THE NEW GENERATION OF ENGINE ROOM SIMULATORS WITH APPLICATION OF 3D VISUALIZATION

Leonard Tomczak
Gdynia Maritime University
Marine Propulsion Plant Department
Morska Street 81-87, 81-225 Gdynia, Poland

Abstract

Nowadays, tremendous changes are taking place in computing, information technology and simulation. Maritime education and training is not isolated from such changes and ought to benefit from these tendencies, specially taking into account the possible improvements for safety of ship operation. The present development of personal computers, modern processors and graphical cards allows for an easy application of 3D simulation techniques and for this reason manufacturers of engine room simulators begin to apply tri-dimensional graphical system’s layout presentation.

Their aim is to provide machinery simulation as close as possible to reality. As a result, following the training, trainees are far better prepared to deal with real life operation of machinery.

The experiences in the application of virtual visualisation, the benefits and advantages of the use of engine room simulators in the educational process of engine room officers are equally presented in this paper. This paper describes an example of application of new generation of engine room simulators with 3D visualization, based on modern - computer controlled engine room with medium speed main engine, applied on a container ship.

The simulator described in the paper provides for a new approach to navigation through the different system’s elements, allowing for an easy and quick access to basic engine room operation (valve opening/closing, setting position of switches, push-buttons etc.). This has been possible due the application of state-of-the art 3D visualisation with zoom techniques.

Keywords: 3D computer simulation, marine engine room simulators.

1 Introduction

Engine room simulators are used in maritime academies as a valuable asset for the educational process for more than 30 years [1]. The application of engine room simulators is also recommended by STCW 95 IMO Convention [2].

Marine engine simulators allow for operation of emergency situations that are not permissible under normal exploitation conditions due to safety limitations [3]. Simulator’s software includes also assessment features that enable the objective review of the capacities acquired by trainees. During simulator exercise the instructor is able to apply various exercise set-ups (initial conditions) and scenarios that include different fault finding tasks.

It is worthwhile mentioning that marine engine room simulators used until now represented also some basic disadvantages. Namely, they include lots of simplifications, abbreviations and schematic presentation of machinery systems as a result of the fact that they are presented only in 2D visualization. Hence, the trainee with perfect knowledge of simulator operation can experience serious problems with real ship power plant operation, because the
graphical presentation and operating procedures of the simulator are distinct from the reality.

For this reason, manufacturers started to apply 3D graphical system’s layout presentation in in new generation of engine room simulators, in order to provide a machinery configuration as close as possible to reality.

The main problem in creation of 3D simulators is to provide for proper navigation through the system’s elements [4,5,6]. Engine room is a complex, multi level and complicated set of sub-systems, equipment and machinery and this requirement constitutes a new challenge for entities creating such kind of simulators.

It is also necessary to allow for an easy and quick access to basic engine room operation (valve opening/closing, setting position of switches, push-buttons 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 pre-select specific parts of the engine room.

Based on the author’s experiences with the application of different types of simulators, a better solution consists in navigation by mouse cursor and zooming facilities.

The application of new 3D simulation techniques in marine engineering education shall be analysed on the examples of full mission, hardware type engine room simulator with medium speed main engine type MED3DH.

A new technique of navigation through the system’s elements has been applied in this virtual reality simulator, providing for a solution of the main problem in creation of 3D visualisation. The latest development includes also a combination of 3D and 2D diagram presentation, which enables to follow how a certain device really functions and provides a complete picture of its structure. The presented solutions have improved considerably the level of simulator fidelity in relation to real machinery. In consequence, it was possible to eliminate the disadvantages of the engine room simulator with typical 2D presentation consisting in a schematic and simplified presentation of machinery systems.

The application of virtual simulation in teaching the operation of complex marine machinery leads to a better understanding of the functioning principles of both the equipment and the systems in comparison with traditional educational methods. As a result, trainees are far better prepared to deal with real life operation of machinery, thus increasing in a considerable manner the standards of safety of ship operation. It has been observed during many years of application of engine room simulators in Gdynia Maritime University that trainees have a very different approach to exercises conducted with hardware type of simulator in comparison with training conducted only with software. The trainee’s attitude to exercises conducted only with software is very similar to the approach adopted to computer games and the trainee often does not consider these as serious experience that reflects reality. If the exercise is conducted with the application of hardware, the trainees have the impression to conduct real life operations and in consequence, their aptitude to perform such operations in reality increases. On the other hand, software, due to its features enables the trainee to repeat in an unlimited number of times the required operations, thus to achieve the necessary preparedness level.

The engine room simulator based on the medium speed engine room simulator is one of the first simulators which uses hardware and software type of consoles combined with 3D visualization.

This simulator specially enhances the operational procedures related to emergency situations, like electrical black-down, emergency manual operation of the main engine with propulsion system as well as auxiliary machinery in case of remote control failure. As it has been said before, these procedures may not be trained in real life conditions due to safety constraints. From didactic point of view the best solution is to combine hardware version of engine room simulator with 3D visualization. Such combination improves in a considerable
manner the safe operation of marine engine room, as the crew members have previously been trained in relation to various fault scenarios.

