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THE USE OF THE SIMULATOR AS A TOOL FOR TRAINING STUDENTS OF MARINE ENGINEERING FACULTY

Marcin Szczepanek
Maritime University of Szczecin
Faculty of Marine Engineering
ul.Wały Chrobrego 1-2, 70-500 Szczecin
e-mail: m.szczepanek@am.szczecin.pl

Abstract: The paper aims at estimating how much the training on computer simulators improves safety, how it permits to prepare engine crew to possible situations that can happen during exploitation ships engine rooms. The opinion expressed by classification institutions and insurance companies representatives, that training on well equipped simulators will reduce the breakdowns number of about 50% in comparison to the training in a traditional way is expressed in the article. This paper presents the view on the use of the simulator as a tool for training Marine Engineering students.

Keywords: software simulator, training, training staff.

Introduction

A ship is a complex and fully automatic technical object used in extremely changeable conditions of operation and surroundings. In operation, it is the adequately trained crew that decide about the safety of sailing, mainly navigational and engineering officers. Introduction of more and more advanced testing and measuring systems for control and steering causes less workload for performing routine duties, repeated activities for machine, device and systems operation - particularly for ER crews.
Information sent to ECR gives the possibility to assess machinery and ER devices working parameters and their technical condition as well. In case of critical value of working parameters an alarm in "on" and the information about its reason is sent to engineers' cabin or widely available places such as the mess room, the TV room or the bridge.
All that requires more prerequisites of knowledge and skills for marine engineers. There are more perfect methods of education, taking into account technical development of machinery, marine devices, engine room systems, automation systems, computer technologies and rules for natural environment protection.
Problems of marine staff training are regulated by International Convention on Standards of Training Certification and Watchkeeping for Seafarers (STCW) where the knowledge and skills required by crews of sea-going vessels are included. The content of the STCW convention is determined during meetings of IMO (International Maritime Organisation) representatives from membership countries. After the ratification, membership countries - Poland too - are obliged to use it as standard training for marine crews [1].
Education plans for propulsion turbines are as follows.
According to STCW [2]:
- there are different forms of developing professional career – starting with courses and up to academic studies;
- assessment of professional qualifications is based on the testing of knowledge and skills used by a particular rank;
- it determines training requirements for crews on specialized vessels (with turbine propulsion);
- it determines requirements for teaching staff for subjects covered by the convention;
- it introduces competence norms and responsibility levels:

a) support level (refers to ordinary crew members, for the ER it refers to motormen who perform duties under control of the person from operational or managing level),
b) operational level (refers to watch engineering officers performing independent activities and duties who are responsible for ER operation),
c) management level (refers to chief engineers and second engineer officers responsible for direct control of duties performed by ER crew);
- it introduces requirements for teaching equipment, including laboratories and simulators necessary for the training.

The IMO requirements are a challenge for marine academies in order to provide a proper level of training, following STCW training standards and current domestic education prerequisites.

Training process at marine academies is under control of Polish Accreditation Committee, some committees designated by Polish marine administration and EMSA (European Maritime Safety Agency) and it means getting a certificate for crews training on the proper level.

Our academy has obtained the training certificate for marine crews on the highest level of management. Thanks to that our graduates are given engineering officers diplomas recognized all over the world.

Classes performed with the use of marine ER simulators

A marine ER simulator, based on many mathematical models of processes taking part in the ER allows the trainee to follow their dynamics in the real or accelerated time. It gives a chance to know the structure of each system, machine or device in the ER, with the proper way of their operation and diagnosing. All the operations done by the trainee are registered and performed under the supervision of the instructor and the malfunction made are widely discussed [1]. The idea of training and evaluation of training courses shows figure 1.

