECT CENTRED LEARNING IN CHEMICAL ENGINEERING: AN AUSTRALIAN PERSPECTIVE
Caroline Crosthwaite and Ian Cameron 95

10 A CURRICULUM PROGRAM FOR ELECTRONICS PACKAGING
Y. R. Jeng, D. S. Liu, C. F. Lee and J. N. Aoh 107
<table>
<thead>
<tr>
<th>Article Number</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>BIOREFINING: A NEW FRONTIER FOR ENGINEERING EDUCATION</td>
<td>Kurt A. Rosentrater and K. Muthukumarappan</td>
</tr>
<tr>
<td>12</td>
<td>A PROPOSED TRANSFERABLE CURRICULUM FOR MECHANICAL ENGINEERING TECHNOLOGY PROGRAMS</td>
<td>Xin-Ran Duan</td>
</tr>
<tr>
<td>13</td>
<td>PARTNERSHIP PROGRAMS TO ADDRESS ECONOMIC AND SOCIAL IMPACTS OF SMALL (MICRO/NANO) TECHNOLOGIES: THE VICTORIA UNIVERSITY CASE STUDY</td>
<td>Judgutt (Jack) Singh and Hai Phuong Le</td>
</tr>
<tr>
<td>14</td>
<td>ENHANCING THE CURRICULUM FOR PRECISION MOLD AND DIE DESIGN AND ANALYSIS ENGINEERING PROGRAMS IN TAIWAN UNIVERSITIES</td>
<td>Albert W.L. Yao, Chia-Hung Ku, Tsow-Chang Fu, Ming-Shyan Huang, Bor-Tsuen Lin and Jin-Bin Yang</td>
</tr>
<tr>
<td>15</td>
<td>BOUNDARY CROSSING: NEGOTIATING LEARNING OUTCOMES IN INDUSTRY-BASED STUDENT PROJECTS</td>
<td>Erik Bohemia and Kerry Harman</td>
</tr>
<tr>
<td>16</td>
<td>ENHANCING EDUCATION IN CONTROL ENGINEERING VIA INTERACTIVE LEARNING TOOLS</td>
<td>Valeri Kroumov, Keishi Shibayama, Misae Ishida, Akira Inoue and Hiroyuki Narihisa</td>
</tr>
<tr>
<td>17</td>
<td>A MODERN OPTICS LABORATORY FOR UNDERGRADUATE STUDENTS IN SCIENCE AND ENGINEERING</td>
<td>Cristian Bahrim</td>
</tr>
<tr>
<td>18</td>
<td>TRAINING AND PROFESSIONAL DEVELOPMENT THROUGH STUDENT SUMMER INTERNSHIPS AT UMES</td>
<td>Joseph O. Arumala and Ibibia K. Dabipi</td>
</tr>
<tr>
<td>19</td>
<td>THE USE OF FUNCTIONAL MODULES IN THE MECHATRONICS EDUCATION</td>
<td>Victor Giurgiutiu and Weiping Liu</td>
</tr>
<tr>
<td>20</td>
<td>UK ENGINEERING STUDENTS’ KNOWLEDGE OF MECHANICS ON ENTRY: HAS IT ALL GONE?</td>
<td>Stephen Lee, Martin C. Harrison and Carol L. Robinson</td>
</tr>
<tr>
<td>21</td>
<td>UNIVERSAL DESIGN AND ITS RELEVANCE TO ENGINEERING ETHICS</td>
<td>Masahisa Seguchi and Terumasa Ohkusa</td>
</tr>
<tr>
<td>22</td>
<td>GERMAN-POLISH DOUBLE GRADUATION IN MATERIALS SCIENCE AT M.SC. LEVEL</td>
<td>M. Bredol, M. Wojcik, H. Altenburg, J. Plewa1 J. Lis, M. Sopicka-Lizer and L. Blacha</td>
</tr>
<tr>
<td>23</td>
<td>AN INTEGRATED ETHICS CURRICULUM FOR ENGINEERING MAJORS</td>
<td>Wei-Lee Lu</td>
</tr>
<tr>
<td>Chapter</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>24</td>
<td>INTRODUCTION TO ENGINEERING PHYSICS - A MULTIMEDIA CD TOOL FOR STUDENTS ENTERING SLOVAK ENGINEERING UNIVERSITIES</td>
<td>287</td>
</tr>
<tr>
<td>25</td>
<td>INTERNET REMOTE PHYSICS EXPERIMENTS IN A STUDENT LABORATORY</td>
<td>297</td>
</tr>
<tr>
<td>26</td>
<td>CREATIVE LABORATORY EXPERIMENTS FOR BASIC PHYSICS USING COMPUTER DATA COLLECTION AND EVALUATION EXEMPLIFIED WITH THE INTELLIGENT SCHOOL EXPERIMENTAL SYSTEM (ISES)</td>
<td>305</td>
</tr>
<tr>
<td>27</td>
<td>A WEB-BASED INTERACTIVE STUDENT LEARNING TOOL FOR VISUALIZATION, SIMULATION AND KNOWLEDGE INTEGRATION IN THE UNDERGRADUATE THERMODYNAMICS COURSE</td>
<td>313</td>
</tr>
<tr>
<td>28</td>
<td>APPLICATION OF NEW METHODOLOGIES IN AN INDUSTRIAL ELECTRONICS ENGINEERING COURSE: CASE STUDY</td>
<td>323</td>
</tr>
<tr>
