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# Collaborative Partnerships for Technical Interactions (CPTI): a Successful System for an Integrated Learning Environment\*

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Engineering education has the responsibility to develop and deliver relevant engineering programmes to answer tomorrow's challenges. They also must share the burden of educating non-engineering sectors on important concepts and solutions provided by engineers. A piece-wise introduction of innovations is not sufficient by itself. In a fast moving world a *system of strategies* must be established to design system-wide educational innovations. All of the above require significant interaction with multiple partners in developing innovations in engineering education. The partners range from high schools to aerospace companies. This paper discusses an interactive educational system developed under the auspices of the Collaborative Partnerships for Technical Interaction (CPTI) organisation at the College of Engineering and Engineering Technology at Northern Illinois University. The CPTI Organisation has general education, undergraduate and graduate, and external programming elements.

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## INTRODUCTION

Effective business decisions need both good engineering and a good understanding of engineering. Both non-engineering and engineering sectors must work together to understand each other in order to meet internal and global challenges. These challenges create opportunities for improving engineering programmes and interfacing with other sectors. Good engineering education must go beyond so-called good engineering approaches. Engineering education cannot solely rely upon providing narrowly focused programmes. All engineering programmes must parallel a popular saying that *it takes a village to raise a child* with reference to the underlying meaning of collaboration: cohesion and partnership. Similarly, it takes more than a group of educators to develop and deliver effective

engineering education for the present and the future. This sentiment gains more meaning in the face of ABET 2000 accreditation criteria, which strongly advocates teamwork and collaboration with industry.

The present is an excellent time for engineering educators to forge broad-based partnerships with various engineering and non-engineering sectors [1-8]. The partners that can benefit from the combined experiences include high schools, two-year community colleges, universities, industries, various business and service sectors, professional associations, and the general public. Broad-based partnerships go beyond typical two-way exchanges in the sense that they are multifaceted interactions with varying needs and interests. The College of Engineering and Engineering Technology at Northern Illinois University has created, for that purpose, an encompassing umbrella organisation for properly channelling partnership efforts into engineering education innovations, general technical education to non-engineering sectors, outreach programmes and off-campus programming. The main goal of the organisation, which is named Collaborative Partnerships for Technical Interactions (CPTI), is to exchange information and encourage new initia-

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\* This paper was awarded the UICEE diamond award (equal first grade with two other papers), by popular vote of Congress participants, for the most significant contribution to the field of engineering education.

tives among partners, faculty and administration.

In today's global economy, all countries have either become competitors or members in co-operative ventures. Participants from various countries confirmed this fact at the 1998 UICEE congress in Cracow, Poland. Certain aspects related to internationalisation of engineering curriculum were also discussed, in particular international collaboration and developing courses/programmes dealing with international issues in engineering. The attendees felt that such collaborations were possible due to advancement in information technology. Academic units across the world could work together sharing courses through communication technologies or offer programmes at one site for the benefit of the entire international community.

In the 1990s there has been a dramatic change in employer expectations going beyond the technical skills of fresh engineering graduates. The need for CQTP skills has put all undergraduate engineering programmes in a very peculiar and challenging situation. Current technical expectations include teamwork, timely product delivery, and the ability to utilise the most current technology available. In addition, industry now expects engineers to be proficient in many nontechnical, yet essential areas, such as communication skills, Total Quality Management (TQM), teamwork skills, and a perspective on international markets and competition, etc. These additional skills can be loosely defined for the purpose of this paper as CQTP skills.

The CQTP skills, while very important within the context of engineering programmes, are not at the graduate study level. Similarly, introduction of all CQTP skills on a formal basis into current undergraduate engineering programmes would exceed the accepted four-year credit ceilings.

On average, accredited undergraduate engineering programmes in the United States require about 130 semester hours for students to graduate, which takes approximately 4.5 years to complete. The addition of new courses to address all CQTP and other industrial concerns at the undergraduate level is hardly possible without increasing the overall semester hour expectations. This situation can be addressed by involving industrial partners within the CPTI system in developing new curricular interfaces via industrial projects and learning modules. The remaining *unfulfilled* portions of the CQTP skills then could be delegated to the career-long learning process, which would start soon after graduation. In that sense, universities, industrial and business sectors would all be involved in off-campus and/or after-hours training.

