Journal of POLISH CIMAC

Faculty of Ocean Engineering & Ship Technology
GDAŃSK UNIVERSITY OF TECHNOLOGY

APPLICATION OF MARINE ENGINE ROOM SIMULATORS WITH 3D VISUALIZATION FOR EMERGENCY OPERATING PROCEDURES TRAINING

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Abstract

It is well established that one of the major factors of accident prevention on board is the perfect theoretical and practical knowledge possessed by engine room officers while operating engines and auxiliary equipment.

This paper describes the latest developments in 3D computer simulation applications, designated for the familiarization with marine machinery, specially taking into account the emergency operating procedures training.

The experiences in 3D computer simulation application, the benefits and advantages of use of computer simulation in educational process of engine room officers in the Gdynia Maritime University are equally presented in this paper.

This paper describes an example of application of new 3D simulation techniques in engine room simulator based on modern - computer controlled engine room with low speed main engine MAN Diesel LMC type, applied on a container ship, where trainees have possibilities to develop operational skills, update their know-how and refresh emergency procedures.

This installation plays a vital role in the safety on board. Thus, it is of extreme importance that trainees acquire the capacity to react in a prompt and effective manner to emergency situations. This new 3D simulation technique specially emphasizes the relation between simulation and realism of machinery operation. 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.

The basic tasks for computer simulation in maritime education are equally described, taking into consideration the new methods and emergency procedures training.

This papers' conclusion is that the use of 3D computer simulation in maritime education results in increased emergency preparedness and in consequence, leads to hazard mitigation and reduces the risk of human error in the operation and maintenance of marine equipment.

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

1 Introduction

Marine engine simulators allow for operation of emergency situations that are not permissible under normal exploitation conditions due to safety limitations. Simulator's software includes also assessment features that enable objective review of trainees acquired capacities. During simulator

exercise the instructor is able to apply various exercise set-ups (initial conditions) and scenarios that include different fault finding tasks.

For this reason, engine room simulators are more and more used in maritime academies as a valuable asset for educational process [1]. The application of engine room simulators is also recommended by STCW 95 IMO Convention [2].

It is worthwhile mentioning that marine engine room simulators have 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 of engine room simulators begin to apply 3D graphical system's layout presentation 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 is 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 low speed main engine.

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 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.

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.

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 use hardware 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 LER3D Low speed engine room simulator's description

The application of new 3D simulation techniques in marine engineering education shall be analyzed on the examples of software type engine room simulator with low speed main engine. The LER3D 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.

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 main purpose of the LER3D 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 maneuvering ;

The software also generates the main engine room's sound.
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.

A general view of the LER3D simulator engine room (main engine) has been presented on fig.1.

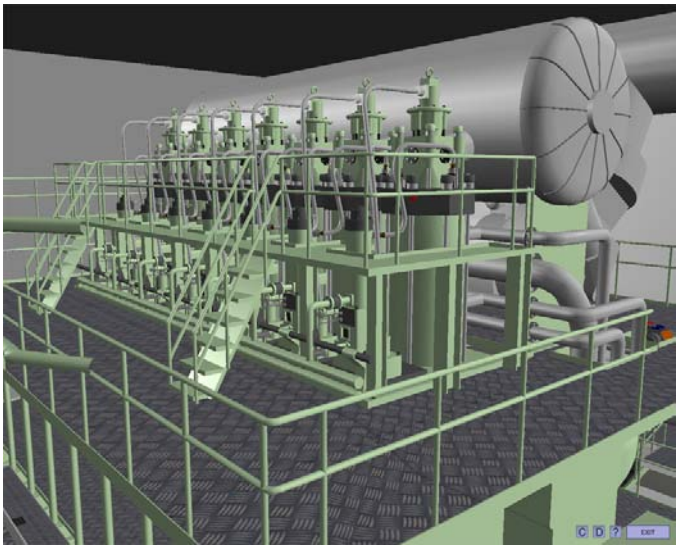

Fig. 1 Low Speed Engine Room Simulator LER3D – General view of main engine

It is well known that one of the major factors of accident prevention on board is the perfect theoretical and practical knowledge possessed by engine room officers while operating engines and auxiliary equipment. The basic role of Low Speed Engine Room Simulator LER3D is the familiarization with different operational modes, required for achieving a high level of emergency preparedness [6].

