New Simulation Technology for Safety & Security Training in MET

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Abstract: New technologies as Fast Time Simulation (FTS) and serious game engine software have great potential for teaching and learning in the maritime training environment and for use on board of ships. New concepts for application of these new technologies were developed at Maritime Simulation Centre Warnemunde MSCW in a research project for training of safety and security elements.
A new type of simulator called the Safety and Security Trainer (SST) was developed in a research project VESPER dedicated to the enhancement of passengers' safety on Ro-Pax- ferries using new technologies of game engines. A 3D-model of such a ship was implemented for full 3-D training environment for scenarios representing fire fighting, water inrush and security measures. An integrated support and decision system, called MADRAS, was interfaced into the SST and the entire system was interfaced to the Ship Handling simulator at MSCW in order to assists officers in coping with safety and security challenges during manoeuvres of the vessel.
The paper will introduce the basic concepts and examples will be given for results from tests in the Maritime Simulation Centre Warnemunde interfacing the full mission ship handling simulator and the Safety and Security trainer SST for complex integrated exercises
Keywords*:* maritime education, integrated training, simulation, safety and security

1. INTRODUCTION - RESEARCH PROJECT “VESPER” AND SST

1.1 Elements of the Research Project “VESPER”

The research project "VeSPer" is dedicated to the "Enhancement of passengers' safety on RoRo-Pax-ferries" and was designed thanks to various initiatives from the German government such as "Research for civil safety" and specifically "Protection of traffic infrastructures". The project is supported by the Ministry of Education and Research, under the aegis of the Technology Centre Düsseldorf (VDI). Hochschule Wismar Dept. of Maritime Studies / MSCW is involved into that project which will be finished in Aug 2011.

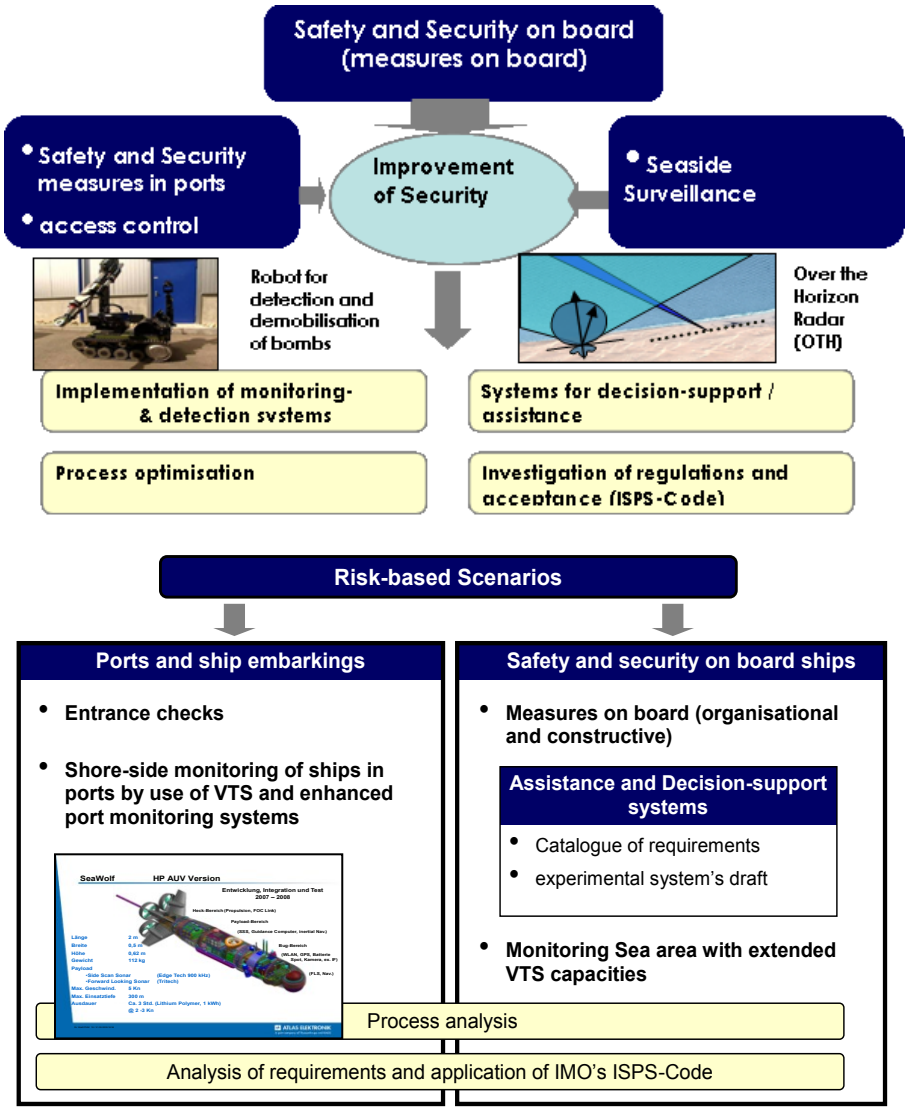

Figure 1. Research project "Enhancement of passengers' safety on RoRo-Pax-ferries" -structure, content and methods

