Global J. of Engng. Educ., Vol. 2, No.2
Printed in Australia

New Didactic Methods in the Education of Engine Room Officers*

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Effective and efficient approaches to teaching now require the application of modern technology in engineering education. Modern Computer-Aided Education (CAE), which uses contemporary multimedia technology, has made the teaching and learning process much more exciting for both the academic teacher and the student. This paper presents a set of computer-based teaching instructions being used in the teaching of engine room officers in the Department of Marine Power Plants at the Gdynia Maritime Academy, Gdynia, Poland. Some practical applications of interactive computer-assisted teaching programs are demonstrated and discussed. Their benefits and advantages in the education of ship engineers are also indicated and discussed. The method of training marine professional engineers considered here can be successfully replicated in teaching other complex technical subjects.

INTRODUCTION

Education of an engine room officer is an extremely complex and expensive process due to the extensive range of theoretical knowledge and practical skills that must be acquired by students in order to be able to practise the profession on graduation. There are various diverse reasons why the educational process is difficult and complex, including the following:

- Professional education in the field of exploitation of engines and marine technology requires the knowledge and understanding of a number of sophisticated marine installations.
- The necessity for an intensification of students' activity during their education in order to acquire highly specialised professional knowledge and skills.
- The requirement for continuous and periodical assessment and control over students' work in an objective manner.
- The need for the application of modern teaching methods in order to disseminate complex information.
- Ever decreasing funding for education.

Taking the above factors into account, new teaching methods based upon Computer-Assisted Training (CAT) programs, similar to those used in foreign language teaching at the Gdynia Maritime Academy, have been devised and introduced into the education of engine room officers in the Department of Marine Power Plants. At present, CAT programs are being used in subjects such as:

- Marine engines
- Refrigerating systems
- Other marine installations

It is envisaged that the same educational approach will be introduced to teaching of other subjects delivered by the Department in the near future.

DESCRIPTION OF THE PROGRAMS

A special set of interactive CAT programs has been developed by UNITEST for the Department of Ma-

