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New Simulation Techniques Developed for Maritime Engineering Education*

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In the article, the authors detail an example of the application of, and latest developments in, new simulation techniques in computer-based programs (CBP) for mechanical engineering students. An interactive program has been devised that is related to the fuel oil separator installation, wherein trainees have the possibility to familiarise themselves with the system and develop operational skills. Various multimedia techniques of simulation have been applied in this program, including three-dimensional presentations, sound applications, diagrams, pictures, etc. The relationship between simulation and the realism of the machinery's operation has been particularly emphasised in this application of new simulation techniques employed in the program. The experiences in this application of modern tools and techniques, as well as the advantages and drawbacks of the use of interactive programs in the educational process of engine room officers, are also presented and discussed in the article.

THE APPLICATION OF ENGINE ROOM SIMULATORS

Today, many maritime academies and vocational training centres apply engine room simulators in their didactic processes. Furthermore, the STCW 87/95 Convention strongly recommends the application of engine room simulators in the teaching/learning process [1-3]. Indeed, the application of simulators in the professional training of marine engineering is a mandatory requirement as determined by the Standards of Training, Certification and Watchkeeping (STCW), which is an international convention on the standards of training, certification and watchkeeping for seafarers. The objective of this convention is to establish a minimum level of specialised knowledge and qualification in global ship traffic [4].

However, it is worthwhile mentioning that, apart from several benefits, engine room simulators have also some basic drawbacks and disadvantages.

First of all, simulators involve many simplifications, abbreviations and schematic presentations of machinery systems. As a result, trainees with even a perfect knowledge of the simulator operation can have serious problems while operating a real ship power plant, primarily because the graphical presentation and operating procedures of a simulator are different from the real environment that the trainee is normally being confronted with.

For this reason, computer-based training (CBT) is being increasingly utilised in maritime academies as a preparatory stage, prior to the use of *full mission* engine room simulators. The basic role of CBT interactive programs is the familiarisation with individual auxiliary machinery and associated systems, prior to the commencement of the operation with the whole engine room plant [5-7].

The use of CBT modules is especially important in the case of complex marine control systems, where a perfect knowledge of different operational modes is required. Hence, the application of new simulation

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techniques in marine engineering education may be analysed based on an example of a CBT module ALFA LAVAL - S type Separation System. The general view of this interactive program is shown in Figure 1.

Figure 1: General view of the CBT module ALFA LAVAL S-type Separation System.

The Involvement of Gdynia Maritime University

This new generation of CBT modules, prepared in close cooperation with the ALFA LAVAL company, is also a result of the experiences gained in the application of CBT in the education process of maritime engineers at Gdynia Maritime University, Gdynia, Poland.

It should be noted at this point that Gdynia Maritime University has established and developed the Centre for Maritime Engineering Education, a satellite centre of the UNESCO International Centre for Engineering Education (UICEE). This satellite centre carries out research and development activities specifically dedicated to maritime engineering education, and facilitates the continuing education needs of maritime personnel [8]. Part of this entails research and development into simulation techniques for the training of the next generation of maritime engineers.

Advancements

In comparison with the previous CBT modules developed, the new generation of these programs includes a better graphical presentation (involving also three-dimensional techniques). Additionally, the program presents a much closer relationship between simulation and realism of the machinery's operation, as well as the adjustment of the machinery parameters, which is possible through the operation of a digital panel. The program also provides facilities for the preparation of a training report.

DESCRIPTION OF THE MODULES

The new generation of CBT modules consists of the following sections as presented in Figure 2. The system description presents the application, working principles and main components of the installation, together with different kinds of graphical presentation, such as pictures, photos, diagrams, etc. These can be better understood in the examples presented in Figures 3, 4 and 5.

A digital control panel was intentionally designed to be as close as possible to the real equipment design. The real control panel of a separator system is shown in Figure 6, and its graphical form, as used in the simulator, is presented in Figure 7.