The basic role of this simulator is the familiarization with different operational modes.

This simulator allows not only for training under normal operation conditions but also

for emergency operation procedure training. The more familiar the trainee is with the equipment the faster and more effective are his reactions to a state of emergency [3].

On fig. 2 main engine's emergency control local station is presented.

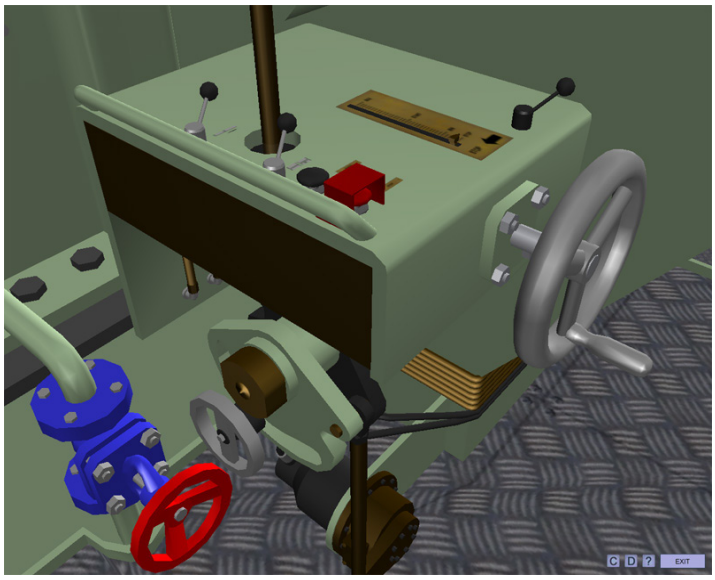

Fig. 2 Low Speed Engine Room Simulator LER3D - Main engine emergency local control station

On of important element for training emergency operating procedure in LER3D simulator is emergency power plant. The basic role of Emergency Power Plant is to supply electric current, in case of failure of main diesel generators.

General view of 3D Emergency Power Plant simulator is shown on fig.3.

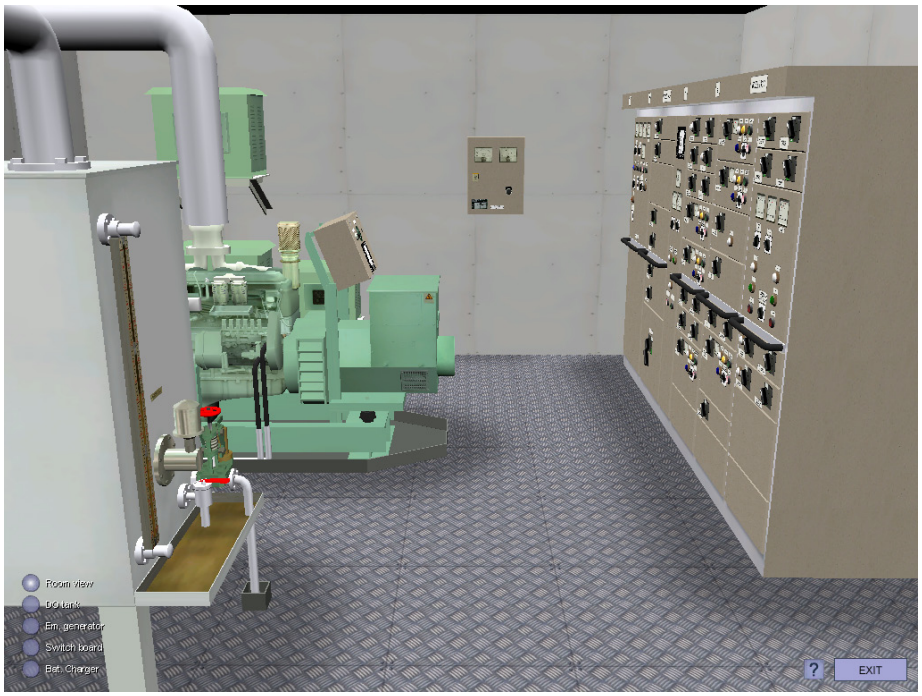

Fig.3 Emergency Power Plant – 3D simulator's general view

Emergency Power Plant diesel engine view with control panel zoom selection is presented on fig. 4.