## COLLABORATIVE PARTNERSHIPS FOR TECHNICAL INTERFACING (CPTI)

While there can be several approaches to establish effective collaborative partnerships, this paper presents and discusses one of the possibilities, namely Collaborative Partnerships for Technical Interfacing (CPTI). The CPTI is a fully developed and functioning system in the College of Engineering and Engineering Technology (CEET) at Northern Illinois University (NIU).

Collaboration among various faculty groups within the College facilitated the establishment of the CPTI organisation. A significant array of organisations is involved in various partnerships with the CPTI programme. The CPTI schematic model shown in Figure 1 indicates the principal flow of information and exchanges. In this working model, the College is the clearinghouse for innovations as well as respondent to the feedback and needs coming from the partners in the academic, industrial, business and general public sectors. In this respect, the CPTI, with its integrated collaborative structure, has become a natural resource for designing and providing the necessary working components to both academia and professional sectors. A more detailed list of the CPTI project is provided in the subsequent sections of this paper.

Currently the CPTI has five driving elements for enhancing and executing all collaborative efforts:

- I. Innovations in engineering education
- II. Engineering-oriented general education for non-engineering students/sectors (EOGENES)
- III. Career-long off-campus programming for practising professionals in various engineering and non-engineering groups - external programming
- IV. Interactive feedback and assessment loop from customers and partners
- V. Co-operation with other units within the institution

In the following sections all five elements are described in greater detail. It must be noted that all five perform a very important interactive role in the entire broad-based partnership organisation. All elements have a valuable feedback/assessment input from partners and customers [9-11].

## INNOVATIONS IN ENGINEERING EDUCATION - ELEMENT I

Most of the new academic happenings in the College take place within CPTI Element I. A number of innovations, such as the EOGENES programme, were started here, but later, because of its significance, the EOGENES programme became an individual element