The operating procedures section includes a step-

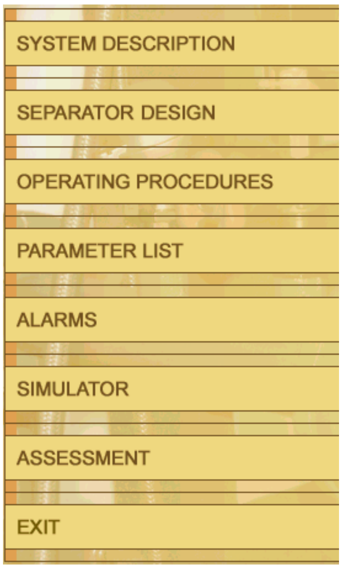

Figure 2: CBT module elements.

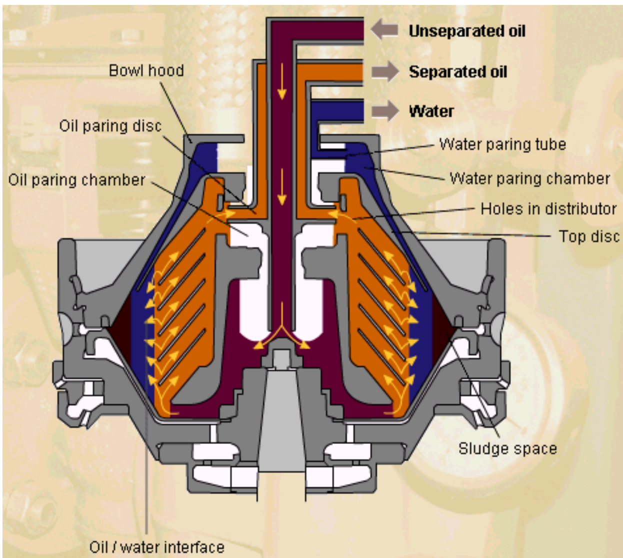

Figure 3: Working principles of a separator.

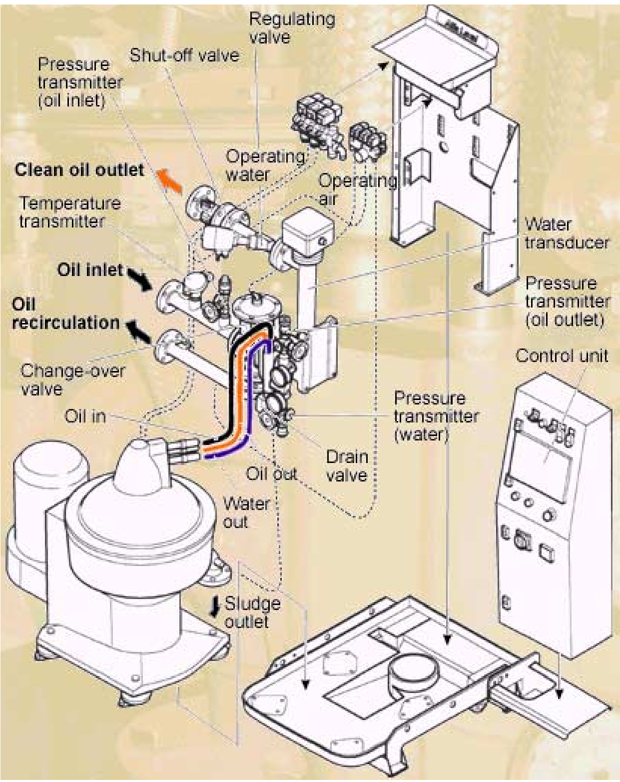

Figure 4: Separator elements – a three-dimensional presentation.

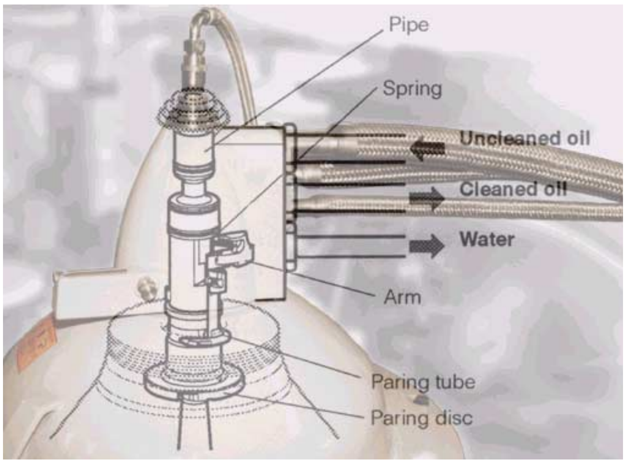

Figure 5: The combination between a photo and a picture presentation.