<td>29</td>
<td>ELEARNING ACADEMIC NETWORK - BLENDED LECTURES</td>
<td>333</td>
</tr>
<tr>
<td>30</td>
<td>WEB-BASED PROJECTS IN CIVIL AND ENVIRONMENTAL ENGINEERING EDUCATION: PEDAGOGY, ASSESSMENT AND LESSONS LEARNED</td>
<td>343</td>
</tr>
<tr>
<td>31</td>
<td>USING CASES TO TEACH USABILITY ENGINEERING: DESIGNING THE TAPPED IN CASE STUDY</td>
<td>351</td>
</tr>
<tr>
<td>32</td>
<td>DEVELOPMENT OF CAD/CAM/CAE COLLABORATION AND WEB-BASED REMOTE FE ANALYSIS SYSTEM</td>
<td>363</td>
</tr>
<tr>
<td>33</td>
<td>INTRODUCING E-LEARNING SOLUTIONS AND FLEXIBILITY IN HIGHER EDUCATION: OBJECTIVES AND CHALLENGES</td>
<td>375</td>
</tr>
<tr>
<td>34</td>
<td>USE OF ANIMATIONS IN DELIVERING ELECTRONIC COMPUTER AIDED DESIGN ON VIRTUAL LEARNING ENVIRONMENT</td>
<td>389</td>
</tr>
<tr>
<td>Page</td>
<td>Title</td>
<td>Authors</td>
</tr>
<tr>
<td>------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>35</td>
<td>LOW-COST SIMULATED CONTROL EXPERIMENTATION CONDUCTED IN ELECTRICAL ENGINEERING DEPARTMENT OF NATIONAL YUNLIN UNIVERSITY OF SCIENCE AND TECHNOLOGY</td>
<td>Juhng-Perng Su, Jhen-Jia Hu And Ying-Jin Ciou</td>
</tr>
<tr>
<td>36</td>
<td>MOBILITY AND INK WRITING IN A COURSE OF APPLIED ELECTRONICS OF THE ELECTRONICS ENGINEERING UNDERGRADUATE PROGRAM</td>
<td>Uriel R. Cukierman, Julieta C. Rozenhauz and Jose M. Virgili</td>
</tr>
<tr>
<td>37</td>
<td>USING COLLABORATIVE WRITING TO ENHANCE STUDENT PARTICIPATION AND LEARNING IN GROUP WORK</td>
<td>Olav Talberg</td>
</tr>
<tr>
<td>38</td>
<td>CULTIVATING ACTIVE LEARNING ABILITIES AND TEAMWORK SKILLS IN A TEAM-BASED DESIGN COURSE</td>
<td>Pei-Fen Chang and Dau-Chung Wang</td>
</tr>
<tr>
<td>39</td>
<td>HUMANITARIAN ENGINEERING PROJECTS IN MULTIDISCIPLINARY SENIOR DESIGN</td>
<td>Catherine Skokan, David Munoz and Joan Gosink</td>
</tr>
<tr>
<td>40</td>
<td>IMPROVING THE COMMUNICATIVE COMPETENCE IN SPOKEN ENGLISH OF TAIWANESE ENGINEERING STUDENTS: A PROSODIC APPROACH</td>
<td>Hua-Li Jian</td>
</tr>
<tr>
<td>41</td>
<td>DIGITAL DIVIDE AND EDUCATION</td>
<td>James O. Uhomoibhi</td>
</tr>
<tr>
<td>42</td>
<td>“RELATIONSHIPS FIRST” - BRIDGING WESTERN AND ARAB CULTURES WITH ENGINEERING EDUCATION</td>
<td>Suzanne W. Scott and Robert M. Baldwin</td>
</tr>
<tr>
<td>43</td>
<td>PLAYING WITH BLOCKS</td>
<td>Brian Brenner, Brian Gravel, Cindy Tran and Aaron Levine</td>
</tr>
<tr>
<td>44</td>
<td>TRAINING TOMORROW’S ENGINEERS THROUGH COLLABORATIVE PROJECT-ORIENTED EDUCATION: A CASE STUDY</td>
<td>Albert W. L. Yao, Jessica S. C. Chi and Robert L. Good</td>
</tr>
<tr>
<td>45</td>
<td>TEACHING ENGINEERING CONCEPTS BY USING COLLABORATIVE WORK TOOLS</td>
<td>Carmen Bachiller, Carlos Hernández and Francisco Ramos</td>
</tr>
<tr>
<td>46</td>
<td>DEVELOPING INTERNATIONAL PARTNERS TO TEACH SUSTAINABILITY, GLOBALIZATION AND GERMAN CULTURE TO UNDERGRADUATE ENGINEERING AND TECHNOLOGY STUDENTS</td>
<td>Patrica Fox, Kay Wilding, Stephen Hundley and Elizabeth Coles</td>
</tr>
<tr>
<td>47</td>
<td>THE OSTE: OBJECTIVE STRUCTURED TECHNICAL EXAMINATION FOR ENGINEERING STUDENTS</td>
<td>Nandini Alinier and Guillaume Alinier</td>
</tr>
</tbody>
</table>
INTEGRATED STRATEGIES AND IMPLEMENTATION PROCESSES FOR ACCREDITATION CRITERIA IN TAIWAN
Pei-Fen Chang, Chia-Hao Ko, Chia-Ling Ho, Jia-Yush Yen, Andrew M. Wo And Yeong-Bin Yang