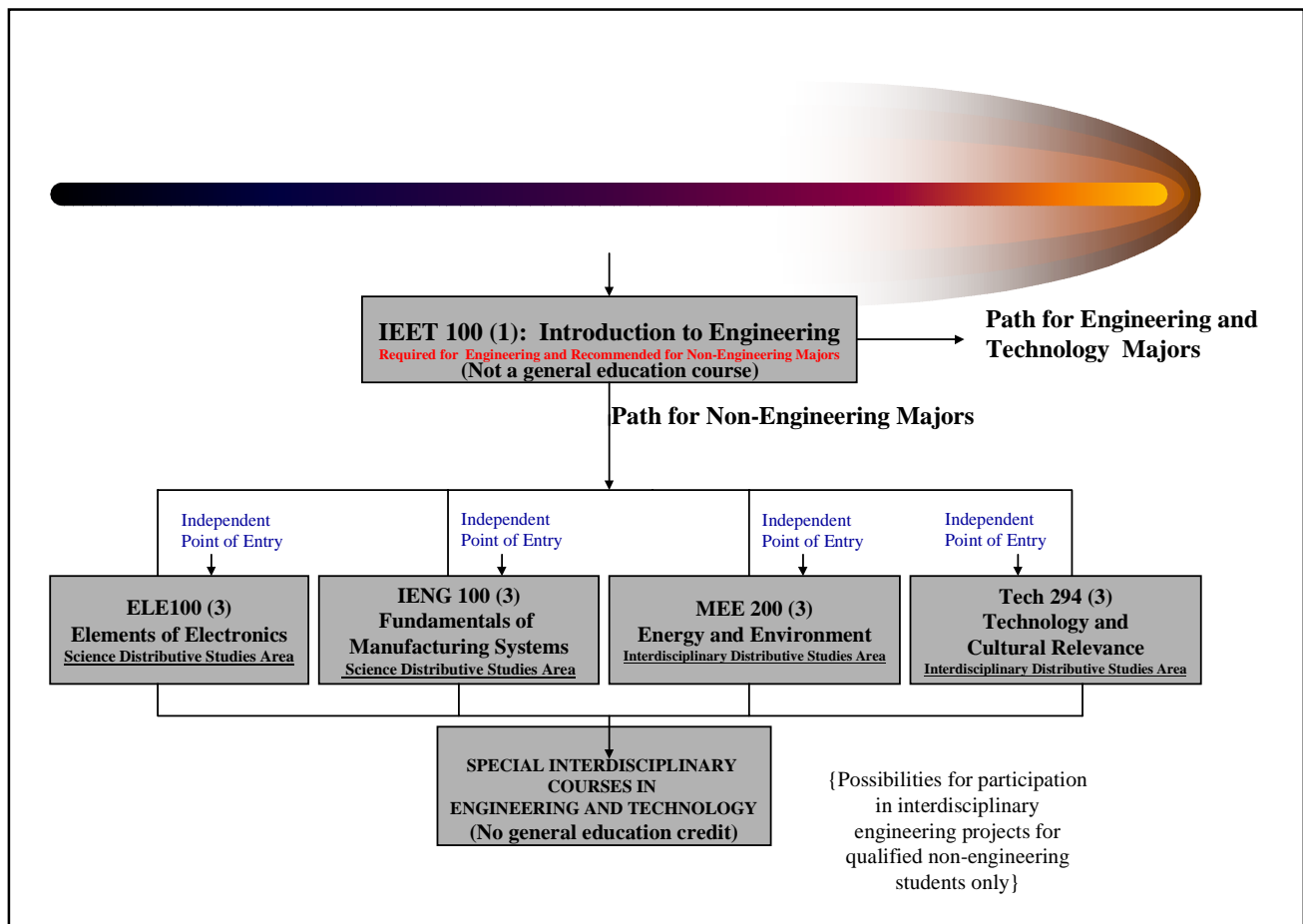


Figure 3: EOGENES cluster.

- Development of modules for acquainting students with engineering subjects outside their majors.
- Industrial involvement in blending concurrent engineering/interdisciplinary projects with realistic introduction of CQTP skills [1][2][4][7].
- Internet-based resources to enhance student learning and the accessibility of course material.
- Feasibility of delivering degree programmes via distance education.
- Master's degree in Engineering across International Boundaries (MSEIB) [11].
- Performance outcome-based assessments.

There is also a payback for industry: a number of items considered in improving academic engineering programmes were developed by the CPTI in a modular workshop format to industry. Among the topics covered were: team building, rapid prototyping, ergonomics and safety, quality control, philosophy of concurrent engineering, etc.

## PUBLIC AWARENESS OF ENGINEERING CONCEPTS (EOGENES) - ELEMENT II

The bridge-building between engineering and non-en-

gineering communities is still in its infancy. In today's technologically rich society, it is necessary for society to understand technological issues such as energy, manufacturing processes, the impact of technology on the environment and socio-economics, electronics, communications, etc. The engineering profession, including engineering educators, must become involved in educating non-engineering sectors about engineering concepts and issues, limitations, solutions and problems. To date, the questions of how to incorporate technological issues systematically into the general education of non-engineers are rarely asked by engineers and non-engineers alike. Therefore, the College of Engineering and Engineering Technology at Northern Illinois University has undertaken steps to develop a uniquely focused general education programme entitled Engineering-Oriented General Education for Non-Engineering Students/Sectors (EOGENES).

The initial core of the EOGENES programme comprises four courses:

ELE 100:	Elements of Electronics
MEE 200:	Energy and Environment
IENG 100:	Manufacturing Processes
TECH 294:	Technology and Cultural Relevance

In addition, non-engineering students can also enrol in Introduction to Engineering Course, IEET 100 [4].

The EOGENES programme was developed to provide an opportunity for all non-engineering students at Northern Illinois University to become acquainted with important engineering concepts that will help them become informed citizens in a modern society. About two years were required to steer the EOGENES programme through the university committees and be sanctioned for general education credits. The credits earned by non-engineering students are counted toward graduation. Now the EOGENES programme is an integral part of the entire general education framework at Northern Illinois University. In that sense the EOGENES is an interdisciplinary *technical humanities* programme. Another unique feature of the programme is that faculty in the College of Engineering and Engineering Technology teach courses in the EOGENES programme. It is also apparent that the EOGENES programme is becoming, in a small way, a recruiting tool for engineering programmes.