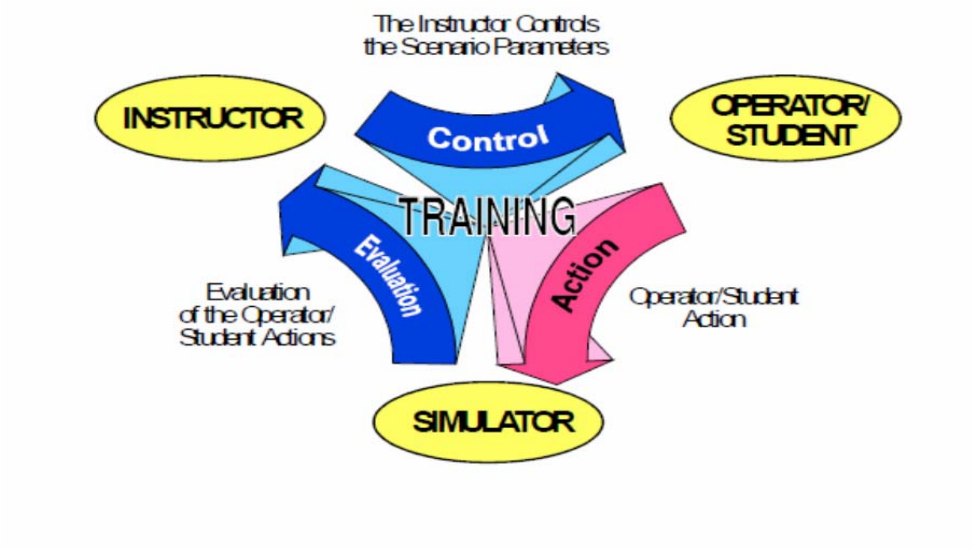

Fig. 1. Training and evaluation control diagram [4]

The high level of physical and behavioral realism creates a professional environment for the following types of marine engineering training:
- familiarisation and education,
- standard operation and watch keeping,
- advanced operation and troubleshooting.

Having realized the important role of simulators in the training process, Marine Academy bought the first one in the year 1980. It was replaced with the new generation device in the year 1991 and in the year 1999 a simulator PPT 2000 was bought which consisted of two parts: operational and graphic ones. The operational part contains 2 simulators of conventional ERs. In the graphic part, 6 simulators of the ERs with different propulsion systems are installed:

- Neptune ERS MAN B&W 5L90MC L11 VLCC,
- Neptune ERS Diesel Electric AC-AC DE22 Cruise Vessel,
- Neptune ERS MaK 8M32C M11 Trawler,
- Sim Engine Sulzer 12RTA84C L11,
- Sim Engine Steam Propulsion SP25,
- Sim Engine GE LM2500 30 Gas Turbine.

Sample simulators:
Steam simulator SP25 equipped with the steam turbine as the main propulsion in the graphic part, simulate on a VLCC (very large crude carrier) where classes on turbine propulsion operation are held.
Basic data of the modelled devices:
Deadweight of the vessel: 280 000 t,
Speed of the vessel: 15 knots,
Rotational speed of the propeller: 70 rpm,
Power on the shaft: 25 158 kW.
The system consists of:
The propulsion machinery - consists of a cross compound, double reduction geared turbine, driving a single, fixed pitch propeller.
The boiler plants - the main and the auxiliary (fig. 2).
The steam plant - consists of a five stage, regenerative steam cycle.
The main vacuum condenser (fig. 3).
The LP turbine extractions
The HP turbine extractions.
The turbo generator - is sufficient for electric power generation at normal cruising conditions.
Three turbine driven cargo pumps.
Trainings are based on earlier prepared scenarios allowing to adopt the level of the training to the requirements and knowledge of the simulator trainees. The system also gives the instructor a chance to interfere in the exercise via remote control panel, which permits to supervise and introduce malfunction or damage on line. Fig. 2, 3 and 4 show examples of simulator systems.