MODEL FOR PROCESS OF MULTIDISCIPLINARY INTEGRATION OF INTERDEPARTMENTAL COURSES
Lucy King, Matthew S. Sanders, Tony Lin, Jacqueline El-Sayed and Mohamed El-Sayed

ALL-DIGITAL DESIGN AND MANUFACTURING (ADDM) - A NEW DEVELOPMENT IN ENGINEERING EDUCATION
Kuang-Hua Chang

DESIGNING AN IC CHIP WITHIN HALF A DAY: A CASE STUDY IN PROBLEM-BASED LEARNING IN TAIWAN
Wei-Chang Tsai, Chun-Ming Huang, Jiann-Jenn Wang, Jing-Yang Jou and Chau-Chin Su

A NEW PARADIGM: BRINGING BIOLOGY AND CHEMICAL ENGINEERING IN EACH OTHER’S CLASSROOMS
Lorenzo Saliceti-Piazza and Rosa Buxeda

A STUDENT DRIVEN MULTIDISCIPLINARY KNOWLEDGE INTEGRATION TEACHING PROGRAM
Nathaly Moreno, Pedro Pieretti, Victor Guzmán and Sergio Diaz

INDEX
PREFACE

The sixth book in the iNEER Innovations Series, “Innovations 2006” includes fifty-three articles covering a broad range of topics written by experts from different parts of the world. Each article has passed through a rigorous peer review process and represents an important milestone of accomplishment recognized by the international community of scholars.

From the diverse topics covered in this volume there emerges a picture of the regional trends for education and research development. Different countries are focusing on different problems arising from their individual education policies, economic interests and workforce needs, but all share a common interest in furthering national economic development and prosperity by promoting and advancing innovations in engineering education and research.

This volume shows that student-centered engineering education is spreading to more regions of the world, and its advantages are being more widely understood and embraced.

The volume also concerns: new curricular materials that address the needs of the 21st Century; the adaptation of e-learning and Internet technologies in teaching and learning; collaborative and experiential learning; inculcating students with a global cultural and societal perspective; multidisciplinary design and integration; and assessment, accreditation and quality assurance.

ENHANCING STUDENT SUCCESS AND LEADERSHIP

As befitting the title of this volume, the lead chapter deals with the importance of innovations in the global marketplace, and is authored by G. Gilbert Cloyd of Procter & Gamble Company (P&G), a company noted for product innovations that have propelled it to become the dominant player in the worldwide consumer product market. As Chief Technology Officer of P&G, he writes (Chapter 1) from the perspective of an industry giant with an annual R&D budget of $2 billion, annual sales of over US$70 billion, and over 9,000 people worldwide in R&D. He calls for the U.S. to produce the innovation talent needed by refocusing on physical science and engineering education as a national priority, and for a new approach to academia-industry collaboration. He also outlines the realities and opportunities presented by what he calls developed market countries and low-income market countries. He writes that, for U.S.-based global companies to remain competitive and continue to grow, they must leverage the capabilities and cost-effectiveness in low-income countries as well as their emerging markets for growth.