Industry, high schools and two-year community colleges have expressed a significant interest in the EOGENES programme. Consequently, the EOGENES programme has shifted from its original aim. Now the EOGENES programme has three objectives:

- To provide an optional credit-earning general education to on-campus non-engineering students to supplement their general education in the humanities, arts and social sciences (original aim of EOGENES).
- To apprise the general public and non-engineering sectors about new happenings in engineering.
- To provide early career guidance at high schools and two-year community colleges, with the possibility of earning some university credits.

The EOGENES programme, as described in Figures 2 and 3, can be offered in both on-campus (credit) and off-campus (credit or non-credit) modes. On the advice of industrial partners, the number and type of EOGENES courses in the near future could be expanded, especially when it will be offered to off-campus non-engineering sectors. Upon the advice of NIU's continuing education office, plans to develop some of the courses on the Internet are being contemplated. The pilot project dealing with the Internet version of courses will be offered to select students on an experimental basis and a control group will be formed to receive instruction on the Internet version of the course so as to allow the instructors to conduct a comparison of learning outcomes.

## Expansion of the EOGENES

The response provided by the audience at the 1998 UICEE congress in Cracow, Poland, was in favour of expanding the EOGENES programme. The expansion of the programme is planned on two fronts. First, the core of the EOGENES programme will be expanded to include additional topics of interest to the non-engineering sectors. In an information, technology-rich society the application of scientific principles must form an important part of general education. It also must be an important endeavour for people who want to live as informed citizens and make positive contributions to their communities and society as a whole. The additional topics of interest that are being explored are:

- Web-based resources and design
- Bio-engineering
- Information technology
- Communications and control
- Engineering in pioneering paradigms for society
- Ergonomics and human factors
- International engineering, etc

A *Request for Proposals* has been given to faculty whose research areas appear to be of general interest. Students from non-engineering disciplines are also being contacted to find out their interest in engineering related areas. It has been found that topics that relate scientific applications to daily lives and concepts that relate to information technology generate the maximum interest in the minds of non-engineering students.

A customised approach to EOGENES is also being explored to develop and deliver courses for which industrial partners express specific interest. The latest trend in manufacturing industry is that of concurrent engineering and teamwork. It is understood that teams in an industrial setting will be diverse in nature and will be composed of people representing different disciplines, including engineering. Therefore, it is essential that all the people in a team have excellent communication skills and a clear understanding of the contribution and potential of each team member, including that of engineering team members. Industries have expressed their desire that their non-engineering team members be appraised of general engineering principles to facilitate an effective exchange of ideas amongst all team members.

## EXTERNAL PROGRAMMING - ELEMENT III

The External Programming Office (EPO) in the College of Engineering and Engineering Technology serves

the College and its Departments of Electrical Engineering, Industrial Engineering, Mechanical Engineering and Technology in their mission to reach out to off-campus students; provide service to the general public; serve professionals in their areas of expertise; and assist companies with education, training and applied research. The EPO assists with the administration and delivery of off-campus credit courses, off-campus undergraduate and graduate degree programmes, professional development seminars, specialised conferences, education programmes and training delivered to companies and organisations at their location. Training also includes some of the CQTP skills, such as quality issues, industrial leadership aspects, team building, as well as safety issues, product design, instrumentation, concurrent engineering issues [6][9]. The EPO utilises both full time faculty as well as adjunct faculty with specific expertise. The EPO also represents the College in its administrative responsibilities to the National Safety Education Centre. In July 1995 the Department of Labor awarded this OSHA Training Institute Education Centre to a consortium consisting of: Northern Illinois University, through its College of Engineering and Engineering Technology, the National Safety Council, and the Construction Safety Council.