The focus of investigations within the project "VeSPer" is laid on

- check-in procedures to increase the safety level for entrances to ferry ships and ports
- preventive measures on board (constructive and administrative)
- Sea side protection of ships in ports as well as in open sea when sailing
- investigations into potential improvement of measures in the case of a crisis

The analysis and investigations deal with subjects such as:

- use and optimisation of monitoring and detection systems
- aspects of potential integration of decision support systems on board ships
- identification of potential for optimisation of processes and measures/procedures including the integration of new innovative technologies and
- consideration and application of rules and regulations according to national and international law

Aims and structure of the overall project are given in the Figure 1. With reference to risk based scenarios in ports and on board the vessels following investigations are processed

- Process Analysis from entering the port, including booking and check in procedures, on approaching access to the vessel and access of embarkation
- Process Analysis on board the vessel from embarkation/departure until arrival/disembarkation
- Analysis of the ISPS Code and measures for the full integrated application on board
- Measurements for improved processes on board and access to the vessels and developing new security technologies and procedures
- Development of a support decision system for emergency measures on board the vessel in case of safety and/or security casualties

1.2 Initial version of Safety and Security Trainer SST and Overall Concept

From the very beginning of the VESPER project in 2008 it was planned to use the Safety and Security Trainer (SST) which was available as a basic version in the design of 2D-presentation at our Department at that time 0. It has been used for student lectures and courses for shipping companies; this simulator supports specifically the training of management level personnel. Each station consists of two monitors. One screen is called Situation Monitor and the other is named Action Monitor. The workplace, comprises the instructor console and two to sixteen stations, provides full equipment for comprehensive safety and security training. The trainee can freely move through all rooms and decks, previously only in birds eye view. The environment is shown on the situation monitor; the operation of equipment is to be done on the action monitor. The most important characteristic of the simulator is its physical model for the processes:

A fire model is incorporated into the simulator and calculates the fire propagation according to flammable materials and gives obvious realistic effects for easy perception by trainees. A modern fire alarm management system with smoke detectors and manual calling points is built into the interior of the ship and easily flammable materials are protected by fire resistant A60 walls and doors. The fire model includes smoke visualisation and a fire fighting system and equipment such as fire extinguishers, water hoses and hydrants, breathing apparatus, CO2 systems and foam. This enables the trainee to simulate a realistic fire fighting situation on board and interact with supporting teams as well as the management team on the bridge and in the engine room. During the simulation the persons' health condition is monitored in relation to oxygen, smoke, temperature and other health influencing parameters and the measurements are monitored in diagrams

One feature of the simulation system is a model calculating water inrush and its influence to the stability of the ship. A ballast system is implemented and can be used during simulation of an emergency instance to help stabilize the ship. The trim and stability calculator is used to predict the effect of a water inrush and show the stability, bending moments and share forces. Water tight doors are built into the modelled vessel. The ballast and stability measuring system is implemented in the simulator, which enables the trainee to take countermeasures.

2. SPECIFIC SIMULATION FEATURES FOR THE RESEARCH PROJECT "VESPER" IN THE SST-SIMULATOR

2.1 Integration of innovative 3D-visual model of SST

During the project it turned out that it would beneficiary to implement new features for safety and security measures and to take advantage from new technologies like game engines and 3D-modelling capabilities. One of the most challenging innovations developed during the research project is the improvement and further development of the Safety and Security Trainer SST 7, specifically the implementation of the 3D-designed RoPax ferry "Mecklenburg-Vorpommern" (**Figure 2.**) due to the strong ties between the Hochschule Wismar and the industry.

Figure 2. Co-operation between Hochschule Wismar and shipping company Scandlines in VESPER: Ferry "Mecklenburg Vorpommern" as object for simulation in SST and SHS

The first step was to develop an application of the ship plans which were intricately realised in a 3D Studio Max version for test trials of the spectacular 3D-visualisation of the entire vessel. All decks of the RoPax ferry are now available in the 3D-version and integrated along with the dynamic safety equipment into the games engine by RDE. Functional tests of the developed system are in progress and already running successfully. **Figure 3** and **Figure 4** show the 3D visualisation of decks and public areas of the ferry.

