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Practical Aspects of 3D Graphical Applications in Maritime Engineering Education*

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In this article, the author presents two examples of the application of new 3D simulation techniques in maritime engineering education. This is related to the fuel conditioning module and emergency electric plant module where trainees have the possibility to familiarise themselves with the system and to develop operational skills. Various multimedia techniques of simulation have been applied in this program, including tri-dimensional presentation and sound applications. This new simulation 3D technique particularly emphasises the relation between the simulation and realism of machinery operations. The application of 3D simulation techniques in teaching the operation of complex marine machinery leads to a better understanding of the functioning principles of both the equipment and the systems compared with traditional educational methods. However, in order to achieve the didactic goals, programs have to be designed properly, especially in relation to providing adequate navigation through the system. The author also presents experiences in the application of 3D visualisation, and the benefits and advantages in using Computer-Based Training (CBT) interactive programs in the educational process of engine room officers.

INTRODUCTION

Nowadays, tremendous changes are taking place in computing, information technology and simulation. Maritime education and training is not isolated from such changes and should benefit from these tendencies. For this reason, engine room simulators are increasingly used in maritime academies as a valuable asset for educational processes [1-3]. The application of engine room simulators is also recommended by the STCW 87/95 Convention [4].

It is worthwhile mentioning at this point that engine room simulators and CBT programs also have some basic disadvantages in that they include many simplifications, abbreviations and schematic presentations of machinery systems. As a result, a trainee with perfect knowledge of simulator operation can have serious problems with real ship power plant operations, primarily because the graphical presentation and operating procedure of simulator are distinct from the reality.

For this reason, manufacturers of engine room simulators and CBT programs have begun to apply tri-dimensional graphical system's layout presentation in order to provide a machinery configuration that is as close as possible to reality. The present development of personal computers, modern processors and graphical cards allows for an easy application of 3D interactive programs. Also the tools (software) for the creation of 3D application have become more affordable. As such, engine room simulators and CBT programs are now being incorporated in 3D visualisation techniques.

The main problem in the creation of 3D simulators is to provide proper navigation through the system's elements. The engine room is a complex, multilevel and complicated set of sub-systems, equipment and machinery, and this is a new challenge for those creating this kind of simulators [5][6]. It is also necessary to allow for an easy and quick access to basic engine room operation (valve opening and closing, setting the position of switches, push-buttons,

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etc). It is possible to achieve this feature by applying zoom techniques for selected elements of the system. Users of 3D simulators should also be able to observe the system's elements from different viewpoints (ie front, side, rear, etc).

In the article, the author analyses the application of new 3D simulation techniques in maritime engineering education using two examples of CBT programs: the Fuel Conditioning module and the Emergency Power Plant.

FUEL CONDITIONING MODULE DESCRIPTION

The general view of the Fuel Conditioning module interactive program, including parts description, is shown in Figure 1. This new generation of CBT program has been prepared in very close cooperation with ALFA LAVAL. It also incorporates the results of experiences in the practical application of CBT programs in engineers' educational process at Gdynia Maritime University, Gdynia, Poland [7][8]. When compared with previous CBT programes, this new generation of programs consist of improved graphical presentations (including 3D), a closer relation between the simulation and realism of machinery operations, possibilities to adjust parameters through digital panel operations, and training report facilities [6].

In this CBT program, the 3D simulator has been applied for the first time. This simulator allows for the following features:

- Selecting the viewpoint (front, side, back and bottom views);
- Zooming of selected parts of a system's elements;
- Opening and closing the valves;
- Setting switched positions;
- Operating the digital control panels, including parameter adjustments.

Figure 1: General view of the CBT program, the Fuel Conditioning module.

The general front view of the Fuel Conditioning module is presented in Figure 2, with a side view and zooming selection shown in Figure 3.

The simulator also permits for a valve's opening or closing by clicking on the mouse. The valves' description and their status (open or closed) facilitates the proper operation of the system. Figure 4 shows the Fuel Conditioning module element with a valve's position after supply pump status (zoomed).