* A revised and expanded version of a paper presented in Wismar

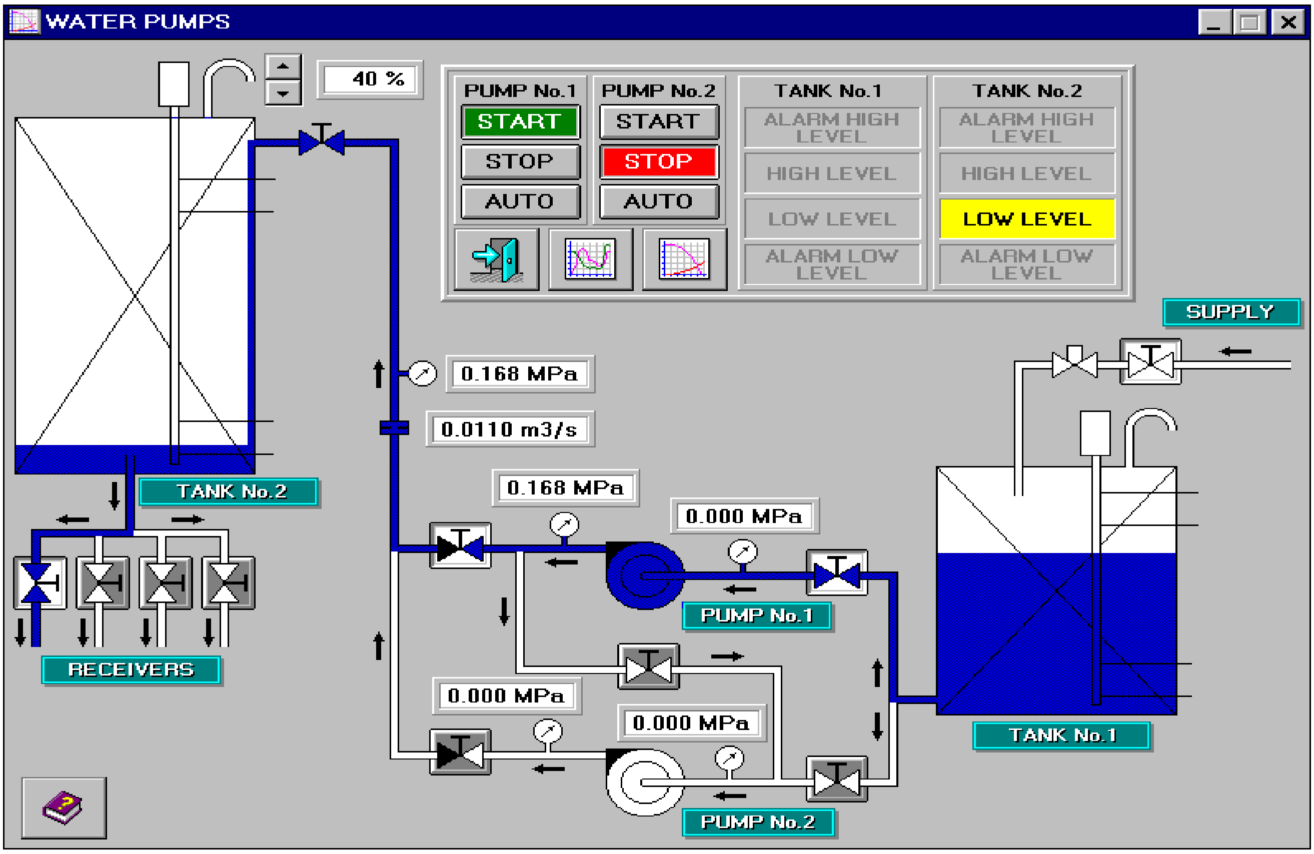

Figure 1: Water pumps plant diagram.

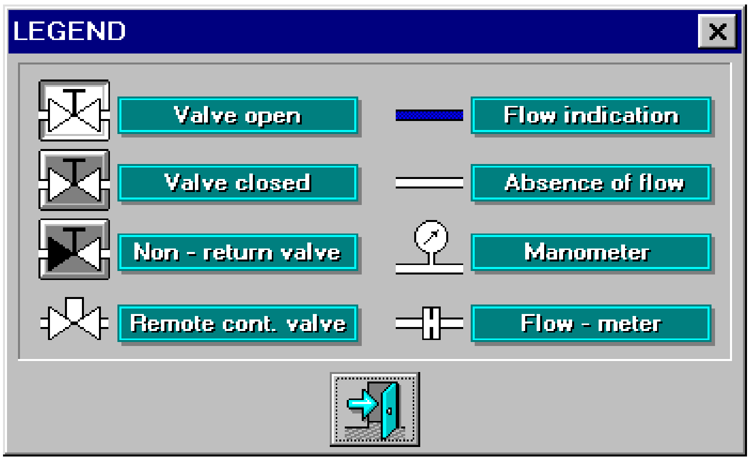

Figure 2: Legend.

rine Power Plants, with each program explaining the rules of exploitation and functionality of a specific marine device or system. An appropriate mathematical and logical model of a device or system ensures that the program reacts to students' actions exactly as the real object would; in the case of faulty operation, for instance, the program will react identically to the real device or system, including alarms, shutdowns, tanks overfilling, etc. Information about individual actions performed by a student is displayed as digital data, colour changes of pipes as well as sound effects. Some programs offer the possibility for students to learn about and realise regulation of the system parameters. All programs are equipped with control panel and system installation diagrams. All operations on the PC screen, such as hand-operated valve opening/closing and pump starting/stopping for instance, are activated by a mouse click. The automatic valves are controlled by the control panel. The developed programs make extensive use of graphical symbols that are fully described in an appropriate legend.

The following programs are presently being used:

- Water pumps - for teaching basic concepts and principles of the operation of typical water pump installations used in marine and industrial power plants.
- Hydrophore installation - for teaching basic concepts and principles of the operation of a typical hydrophore installation for sanitary water used in a marine power plant.
- Fresh water generator - for teaching the basic concepts and principles of the operation of a typical marine fresh water generator plant.
- Piston compressor - the program describes the principles of operation of a single cylinder piston compressor on the basis of an analysis of indicator diagrams.
- Refrigerating plant - for learning the important concepts and principles of the maintenance of a refrigeration room.
- Diesel engines - the program describes the principles of the operation of diesel engines.
- Diesel engine generators - for teaching the basic concepts and principles of the operation of marine diesel generators.