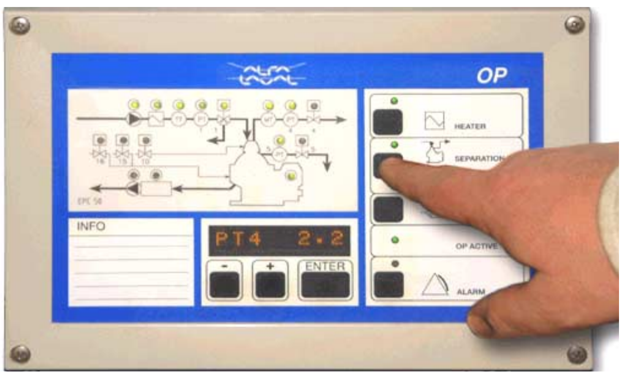

Figure 6: A separator's control panel.

by-step detailed description of the preparation for the process of starting the plant, automatic and manual control functioning, as well as stopping the plant. Importantly, emergency procedures are also included in the procedures. This part also presents diagrams illustrating the consecutive phases of the plant operation, parameters and an alarm list. Digital displays and push buttons allow for the adjustment of the process parameters.

In the simulator part of the program, an interactive software simulator is applied, as shown in Figures 7 and 8.

A fuel oil treatment plant-timing unit is presented in Figure 3. The timing unit gives the possibility to adjust the basic system's parameters as shown in Figure 4. The refrigerating plant pressure control has been presented here (the adjustment possibilities are identical as in real life conditions). By clicking on the mouse, the trainee must set the proper parameters, start the supply pump, the compressor, etc, and he/she must follow the instructions given in the Operating Instructions. This enables the trainee to apply in practice the

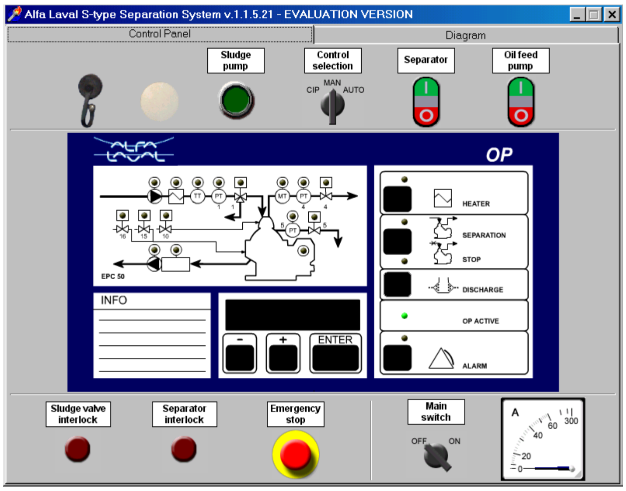

Figure 7: A separator's control panel in the simulator.

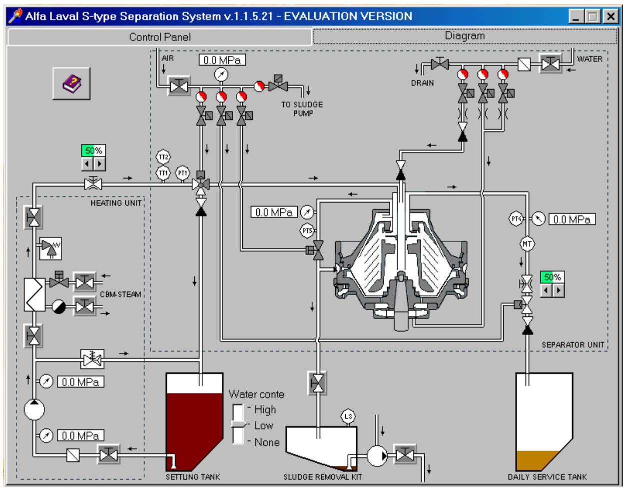

Figure 8: A diagram of the separator's installation.

theoretical knowledge acquired according to the Operating Instructions. The system diagram is shown in Figure 8.