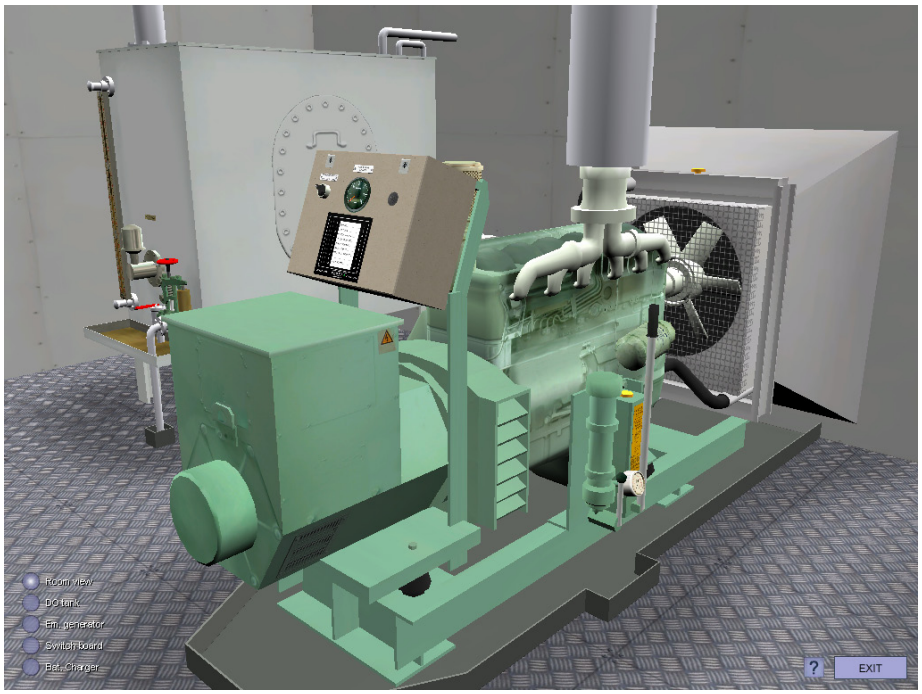

Fig.4 Emergency Power Plant simulator - Diesel engine with control panel

Diesel engine starting procedure can be effectuated in two ways:

- from control panel with application of electrical starter (24 V available)
- by emergency hydraulic starter (24 V not available) – fig. 5

In case of diesel engine emergency operation, the trainee ought to create proper pressure in hydraulic bottle and by manual lever start the engine. Emergency hydraulic engine's starter is shown of fig. 5.

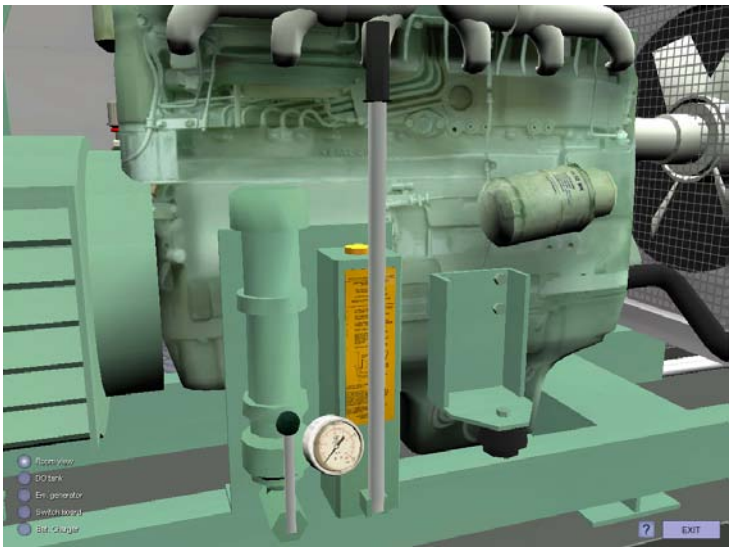

Fig.5 Emergency hydraulic starter

One of possibilities to improve realism and fidelity of operation procedures training is application of touch screen. On fig. 6 use of touch screen is presented for hydraulic starter emergency operation.