The digital control panel, presented in Figure 5, was intentionally designed to be as close as possible to the design of real-life equipment. This digital panel provides the opportunity to adjust basic system parameters (the adjustment opportunities are identical to real life conditions). The trainee can set the proper parameters by mouse clicking, and start the pumps, pre-heaters, etc.

The experience gained in the course of the didactic

Figure 2: The Fuel Conditioning module – front view.

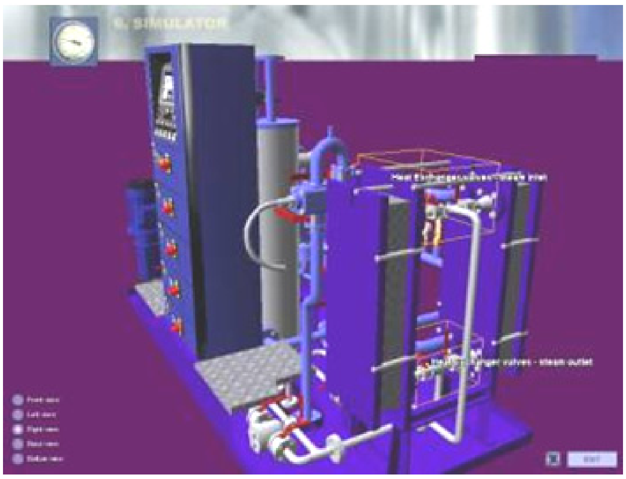


Figure 3: The Fuel Conditioning module – side view with zoom selections.

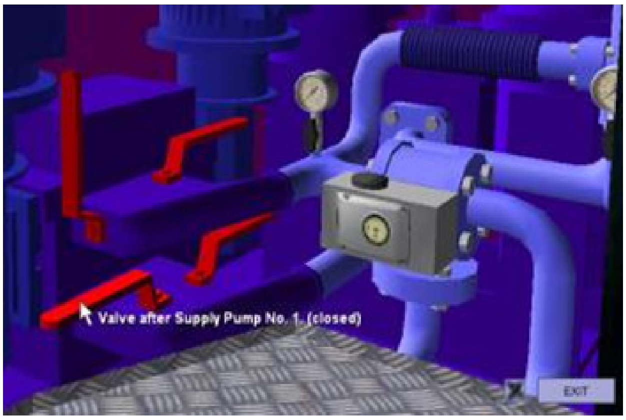


Figure 4: Elements of the Fuel Conditioning module – zoomed image of a valve.

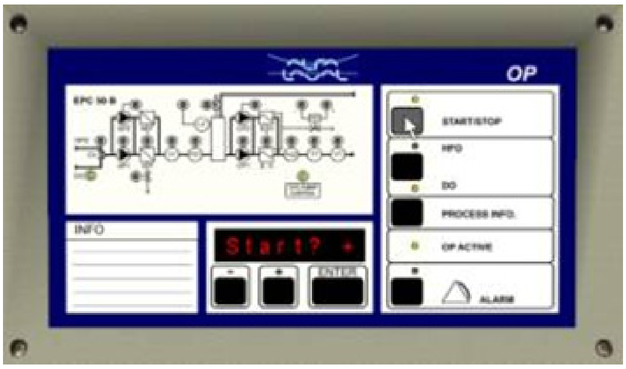


Figure 5: The Fuel Conditioning module's control panel.

process of marine engineers' education indicates that it is extremely important to combine 3D presentations with schematic diagrams in order to understand better the whole process described by a simulator. All the valves' positions and fuel flow are indicated on the installation diagram. Such an approach enables the student to follow how a certain device really functions and gives a complete picture of its structure. The installation diagram is shown on Figure 6.

