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, Ozvoldova 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.

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