The experience gained in the educational process shows that it is extremely important to combine the schematic diagram with the real presentation of a determined part in the form of a photo. The relationships between the graphical presentation and real system's elements are presented in Figure 9.

It should be noted that a new version of the CBT modules contains also a Training Report (see Figure 10), where students' performances during the lessons and their test scores in the assessment section can be recorded in terms of percentage rates (%).

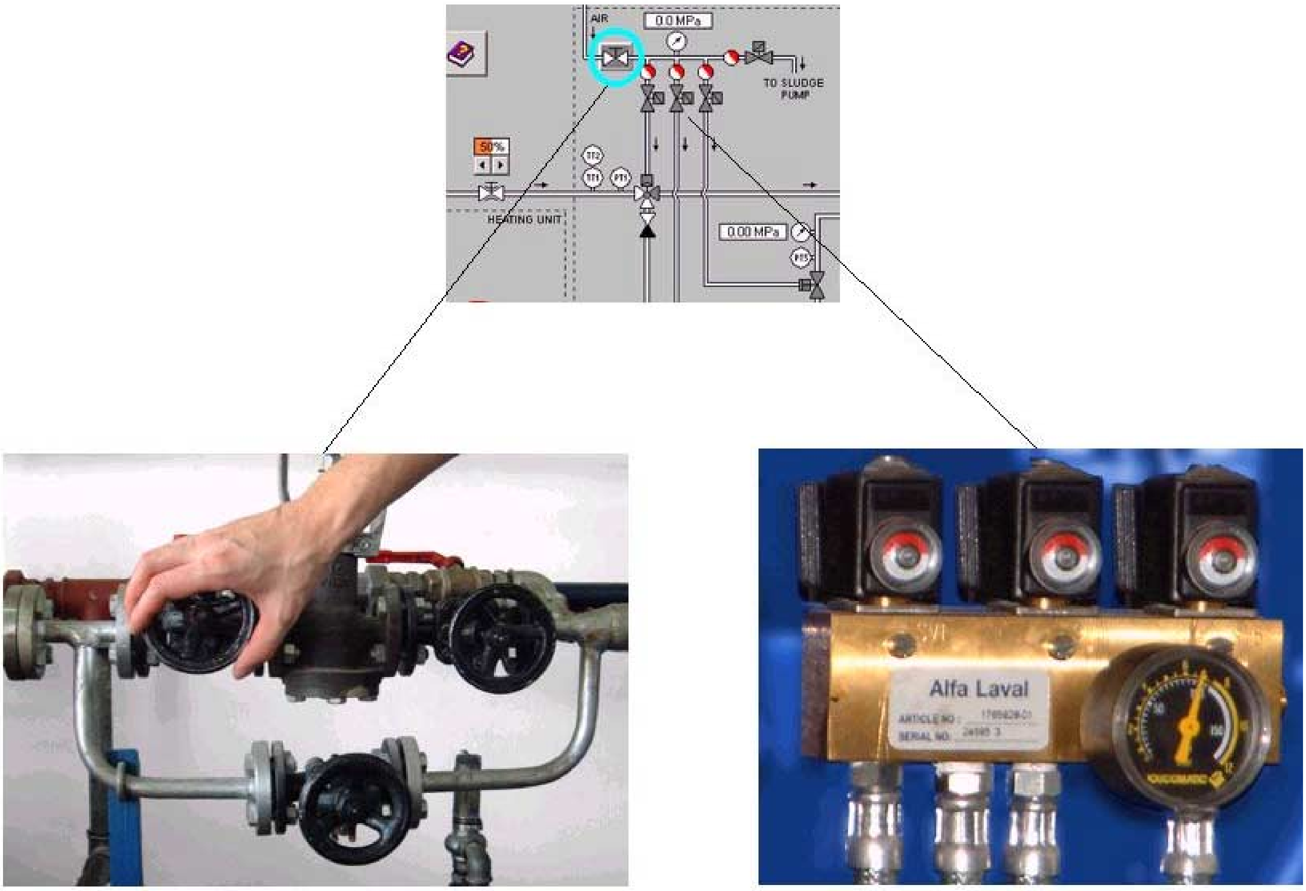

Figure 9: The relations between graphical presentation and the real system's elements.

