INNOVATIONS 2003

World Innovations in Engineering Education and Research

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PREFACE

Propelled by the widening adoption of communication technologies around the world, interest among educators in international cooperation has continued unabated. The present volume follows one published last year (2002) by the International Network for Engineering Education and Research (iNEER). Both books have the same purpose, namely, to chronicle the exciting, multi-faceted worldwide innovations in engineering education and research, much of which having been accomplished through collaborative efforts.

The contemporary issues covered by the thirty-two chapters include funding, multimedia learning and instruction, web-based learning, nanotechnology, mechatronics, and linkages between K-12 and engineering, and between art and engineering. Detailed descriptions of methods and approaches and assessment results are provided, enabling further development by others in the field. The trend toward applying learning theories in engineering education is evident in these chapters.

In the lead chapter, **Altenkirch** (Chapter 1) and eleven other prominent members of the international engineering education and research community join together to make the case for a major commitment by all stakeholders in international cooperation. They assert that the next major advancement in engineering education will come through international cooperation. Next follows a guest commentary by **Ilic** (2) in which he refers to the adverse changes to the environment that are traceable to society's technological progress. He feels that engineers have a responsibility to mitigate and minimise, if not completely eliminate, the undesirable changes. Emphasizing that engineering educators play a pivotal role in shaping new engineers in this increased responsibility, he cites sustainable development, taught within the umbrella of Ethics, as the relevant principal academic subject. **Moskalski** (3) makes the case for deans and department chairs to facilitate faculty innovations in the classroom. From Canada, **Rosen** (4) outlines the challenges and opportunities facing engineering education in that country, and presents possible solutions that emphasize several new focus areas including nanotechnology and alternative energy systems. U.S.A.'s **Patton** and **Bannerot** (5) show the parallel and contrast between art and engineering, a relationship that leads them to develop a course on art-based design education, in which rational and intuitive processing are synthesized. From the U.K., **Benest, Booth** and **Pack** (6) describe the design of a platform-independent delivery mechanism for on-line presentations that may be used live in lectures or during private study, but argue the case for incorporating familiar techniques for teaching and learning.

As academic institutions in developing countries plan their indigenous accreditation system, they face several options. Writing from their experience as faculty and administrators of The University of the West Indies, **Imbert** and **Kochhar** (7) outline the four options available to them, indicating their preference for the ABET approach.

A segmented approach that has been used at the New Jersey Institute of Technology to reach out to pre-engineering students is described by **Rockland, Bloom, Marganoff** and **Kimmel** (8) while, also at the same institution, **Hanesian** and **Perna** (9) are working with programs that foster a desire by underrepresented, undergraduate students to obtain Ph.D. degrees. To enhance student success in an urban commuter college, **Kopec, Whitlock** and **Kogen** (10) have developed a multimedia learning system called SmartTutor, an on-line tutoring system that works hand in hand with peer tutoring.

Gillet (11) uses web-based experimentation resources to provide flexible learning in selected pilot courses in engineering, whereas **Antonidakis, Petrakis, Kaliakatsos,** and **Athanasaki-Michailidou** (12) adopts an open distance learning approach for students to conduct laboratory experiments in teams of two where one student is physically located in the laboratory and the other is remote. The interest of **Komerath** and **Smith** (13) in multidisciplinary learning has led them to develop what they call the Aerospace Digital Library, a continually improved multi-use system that students use for knowledge management.

Also from the U.S.A., **Salamon** (14) reports on the first in a series of innovations aimed at broadening the undergraduate mechanics curriculum while, in a chapter concerning chemical engineering, **Howat** (15) presents new approaches used in integrating concepts of hazards and safety into capstone design.

In Chapter 16, **Cocke, Gossage, Li, Dede** and **Alicli** describe the concept, architecture, and design of a computer-based classroom for problem-based learning, and present results involving co-op students. Asserting that engineering subjects are often difficult to teach, **Woolf** and **Poli** (17) present an effective and cost-saving remedy based on multimedia tutors, detailing best practices gleaned from their own experiences.

In a contribution from Colombia, for automatic control courses, **Jordan**, **Martinez, Martinez, Olarte** and **Tamura's** chapter (18) indicates that much progress has been made there in devising team-based, multidisciplinary design-oriented projects involving remote control of laboratory experiments. Among the benefits cited by students are fairness, and the saving of time and costs. In Hungary, a country where multinational corporations have begun to establish research and development centers, the work of

Tuschak, Vajk, Bars, Hetthessy, Barta and **Charaf** (19) show that there is strong interest in web-based instruction in control engineering.