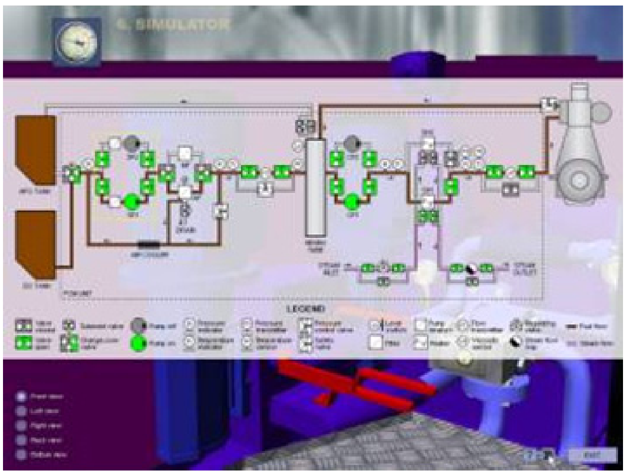


Figure 6: Installation diagram.

It has to be added that this type of presentation also includes sound effects as in real life operations.

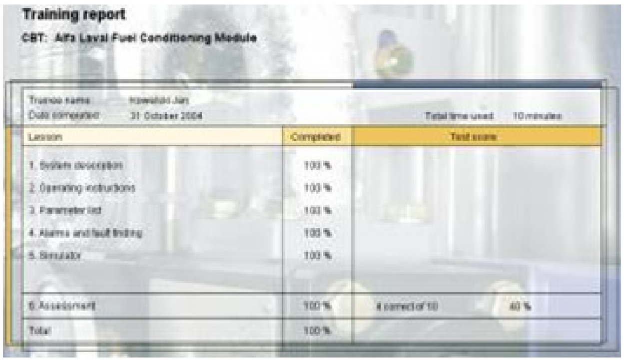
New versions of CBT programs incorporate training reports (see Figure 7), which confirm the degree to which the student has completed the lesson (in percentage) and the test score in assessment.

DESCRIPTION OF AN EMERGENCY POWER PLANT SIMULATOR

It is well known that one of the major factors promoting accident prevention onboard ships is the perfect theoretical and practical knowledge possessed by engine room officers while operating engines and auxiliary equipment [1]. The basic role of an emergency power plant simulator is the familiarisation with different operational modes that are required for achieving a high level of emergency preparedness [9].

This simulator possesses similar 3D features to the Fuel Conditioning module. A general view of the emergency power plant simulator is shown in Figure 8.

3D visualisation has been applied for the first time in this emergency power plant simulator. This simulator also allows for the following features:



Training report

CBT: Alfa Laval Fuel Conditioning Module

Trainee name [illegible]
Date completed 31 October 2004
Total time used 10 minutes

Lesson	Completed	Test score	
1. System description	100 %		
2. Operating instructions	100 %		
3. Parameter list	100 %		
4. Alarms and fault finding	100 %		
5. Simulator	100 %		
6. Assessment	100 %	4 correct of 10	40 %
Total	100 %		

Figure 7: Example of a training report.

Figure 8: The emergency power plant – general view.

- Selection of system viewpoints (front, DO tank, emergency generator, switchboard and battery charger);
- Option to zoom into selected parts of the system's elements;
- The opening and closing of valves;
- The option to set the switched positions;
- Operation of push buttons.

The simulator allows for a valve's opening or closing by clicking the mouse (see Figure 9).

A view of the emergency power plant diesel engine is presented in Figure 10. Side views with zoomed selections are shown in Figures 11 and 12. The diesel engines' control panel, as displayed in Figure 11, was intentionally designed to be as close as possible to the design of the real-life equipment.

The electric switchboard presented in Figure 13 includes the following key elements:

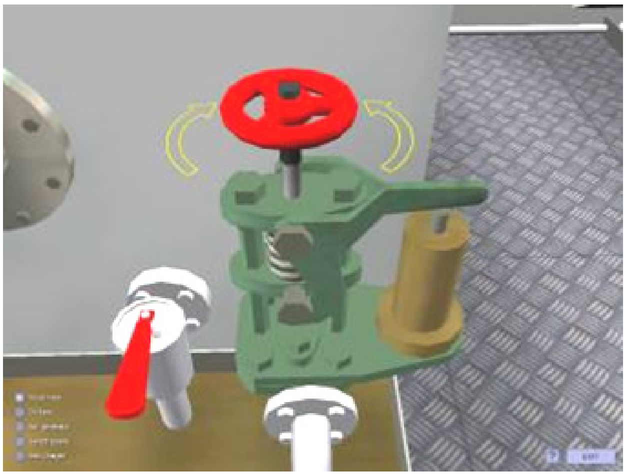


Figure 9: Fuel oil valve visualisation.