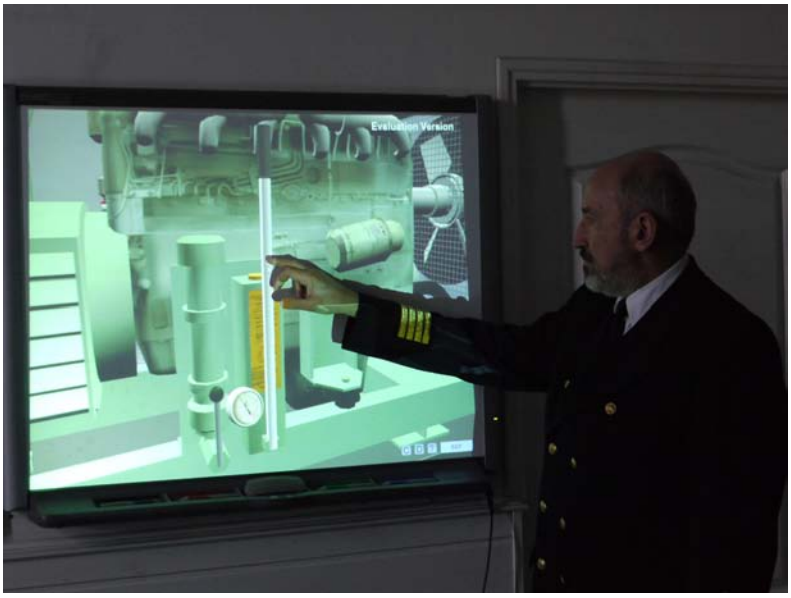

Fig. 6 LER3D Engine Room Simulator – Application of touch screen for hydraulic starter emergency operation

Emergency operation procedures are emphasizes in hydraulic systems operation.
On fig. 7 steering gear installation (rotary vane type) is presented. Trainee, by pressing push-buttons on solenoid control valve can change rudder position in emergency (manual) way.

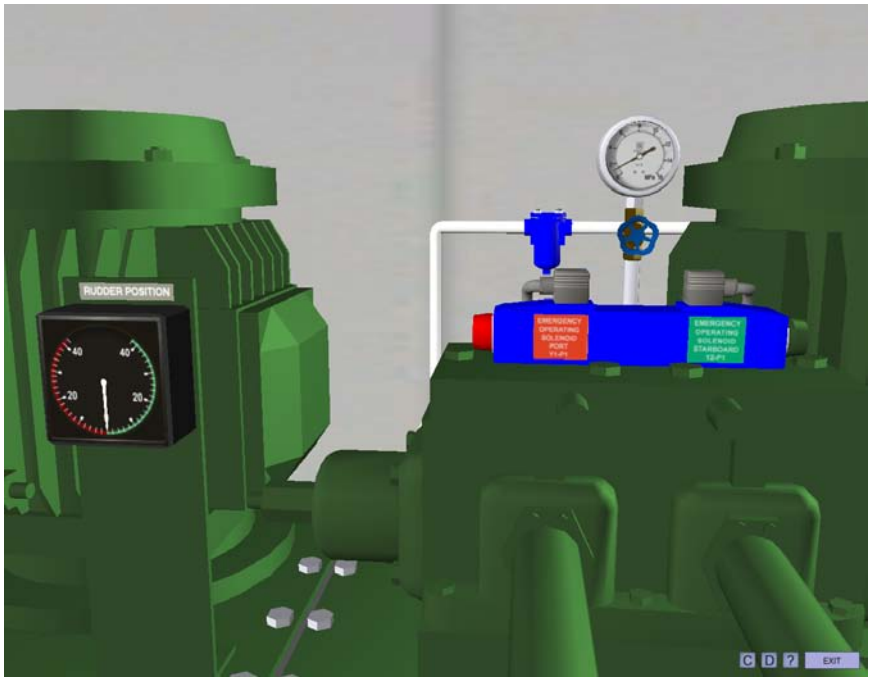

Fig.7 Steering gear installation - Solenoid control valve with emergency push-buttons

Another example of engine room installation where it this possible to train emergency situation is fire fighting system. An example of S-type fuel oil separator fire simulation is shown on fig. 8 LER3D Low Speed Engine Room Simulator in relation to fire fighting system consist of:

- CO_2 system
- Water mist system (fig. 9 – 10)

Described engine room simulator allows for very detailed operating procedure training like CO_2 or water mist system activation.