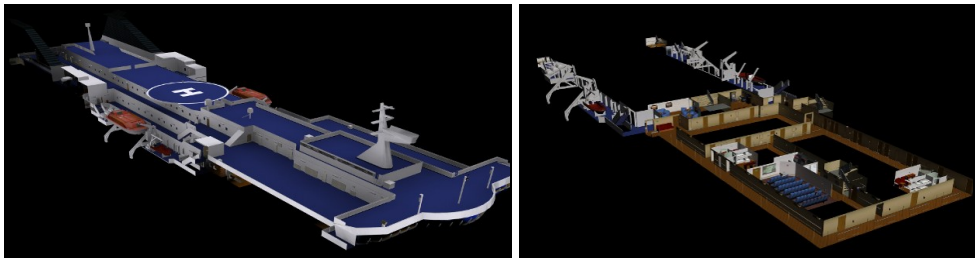

Figure 3. Deck 6 (left) and 9 (right) of the RoPax ferry in 3D visualisation

Figure 4. Public areas of the RoPax ferry in 3D visualisation

2.2 Safety and Security Components in the 3D Visualisation Model

In contrast to the 2D model, where the strategic figure is guided through the decks, now the trainee in the 3D model moves and reacts from his own perspective and can operate the entire spectrum of safety equipment on board the vessel. In the case of fire he activates the alarm from the next manual calling point. According to the safety procedure on board, and after the release of the fire alarm from the bridge, the fire squad team (each trainee with specific role) will operate the fire fighting equipment including the breathing apparatus, fire protection suits, fire extinguishers, fire hoses and other tools (**Figure 5** & **Figure 6**).

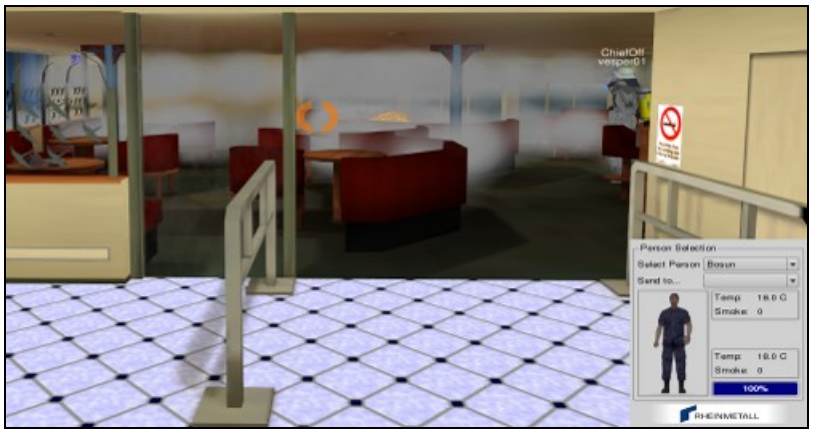

Figure 5. Situation monitor in 3D -Fire fighting / smoke propagation in public area on deck 5 RoPax ferry

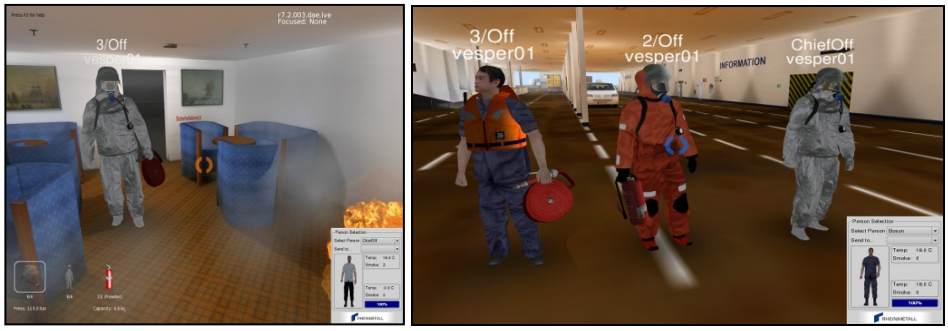

Figure 6. Crew in action with fire fighting equipment in lounge and car deck of RoPax ferry

On the bridge and in the engine control room (Figure 7.) all the operational consoles including; steering panel, fire panel, alarm panel, ballast- and stability panel and the water drenching system, are designed to a generic model and can be integrated on other designed vessels as well. All consoles and panels on the bridge and in the ECR correspond to the integrated sensors placed all over the vessel. The Master and officers operate an interactive board system and can be trained in a wide spectrum focussing on safety and security procedures.