EXAMPLES

Two typical training programs developed and implemented for use in the teaching of engine room officers have been selected for presentation in this paper. Important issues encountered when developing and applying such computer programs will also be discussed.

Water pumps

The *Water pumps* educational program is intended for teaching the basic concepts and operational principles of a typical water pump installation used in marine and industrial power plants. The program is based on an installation with two centrifugal pumps. Each of the pumps can function individually or together in parallel or series operation. The installation diagram is shown in Figure 1. The water pump installation includes:

- Two tanks
- Two centrifugal pumps
- Control panel
- Fittings

Graphical symbols used in the water pump installation diagram are described in the legend shown in Figure 2, where the blue (dark) colour indicates water and the white indicates the absence of water flow in the pipe and the presence of air inside the pipelines. The valves shown in the diagram are active valves, so that their opening and closing status can be obtained by clicking on a rectangle's field. A valve with regulating opening ratio is placed in the inlet pipe that supplies water to Tank 2. This valve makes it possible to simulate changes of the pipeline characteristics. Increasing the valve-opening ratio is done by clicking in the upper field marked with an arrow pointing up. In order to decrease the valve opening ratio one must click the lower field with an arrow. The valve-opening ratio is presented on display in the form of a percentage rate (100% - valve totally open, 0% - valve totally closed). The upper and lower tanks are equipped with level gauges (hydrostatic type).

The operating principles involve several functions. The pumps may be operated manually or can function automatically. If the pump functions automatically, it will start at a low water level in Tank 2 and would stop at high water level. The valves controlling the supply of water to the receivers are placed in the lower part of Tank 2. In the event that all the valves controlling the water flow to the receivers are opened, one pump is unable to supply enough water to Tank 2 to fill up the tank and it is therefore necessary to activate Pump 2 in parallel with the operating Pump 1. Tank 2 will then be filled up automatically. Tank 1 is refilled automatically when the inlet valve is opened. The change in several parameters during the operation of the pumps can be observed in the display areas, such as:

- Pt - pump discharge pressure
- Q - intensity of water flow on the *Parameters time diagram*
- Point of work - on the *Pump and pipeline characteristics*

Diesel engine generators program

The *Diesel engine generators* training program is designed and implemented with the aim of teaching basic concepts and operational principles of marine diesel engine generators. The program structure is based on two diesel engine generators that work in a semiautomatic mode. The entire system used in the program consists of three parts:

- Control panel
- Main switchboard
- Diagrams

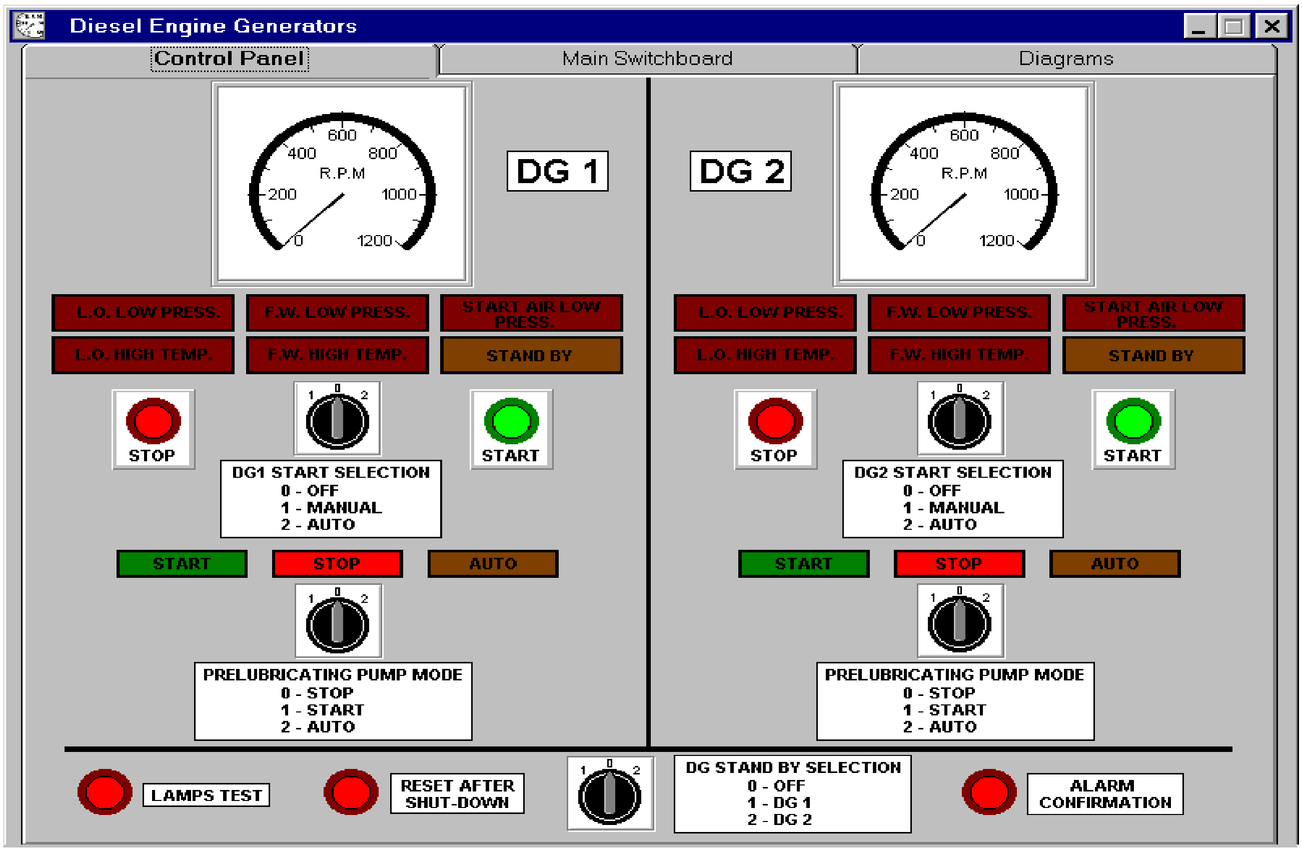

Figure 3: Control panel.