To ensure that students will be successful as engineers in the global marketplace as discussed by Cloyd, it will be necessary for them to acquire, in addition to a strong fundamental technical background and other attributes, a global view with an
appreciation of the different cultures in our diverse world. While this concept is well understood and accepted in Norway, the attention of government funding agencies in that country, previously tuned to English-speaking countries such as U.K., is turning towards non-traditional destinations in Asia such as People’s Republic of China and Taiwan (2). The need for integration into the world space in higher education is also recognized in Russia at the Volgograd State University of Architecture and Civil Engineering where the ideas and tools of the Bologna process is being implemented (3).

To enhance student success, the University of the Witwatersrand in South Africa has started to shift the responsibility for learning to first-year students in an Electric Circuits course, which is compulsory for all electrical, information and biomedical engineering first year students, so as to aid in development of imagination, self-confidence, intrinsic motivation, critical thinking and problem-solving (4). In the U.S., an engineering-based simulation game for instruction has been developed for use in communication and teamwork training (5). In Australia, a structured project-based approach to learning in a Digital Design course has been implemented (6). To ensure student success in computer science and engineering courses, a strategy has been developed in Ireland to lessen student anxiety related to computer programming (7) whereas, in the U.S., Pioro (8) recommends the use of graphs and comments in computer programming solutions for students at the early stages of learning computer programming.

**NEW CURRICULAR APPROACHES**

To promote innovations and the development of human resources needed for the global marketplace, many universities are developing new, responsive curricular materials and new courses of study. Thus, in this volume, many authors are concerned with helping students acquire the fundamental technical knowledge as well as the skills required to work in a diverse, multicultural environment. At The University of Queensland, Australia, Crosthwaite and Cameron (9) are implementing a project-centred curriculum in chemical engineering that integrates problem-based learning with traditional instruction. Other new developments include: a new curriculum for electronic packaging (10) in Taiwan; interest in biorefining research and education (11) and in a transferable curriculum for mechanical engineering technology programs (12) in the U.S.; programs in micro/nano technologies in Australia (13); and a curriculum for the precision mold and die design industry in southern Taiwan (14).

Also in Australia a transition is taking place from university-based to industry-based student projects (15). In Japan, a set of interactive learning tools for basic courses in automatic control developed in Japanese and English using MatLab (16) is now available. Other recent curricular innovations implemented in the U.S. include: a new modern optics laboratory for senior undergraduate students in science and engineering (17); a summer internship activity that seeks to improve students’ oral and written communication skills (18); and the use of functional modules for Mechatronics education (19).

In the UK, concerns about the level of knowledge of mechanics among entrants to programs of study in engineering have led to a study at Loughborough University to review the situation with respect to students’ knowledge of mechanics upon entry to university (20). From Japan, Seguchi and Ohkusa (21) suggest the incorporation of Universal Design into the teaching of Engineering Ethics, presenting the subject to students as ethical checks or standards in many different fields of engineering. A
German-Polish double graduation exchange program has been initiated in the field of materials science between two universities in Poland and a third in Germany (22).

Finally, in a thoughtful article, Lu (23) at the Naval Academy in Taiwan states the importance of ethics in both professional engineering and military practice.

E-LEARNING AND INTERNET TECHNOLOGIES

Several articles in this volume concern the application of e-learning approaches and the use of Internet technologies. From the Slovak Republic and the Czech Republic, Ovzoldova et al. report several successful developments, including: multimedia tools in the teaching of introductory engineering physics (24); a remote physics laboratory accessed through the Internet (25); and a new physics laboratory for non-major undergraduate students with computerized interactive capability (26). In the U.S., Chaturvedi et al. (27) have developed a web-based visualization module for the second undergraduate thermodynamics course in the mechanical engineering curriculum. A ‘blended learning solution’ that combines traditional learning practices and e-learning has been adopted for a graduate course in industrial electronics engineering in Portugal (28).

A similar approach involving six universities in the eLearning Academic Network (ELAN) in Lower Saxony in Germany is discussed by Schafer (29).

A technology-enhanced laboratory manual, or labware, used to provide tools to enrich the learning environment and experience of students is described by Chevalier et al. (30). Also in the U.S., Merkel et al. have developed an online library of hypermedia case studies in usability engineering for use in teaching courses in human-computer interaction (31). At Kumamoto University in Japan Tsuchimura et al. (32) is helping to improve the efficiency of the design process and to shorten the time for product development at small- and medium-sized companies.

