

# The UNESCO-Supported International Centre for Engineering Education\*

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*This paper discusses the concept and idea of establishing a UNESCO Supported International Centre for Engineering in the Faculty of Engineering at Monash University, Melbourne, Australia, with the specific mission to facilitate the transfer of information, expertise and research on engineering education, and in particular to act as a clearing-house for the transfer of information on engineering teaching courseware, software and equipment from developed to developing countries. It is envisaged that the Centre will be an expression of the north-south and east-west dialogue, in which developed countries assist developing countries with the help of UNESCO.*

## AIMS AND OBJECTIVES

A UNESCO Supported International Centre for Engineering Education (USICEE) has been established in the Faculty of Engineering at Monash University, Clayton, Melbourne, Australia, under the chairmanship of the Dean of Engineering, Professor Peter LeP. Darvall. Associate Professor Zenon J. Pudlowski, Associate Dean (Engineering Education) has been appointed Director of the USICEE. It is anticipated that other education institutions in Australia may wish to join this enterprise at a later stage.

The paramount objective of the USICEE is to facilitate the transfer of information, expertise and research on engineering education, and in particular to act as a clearing-house for the transfer of information on textbooks, engineering teaching courseware, software and equipment from developed to developing countries. This will include the specific mission to transfer information, expertise, methodologies and research on engineering education from developed countries to developing countries worldwide. Particular emphasis is placed on Asia and the Pacific region.

It is envisaged that the Centre will be an expression of the north-south and east-west dialogue, in which developed countries assist developing countries under the sponsorship of UNESCO.

## BACKGROUND

The establishment of this Centre is the outcome of two international symposia for engineering deans and industry leaders.

The first symposium was organized in 1989 at Ohio State University, and the second was held at UNESCO Headquarters in Paris, France, between 16 and 20 July 1991. Both meetings were sponsored by UNESCO, with appropriate engineering education groups invited to co-sponsor (e.g. ASEE, Engineering Dean's Council, SEFI, IGIP and AAEE).

These symposia were intended to assist technological development in developing countries by improving engineering education there with the help of institutions in developed countries. The symposia resulted in the development of an action-oriented agenda of specific projects to be undertaken in areas such as: sister university programs, university-industry co-operation, database on engineering education, clearing-house on equipment and courseware, completion of degrees, educational standards/equivalency, use of satellite technology, and worldwide organization.

To implement the projects, UNESCO has recently established a UNESCO Steering Committee on Human Resources Development for Technical Industry Stimulation. The Steering Committee met in Paris, 7-8 January 1993, to formulate action plans for the implementation of the projects. The Steering Committee consists of a dozen members, half from academia and half from industry. At the inaugural meeting of the Steering Committee it was decided that Dr Zenon J. Pudlowski would prepare a submission to UNESCO for the establishment of a UNESCO International Centre for Engineering Education. Under the UNESCO proposal, such a centre would be established in a leading tertiary education institution in Australia which would be able to provide the necessary facilities and support.

A submission to establish a UNESCO Centre in the Faculty of Engineering at Monash University was prepared and presented by Professor Peter

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Darvall and Dr Zenon Pudlowski at the second meeting of the UNESCO Steering Committee on Human Resources Development for Technical Industry Stimulation. This meeting was organized in conjunction with the 3rd International Congress of Engineering Deans and Industry Leaders, held at UNESCO Headquarters in Paris between 21 and 25 June 1993.

The UNESCO Committee then endorsed the submission and announced the establishment of the first worldwide UNESCO Supported International Centre for Engineering Education at Monash University, Australia. It is seen as an acknowledgement of the high standard of engineering education in Australia.

It was also decided that financial resources for this Centre would be attracted from agencies such as the World Bank, regional development banks, private foundations, etc.

It is envisaged that the Centre will undertake research on teaching equipment, courseware and software for teaching, and the methodology of training utilized in engineering education. The Centre will serve the world's engineering education community, with particular commitment to the transfer of expertise from developed to developing countries.

The Federation of Engineering Institutions of South East Asia and the Pacific, the Institution of Engineers, Australia, the International Liaison Group on Engineering Education and the Association for Engineering Education in South East Asia and the Pacific and other national and international organizations have expressed their strong desire to co-operate with this international Centre in Australia.

The Australasian Association for Engineering Education (AAEE), a leading engineering education association in this part of the world with over 700 members, will collaborate closely with the Centre. Members of the AAEE will help facilitate the operation of the Centre by providing resources and expertise. Also, the AAEE headquarters have been transferred to the UNESCO Centre at Monash University.