The EOGENES programme will be provided under the auspices of the EPO to off-campus non-engineering sectors. The engineering topical modules for off-campus audiences (described in Element I) will also be delivered via EPO. The type of delivery (traditional, Internet or live two-way audio/video) will be agreed upon by faculty and involved customers. Most of the programmes conducted by the EPO are geared to the needs of industrial, business and general public sectors. These sectors are also very much involved in assessments of the EPO programmes. On that basis the College is well informed and pleased about the quality of its offerings.

Following the UICEE congress in Cracow, Poland, and upon review of the feedback obtained, the EPO has been requested to look formally in to marketing the EOGENES programme to companies involved in the manufacturing of engineering products. The scope and potential of the programme are being developed in the form of a brochure with the industrial sector in mind. The brochure will highlight advantages of EOGENES, especially for the non-engineering working professional working in a team environment with engineering professionals. The brochure will also attract non-engineering professionals assigned to senior engineering functions by virtue of their experience in manufacturing and not by academic preparation. EOGENES will serve as a bridge between their cur-

rent level of engineering understanding and preparedness to handle advanced topics of engineering and technology.

#### **AN INTERACTIVE ASSISTANCE LOOP - ELEMENT IV**

Economic and professional development between academia and industry and other sectors is not a new concept, but the latest thrust for making these relationships more beneficial has sparked new measures for initiating, developing, maintaining and expanding these relationships. These endeavours have created a win-win situation for all involved. Obviously, engineering education is a major beneficiary in the CPTI model. The support for innovation is coming from partners and customers (Element IV) through its interactive loop to Element I and the College in various forms such as: scholarships, special internships, working projects, faculty/executive exchange programmes, advisory boards, value-added learning initiatives, and programme assessments.

A very important aspect of the planned faculty/executive exchange programme is the Faculty-In-Industry (FII) programme. The FII programme has already provided opportunities for faculty to work at industrial sites during the summer. This initiative helps the participating faculty members to understand the latest industrial practices. In return the industrial hosts benefit from the technical expertise of faculty members. In this interaction, faculty members will continue to bring home industrial inputs for curricular reform and innovations. It is hoped that a number of companies with international divisions will also participate in providing the FII interns with the opportunity to learn about global issues and international collaboration [11].

During the summer of 1998, at least two faculty members from the College of Engineering and Engineering Technology at NIU participated in the FII programme. The faculty members were surveyed after the experience in industry, and the feedback obtained is very positive and indicated significant potential for the initiative. The faculty were not only able to earn industrial wages by participating in FII, but were also able to gain the latest knowledge on engineering practices in an industrial setting. Consequently, they were better prepared to teach graduates the real life aspect of engineering as a profession. It is expected that relationships established as result of participating in FII will bring stronger industrial support for the engineering and technology programmes in terms of sponsored design projects, employment opportunities for students, research opportunities for faculty, collaborative endeavours, customised training opportunities, curricu-

lum growth and advancement, etc. Additionally, a number of faculty spent their academic sabbaticals in industry and federal laboratories. In this, as well as in the FII initiative, the responses from the hosts and participants were very positive. Both academia and industry have a common responsibility to keep engineering faculty sharp.

Under the auspices of the Executive-In-Academia (EIA) programme, industrial participants will primarily be involved during the regular academic year in giving special seminars to students and faculty. During the current semester at least two industry executives have been hired to teach classes in the college as adjunct or visiting professors. Some of them are carrying out the teaching assignments simultaneously with their industrial work while others have made a transition from industry to academia. The College's commitment to EIA is demonstrated by the fact that more than 70% of its faculty has some kind of relevant industrial experience with a terminal degree in their area. Many of the above faculty also have industrial licenses/registrations in their credentials. The college has benefited tremendously from the expertise of these individuals.