The article by Gillet (33) of École Polytechnique Fédérale de Lausanne in Switzerland deals with the challenges associated with the introduction of e-learning solutions and flexibility in higher education. Rafik et al. of the University of Wales Institute, Cardiff (34) in UK present ideas on how a multimedia-based approach in electronic computer aided design (ECAD) could support the learning process.

From Taiwan, Su et al. (35) report a low-cost simulation-based experimental approach developed for a control laboratory course in which a student with only a PC with Windows operating systems and the associated application software can learn how to model a physical plant as well as its power actuator circuit.

To close out this group of articles, Cukierman et al. (36) of Argentina discuss adapting mobile technologies in teaching and learning using Notebook PCs, Tablet PCs and Pocket PCs in an Applied Electronics course at the Universidad Tecnológica Nacional in Buenos Aires.

DIVERSITY, COLLABORATION, TEAMING, AND SOCIETAL CONNECTIONS

The ability to work in diverse teams and to communicate effectively with others, and an appreciation of the problems of society and industry: these are the attributes that contribute to a successful engineering career in the 21st Century. Recognizing this, many educators have incorporated the teaching of what used to be called “soft skills,” such as teamwork and communication skills, directly or indirectly into the classroom. This volume reports recent innovations in these areas that include the work of: Talberg (37) of
the Faculty of Engineering, Oslo University College, Oslo, Norway, on the use of collaborative writing to enhance student participation and learning in group work; Chang (38) of National Central University in Taiwan on cultivating active learning abilities and teamwork skills in a team-based design course; Skokan et al. of the Colorado School of Mines (39) on a minor program in Humanitarian Engineering that has been initiated in which students must complete a humanitarian-designated interdisciplinary senior design project; and Jian (40) who has observed Taiwanese doctoral students’ presentations at international conferences and finds that, while their writing, reading and listening skills are often satisfactory, their presentations in English are hard to comprehend for non-Taiwanese attendees, so that important ideas and thoughts may get lost during the presentation, which has led her, as a linguist, to propose a simple programme that can help improve Taiwanese engineering students’ pronunciation skills.

Most perspectives on economic globalization deal with developments in Europe and Asia, but Uhomoibhi (41) of UK’s University of Ulster in Northern Ireland provides a perspective on an important issue that we as educators must not ignore – that of the digital divide separating rich and poor nations – and must find ways to work with colleagues everywhere. Scott (42) shows how, as a Westerner and a woman, she is contributing to an innovative, multicultural international collaboration between two universities, one in the U.S. and another in the Middle East. The work by Brenner et al. (43) at Tufts University in the U.S. is focused on using buildable bridge models of different structural types for engineering outreach to grade school classrooms for the purpose of demonstrating basic engineering concepts to young students.

With an aim to teaching students to “learn to learn,” Yao et al. (44) presents a case study in collaborative, project-oriented education to demonstrate the viability of academia-industry collaboration, and its benefits to engineering students and the cooperating company. A similar emphasis on teaching students to learn is employed by Bachiller et al. (45) at the Universidad Politécnica de Valencia in Spain, on teaching engineering concepts using collaborative work tools. At Indiana University-Purdue University Indianapolis, Fox et al. (46) have formed an international partnership with Berufsakademie Mannheim Berufsakademie Mannheim (BA-M), a cooperative education university in Mannheim, Germany, to teach sustainability, globalization, and German culture to undergraduate engineering and technology students.

**ASSESSMENT, ACCREDITATION AND QUALITY ASSURANCE**

The increasing attention on enhancement of student success and the trend toward globalization of engineering education has led to an increased focus on assessment, accreditation, and quality assurance in engineering education programs. At the University of Hertfordshire in the UK, Alinier et al. (47) have investigated the adoption of the Objective Structured Clinical Examination (OSCE) principle, long employed in the medical profession, in engineering education to assess students’ skills. Chang et al. describe the formation of the Institute for Engineering Education Taiwan, an organization that is responsible for implementing international accreditation and standards criteria in Taiwan (48).
MULTIDISCIPLINARY DESIGN AND INTEGRATION

It is important for engineering graduates to be able to function in multidisciplinary teams, Organizational studies have shown that using self-directed cross functional work teams shortens the decision cycle, reduces costs, produces better results and yields greater profitability. Authors who address these issues include: King et al. (49) of Kettering University in the U.S. who have developed a process for integrating existing courses in order to provide multidisciplinary learning experience across departmental boundaries; Chang (50) at the School of Aerospace and Mechanical Engineering at the University of Oklahoma who introduces students to an All-Digital Design and Manufacturing (ADDM) education program; and Tsai et al. (51) who describe an innovative design competition in Taiwan in which participants must design an IC chip within one-half day.