The organization of such a centre required the selection of the best university environment in which to operate. It was therefore imperative that the host engineering faculty was chosen on the basis of its staff's expertise and involvement in engineering education, available resources and a long-term commitment to this important project.

The Australian Federal Government strongly supports UNESCO and its activities, and it was the first time that an attempt has been made to establish a UNESCO Centre in Australia. It is therefore anticipated that with the establishment of USICEE, UNESCO will liaise with the Australian Federal Government and other international agencies to ensure that sufficient funds are provided for the Centre.

## INTRODUCTION

The rapidly changing world of engineering requires practising engineers to be flexible problem-solvers, who may well be required to change specializations several times in their career. The debate on engineering education in the developed world is moving its emphasis from what engineers should know to what they can do at the end of training. There are moves towards education systems that are based on project-oriented teaching. Examples indicate that these methods are transferable to a developing world context [1].

It is believed that a solid base of fundamental knowledge and an ability to self-educate, with particular emphasis on problem solving, are the key elements of engineering education in an era of rapidly changing technology [2].

Discussions carried out by the Working Group IV at the 2nd Symposium for Deans and Industry Leaders led to the formulation of the following broad issues:

- Continuation and expansion of coursework and teaching equipment development through UNESCO with active international involvement and collaboration.
- Investigation of the applicability of existing materials for context-dependent and problem-oriented education for engineers.
- Development of ways to collect, evaluate and store information about courseware, software and teaching equipment, etc.
- Development of methods for the dissemination of information on appropriate, tested courseware, software, teaching equipment, etc., used in engineering education.

During the discussions, Working Group IV also formulated a set of proposals to be included in the action plan. The following proposals were aimed at creating a framework to support the transfer of relevant courseware, software, equipment and teaching methodologies between nations.

- A pilot project is essential to investigate the applicability of existing materials specifically for the context-dependent and problem-oriented education of engineers.
- A project is highly desirable and beneficial to study the implementation of problem-oriented educational methods, suitable for developing countries.
- An international project is also desirable to facilitate the collection, description and storage of information on developed courseware, software, teaching equipment, etc., with particular emphasis on the development of suitable methods to disseminate the collected information.

The discussions finally led to the conclusion that, as a matter of urgency, the working party should recommend that a clearing-house (centre) on teaching equipment, courseware, software and the



methodology of training in engineering education be established in a tertiary education institution to carry out and supervise the projects above.

From this background has followed the establishment of the UNESCO Supported International Centre for Engineering Education at Monash University in Australia. It has been decided that the Centre will assume a leading role in research and development activities relating to engineering education, and in particular will conduct research into the application of equipment, courseware and software to engineering education. Also, it is envisaged that the projects mentioned above will be carried out immediately after funds are obtained to support the appointment of academic, professional, technical and administrative staff.

The international engineering community needs such a centre devoted to this kind of activity and expertise. The growing demand for trained engineers, in an era of advancing technology, requires a change in the general perception of the engineering profession, in order to facilitate the development of a favourable climate and infrastructure for the improvement of the quality and direction of the training of engineers [3].

The process of engineering training cannot be improved without the establishment of a centre which will combine engineering specialists and experts in the area of engineering education, and will be able to direct engineering education towards the particular requirements of a modern society.

Education already involves a substantial investment in capital and human resources, and its quality and relevance has tremendous consequences for the future development of the world. Therefore, it is imperative that UNESCO, engineering associations, key industry organizations and the other parties concerned join forces in order to provide support and funding for such an important venture. No cost should be regarded as too high for this enterprise if we are genuinely concerned about the future of engineering education [4].

The general brief for the Centre is to provide expertise in, and improve the quality of, engineering education. In particular, it will carry out research on the equipment, courseware and software utilized in engineering education. The Centre's paramount objective is to ensure an effective transfer of information on engineering education between developed and developing countries, essential for the development and advancement of the underdeveloped world which in turn is so vital to the world's peace and stability.

### OBJECTIVES

The USICEE will endeavour to provide the necessary resources for a wide range of activities including research into the effective use of equipment, courseware and software, as well as the

effective methodology utilized in engineering education. The Centre intends to:

- Collect information on research and development of equipment, courseware and software utilized in engineering education.
- Assess and evaluate established facilities already used in engineering education.
- Assess the effectiveness of teaching programs already in place and programs designed for developing technologies.
- Review and recommend textbooks for engineering education.
- Improve the quality of engineering undergraduate training by research into the methodology of the teaching and learning processes in engineering education.
- Develop modern techniques for the dissemination of engineering knowledge and skills.
- Develop models and methodology for the design and application of educational material and teaching methods which employ modern technology (videotapes, CDs, computers, etc.).
- Promulgate information on recent research and development of teaching equipment, courseware and software.
- Stimulate, initiate and coordinate research into the effective use of equipment, courseware and software in engineering training.
- Promote collaboration in the field of engineering education between institutions in developed and developing countries.
- Provide short courses and seminars on engineering education for academic staff, industry, industrial management and community leaders.
- Research and develop new ways of information dissemination and course delivery such as multimedia and distance education.
- Lobby the world's engineering community, engineering associations, industry organizations and governments for support and understanding of new trends and of the need for the advancement of engineering education.