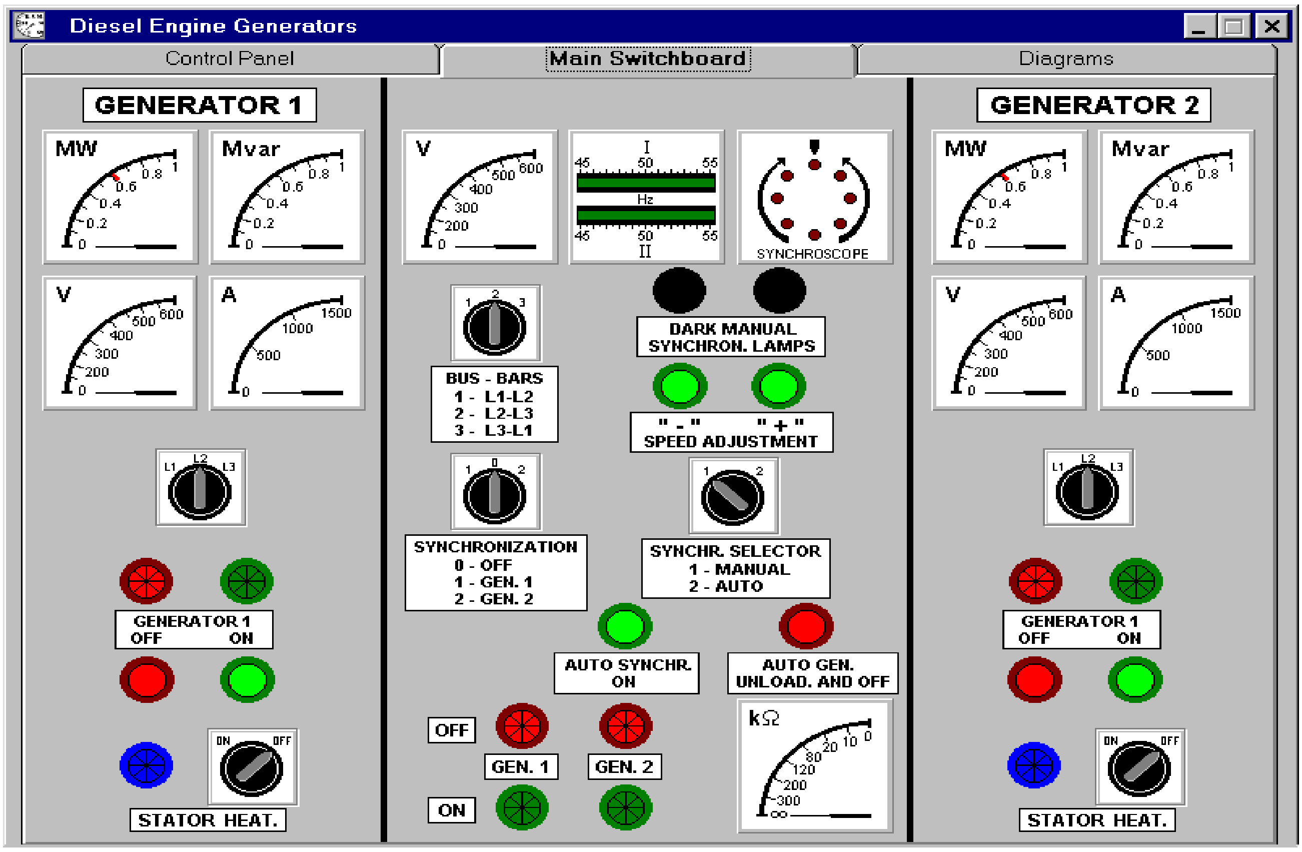

Figure 4: Main switchboard.

The selection of an appropriate part is done by clicking on the strip in the upper part of the screen. The control panel is shown in Figure 3.

The device consists of two identical panels for diesel engine units DG1 and DG2. There are three push-buttons in the lower part of the control panel. One button is for the lamp test; the second is to reset after shutdown; and the third is for an alarm confirmation. There is also a diesel engine stand-by selection switch. The main switchboard is shown in Figure 4. It consists of the generator synchronisation block (middle) and two identical panels for electric generators DG1 and DG2. Figure 5 shows a diesel engine generator diagram. The diagram presents graphical representations of the following components:

- Two diesel engines generators - DG1 and DG2
- Lubricating oil system – LOO
- Fresh water cooling system – FEW
- Seawater cooling system – SAW
- Start air system
- Fuel oil system

The symbols used in the diagrams and the colours of the pipes are described in the legend presented in Figure 6.

It is possible to realise the following operational procedures during the operation of the diesel engine generators:

- Starting the engine.
- Starting the first generator (also after an accidental *black-out*).
- Generator's synchronisation procedure – automatic.
- Generator's synchronisation procedure – manual.
- Unloading and switching off the generator.
- Stopping the engine.
- Engine's stand-by position (*stand-by*).

DISCUSSION

These teaching/learning programs were developed for typical ship devices and installations, taking into account the latest technical and technological advances and solutions. The operational procedures concerning the devices and installations included in the programs describe all typical situations encountered during ship exploitation. The trainee engineers have the opportunity of using all of them, including checking out system reactions for incorrect decisions.

Practical experience demonstrates that students can learn faster and can better understand the ideas and rules, as well as the principles of operation and exploitation of certain important marine devices or installations through the application of these programs in the education process. The programs are very easy to administer due to the wide availability of personal computers in the University.

Introducing some elements of competition between students through the use of the programs can greatly improve the level of their activities in the teaching/learning process. Simultaneous access to several computer-assisted instruction programs significantly reduces the time needed for learning. Also, the time required for the evaluation of students' progress is greatly reduced and is much more objective than that used in classical classroom education. It has also been observed that those students who have had the opportunity of using the programs can perform better when dealing with real physical objects in their later stage education, demonstrating a much better knowledge of marine devices, systems and installations.

It should be pointed out that the number of typical mistakes made by students when solving theoretical problems and doing practical classes in these subjects has also fallen significantly after the introduction of these computer-assisted training programs. In addition, it has been estimated that by using these programs the cost of education has been reduced by about 5%.