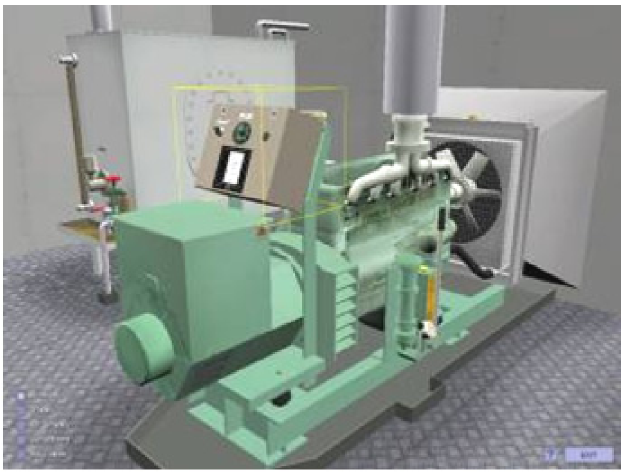


Figure 10: Emergency Diesel generator with control panel zoom selection (box surrounding control panel).

Figure 11: Zoomed presentation of the control panel.

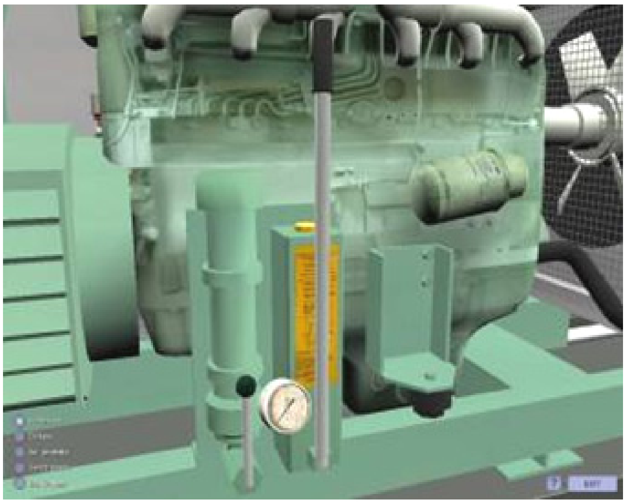


Figure 12: Starter for the emergency hydraulic engines.

Figure 13: General view of the emergency switchboard.

- Emergency generator panel (see Figure 14);
- Shore supply panel;
- Control panel for the diesel engine and for the battery charger;
- Emergency supply receivers;
- Panel for the transformer.

CONCLUSIONS

The application of 3D simulation techniques in teaching the operation of complex marine machinery leads to a better understanding of the functioning principles of both the equipment and the systems, especially when compared with traditional educational methods. However, in order to achieve didactic goals, such programs have to be designed in a proper increased emergency preparedness and, as a consequence, leads to hazard mitigation and reduces the risk of human error in the operation and maintenance of marine equipment.

Given the results described above, the latest developments in simulation techniques, including 3D presentations, enhance the above-mentioned benefits, as it brings the engine room simulators closer to reality. As a consequence, the differences that exist between operating marine machinery under simulation conditions and actual real life situations are grossly reduced.

The application of this kind of programs plays also a very important role as a preliminary stage for preparing students to use *full mission* - hardware type simulators.

In the near future, it is envisaged that this type of 3D solutions will be applied more and more, particularly with regard to engine room simulators and the interactive program design of Computer-Based Training (CBT) packages.

Figure 14: The emergency generator's control panel.

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BIOGRAPHY

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

From 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, then later as a senior lecturer. He is presently an assistant professor at the 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 maritime engineering education.

He is the author or co-author of many refereed journal and conference articles. He was also a visiting professor at Shanghai Maritime University.

Dr Leonard Tomczak was awarded the UICEE Silver Badge of Honour in 2004 at the *7th UICEE Annual Conference on Engineering Education*, held in Mumbai, India.