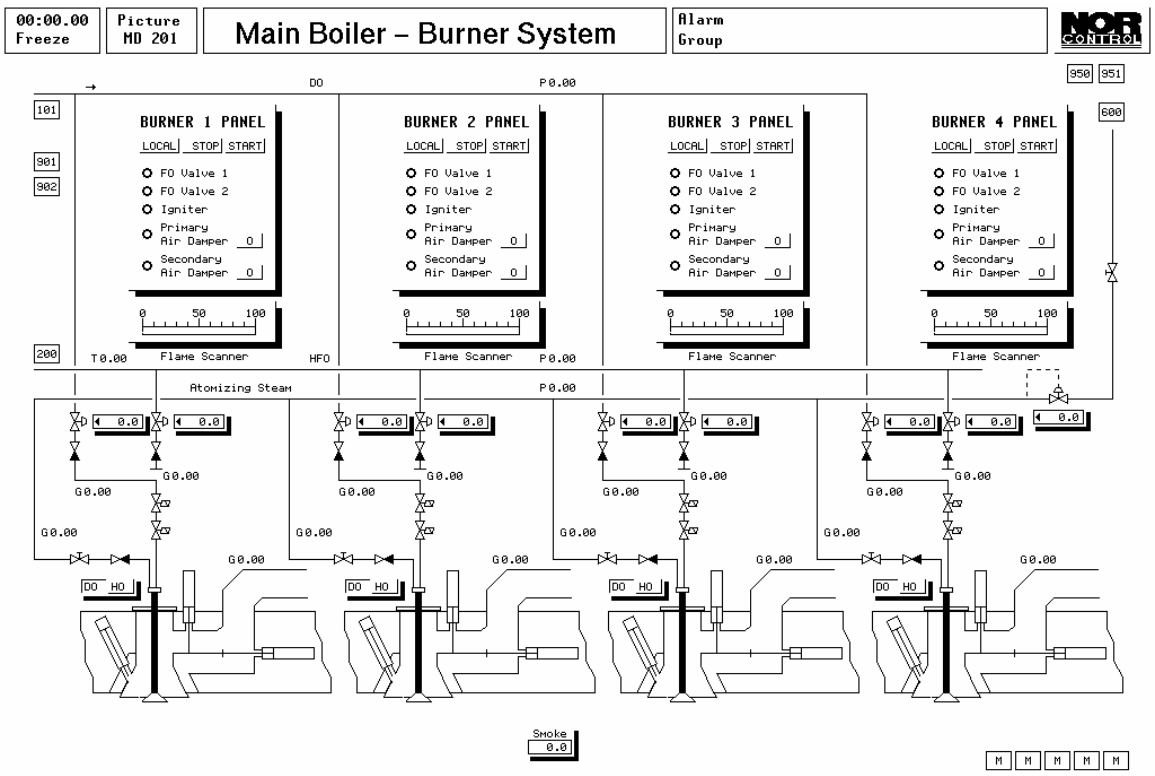

Fig 2. Simulator screenshot showing the Main Boiler-Burner System [3]

