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COMPUTER BASED TOOLS AND SIMULATION SYSTEMS IN THE PROCESS OF EDUCATION OF MARITIME AND TRAFFIC ENGINEERS

Information technology and tools are very important in today business and also in education of students. There are many useful tools we can use. One of them are simulation tools which are very powerful computer based systems that represent the real world and offer the opportunity to practice various situations and scenarios which are part of this real world. Simulation tools are used also for training and optimization of various processes. In this paper some simulation tools used in the process of education of maritime and traffic engineers are presented.

1. Information technology (IT) and simulation tools

Today's importance and role of IT in the business is well known. There are many benefits companies can obtain using information technology in the right way. For that very reason is important that we introduce in educational process various tools and technologies and make the students familiar also with information technology used in the performance of business processes.

Simulation tools are very powerful computer based systems that represent the real world and offer the opportunity to practice various situations and scenarios which are part of this real world. Simulation tools are used also for training and optimization of various processes.

2. Marine simulators

In our faculty a range of advanced maritime simulators are used for the training of maritime operations (Figure 1). The simulators provide a high fidelity virtual

environment for efficient and safe training of students and also marine officers and crew across the entire range of maritime operations. Simulators are effectively used to address various training needs: process and equipment familiarization, competence enhancement at multiple levels, mandatory compliance, evaluation and assessment, contingency and emergency planning, and other aspects of training and skill development.