With the continuation of the CPTI activities, the College of Engineering and Engineering Technology at Northern Illinois University will be able continuously to supply ready-to-function engineers, support the efforts of the lower-echelon technical workers to reach academic degrees, provide career-long education to practising professionals, etc. It is also important to observe that the CPTI model with its ongoing projects and interactions are well within ABET 2000 accreditation criteria and expectations. The college already has assessment criteria for all of its programmes and is in the process of modifying its current assessment criterion based largely on course content to a learning-outcome-based criterion. This transition will better prepare the engineering programmes within the college for accreditation under the ABET 2000 criteria. All engineering programmes at Northern Illinois University are practice-oriented programmes, which will be further strengthened through its CPTI organisation. The college actively promotes concurrent engineering principles within the design projects and is committed to prepare students who are increasingly functional and cross-trained on an interdisciplinary level. With these interactions the College is looking very confidently toward the next millennium.

## **CO-OPERATION WITH OTHER UNITS AT THE INSTITUTION - ELEMENT V**

The development phase of EOGENES and other ele-

ments of the CPTI system involved significant co-operation from some of the other units at the University. Also, the success of Element I, as described before, depends partly upon the co-operation of internal units within the institution. Element I must seek natural allies within the institution. Many of the ongoing projects and new initiatives require mutual assistance from internal sources involving projects of common interest. In that respect, Element I has to seek and maintain natural co-operation with the College of Liberal Arts and Sciences, College of Business, International Programmes, the University's Curriculum Committee, the University's Assessment Committee, etc.

Some of the projects/initiatives that are in progress, and through which co-operation is being sought, are:

- Institution-wide reform in the area of undergraduate mathematics, physics, chemistry and communications.
- Institution-wide reform in the area of assessment based on performance outcomes.
- Master's programme in Engineering Management.
- Master's programme in Engineering across International Boundaries.
- University-wide assessment of students' acquired knowledge in the areas of general education, communications, etc.

## **SUMMARY**

The relationships between industry and other sectors with academia cannot be meaningful unless they produce mutual benefits. Therefore, a working organisation called the Broad-based Collaborative Partnerships for Technical Interfacing (CPTI) was created to enhance interactions at the general education, undergraduate and graduate engineering levels. The new industrial and educational environments demand initiatives such as TQM, concurrent engineering, teamwork, group dynamics, international perspectives, advanced technologies, and cross-functional skills. All of which makes it even more important for nontechnical people to have an understanding of some of the important aspects of engineering issues and concepts that form a part of everyday life. The mutual participation of academia and industry, under the auspices of proposed initiatives such as FII and EIA, will serve to improve engineering education significantly. Therefore, academia not only has the responsibility of delivering undergraduate and graduate engineering programmes but also has the burden of educating non-engineers on important engineering and technology concepts. The CPTI initiatives also have a goal to



improve the image of and awareness about the engineering profession in general. The activities conducted under these initiatives will also motivate, educate and attract high school and two-year community college students into engineering disciplines, thereby expanding the pool for the future professional workforce. Active participation of industry and non-engineering sectors is needed to design effective educational and innovative tracks for the technically-oriented workforce of the next millennium.

Success of the CPTI organisation can be ensured only if all five elements work in cohesion. To date, it is worth noting that this is a working system because it unifies many interests and goals. Again, it requires a system-wide subscription to the aims of the project. A simple piece-wise approach to innovations will not serve the purpose of any engineering college to prepare the students that will form the workforce of the future.

The participation and comments at the 1998 UICEE congress in Poland further strengthened the need and scope of the CPTI model. The college is looking forward to continuing and expanding the proposed model to benefit the engineering as well as the non-engineering community on an international level. The need expressed by the international community at the UICEE congress indicated that information technology could be used to share the work done by the college to benefit the interested parties.

The CPTI system in the College of Engineering and Engineering Technology at Northern Illinois University is not a universal solution for all problems. It is one way to address issues related to delivering effective engineering education collaboratively with several partners. The CPTI system has been designed for diverse geographical and industrial environments in the northern Illinois region covering more than 6,000,000 people. Such a system also has to have an internal critical mass to engage in teaching and research and to participate in other developmental functions.

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## BIOGRAPHIES



Cleveland, Ohio.