### THE NEED FOR ENGINEERING EDUCATION RESEARCH

It is apparent that tertiary institutions involved in engineering education are realizing the importance of research into, and development of, educational technology and knowledge engineering, as well as the relevant cognitive sciences. This carries with it serious implications for the training of undergraduate and postgraduate students. Academics involved in this area are still few in number and financial support is very limited.

There is no organization presently coordinating research into education in engineering. Governments, professional associations and industry organizations would most certainly support this work if they could see results leading to more effective, faster teaching programmes. General support



would emerge if one could demonstrate an improvement in the quality of engineering education and training in general, and in the more effective use of equipment, courseware and software in engineering education in particular. The development of methods of assessing such effectiveness is also of tremendous importance to the process of improving engineering education [5].

The objectives set out above for the established research Centre are far-reaching. The work will assist developed and developing countries in their quest for quality engineering education. Research into engineering education must be used to improve the quality of engineering education and training. Hence, an important aim of the USICEE is to encourage academics in developed countries to pursue educational research and to assist new staff to take teaching and educational research more seriously. In addition, encouragement will be given to increase interest and involvement in teaching methodology and technology, and to establish a basis for advancing the fields of cognitive sciences and knowledge engineering [6].

### THE ROLE OF THE CENTRE IN RESEARCH

The initial task of the Centre is to concentrate on the most urgent problems and most important activities. These will include the establishment of a system to collect information on the effective use of equipment, courseware and software in engineering education and to carry out projects mentioned above.

Foremost of these will be to analyse the more effective methodologies used in engineering education and to see how the application of appropriate equipment, courseware and software improves the quality of engineering training.

The next stage will be to devise a system for the efficient dissemination of information on research

results. To improve the quality of engineering training in developing countries, the Centre must establish a mechanism for the efficient flow of information between universities in developed and developing countries.

The variety of tasks carried out by the Centre requires staff with the highest skills and with a sound, broadly based background. In addition, the staff must be competent in modern teaching technologies, involving aids such as videotapes, CDs and computers. They must also be familiar with the basic research methods used in engineering education [7].

The Centre itself will in future provide consultative services in skill development to engineering educators in developing countries. This will become particularly important in areas requiring the development of teaching equipment, courseware, computer-assisted instruction, authoring programmes, computer-controlled videotapes and CDs.

Generally, the Centre will not design, develop and manufacture programmes for all specialities and topics, except on a consulting basis or for research.

### THE CENTRE'S STRUCTURE

The structure of the Centre is depicted in Fig. 1. The Centre is governed by an Academic Council under the leadership of a chairman. The Academic Council consists of members of the UNESCO Steering Committee on Human Resource Development for Technical Industry Stimulation. Other members of the Academic Council are drawn from academia and industry leaders worldwide, who are particularly concerned with, and involved in, engineering education.

The Dean of the Faculty of Engineering at Monash University, Professor Darvall, is the

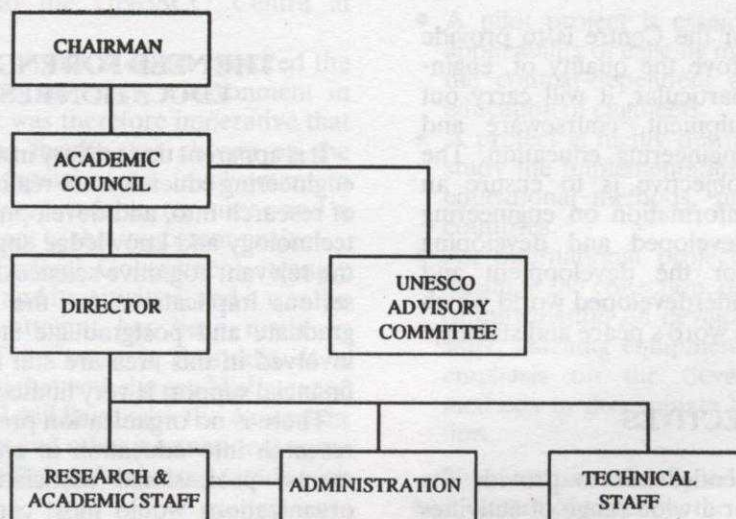


Fig. 1. Administrative structure of the centre (USICEE).