At the University of Puerto Rico, Mayagüez, integration of biology and chemical engineering has been successfully carried out (52), while at the Universidad Simón Bolívar in Venezuela, Moreno et al. (53) is integrating different disciplines of engineering in the context of an international Formula SAE competition, and transferring the full responsibility to manage and complete the multidisciplinary engineering project to students.

ACKNOWLEDGEMENTS

We are pleased to present the above survey and summary as an introduction to the articles in this volume. The 53 articles are written by 130 authors are from 20 countries. Two hundred ninety-eight (298) experts from 41 countries formed the reviewer pool. The country that has contributed the largest number of reviewers by far is U.S.A, with 102, followed by Australia (23), UK (17) and Brazil and Spain, each with 14 reviewers. A significant number of reviewers are repeat reviewers, having also reviewed articles for previous volumes.

We are sincerely grateful to authors and reviewers alike. Their collective work has helped render this volume into a veritable chronicle of recent world innovations in research and education.

iNEER Board of Editors

Win Aung
iNEER, Arlington, VA, USA

Caroline Crosthwaite
The University of Queensland, Brisbane, Australia

Ramon Vasquez Espinosa
University of Puerto Rico, Mayaguez, Puerto Rico

Jerzy Moscinski
Silesian University of Technology, Gliwice, Poland

Shan-Hwei Ou
National Cheng-Kung University, Tainan, Taiwan

Luis Manuel Sanchez Ruiz
Polytechnic University of Valencia, Valencia, Spain

May 5, 2006
BOARD OF EDITORS

WIN AUNG
Following baccalaureate and post-graduate studies at the Rangoon Institute of Technology and the University of Minnesota, respectively, Win Aung joined Bell Laboratories in Whippany, NJ in 1969 as a Member of Technical Staff. In 1974 he became a Program Director at the U.S. National Science Foundation (NSF). From 1986 to 2000 he was named in succession as Director of the Division of Mechanics, Structures and Materials Engineering, Director of the Division of Civil and Mechanical Systems, and Senior Staff Associate – Engineering Education. He was appointed to the U.S. Senior Executive Service in 1985 and was recipient of the first NSF Federal Engineer of the Year Award in the same year. From 1976 - 1996, he held adjunct and visiting professorships at several universities in the U.S. and abroad, with an active schedule of teaching, research and student mentorship. In 1994, he initiated the ICEE (International Conference on Engineering Education) 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. A Fellow of American Society of Mechanical Engineers (ASME) since 1983, he has written extensively on research and education and is a frequent speaker on campuses around the world and at international conferences. He has published over 120 technical papers, and has edited or co-edited more than 10 books. In 1999, he was awarded an honorary doctorate (Doctorem Honoris Causa) by VSB – Technical University of Ostrava in Ostrava, Czech Republic, and in 2005, he was awarded the Medal of Merit by Silesian University of Technology in Gliwice, 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 is a member of the Scientific Board of VSB - Technical University of Ostrava and was an editor of Transactions of ASME, Journal of Heat Transfer.

CAROLINE CROSTHWAIT
Caroline Crosthwaite, BE (Hons), MEngStud, UQ, MSc, JCU, is an Associate Professor of Chemical Engineering at the University of Queensland, Brisbane, Australia, with extensive experience in curriculum design and innovation in engineering education. She is the coordinator of the curriculum team that won the 2005 Australian Award for University Teaching in the category of Enhancing the Quality of Teaching & Learning for the University of Queensland’s Project Centred Curriculum in Chemical Engineering. She received the 2004 Australasian Association for Engineering Education Award for Excellence in Curriculum Innovation. She has taught across all levels of the
undergraduate curriculum, has written many papers on engineering curriculum and pedagogy, and consults nationally and internationally on engineering education development. As Director of Studies she is responsible for teaching and learning in all degree programs in the Faculty. She is also a Co-Director of the Catalyst Research Centre for Society & Technology.