Dr Kasuba has about eleven years of industrial experience in aerospace (TRW Inc) and manufacturing systems (Warner & Swasey, Danly Machinery Corp) industries. He participated in projects such as Saturn IV, Lunar Excursion Module, auxiliary power systems

Prior to joining Northern Illinois University as the first dean of the College of Engineering and Engineering Technology, Dr Romualdas Kasuba was director of engineering doctorate programmes, head of the Department of Mechanical Engineering and professor at Cleveland State University,



for unmanned flights, etc. Dr Kasuba is a graduate of the University of Illinois in Urbana receiving all three degrees in Mechanical Engineering. He is also a licensed professional engineer (PE) in Illinois and Ohio. Dr Kasuba is a veteran of the United States Army.

In the academic and professional areas Dr Kasuba was a recipient of several awards: Fellow, American Society of Mechanical Engineers; Distinguished Faculty Award, Cleveland State University; Sigma Xi, Tau Beta Pi; Certificate of Recognition from NASA Inventions and Contribution Board for Developing New Technology; listed in American Men and Women of Science, Who's Who in America. In 1998 he was awarded an Honorary Doctorate by Kaunas University of Technology, Lithuania.



Dr Promod Vohra is the associate dean of the College of Engineering and Engineering Technology, serving as the person responsible for undergraduate education in the college. Dr Vohra, in addition to having a doctorate in Instructional Technology (with cognate in Industrial Engineering), has both a Master's degree and Bachelor

degree in Electrical Engineering. Prior to coming to the field of academia, he worked in industry (Philips) for five years as a technical support engineer. His research interest are digital systems, instruction design, industrial training, new technologies and applications of technologies. Dr Vohra has brought in a total of more than \$2.5 million donations in soft and hard monies.

He was the recipient of the 1988 *Outstanding Young Alumnus Award*. In 1995 he was given the *Excellence in Undergraduate Teaching Award* by Northern Illinois University and in 1996 he received the *Outstanding Professor Award* in the region (seven states) by the National Association of Industrial Technology (NAIT). In 1998, one of his papers, coauthored with Dean Kasuba, and presented at the *Global Congress on Engineering Education* in Cracow, Poland, won the best paper award (diamond award). Dr Vohra holds professional registrations such as a professional engineer (PE) and a senior certified industrial technologist (CSIT).

Dr Vohra envisions a meaningful educational system based on productive partnerships between high schools, community colleges, universities, industries, and community-based organisations. A partnership, which is mutually beneficial for everyone involved and serves the primary purpose of facilitating learning for the members of the community.

## **2nd Baltic Region Seminar on Engineering Education: Seminar Proceedings**

edited by Zenon J. Pudlowski & John D. Zakis

The *2nd Baltic Region Seminar on Engineering Education* took place at the Riga Technical University, Riga, Latvia, between 26 and 28 September 1998, one of several regional meetings organised around the world in 1998 in conjunction with the extremely successful *Global Congress on Engineering Education*.

The on-going objective of the Seminar series is to bring together educators from the Baltic Region to continue debate about common problems and challenges in engineering and technology education; to discuss the need for innovation in engineering and technology education; and to foster the links, collaboration and friendships already established in the region. The 35 papers in these proceedings present the views of authors - senior academics from twelve countries, including most of the rectors of the technical universities in the Baltic States, and some from Sweden - on such issues as:

- Innovation in engineering and technology education
- Effective methods in training engineers & technologists
- Industry requirements of engineering & technology education
- Sustainable development and environmental engineering education
- Engineering & technology education in other countries
- Management of engineering & technology education in institutions
- Academia/industry collaboration programmes
- International collaboration in engineering education
- Further and continuing, education needs of engineers and technologists

All of the papers were subjected to formal review by Seminar participants and it is anticipated that this volume of proceedings will prove to be a valuable resource for those involved in the development of systems of engineering and technology education in the Baltic region and elsewhere.

To purchase a copy of the Congress Proceedings, a cheque for \$A50 (+ \$A10 for postage within Australia, and \$A20 for overseas postage) should be made payable to Monash University - UICEE, and sent to: Administrative Officer, UICEE, Faculty of Engineering, Monash University, Clayton, Victoria 3168, Australia. Tel: +61 3 990-54977 Fax: +61 3 990-51547