Chairman of the Academic Council. The international nature of this Centre is reflected by the establishment of four Vice-Chairman positions will be filled by prominent international educators who are experts in engineering education. The Director of the Centre, Associate Professor Zenon J. Pudlowski, assumes overall responsibility for the operation of the Centre and is advised by, and responsible to, the Chairman and the Academic Council.

It is envisaged that the research staff will be a mixture of engineering and educational experts with strong expertise in and devotion to engineering and technology education. The research staff will in due course represent a wide range of engineering specialities, as well as include educators specializing in educational psychology, educational technology and industrial psychology. Several members of the Faculty of Engineering at Monash University will provide their expertise to the Centre on a casual or voluntary basis.

Experienced professional, technical and administrative staff are needed to support the research staff and to ensure the effective operation of the Centre. They must be computer literate and be able to handle computer-aided design techniques. The work involved will also require experience with software and hardware and laboratory supervision.

## MANAGEMENT OF RESEARCH PROJECTS

The overall responsibility for the management of individual projects lies with the staff of the Centre and a Steering Committee established to supervise a particular project. Members of the Steering Committee will typically include staff associated with the Centre, delegates from the industrial sponsors and representatives of the academic institutions associated with the project.

A typical research project involves a number of categories of research staff associated with the proposed work: the Project Manager, a Researcher, a Professional and/or Administrative Officer and a Technical Officer. The project is managed on a day-to-day basis by the Project Manager, who reports to the Director of the Centre who has overall responsibility for the running of the Centre.

The Project Manager is responsible for project development, while the Director guides the research.

## BUDGET

Substantial financial support is needed to achieve the aims and objectives of the Centre. In the developed first stage, the Centre will require A\$3,610,000 over a period of five years. A typical annual budget, assuming steady employment of staff, is detailed in Table 1. This money would be used to enable the Centre to carry out a number of

Table 1. Annual budget of the USICEE

Purpose	Annual exp. (A\$)
Director (Professor)	75,000
Senior Researcher	60,000
Senior Researcher	60,000
Researcher	45,000
Researcher	45,000
Administrative Officer	40,000
Professional Officer	40,000
Technical Officer	35,000
Executive Secretary	30,000
Staff salaries	430,000
33% on-cost	142,000
Sub-total	572,000
Travel expenses	35,000
Administrative support	20,000
Publications	25,000
Maintenance	10,000
Hardware	20,000
Software	10,000
Rent (Office)	30,000
Total	722,000

Values are in 1993 Australian dollars.

projects. A number of academic and support staff would be appointed to the Centre. It is anticipated that the level of financial support required for the operation of the Centre will be gradually reduced by revenue generated by the Centre.

## JUSTIFICATION OF BUDGET

Such a complex project requires considerable financial assistance. The required funds may be divided into two groups.

The first group concerns the proposed staff salaries and the 33% on-cost necessary for superannuation, insurance, workers' compensation, etc.

The second group of expenses relates to the operational costs such as travel expenses, administrative support, maintenance, hardware and software purchase. It is assumed at this stage that the Centre would need to pay a rent for hiring premises.

Part of the budget would go towards the purchase of personal computers, software, equipment and office furniture. In addition, some money would be spent for purchasing textbooks and stationary.

## CONCLUSIONS

This paper presents the idea and concepts in establishing a UNESCO Supported International Centre for Engineering Education in the Faculty of Engineering at Monash University, Melbourne, Australia. It outlines the Centre's specific mission, which is to facilitate the transfer of information,



expertise and research on engineering education, and in particular to act as a clearing-house for the transfer of information on engineering teaching courseware, software and equipment from developed and developing countries.

It considers the importance of such a centre in the process of training of personnel involved in teaching and the advancement of research into, and development of, engineering education and industrial training of engineers in an era of rapidly changing technology. It demonstrates that the Centre is an expression of the north-south and east-west dialogue, in which developed countries assist developing countries under the sponsorship of UNESCO.

The purpose of this paper is to give some general

information regarding the Centre's aims and objectives, and the Centre's structure, as well as some details concerning its operation. The material offers outlines of activities which have been initiated already, and plans for future developments.

The effort required to undertake such an important activity on an international level will be extensive, and needs the active support of governments, international financial institutions, industry and professional associations.