CONCLUSIONS

This paper discusses the application of Computer-Assisted Training programs in the teaching and learning process of engine room officers in the Department of Marine Power Plants at the Gdynia Maritime Academy. This method of education has demonstrated a number of significant advantages, such as:

- The system has made the teaching/learning process much faster.
- There has been a significant increase in the quality of training.
- There has been an intensification of students' activity during the educational process.
- There has been a reduction in the costs of education and training.
- There is greater objectivity in the evaluation and assessment of student progress.

It should be emphasised at this point that more comprehensive qualitative and quantitative evaluation studies of the system are planned for the near future. It is

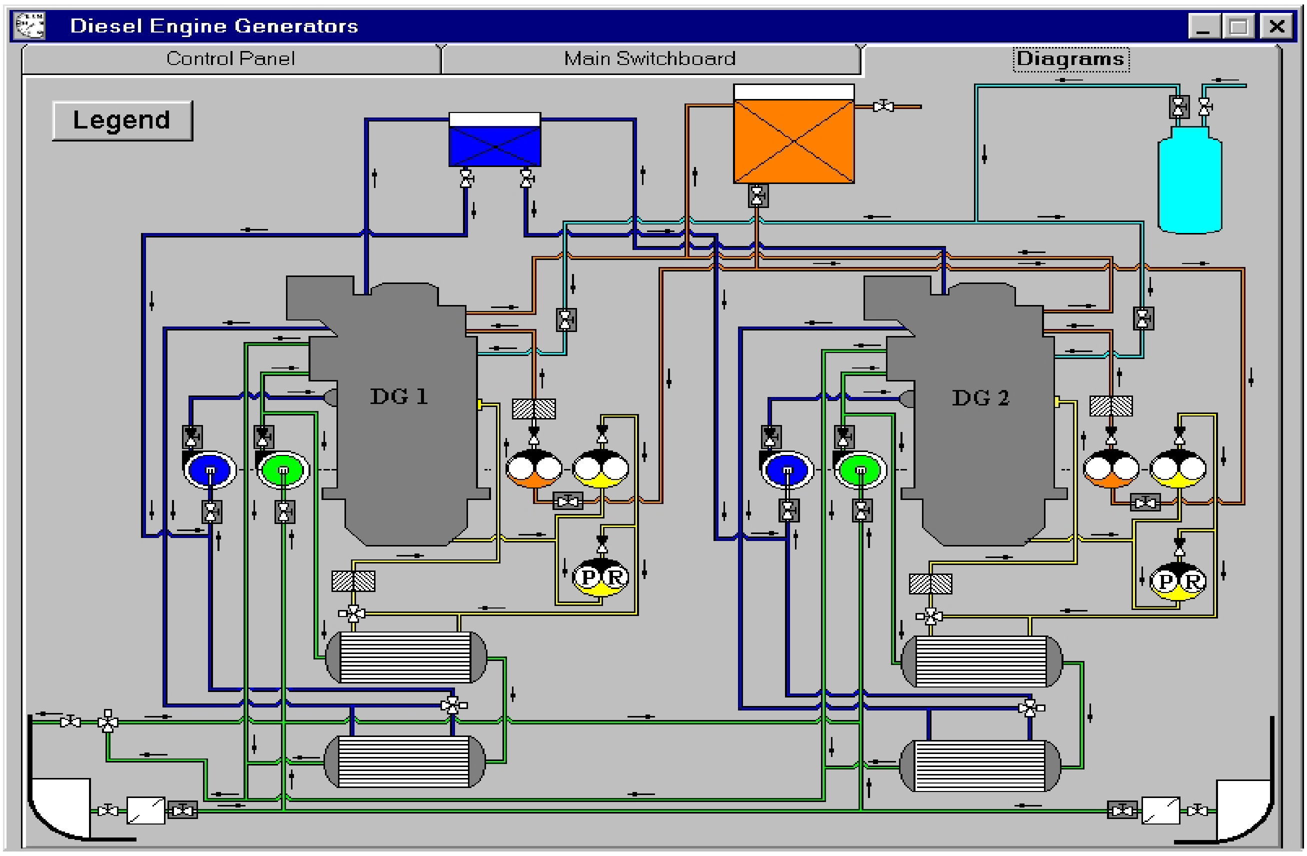

Figure 5: Diesel engine generator diagram.