**RAMON VASQUEZ ESPINOSA**

Ramon Vasquez Espinosa has been Dean of the College of Engineering at the University of Puerto Rico, Mayaguez (UPRM), since 2000. He first joined UPRM as a teaching assistant in 1974 and was appointed Assistant Professor and Associate Professor in 1984 and 1987, respectively. He became Professor of Electrical and Computer Engineering at UPRM in 1992. He received the BSEE and MSEE degrees from the University of Puerto Rico in Mayaguez in 1974 and 1979, resp., and the Ph.D. from Louisiana State University in 1984. From 1994 to 1999 he held a series of administrative and managerial positions including Associate Dean of Academic Affairs, Director of the laboratory of Remote Sensing and Image Processing (LARSIP), and Director of the Center for Computing Research and Development, Department of Electrical and Computer Engineering. A member of IEEE, ASEE, APIE and ACM, Sigma Xi, Eta Kappa Nu and Tau Beta Pi, he has received many honors and distinctions including the Centennial Certificate of ASEE. He has published and presented over 75 technical papers.

**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 several courses in the field of Control, Signal Processing, Identification and Estimation, Computer Controlled Systems and Computer Networks in the Department of Automatic Control, Electronics and Telecommunications and Computer Science, SUT, Gliwice. Since 1993 he has been involved in the organization of international cooperation at the Silesian University of Technology as Rector’s Representative for International Collaboration. 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 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.

**SHAN-HWEI OU**

Shan-Hwei Ou is a Professor of Dept. of Hydraulic and Ocean Engineering at National Cheng Kung University, Tainan, Taiwan. He now serves as Vice President of the university. Dr. Ou received his education at National Cheng Kung University, earning the B.S., M.S. and Ph.D. degrees in civil engineering in 1968, 1971 and 1978, respectively. He spent much of his career as an educator and for more than 20 years has been on the faculty of the National Cheng Kung University. He has served in a succession of administrative posts in higher education, each for several years: Chairman and Director of Hydraulic and Ocean Engineering at National Cheng Kung University, Dean of the
INNOVATIONS 2006

College of Engineering at National Cheng Kung University. He has many publications, honors and awards and professional activities to his credit.

LUI S MANUEL SÁNCHEZ RUIZ
Since 1980 Luis Manuel Sánchez Ruiz has been affiliated with Universidad Politécnica de Valencia (UPV), Spain, where he became Full Professor of Mathematics in 2000. He graduated and received his Ph.D. from Universidad de Valencia in 1980 and 1988, respectively, and was a Visiting Professor at the University of Florida, Gainesville, FL, USA on several occasions during 1992-99. His current research interests include Functional Analysis from both theoretical and applied points of view. He has published over 100 papers in scientific journals and conference proceedings and more than 10 textbooks on Mathematics for Engineers, and is co-author of the research monograph *Metrizable Barreled Spaces* published by Longman. The former Academic Coordinator of Mediterranean University of Science and Technology, he has been responsible for several research projects granted by the Spanish Ministry of Education. He is currently a reviewer for publishing companies, research projects and several international journals, as well as a member of the Editorial Board of Scientiae Mathematicae Japonicae. He has been a member of the International Steering Committee (ISC) of International Conference on Engineering Education (ICEE) of iNEER, and was General Chair of ICEE-2003: Valencia.
REVIEWERS