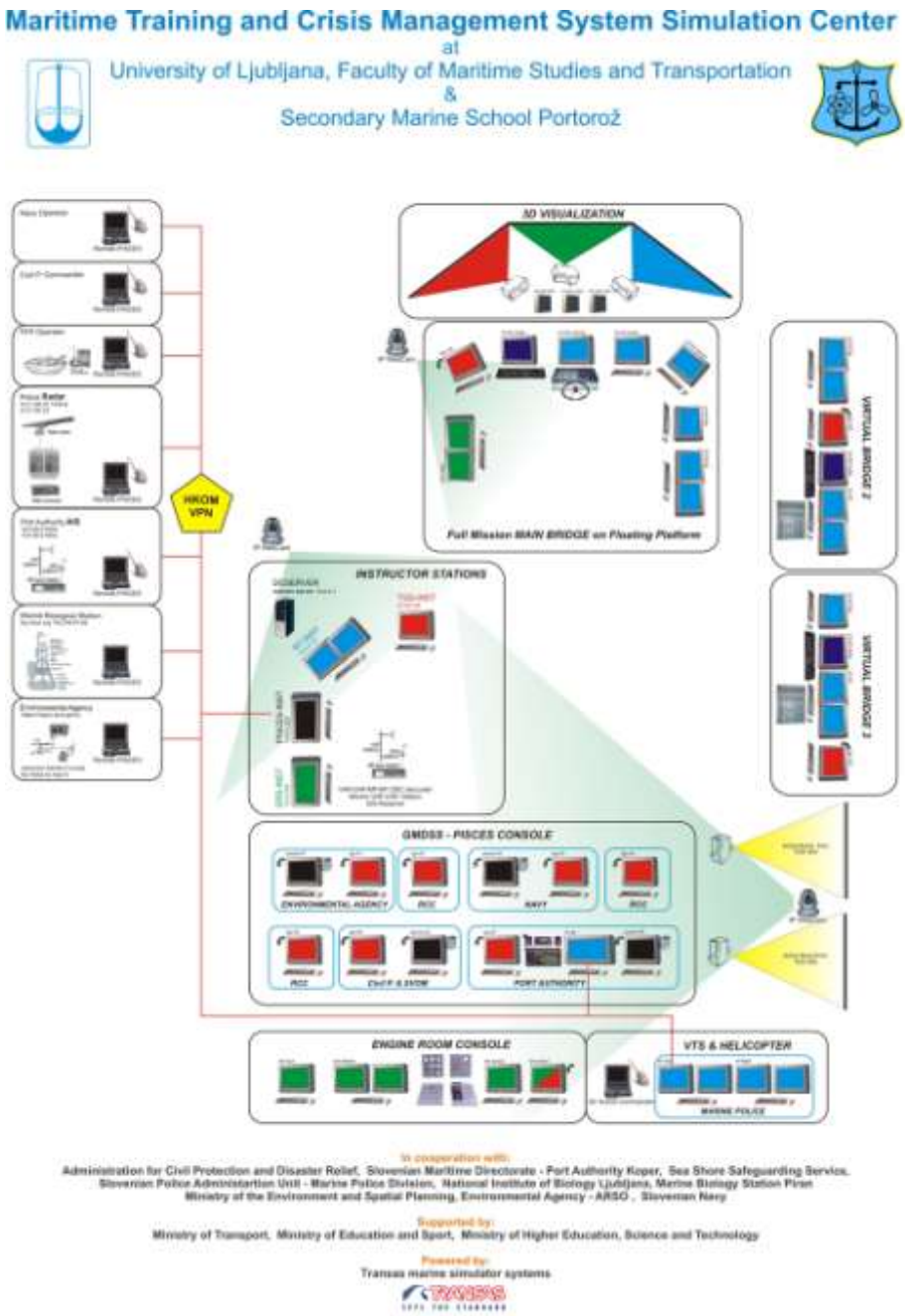

Figure 1: Maritime training and crisis management system simulation center of our Faculty [6].

Figure 2: Integrated maritime simulation solutions [6].

Integrated simulation solutions (Figure 2) allows to conduct large scale training activities simultaneously and interconnected involving different scenarios and all shipboard teams in one location, across one or more vessels/ships (there are more than 150 different vessels and more than 100 navigation areas available). Integrated simulation solutions comprises a number of functional simulators including full-mission navigational bridges, engine room simulator with CBT (Computer Based Training) educational equipment, liquid cargo handling simulators, GMDSS (Global Maritime Distress Safety System) simulator, VTS (Vessel Traffic System), SAR (Search and Rescue), ARPA (Automatic Radar Plotting Aid) simulator, ECDIS (Electronic Chart Display and Information System) simulator, and Potential Incident Simulation, Control and Evaluation System. All these simulators provide an ideal platform for large scale team building exercises involving participants with different function roles within and across the shipboard environment.

Each individual simulator retains its own complete set of working characteristics and can be used individually or in combination with any number of other simulators. The Integrated simulation solution is characterized by a high degree of visual and behavioral realism.

2.1 Full Mission Navigational Simulator (Nautical simulator)

It is a complete maritime navigation training solution for all training needs related to navigation and ship handling. Training is conducted in a realistic atmosphere with full visual, instrument and aural clues available to the trainees that can be engaged in

the complete range of navigational scenarios normally encountered at sea. All external factors pertinent to safety of navigation, including state of visibility, weather, tides and currents can be established and modified to suit the specific training requirements. The visualization of the marine environment is extremely realistic.

Figure 3: The visualization of the special training scenario [6].

It consists of three command or navigational bridges. So called "full mission bridge" is placed on the moving platform and offers a feeling of rocking and plunge of the large ships at sea. It is a 135° bridge (it offers a 135° field of view).

Figure 4: Full mission "command" bridge.

The view field can be arbitrarily rotated and also distributed to the desired smaller sectors. This bridge provides training of management of ships of various types and with various propulsion systems. There are also two additional, so called "virtual bridges" that offer also a visualization of the voyage through the canal, which is projected onto the 42" LCD screen with 60° field of view. The bridge is also equipped with steering wheel for the classic propulsion performances (integrated steering simulator realistically simulates the steering system on a vessel including simulation of the gyro compass, magnetic compass, engine telegraph, auto pilot, rudder angle indicator, non follow-up steering as well as a comprehensive range of steering alarms). The bridges are integrated with a signaling and SAR modules and with the system of radars and ECDIS system as well. The simulator is updated every year so the most modern navigation equipment can be used all the time.

2.2 ECDIS Simulator

It is a complete system for training users in understanding the operation of an Electronic Chart Display and Information System. The trainee can train special operations involved in use of ECDIS (chart loading, zooming and panning, route checking and monitoring, hiding and retrieving information, chart corrections, use of color pallets and others).

2.3 VTS (Vessel Traffic System - Versatile Simulator)

VTS operates in the domain of navigation simulator. It can be used for training at operator and supervisor levels. It is possible to prepare a scenario with two VTS stations in any navigation area. VTS station can be set with different radars, which are located in various heights, with properly located AIS base station, with video surveillance cameras, with radiogoniometer and with communication multichannel station on which all messages are stored. All traffic data are stored in a database and are available for later use and analysis.