2 MED3H Medium speed engine room simulator’s description

The basic role of this simulator is the familiarization with different operational modes.
This simulator is designated for training students of maritime academies as well as for different types of marine vocational training centres. The simulator has universal features and may be used both for training merchant and navy fleet crew.

The MED3DH is a full mission, hardware type Engine Simulator and has been based on very modern solutions, being presently used in medium-sized, computer controlled, engine rooms (one four-stroke type main engines with reduction gear and controllable pitch propeller). This kind of computer controlled engine room is a typical configuration applied on modern container ships. The main purpose of the MED3DH simulator is the practical preparation of the trainee for engine room operation, and more particularly:
- familiarization with the basic engine room installation (compressed air system, fresh and sea water cooling system, lubricating, fuel oil system etc.), specially taking into account training on the base of modern, computer controlled engine room;
- acknowledgment with main engine and auxiliary equipment exploitation procedures;
- propulsion system manoeuvring (main engine – reduction gear – CPP);

The simulator has been developed in compliance with:
- STCW Code: Section A-1/12 and Section B-1/12.
- ISM Code: Section 6 and Section 8.

The MED3DH simulator has been equipped with a hardware consoles and panels that enable main engines, gear, CPP, auxiliary machinery and electric system’s operation and control.

MED3DH simulator consists of three main parts (Fig. 1):
- Engine Control Room ECR with main engine control console and main electric switchboard,
- Engine Room with two PC projectors and control console for 3D visualization combined with diagram presentation,
- Instructor’s Room.

Fig. 1 General view of Full Mission Engine Room Simulator – MED3DH
The MED3DH simulator room’s panels and consoles have been presented on Fig. 2 and 3.

Fig. 2  MED3DH Engine Room Simulator – Switchboard panels

The basic operation with auxiliary sub-systems, identically as in real modern ship, is performed by “mouse clicking” operation on the PC monitors screen (Fig. 3). On the PC’s screen diagrams related to specific installation like fuel oil, compressed air system, cooling
system, lubricating system, steam system, etc. are presented. For security reasons and in the same way that in real engine room, the Engine Control Room is equipped with two identical PCs with monitors. In case of one PC failure, the second one takes over the systems’ control automatically. On the monitor screen by “mouse clicking” it is possible to start/stop the pumps, compressors and open/close the valves which are remote controlled. On fig. 4 an example of compressed air diagram for remote control from PC screen is shown.

Fig. 4 MED3DH Engine Room Simulator - Example of compressed air diagram (remote control from PC screen)

All operating procedures which are necessary to be performed in engine rooms (outside of Engine Control Room) are effectuated in a separate room equipped with two projector screens. One screen presents engine room elements in 3D visualization and another one presents in form of a diagram related to specific and selected compartments or system of engine rooms, for example auxiliary generators’ room, emergency generator’s room, compressed system room etc. On fig. 5 two screens visualization of main engine is presented. Selection of engine room’s elements that are important from the point of view of exploitation is performed by zoom techniques.

The software allows for the simulation of opening/closing of basic valves and auxiliary equipment operation in engine room. The software also generates the main engine room’s sound.
The MED3DH virtual reality simulator provides for a new approach to navigation through the different system’s elements, allowing for an easy and quick access to basic engine room operation (valve opening/closing, setting position of switches, push-buttons etc.). This has been possible due the application of state-of-the art 3D visualisation with zoom techniques. The latest development includes also a combination of 3D and 2D diagram presentation, which enables to follow how a certain device really functions and gives a complete picture of its structure. The presented solutions have improved considerably the level of simulator fidelity in relation to real machinery. In consequence, it was possible to eliminate the disadvantages of the engine room simulator with typical 2D presentation consisting in a schematic and simplified presentation of machinery systems.

On fig. 6 – 9 selected part of engine room machinery with 3D visualization are shown.
Fig. 7 MED3DH Engine Room Simulator – Fresh water generator installation

Fig. 8 MED3DH Engine Room Simulator – fuel separator module
3 Conclusion

As it has been mentioned above, the new generation of engine room simulator combining hardware with 3D visualization improves in a considerable manner the safety of operation of marine engines as it enables the trainee to achieve high level of emergency preparedness. The didactic purposes are achieved through training involving various fault scenarios and the simulator also enables proper navigation through its elements. The new concepts of view selection, zooming features of elements and operation by cursor and mouse clicking, as applied in the simulator that has been described in this paper, appears to be very effective and easily adaptable by trainees in practice.

Due to the specificity of operating marine equipment in real life conditions, the didactic goals in marine education are directly linked with achieving preparedness for emergency situations. Such preparedness may only be achieved if the trainee is familiar with both the equipment and its operating modes, including emergency situations. If the trainee has been trained only on simulators that are far from real machinery environment, his state of preparedness for emergencies on board is not satisfactory and safety is put at risk.

3D visualisation reduces the gap between operating marine machinery in simulation conditions and in real life. In the near future, this type of 3D solutions should be applied more and more often in engine room simulators design. The presented simulators are related to marine machinery, but the concept of composition and navigation through the system’s elements can be easily applied for the purposes of any type of technical equipment.

To summarize, the application of a new generation of engine room simulators with 3D visualization improves the safety of operation of marine equipment on board as it reduces the level of human error in the operation and maintenance of these devices.
References