Other chapters that deal with technology-based teaching and learning include that by **Rodrigo** and **Ferrando** (20), who focus on applying the time domain multiplex technique for remotely controlled virtual laboratories. This is followed by the chapter jointly written by **Brunet** and **de Lafontaine** from Canada and **Schilling** from Germany (21). These authors describe the design and implementation of a virtual laboratory that allows for remote control of experiments in aerospace engineering and mechatronics. On the other hand, **Wu, Lin** and **Tsai** (22) are concerned with distance learning and circuit diagnostics in digital circuit laboratory courses. Using the learning environment provided by the AulaNet collaborative model in which all services are organized into the topics of communication, coordination and cooperation, **Fuks, Gerosa** and **Lucena** (23) have developed a new course that seeks to get students to learn to work in groups with information technology.

Verner and **Ahlgren** (24) describe an international contest for firefighting robots, and present results of a study on learning through contest-related activities, including an assessment of the value of this type of project for achieving outcomes. **Gutierrez** (25) discusses his experiences in using an integrative manufacturing software tool to deal with business gaps and education outcomes objectives that have been identified by the Society of Manufacturing Engineers. This is followed by **Carpinelli** and **Perna** (26) who deal with innovations by university coalitions and how the innovations are disseminated.

In Australia, where there is keen interest in contextual learning and a strong engagement in international cooperation, **Ford** and **Barber** (27) have implemented a Labweek for first year mechanical engineering students, in which hands-on laboratory experience was substituted for normal classes. Using a somewhat similar but more structured approach, their fellow countryman **Snyder** (28) employs problem-based learning to develop a course offered during the third year of a mechatronics degree program, a course that consolidates a number of mechanical and electrical engineering concepts.

Several chapters deal with new courses that involve students in an environment of collaboration and teamwork. Thus, **Watkins** and **Hall** (29) discuss the implementation of structured collaborative and cooperative learning at the senior and graduate levels. Going one step further, **Nortcliffe, Featherstone, Garrick** and **Swift** (30) show that mutual assessment and instruction, which learning theorists call "supplemental instruction", can in principle provide a more relaxed framework for the students' learning experience, but in practice is limited by students' lack of teaching experience and by friction and apprehension that could arise in the mutual assessment phase.

An on-line self-learning tool implemented by **Daku** and **Diefes-Dux** (31) is employed in teaching the basic concepts of MATLAB. The system incorporates challenging and significant exercise problems, and can evaluate student solutions thereto, thereby providing a measure of student performance. Especially noteworthy here is the approach adopted for assessing student progress and performance for on-line, self-learning programs.

Last but not least, extensive previous positive experience in working with students in industrial internships has led **Dallas, Berg, Holtz, Gangopadhyay** and **Temkin** (32) to develop what they call "internal internships", a two-course sequence in micro- and optoelectronics research that also emphasizes multidisciplinary teamwork and leadership skills.

These thirty-two chapters clearly show how far the education process for engineering has come in the last few years. Gone are the days when the process was basically "chalk-and-talk". We believe this volume provides a fair representation of recent developments in the respective countries and regions. The level of innovation worldwide is rising, no doubt an outcome, among other factors, of enhanced communication, cooperation, cross-fertilization, and partnership linkages in recent years.

It has been a privilege and a pleasure for us to serve as co-editors of this volume. We are grateful to the authors who submitted their papers for our consideration.

Our job, pleasant as it was, was made tougher by the high standards of the submissions. Limited by the page count constraints, our only regret is that we could not accept more of the eighty-five papers submitted.

In the final analysis, the quality of a publication such as this depends not only on the authors, but also the peer reviewers. There were three of them on the average for each of the papers we considered, and so it is impossible to name the reviewers here, but we are indebted to each and every one of them for the critical role that they have played so conscientiously. Also playing important roles are Clement Imbert of Trinidad and Tobago, and Robert Aung of Alexandria, Virginia, USA, both of whom contributed immeasurably to the fruition and, equally important, the intellectual quality of this volume. It has been our pleasure to work with these folks.

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