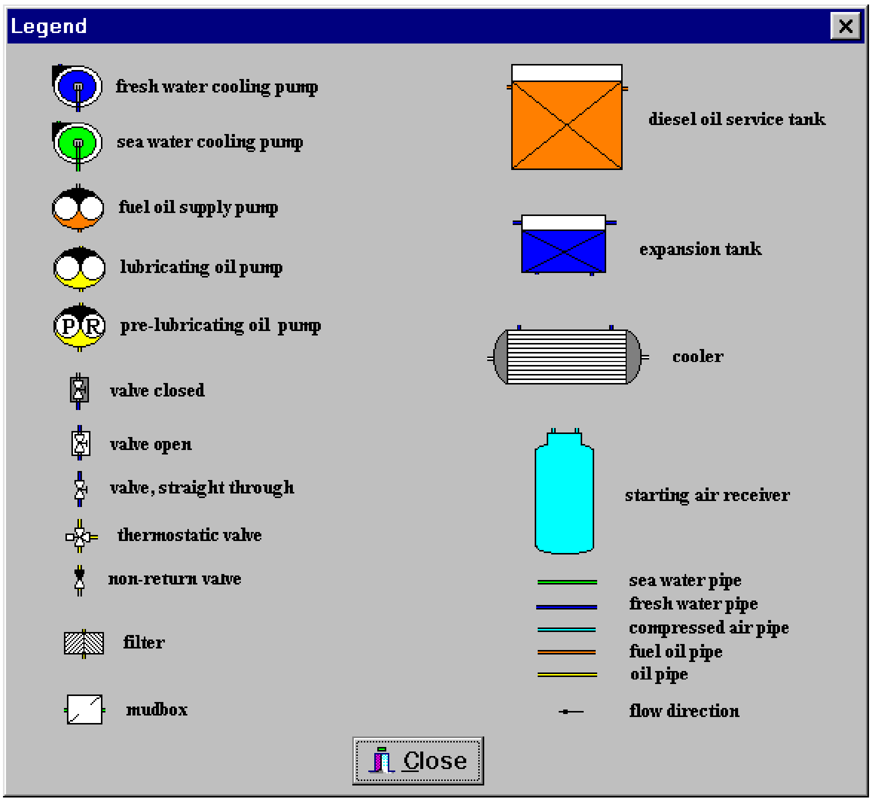

Figure 6: Legend.

envisaged that a research project to evaluate the effectiveness of the programs will be set up in collaboration with the UNESCO International Centre for Engineering Education (UICEE), and an application for financial support is being currently prepared. The authors hope that on completion of the evaluation process the programs will be available for wider use by other academic institutions worldwide, and especially other maritime universities.

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BIOGRAPHIES

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 on marine gas turbines, and a DSc in 1993 in the same specialisation. He has been a professor of the Gdynia Maritime Academy since 1993. His professional interests are in the optimisation of power engineering processes and diagnostics of ship's technical systems. He is the author of many publications, conference papers and patents concerning his field of specialisation. He has been Visiting Professor of the Hochschule Bremerhaven and the Shanghai Maritime University. Presently, he is head of the Marine Power Plants Department of the Gdynia Maritime Academy.

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); from 1976 to 1979 he was a researcher at the Institute of Vocational Education (Warsaw); and from 1979 to 1981 he was an Adjunct Professor 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. He is presently an Associate Professor, Associate Dean (Engineering Education) and Director of the UNESCO International Centre for Engineering Education (UICEE) in the Faculty of Engineering at Monash University, Clayton, Melbourne, Australia.

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

Professor Pudlowski is a Fellow of the Institution of Engineers, Australia, and member of the editorial advisory boards of many international journals. He is the founder of the Australasian Association for Engineering Education (AAEE) and the Australasian Journal of Engineering Education (AJEE), and 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. He is the Foundation Secretary of the International Liaison Group for Engineering Education (ILG-EE).

Professor Pudlowski is a member of the UNESCO International Committee on Engineering Education (ICEE). He has chaired and organised several international conferences and meetings. He was the Academic Convenor of the *2nd World Conference on Engineering Education*, the General Chairman of the *1st*, *2nd* and *3rd East-West Congresses on Engineering Education* and General Chairman of the *UNESCO International Congress of Engineering Deans and Industry Leaders*.

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 Donetsk State 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.