Figure 7. Interactive consoles on Bridge and in Engine Control Room

In addition, the security components can be practised on the new simulator. For example the RFID based appliance, which is integrated into the SST bridge station, enables the officer to observe the movement of persons on board. In all security declared areas the doors are locked and the areas are accessible only by entering the specific code into the lock system beside the doors. On all decks cameras are installed and can be monitored from the bridge station. The camera view can be changed and adjusted by the instructor.

In the case of a bomb alert the crew can investigate the affected area with a bomb detector. On approaching any dangerous object, the detector sounds alarm. Figure 8 shows a crewmember crawling in the direction of a suspicious suitcase. When the bomb has been identified the dangerous object can be removed with a new remote controlled defence system called TELEMAX. This multipurpose vehicle can be used to detect and approach any suspicious objects from a safe distance using the remote control.

The threat of gas attack has also been integrated into the simulation system. In this kind of a threat the crew could approach the affected area wearing protection suits and

breathing apparatus and can undertake all appropriate measures, i.e. for ventilation and evacuation of passengers.

Figure 8. Bomb search in the lounge and removal of suspicious object by TELEMAX

2.3 Support and Decision System MADRAS

The simulation platform includes a new support and decision system called MADRAS. This system was designed by the company MARSIG mbH Rostock and especially tailored for the SST simulator and the simulated RoPax Ferry "Mecklenburg-Vorpommern". The MADRAS computer is linked to the SST simulator and receives the sensor data from the SST. The control module selection contains the following elements for automatic survey; FIRE, EXPLOSIVES, SECURITY, EVACUATION, GROUNDING and FLOODING. In the event of any sensor alarm the Madras menu opens and displays the affected deck/area with the activated alarm sensor. The following menus can be selected:

- MONITORING – list of all existing sensors, grouped in different types and presenting the actual data of sensors
- DECISION SUPPORT – recommendation structure and decision advise in specific safety- and security issues including necessary procedures:
- OVERVIEW– deck overview displaying all installed sensors and highlighting the activated ones including diagrams
- DEVICE CONTROL – list of all sensors – according to type, location, showing maximum and minimum values and the adjustable alarm level
- PROTOCOL CHECK– date and time of sensor activation, location loop of sensors, duration of alarm, values of alarm and time record for reset
- CONTROL – menu for sensor connections, support manager, value input, extended functions and system options

MADRAS is an interactive system and is a helpful tool for Master and officers in critical situations. The system guides the officer through all necessary choices and helps in finding the correct emergency procedures. This helps to avoid dangerous mistakes and ensures not missing any steps imperative for the safety of the vessel. MADRAS was recently installed into the SST and is still under development. Test trials are running successfully (see Figure 9 & Figure 10). The basic system of MADRAS was tested on board of the ferry "Mecklenburg-Vorpommern" during the last two years.

Figure 9. MADRAS – Overview of deck and installed sensors, diagram of activated sensor

Figure 10. MADRAS - decision support for security measures and escape routes

3. INTEGRATION OF SST INTO THE MARITIME SIMULATION CENTRE MSCW FOR COMPLEX SCENARIO TRAINING

The new simulator, implemented as Safety and Security Trainer SST, was designed by the manufacturer Rheinmetall Defence Electronics Bremen in co-operation with Wismar University, Department of Maritime Studies ([2] to [4]). The simulator can specifically be used for stand alone and for integrated training with the MSCW. The complex simulation platform Figure 11 with several full mission simulators enables the department to simulate the entire "system ship" with the maritime environment including VTS and offers challenges to officers and crew on board the vessels (http://www.sf.hs-wismar.de/mscw/). The simulator arrangement (MSCW) comprises already

– Ship Handling Simulator SHS with for 4 Full Mission bridges and 8 Part Task Bridges,

– Ship Engine Simulator SES with 12 Part Task station and
– Vessel Traffic Services Simulator VTSS with 9 operator consoles

10 SST-stations are being additionally installed in the MSCW this year (Figure 12): eight training stations (one of the stations on the SHS Bridge 1) and two instructor consoles as well as one communication computer system and another computer for the new support and decision system MADRAS. Each station (with head phones or microphone for communication) consists of two monitors used as Situation Monitor and Action Monitor. Complex scenarios can be developed and trained as for example in Figure 13.