Trainee name: Jan Kowalski		
Date completed: 3 November 2003		Total time used: 5 minutes
Lesson	**Completed**	**Test score**
1. System description	100 %	
2. Separator design	100 %	
3. Operating instructions	100 %	
4. Parameter list	100 %	
5. Alarms	100 %	
6. Simulator	67 %	
7. Assessment	100 %	4 correct of 10 40 %
Total	95 %	

Figure 10: A training report template.

RECENT DEVELOPMENTS

The latest development in the CBT simulator is presented in Figures 11 and 12. This three-dimensional presentation of the complex ALFA LAVAL Fuel Conditioning Module allows for zoomed and detailed observations of the system's elements (as viewed from different sides). This technique also permits changing valve positions and the activation of switches and push buttons – all by simply clicking the mouse.

This innovative type of complex three-dimensional technique for machinery presentations appears very close to reality. Such an approach enables the student to follow how a certain device really functions and gives him/her the opportunity to see a complete picture of the structure. It should also be added that this type of presentation also includes sound effects that can be found in real-life operations.

It is envisaged that, in the near future, this type of solutions will be applied at an increasing rate with regard to the design of CBT interactive programs.

Figure 11: Fuel conditioning module – general view.

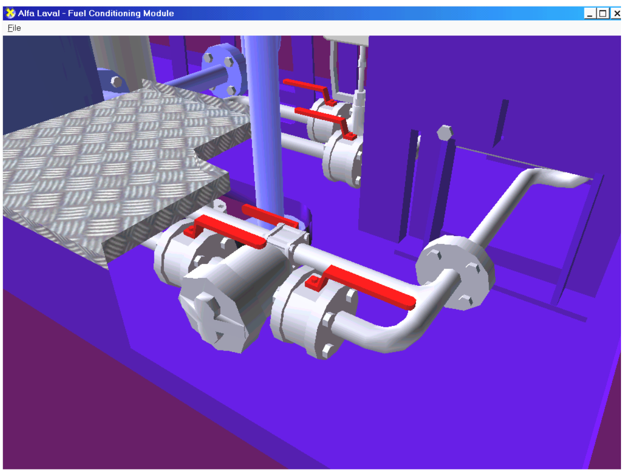

Figure 12: Fuel conditioning module elements (zoom).

CONCLUSIONS

It has been learnt through experience that the application of simulation in teaching complex control systems leads to a better understanding of the principles of operation of both the equipment and the systems in comparison with traditional education methods. Moreover, it reduces the cost of training and increases the effectiveness of engineering educational scheme. Trainees not only acquire the knowledge concerning the operation of the equipment in normal exploitation conditions, but are also familiarised with emergency situations. As a consequence, trainees are better prepared to deal with potential emergencies during operations on board [4][9].

The application of CBT interactive programs plays a very important role in a preliminary stage of the preparation for the use of *full mission* simulators. During the exercises conducted with the application of *full mission* simulators, the instructor has no time to present the detailed description and the principles of operation of each individual parts of the system. Thus, the use of CBT interactive programs in the educational process increases, in a very important way, the effectiveness of the application of a *full mission* simulator.