2.4 SAR (Search and Rescue) simulator

SAR simulator is a supplement to the VTS and navigation simulator. The search and rescue module is already installed on the command bridge. Special station permits also simulation of the search and rescue with involvement of the helicopter. Aero VHF station, used by VTS center for the communication with the rescue team and ships in the searching area, is located near the helicopter station. All whether and other conditions (wind, currents, etc.) in the navigation area can be defined either by nautical simulator or in the integration with the simulator for crisis management.

2.5 ARPA/ RADAR Simulator

This simulator is used for training on navigation and collision avoidance routines relating to a marine RADAR/ARPA system (Figure 5). The simulator emulates all functionalities of modern marine RADAR system and provides also the control over traffic density, waterways, sea state and weather conditions. It can be implemented in any of the three bridges and also on the helicopter radar.

Figure 5: A typical shipboard ARPA/RADAR system [7].

2.2 GMDSS Simulator

GMDSS simulator provides complete training in communication using GMDSS equipment as found on marine mobile and offshore units and on modern ships. It is suitable for training of handling routine and distress communication at sea. The GMDSS simulator is computer based system, so all equipment is simulated through on-screen graphical controls. All the capabilities, limitations (atmospheric or

Figure 6 and 7: GMDSS console and simulation observation [6].

obstructions conditions that affect the quality of transmission) and possible errors of equipment are simulated.

2.7 Engine Room Simulator

Figure 8: Engine Room Simulator [6].

The simulator provides a realistic and accurate simulation of the shipboard engine room. Simulation training provides a platform for experiential learning about control and management of complex large engines end power generation systems. It provides for a range of main propulsion systems including two and four stroke engines and dual fuel steam turbine propulsion. It includes eight stations, one is for the instructor. Each station permits the use of the one of the three different propulsion systems: large two stroke engine (embedded in the VLCC tanker), medium speed four stroke engines (used on fishing boats) and Diesel Electric drive (used on a modern passenger ship). The simulator is integrated with a main engine console ("Full Scope" console) with five screens showing the real indicators of the engine and associated subsystems of the ship.

2.8 CBT (Computer Based Training) Simulator

Ship's engine room is made up of various complex subsystems, which cannot be described in simulator in detailed way. To provide additional knowledge about these subsystems CBT educational software is used. The knowledge is represented by detailed technical drawings of each engine or machinery, description of the process of engine's operation and process of maintenance. A simplified simulator startup device is also attached. Each student can independently follow the educational program and end with a test (result of the test are automatically stored in the archive).

2.1 Liquid Cargo Handling Simulator

In the maritime education a great emphasis to the cargo handling is made. For the simulation of basic learning contents so-called "Load Masters" are used. These are specific calculators for calculating stability and load for different types of ships. Liquid Cargo Handling Simulators are advanced training solutions and upgrades of these calculators. Liquid Cargo Handling is carried out in a dynamic environment. The Liquid Cargo Simulator simulates the real time process flow control systems in the storage and transfer of potentially hazardous bulk liquids from shore to ship and vice versa. It can be used over the full range of situations from routine operations to emergencies.

2.10 Potential Incident Simulation, Control and Evaluation System

It is an incident response simulator intended for preparing and conducting command centre exercises and area drills. The application is developed to support exercises focusing on oil spill response. Information environment of the simulator is based on the mathematical modeling of an oil spill and its interaction with geographic constraints, environmental forces, and combat resources. It is used for various tasks: response planning, decision-making and overall operational control, emergency response drills and training exercises, 3-D visualization of oil spill and response resources, calculation of operational costs based on individual resource costs and

usage time, conducting realistic exercises and drills with real-world vehicles or vessels that can be tracked on the chart display.

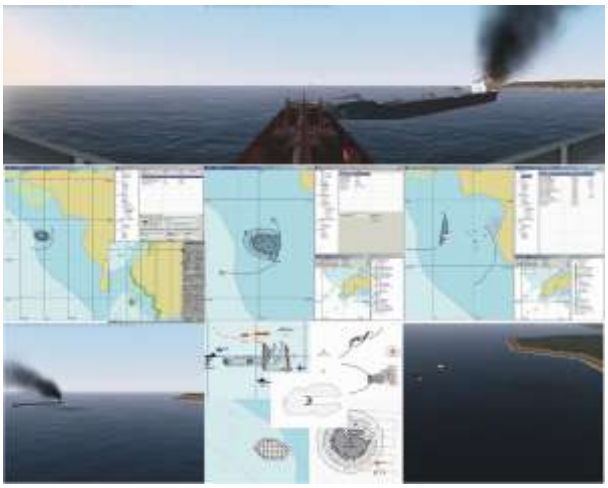

Figure 9: Incidence response in case of oil spill [6].