It is also hoped that this paper will draw the attention of the international community of engineering educators to the formation of the USICEE, and will elicit their positive response and support.

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**Zenon Jan Pudlowski** graduated Master of Electrical Engineering from the Academy of Mining and Metallurgy (Cracow, Poland), and Doctor of Philosophy from Jagiellonian University (Cracow), in 1968 and 1979 respectively. From 1969 to 1976 he was a Lecturer in the Institute of Technology within the University of Pedagogy (Cracow). Between 1976 and 1979 he was a Researcher at the Institute of Vocational Education (Warsaw) and from 1979 to 1981 was an Adjunct Professor (Senior Lecturer) at the Institute of Pedagogy within Jagiellonian University. From 1981 to 1993 he was with the Department of Electrical Engineering at the University of Sydney where in recent years he was a Senior Lecturer. Recently he has been instrumental in establishing an International Faculty of Engineering at the Technical University of Lodz, Poland, of which he is the Foundation Dean and Professor. He has been recently appointed Associate Professor, Associate Dean (Engineering Education) and Director of the UNESCO Supported International Centre for Engineering Education in the Faculty of Engineering at Monash University, Clayton, Melbourne, Australia. His research interests include circuit analysis, electrical machines and apparatus, implementation of computer technology in electrical engineering, software engineering, methodology of engineering education and industrial training, educational psychology and measurement, as well as human aspects of communication in engineering. His achievements to date have been published in over 90 scientific papers, in refereed journals, conference proceedings and manuals. Dr Pudlowski is a Fellow of the Institution of Engineers, Australia. He is a member of the editorial advisory board of the *International Journal of Engineering Education*, the *International Journal of Electrical Engineering Education* and the *European Journal of Engineering Education*. He is the Foundation First Vice-President and Executive Director of the Australasian Association for Engineering Education and the Editor-in-Chief of the *Australasian Journal of Engineering Education*. He is the Foundation Secretary of the International Liaison Group on Engineering Education. Dr Pudlowski is a member of the UNESCO Steering Committee on Human Resources Development for Technical Industry Stimulation. He has chaired and organized several international conferences and meetings. He was the Academic Convener of the 2nd World Conference on Engineering Education and the General Chairman and Program Committee Chairman of the East-West Congress on Engineering Education. He received the inaugural AAEE Medal for Distinguished Contribution to Engineering Education (Australasia) in 1991.



Peter Darvall has been Professor and Dean of Engineering at Monash University since 1988. He graduated in engineering at Melbourne University in 1963 and gained higher degrees at Ohio State University and Princeton University and a Dip.Ed. at Monash. He joined Monash as a lecturer in civil engineering in 1970, after experience with Maunsell and Partners, with Freeman, Fox and Partners, as surveyor for a glaciological expedition in Alaska and as a site engineer for an archeological expedition in Egypt. He has held visiting appointments at UNAM in Mexico, the University of California at Berkeley and the University of Wisconsin. He is the author or co-author of books on mechanics and structures, and reinforced and prestressed concrete. His research papers have covered a variety of areas, but in recent years he has concentrated on softening in concrete structures, and high-strength concrete. He was for many years a member of the Monash University Council and was National President of FAUSA, 1979-81. He has acted as a consultant to a number of engineering organizations. He is currently President of the Australasian Association of Engineering Education and an active member of the International Liaison Group on Engineering Education. Professor Darvall is Chairman of the UNESCO Supported International Centre for Engineering Education, established at Monash University in 1993.

INTRODUCTION

The first year of a four-year engineering program is critical for the student's success. It is a time when the student must adjust to a new environment, learn the basic principles of engineering, and develop the skills necessary for the profession. This paper discusses the challenges faced by female students in the first year of an engineering program. It examines the reasons for the low retention rate of female students and offers suggestions for improving the experience. The paper is based on a survey of female students in the first year of an engineering program at the University of Western Ontario. The survey was conducted in 1991 and 1992. It involved 100 female students who were asked to complete a questionnaire about their experience in the first year of the program. The results of the survey are presented in this paper. The paper is divided into three main sections: a description of the survey, a discussion of the results, and a conclusion. The first section describes the survey and the questionnaire. The second section discusses the results of the survey, and the third section offers suggestions for improving the experience of female students in the first year of an engineering program.

PROCEDURE

The survey sample was drawn from the core first-year courses of about 1000 female students. The survey was conducted in the classroom by thirty female student interviewers. The interviewers were trained to ask the questions and to record the answers. The questions were open-ended, and the students were asked to provide their own opinions and recommendations. Some questions were specifically directed toward women to answer from the female perspective, and only women were asked whether they were concerned that female