REFERENCES

1. Cwilewicz, R., Tomczak, L. and Pudlowski, Z.J., The application of interactive Computer Based Training (CBT) programs in engineering education. *Proc. 3rd Baltic Region Seminar on Engng. Educ.*, Göteborg, Sweden, 113-116 (1999).
2. Cwilewicz, R., Tomczak, L. and Pudlowski, Z.J., The application of simulators in marine engineering education. *Proc. 2nd Global Congress on Engng. Educ.*, Wismar, Germany, 138-140 (2000).
3. Cwilewicz, R., Tomczak, L. and Pudlowski, Z.J., Computer Based Training (CBT): the application of interactive programs in maritime education and training. *Proc. 4th Baltic Region Seminar on Engng. Educ.*, Copenhagen, Denmark, 62-65 (2000).
4. Cwilewicz, R., Tomczak, L. and Pudlowski, Z.J., Practical aspects of conducting simulator exercises in marine engineering education. *Proc. 6th UICEE Annual Conf. on Engng. Educ.*, Cairns, Australia, 171-174 (2002).
5. Cwilewicz, R., Tomczak, L. and Pudlowski, Z.J., New technologies for the effective training of marine engineers. *Proc. 4th UICEE Annual Conf. on Engng. Educ.*, Bangkok, Thailand, 270-273 (2001).

6. Cwilewicz, R., Tomczak, L. and Pudlowski, Z.J., The effective application of engine room simulators in marine engineering education. *Proc. 3rd Global Congress on Engng. Educ.*, Glasgow, Scotland, UK, 316-318 (2002).
7. Cwilewicz, R., Tomczak, L. and Pudlowski, Z.J., The application of simulation techniques in marine engineering education. *Proc. 6th Baltic Regional Seminar on Engng. Educ.*, Wismar/ Warnemünde, Germany, 165-168 (2002).
8. Cwilewicz, R., The Centre for Maritime Engineering Education. *Global J. of Engng. Educ.*, 8, **1**, 71-75 (2004).
9. Cwilewicz, R., Tomczak, L. and Pudlowski, Z.J. The development and application of computer-based training programs in maritime engineering education. *Global J. of Engng. Educ.*, 7, **2**, 209-218 (2003).

BIOGRAPHIES

Prof. Romuald Cwilewicz was born in 1939 in Gdynia, Poland. He graduated from the Technical University of Gdansk in 1962 with an MSc in mechanical engineering. In 1974, he gained a PhD, based on a dissertation concerning marine gas turbines, and a DSc in 1993 in the same specialisation.

He has been a professor of the Gdynia Maritime University (GMU) since 1993, and has held several managerial positions, including the position of Vice-Rector for Educational Affairs (1990-1996) and Dean of the Faculty of Maritime Mechanical Engineering (1999-2002). He is presently Head of the Department of Marine Power Plants and Vice-Rector for Educational Affairs.

His professional interests are in the optimisation of power engineering processes and diagnostics of ships' technical systems. He has published extensively, and is the author or co-author of many journal articles, conference papers and patents concerning his field of specialisation, as well as engineering education. Also, he was a Visiting Professor of the Hochschule Bremerhaven and Shanghai Maritime University.

Prof. R. Cwilewicz is an active member of the UICEE, and is Director of the Centre for Maritime Engineering Education (CMEE), a satellite centre of the UICEE, based at the GMU. He was awarded the UICEE Silver Badge of Honour in 1997 at the *1st Asia-Pacific Forum on Engineering & Technology Education.*

Dr Leonard Tomczak was born in 1950 in Nowy Targ, Poland. He graduated from Gdynia Maritime University (GMU), Poland, with a BSc in 1974 and with an MSc in 1987, both in marine mechanical engineering. He gained his PhD in 2001 from the Technical University of Gdansk, Poland, on completion of a dissertation concerning marine electronic diesel indicators.

In 1977-1985, he was a United Nations Development Programmes expert in diesel engines in Angola. He has worked at Gdynia Maritime University since 1976, initially as a research assistant and later as a senior lecturer. He is presently an assistant professor at GMU and Managing Director of UNITEST, a Gdansk-based company. Since 2002, he has been a consultant within the International Maritime Organisation (IMO).

His professional interests are in the application of measuring equipment for marine diesel engines injection and combustion process analysis, as well as in the practical application of engine room simulators and interactive Computer-Based Training (CBT) programs for marine engineering education. He is the author or co-author of many refereed journal and conference articles.