2.11 Active board

Active boards are indispensable element in education in the simulator-based system environment. Through video projector pictures from screens of various simulators are displayed on the board. The teacher can manage each element of the displayed simulator just with simple press on it. Teacher can also write over the displayed picture and show desired details (use, operation, problem resolving mode etc.). In this way expression of very complex systems in greatly simplified.

3. Logistics simulators

Also in the education of logistics and distribution operations some simulation tools and educational games are used. These tools and games are used to provide students with a more profound understanding of real situations in distribution and transport companies as well as the reasons why information technologies are used in contemporary supply chains.

Figure 10: Virtual bridge and active board for guided survey of simulations [6].

3.1 Logistics games[1]

During each year different educational game, designed to interest students in transport and distribution problems as well as supply chain problems are played. In this section three examples of these games are described.

Distribution game: is designed to resolve problems of ordering and allocation stock in multi-level distribution system. There are two stocking levels in the distribution system: the WAREHOSE and the RETAILERS. The student, as the owner of the company, has to control both levels and has to decide WHEN to order and HOW MUCH to order from supplier and WHEN to ship and HOW MUCH to ship to each retailer. The objective of the game is to make as much money as possible from these sales.

Transportation game: is a simulation of the daily routing and scheduling activity that must be performed by a dispatcher (student). The dispatcher is responsible for managing a fleet of trucks transporting products from a warehouse to customers in surrounding cities. The purpose of the game is to interest student in the problem of routing and scheduling delivery vehicles. After completing the game students are able to identify tradeoffs that must be considered when dispatching vehicles, describe a procedure for making routing and scheduling decision, quantify the impact of the order horizon policy variable and identify economic inefficiencies in the design of the transportation system. Advanced students should be able to develop mathematical

[1] The description of simulation tools and game was provided by colleague of mine, Patricija Bajec, M.Sc., who is working in the field of logistics.

models of the routing and scheduling activity and propose techniques to optimize the decision.

Beer game: The Beer Distribution Game (The Beer Game) [1] is a simulation game created to demonstrate a number of key principles of supply chain management. The game is played by teams of at least four players, often in heated competition, and takes from one to one and a half hours to complete. The purpose of the game is to meet customer demand for cases of beer through a multi-stage supply chain with minimal expenditure on back orders and inventory. Players can see each other's inventory but only one player sees actual customer demand. Verbal communication between players is against the rules so feelings of confusion and disappointment are common. Players look to one another within their supply chain and try to figure out where things are going wrong. Most of the players feel frustrated because they are not getting the results they want. Players wonder whether someone in their team did not understand the game or assume customer demand is following a very erratic pattern as backlogs mount and/or massive inventories accumulate. During the debriefing, it is explained that these feelings are common and that reactions based on these feelings within supply chains create the bullwhip effect.

3.2 Information support of logistics processes

The aim of this subject is to make an overview of most important information technologies, tools and systems used to support all of the logistics operations in various types of companies and to present the importance of the integration of these tools and systems. Good way to demonstrate the real power of information technology in the business is to give students the possibility to practice some of these tools.

Cargo simulator: is a cargo loading optimization software that allows creation of compact graphical load plans, selection of the optimal truck/container for transportation of the specified cargo, and maximizes truck/container utilization. Students can practice creation of manual and automatic loading plans and make comparisons between them.

Route planning software: is a route optimization software programme, which allows the routing of multiple vehicles simultaneously honor various business rules (vehicle capacities and costs, work day rules, specialty pre-assignment of orders to vehicles, customer-committed time windows, etc.). It is designed to plan an optimal route between two geographical locations and to provide a list of places a vehicle will pass by, with crossroads and directions that must be followed, road numbers, distances, etc. It also usually provides an interactive map with a suggested route marked on it.

Artificial neural network: is composed of interconnecting artificial neurons - programming constructs that simulate the properties of biological neurons. Artificial neural networks are usually used to gain an understanding of biological neural networks. It is complex computer software that provides very good facilities for approximating data, learning knowledge from data, approximate reasoning, and parallel processing. It is used for function approximation, regression analysis, pattern recognition, predictions, discovering potential problems, data mining, system identification and control (vehicle control, process control), customer requirements and habits etc.

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