Figure 11. Overview on MSCW (left), Bridge 1 of Ship-Handling-Simulator (SHS) with new Displays of Bridge Safety & Security Centre of SST and MADRAS Decision Support System (right top) and Training room of new Safety & Security Trainer of SST (right bottom)

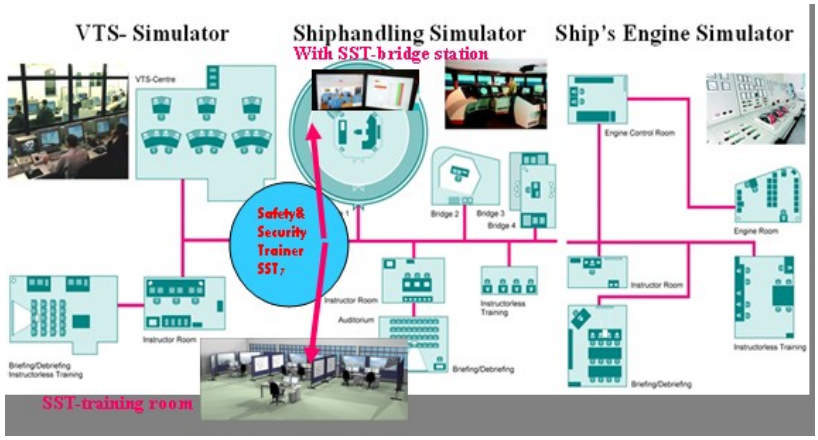

Figure 12. Simulation Centre Warnemünde (MSCW) – structure and interfacing network with new Safety & Security trainer SST

1. SST - Scenario 3D - MECK-POM - Fire in Lounge Deck 7
Objective: Fire Fighting and Training Procedures in case of fire event
Initial Parameter: 3 Fire Cells Lounge activated - wood material, quantity 20kos
Capt., Ch.Off., 02nd Off. on bridge, 03rd Off. in lounge with BA, 2 Passengers in lounge
Ch.Eng., 01st Eng., 03rd Eng. (ECR), 2nd Eng. (Boats Deck)

2. SST - Scenario 3D - MECK-POM - Gas Attack Lounge Deck 7
Objective: Precaution Meausures and Procedures in the event of gas attack
Initial Parameter: Lounge selected under parameter for gas attack - selected gas "Sarin"
Capt., Ch.Off., 02nd Off. on bridge, 03rd Off. located in front of lounge, equipped with HPS and BA.
Ch.Eng., 01st Eng., 03rd Eng. (ECR), 2nd Eng. (Boats Deck)

3. SST - Scenario 3D - MECK-POM - Bomb Alarm Lounge Deck 7
Objective: Precaution meausures and procedures in the event of bomb alarm
Initial Parameter: Lounge selected under Parameter for bomb alarm - suitcase with explosive placed in lounge
Capt., Ch.Off., 02nd Off. on bridge, 03rd Off. located in front of lounge, equipped with HPS and BA.
Ch.Eng., 01st Eng., 03rd Eng. (ECR), 2nd Eng. (Boats Deck)

Figure 13. Sample scenarios for interfacing ship handling simulator with new Safety & Security trainer SST

4. CONCLUSIONS AND ACKNOWLEDGEMENTS

Within the frame of investigations into potential enhancements of maritime safety and security the use of simulation facilities were investigated. The Safety and Security Trainer SST is a new product developed by Rheinmetall Defence Electronics (RDE) Bremen in co-operation with the Wismar University, Department of Maritime Studies in Rostock-Warnemuende. It can be operated in a standalone version for up to eight training stations and could be extended to include the training of the entire crew. The SST is also designed for integration into complex systems and was interfaced now with the existing ship handling simulator SHS of the MSCW for training of comprehensive scenarios in combination with the SHS, SES und VTS. The complex simulation platform with the full mission simulators enables the trainees to simulate the entire ship system and presents challenges to both officers and crew. A new quality of scenarios can be generated now for the comprehensive training of ship officers. On the other hand this new and enhanced simulation facility allows for in depth studies of the effects of ship's safety procedures and to evaluate their efficiency.

The investigations and developments described here are mainly performed in a project for research and technical development funded by the German Ministry of Education and Research Berlin and surveyed by VDI Technology Centre Düsseldorf. During the project also cooperation were established with World Maritime University. This cooperation covers e.g. aspects of international harmonisation of training requirements and standards. The authors would like to thank Rheinmetall Defence GmbH as well as the company AIDA Cruises Ltd and the involved ferry companies TT-Line and Scandlines for their grateful assistance and cooperation.

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