Zenon Jan Pudlowski graduated Master of Electrical Engineering from the Academy of Mining and Metallurgy (Kraków, Poland), and Doctor of Philosophy from Jagiellonian University (Kraków), in 1968 and 1979 respectively. From 1969 to 1976, he was a lecturer in the Institute of Technology within the University of Pedagogy (Kraków). Between 1976 and 1979, he was a researcher at the Institute of Vocational Education (Warsaw), and from 1979 to 1981, was an Adjunct Professor at the Institute of Pedogogy 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.

He is presently Professor and Director of the

UNESCO International Centre for Engineering Education (UICEE) in the Faculty of Engineering at Monash University, Clayton, Melbourne, Australia. He was Associate Dean (Engineering Education) of the Faculty of Engineering between 1994 and 1998. His achievements to date have been published in more than 300 works, including books, manuals and scientific papers in refereed journals and conference proceedings.

In 1992, he was instrumental in establishing an International Faculty of Engineering at the Technical University of Lodz, Poland, of which he was the Foundation Dean and Professor (in absentia) (1992-1999). He was also appointed Honorary Dean of the English Engineering Faculty at the Donetsk National Technical University (DonNTU) in the Ukraine in 1995.

Professor Pudlowski is a Fellow of the Institution of Engineers, Australia. He is a member of the editorial advisory boards of many international journals. He was the 1st Vice-President and Executive Director of the AAEE and the Editor-in-Chief of the AJEE since its inception in 1989 until 1997. Currently he is the Editor-in-Chief of the *Global Journal of Engineering Education*, and is the Foundation Secretary of the International Liaison Group for Engineering Education (ILG-EE).

Professor Pudlowski has chaired and organised many international conferences and meetings. He received the inaugural AAEE Medal for Distinguished Contributions to Engineering Education (Australasia) in 1991 and was awarded the Order of the Egyptian Syndicate of Engineers *for Contributions to the Development of Engineering Education on both National and International Levels* in 1994.

In June 1996, Professor Pudlowski received an honorary doctorate from the then Donetsk National Technical University in the Ukraine in recognition of his contributions to international engineering education, and in July 1998 he was awarded an honorary Doctorate of Technology from Glasgow Caledonian University, Glasgow, Scotland, United Kingdom. In 1997, he was elected a member of the Ukrainian Academy of Engineering Sciences. In 2002, he was awarded the title of an Honorary Professor of the Tomsk Polytechnic University, Tomsk, Russia, and was appointed an External Professor at Aalborg University, Aalborg, Denmark.

Conference Proceedings of the
7th UICEE Annual Conference on Engineering Education
under the theme: *Educating for the Global Community*

edited by Zenon J. Pudlowski

The *7th UICEE Annual Conference on Engineering Education*, held under the theme of *Educating for the Global Community*, was organised by the UNESCO International Centre for Engineering Education (UICEE) and was staged in Mumbai, Maharashtra State, India, between 9 and 13 February 2004.

This volume of Proceedings includes papers submitted to this Conference and offers a diverse compendium of articles that detail various international approaches to engineering education research and development related to the Conference theme, as well as other specific activities.

The 47 published papers, representing 21 countries, offer an excellent collection of works that tackle fundamental issues, concepts and achievements of individual researchers, as well as the concerns and challenges regarding engineering and technology education in different cultures.

The papers have been organised into the following groups:

- Opening and Keynote addresses
- Multimedia and the Internet in engineering education
- Quality issues and improvements in engineering education
- Innovation and alternatives in engineering education
- International examples of engineering education and training
- New trends and approaches to engineering education
- Important issues and challenges in engineering education
- Specific engineering education programmes

The variation of subjects, concepts, ideas and international backgrounds in this volume of Proceedings demonstrate the global nature of UICEE-run Conferences, as well as its relevance within the worldwide affairs related to engineering and technology education.

In order to ensure the high quality and value of the Proceedings into the future, all of the papers have undergone assessment by independent international peer referees and have been professionally edited. As such, it is envisaged that this volume will become a useful source of information on research and development activities in engineering and technology education, seen within the context of educating future engineers for the global community.

In order to purchase a copy of the Proceedings, a cheque for $A100 (+ $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 3800, Australia. Tel: +61 3 990-54977 Fax: +61 3 990-51547