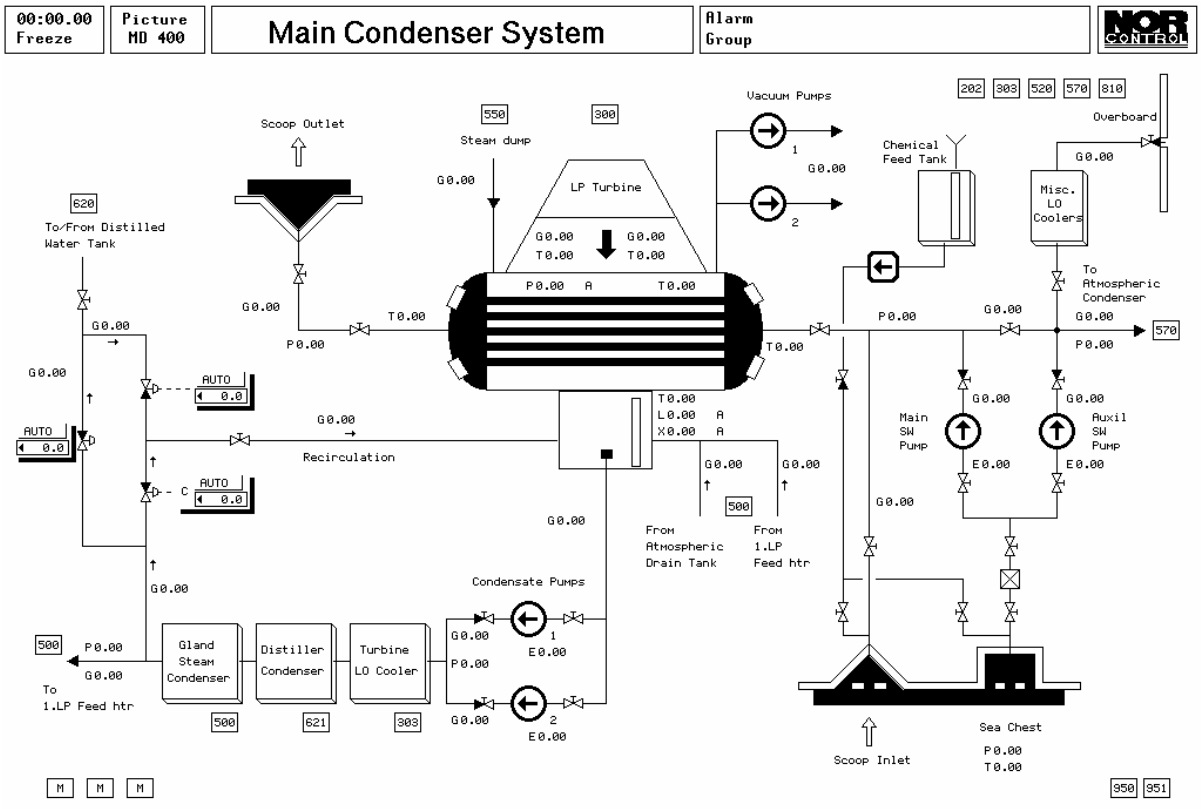

Fig 3. Simulator screenshot showing the Main Condenser System [3]