A. Chatterjee, India
A.M.C. Pretorius, South Africa
Abdulkadir Erden, Turkey
Abelardo Pardo, Spain
Ahmed Subaih, UK
Alcinia Zita Sampaio, Portugal
Alessandro La Neve, Brazil
Alexander Chernikov, Ukraine
Alfred Posch, Austria
Algirdas Sokas, Lithuania
Algirdas Vaclovas Valtulis, Lithuania
Ali Setoodehnia, USA
Alina Andreica, Romania
Anand D. Sharma, Puerto Rico
Anastasia S. Safigianni, Greece
Andreas Schlachetzki, Germany
Andrew Kline, USA
Andrew Martin, Sweden
Andrew Nafalski, Australia
Andy Koronios, Australia
Angelo J. Perna, USA
Anna Dias de Carvalho, Brazil
Anna Friesel, Denmark
Anna Igual Muñoz, Spain
Anna Wanclaw, Poland
Anne Nortcliffe, UK
Anthony J. McGoron, USA
António Betâmbio de Almeida, Portugal
Antonio Dias de Figueiredo, Portugal
Antonio José Caulleriaux Pithon, Brazil
Antonios Zavaliangos, USA
Arne Gjengedal, Norway
Asad Azemi, USA
Audun Weierholt, Norway
Babak D. Beheshti, USA
Bakari M. M. Mwinyiwiwa, Ethiopia
Barbara T Pioro, USA
Bernard Courtois, France
Bernardo Wagner, Germany
Bhaskar Choubey, UK
Birute Juodagalviene, Lithuania
Blaine W. Lilly, USA
Bobby G. Crawford, USA
Boguslawa Adamowicz, Poland
Brian Canavan, UK
Brian Daku, Canada
Brian Lithgow, Australia
Bruce R. Maxim, USA
Burford Ferman, USA
C.T. Tsai, USA
Camilo Quintáns Graña, Spain
Carlos Sá Furtado, Portugal
Carol Crumbaugh, USA
Carol J. Miller, USA
Carol Robinson, UK
Caroline Crosthwaite, Australia
Catherine Skokan, USA
Ceeyavash (Jeff) Salehi, USA
Celina Pinto Leão, Portugal
Charles Lemeckert, Australia
Charlie McDowell, USA
Che-Ho Wei, Taiwan
Chris Smaill, New Zealand
Chung-Ming Huang, Taiwan
Ciarán O’Leary, Ireland
Claire Davis, UK
Clara Amelia de Oliveira, Brazil
Claudiu Mereuta, Romania
Cornelia Connolly, Ireland
Cornelie Leopold, Germany
Costas Tzafestas, Greece
Cristina Alonso-Tristán, Spain
Cristina Pfeiffer, Brazil
D. Subbaram Naidu, USA
John Watson, USA
Jonathan Grudin, USA
Josip Orovic, Croatia
Jugdutt (Jack) Singh, Australia
Julie E. Sharp, USA
Julie Mills, Australia
Julius Christauskas, Lithuania
K. L. DeVries (Larry), USA
K. J. Hill, UK
Karl A. Smith, USA
Karl M. Gosechka, Austria
Kent L. Lawrence, USA
Kevin Janni, USA
Kevin Taylor, USA
Koichi Sumikura, Japan
Krystyna Stec, Poland
Krzysztof J. Kurzydłowski, Poland
Kurt Gramoll, USA
L.M. Sanchez Ruiz, Spain
Linda C. Schmidt, USA
Loren Schwiebert, USA
Low Sew Ming, Malaysia
Luke H. Huang, USA
M. Ashraf Iqbal, Pakistan
M. Lucia P. Silva, Brazil
Manfred Andrée, Germany
Manuela Nechita, Romania
Marcelo Rodrigues da Nóbrega, Brazil
Marek L. Szafr, USA
Marek Perkowski, USA
Maria C. Bachiller Martin, Spain
Maria Dinescu, Romania
Maria Helena Braz, Portugal
Maria Helenowska-Peschke, Poland
Maria Pereira da Silva, Brazil
Marina Y. Koledintseva, USA
Marios Kassinopoulos, Cyprus
Mark R. Henderson, USA
Martin Grimheden, Sweden
Martin J. Weller, UK
Marya Lieberman, USA
Mauricio Duque, Colombia
Mehter Mohammed Allam, India
Michael Bredol, Germany
Michael L. Raymer, USA
Michel Robert, France
Mihai Scarlete, Canada
Milton Vieira Junior, Brazil
Modris Dobelis, Lithuania
Mohd Fairuz Shiratuddin, USA
Morteza Biglari-Abhari, New Zealand
Nelson L. Lammoglia-Hoyos, Colombia
Nikolaos Bilalis, Greece
O. Hayden Griffin, Jr., USA
Okyay Kaynak, Turkey
Orlando J. Hernandez, USA
Ovid A. Plumb, USA
Palaiologou Nektaria, Greece
Pat Connolly, Ireland
Paula Postenicescu, Romania
Paulo Rupino da Cunha, Portugal
Pei-Lin Liu, Taiwan
Peter Moson, Hungary
Peter Stallinga, Portugal
Peter Willmot, UK
Poika Isokoski, Finland
R. de Toledo Assumpção, Brazil
Radovan Stulic, Serbia
Rainer Oechsle, Germany
Ramon E. Vasquez, USA
Ranjith Liyanapathirana, Australia
Renata Wagnerová, Czech Republic
Richard C. Kavanagh, Ireland
Richard Gale, USA
Richard M. Felder, USA
Richard Morris, UK
Rick Parent, USA
Robert M. Nerem, USA
Robertas Kersys, Lithuania
Roberto de Toledo Assumpção, Brazil
Robin Ford, Australia
Rogelio Palomera-Garcia, USA
Rolandas Domeika, Lithuania
Roman Miksiewicz, Poland
Rubens Nascimento Melo, Brazil
Rui Ferreira, Portugal
Ryte Ziuriene, Lithuania
S. M. Aziz, Australia
Salvador Cardona Navarrete, Spain
Santosh K. Kurinec, USA
Scott Clark, USA
Sebastian F. Colomar, Spain
Shia Chung Chen, Taiwan