Fig. 8 S-type fuel oil separator fire simulation

Fig. 9 Water mist system – activation panel on engine control room

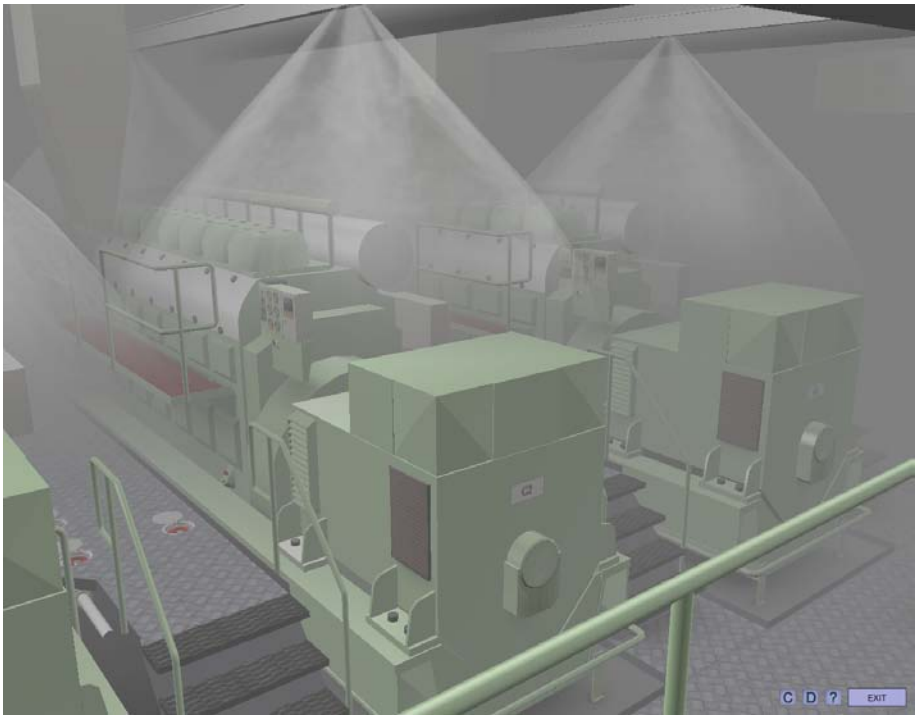

Fig. 10 Water mist activation in Diesel generators section

LER3D virtual reality engine room simulator can support and facilitate preparation of trainee for use of full mission, hardware type of engine room simulator.
This software type simulator is first of all intended for individual students' training (one student – on PC). Typical configuration of PC classroom is 8 till 12 stations + instructor station. En examples of PC classroom with two screen solution on each station and PC projector is shown on fig. 11.

Fig.11 LER3D Engine Room Simulator – PC classroom

3. Conclusion

The application of engine room simulators with 3D visualization, in maritime education leads to a better understanding of the marine machinery and results also in increased emergency preparedness and in consequence, leads to hazard mitigation and reduces the risk of human error in the operation and maintenance of marine equipment.

The application of simulator gives the operator of equipment the opportunity to get acquainted with the system's operation, before starting real life usage. For this reason, more and more often, manufacturers of marine equipment supply their products accompanied with software type of simulators.

As it results from the above, the latest developments in simulation techniques, including 3D presentation enhances the above mentioned benefits, as it brings the engine room simulators closer to reality. In consequence, the gap between operating marine machinery in simulation conditions and in real life is decreased.

As it has been mentioned above, proper navigation through the 3D simulator's elements is the key point in order to achieve the didactic purposes. The new concepts of view selection, zooming features of elements and operation by cursor and mouse clicking, as applied in LER3D low speed engine room simulator, 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.

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 and shall contribute in a similar manner to hazard prevention.

To summarize, the application of engine room simulators with 3D visualization is a valuable hazard prevention tool as it reduces the level of human error in the operation and maintenance of marine equipment.

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