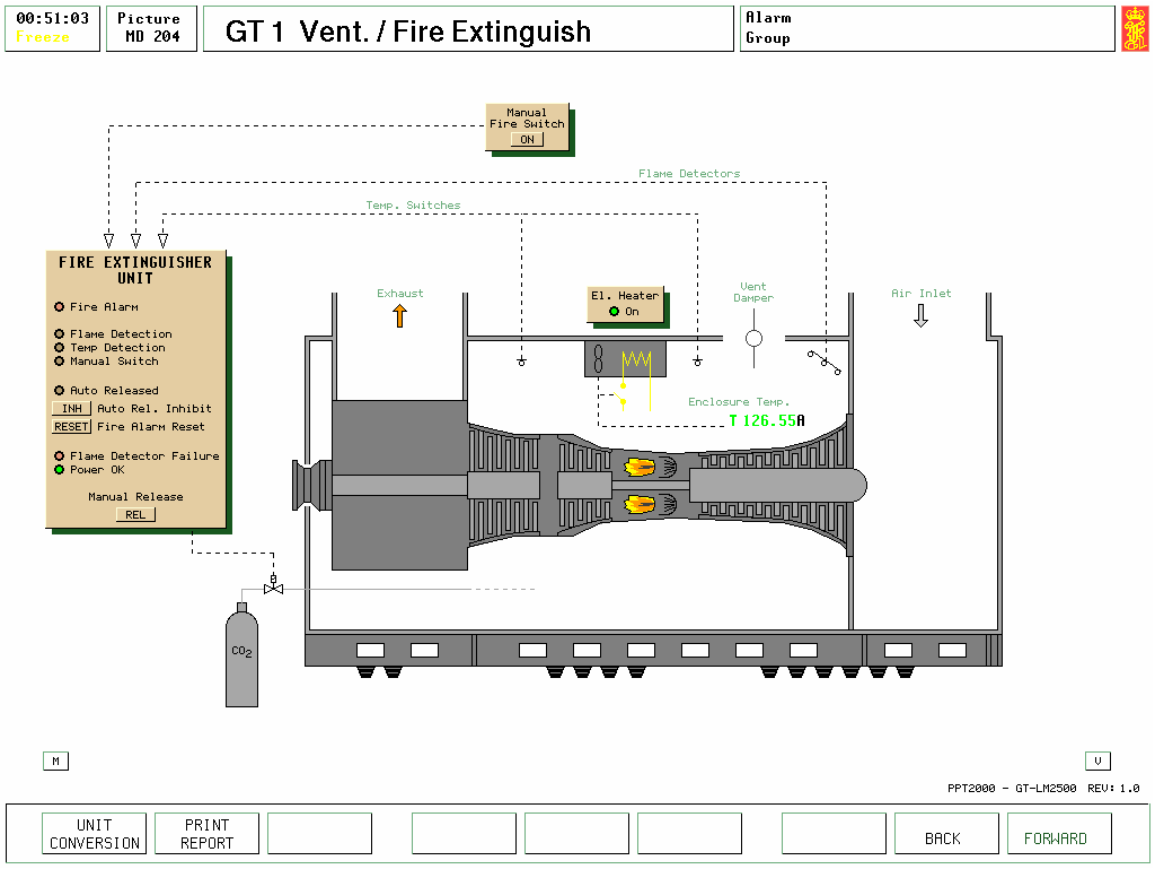

Fig 4. Simulator screenshot showing the Fire Detection and Extinguish [3]

Simulator of the ER equipped with gas turbine. In the graphic part, there is also a simulator GT-22 with main turbine propulsion equipped with two gas turbine General Electric LM2500 of the power 19 700 kW each and the rotational speed of 3 600 rpm.
The fire detection and extinguishing systems as shown in Fig. 4 consist of:
- two temperature switches,
- three flame detectors,
- a manual push button switch,
- CO2 cylinders,
- CO2 discharge nozzles.

Local Operation Panel is used to operate and monitor the operation of the gas turbine unit (fig. 5).
The following buttons are provided [3]:
Start Permi - This indicates that starter permission is granted by the automation control and monitoring system. Once this button is lit the turbine start command can be activated;
Start - Activation of this button will start the turbine on an automatic programme;
Normal Stop - This button will activate the automated turbine stop sequence;
PT O/S Reset - This button will manually reset the over-speed of power turbine;
SEQ Reset - This button will reset the automatic start sequence. It should be reset before the automated start sequence is selected;
Start On/Off - This button is selected when manual operation of the turbine is required, and will over-ride the automated functions;
Ignit On - This button will automatically start the ignitor within the combustion chamber;
Fuel On - This button will open the shut-down isolation valves;
Emerg Over-ride - This button will over-ride the shut-down functions of the gas turbine. It could be used to prevent turbine shut-down;
Shutdown bypass - This button will block the signal to the fuel bypass valve that dumps the fuel entering the gas turbine. It could be used when testing the turbine shut-down systems without causing the turbine to shut-down;
Lost speed sign - This button will over-ride the control shut-down that would occur if the speed signal from the power turbine were lost.

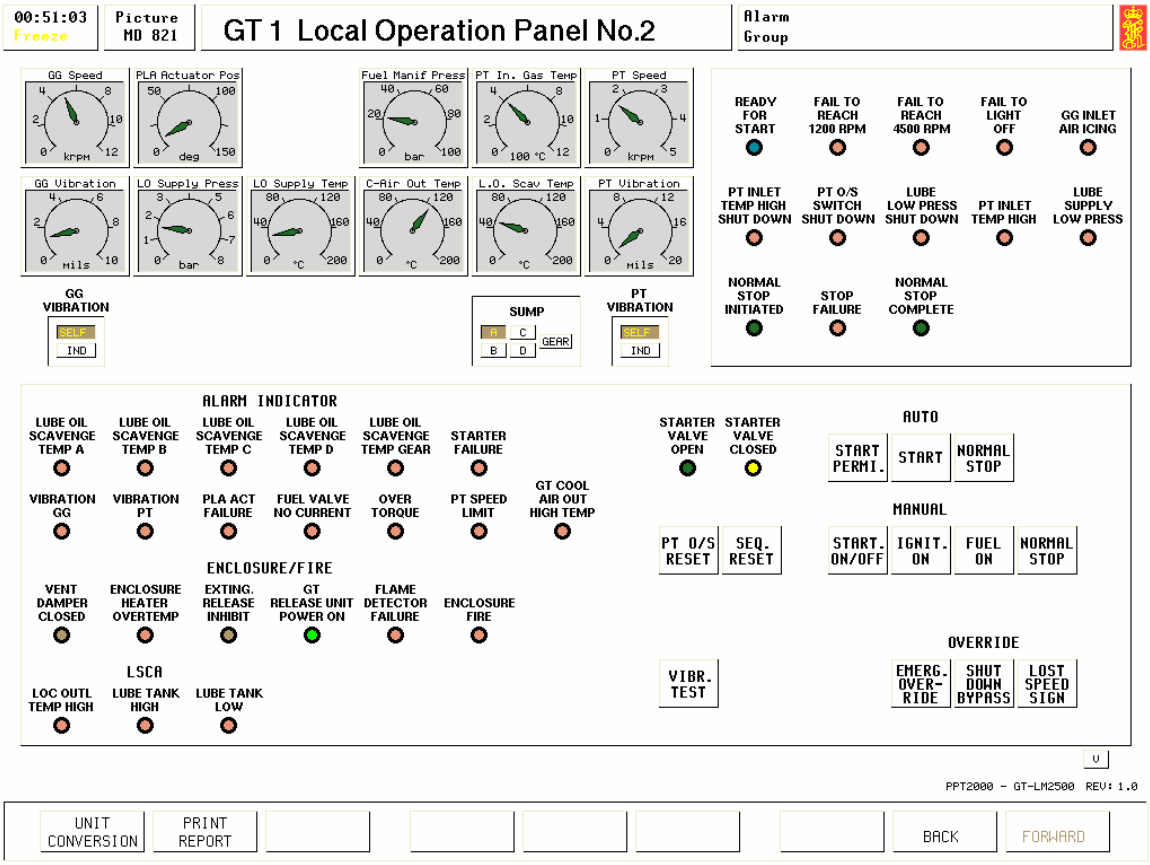

Fig 5. Simulator screenshot showing the Local Operation Panel [3]

The reason to appreciate the use of a simulator for laboratory classes is its potential - hard to deny because of the didactic goal. It means the simulation of the real, correct running of the machinery and ER systems in the changeable conditions of the ship operation. The second, unique advantage of the simulator is the possibility of malfunction introduction to their regular running, as long as to bring about a serious damage.

On real objects such experiments as axial displacement of turbine rotor cannot be demonstrated due to enormous costs or safety reasons.

There is a possibility to introduce various malfunction or interferences in the operation of the ER on the owned simulator. That exclusive feature of the simulator allows the trainee student get to know different kinds of damage and breakdowns in the ER. By means of learning about the reasons of the malfunction which led to the particular faulty situation in the ER, the trainee gains the important knowledge how to act on a real object in order to minimize the risk of disorder at work.

In order to get the positive mark, students are required to pass the consecutive blocks in a few steps because of the classes being divided according to subjects and timing (into 2 hour or 4 hour blocks). Having completed the task, student's simulation is recorded and malfunction or alarms found during the training are discussed by the instructor.

To get the final positive score, students must obtain positive results of all particular steps and carry out the simulation from the syllabus correctly, in due time, giving the explanation of the performance.

Summary

The use of the simulator as a tool for training staff connected is a key issue, due to practical application of acquired skills. Practice on the most corresponding to reality object with the possibility of supplying scenarios based on used at work procedures, tools and probable emergency situations allows the trainees to perform technological operations safely and learn from their mistakes without any influence on reality. Software simulators make the training process for ER crews easier and faster as a result of learning by one's mistakes, without the cost of damaging or destruction of a real device. That plays an important role in the process of acquiring proper maintenance skills for a future ER operator.

It is difficult to estimate how much the training on computer simulators improves safety, yet it permits to prepare engine crew to possible situations that can happen during exploitation ships engine rooms. Insurance companies and institutions that ER crew training simulators for certifications provide an classification significantly affects the reduction in the number of accidents compared with the number of fatal accidents on the training without the use of simulators.

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