Maritime Simulation Technology for Training and Research at the Maritime Simulation Centre Warnemünde MSCW

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Abstract: The Maritime Simulation Centre Warnemünde had its inauguration in 1998 and was upgraded just recently in 2008. The Centre accommodates several sophisticated Full Mission simulation systems built by Rheinmetall Defence Electronic, connected to a common network comprising Ship-handling bridge simulators complex ship's engine simulators and also Vessel Traffic Services (VTS) simulation systems. Numerous Part task simulators allow the effective preparation of the trainees and specific systems for briefing and debriefing can be used for extended training and assessment. A new Safety and Security Simulator was just installed as a 3D- virtual environment to be completed for new ship models until 2011. Networking of all simulators at the Centre in Complex Operation Mode gives a comprehensive overview of all maritime traffic events. At the same time, simulators can be operated either collectively or independently for given exercises. In the paper a detailed description of the simulators will be given and some activities will be mentioned as examples for the work in the centre.

Keywords: Maritime simulation, Training, Ship manoeuvres

1. INTRODUCTION – GENERAL ASPECTS AND EXCELLENT CONDITIONS FOR MARITIME TRAINING AT MSCW

The Maritime Simulation Centre Warnemünde (MSCW) is situated in the city of Rostock in the Northeast of Germany. The centre belongs to the Warnemünde Department of Maritime Studies of the Hochschule Wismar, University of Applied Sciences -Technology, Business and Design. This centre and the department are embedded in a sound maritime environment: it is based on the tradition and experience of 160 years of ship officer education in this area and the collaboration with renowned shipping companies such as AIDA CRUISES and LAEISZ which have their headquarters in the same city.

There are excellent technical facilities and conditions based on human resources for education and training as well as for research in this centre:

The Centre accommodates several sophisticated Full Mission simulation systems built by Rheinmetall Defence Electronic (RDE) Bremen, connected to a common network comprising Ship-handling bridge simulators (SHS) with different levels of equipment, complex ship's engine simulators (SES) and also Vessel Traffic Services (VTS) simulation systems (Fig. 1). Numerous Part task simulators allow the effective preparation of the trainees and specific systems for briefing and debriefing can be used for extended training and assessment. The simulators are in full conformity with IMO regulations (STCW'95) and certified by international classification societies (Germanischer Lloyd and DNV).

A great variety of ship types for the simulation are available in the ship handling simulators of SHS modelled by our own staff and in the SES the ship engine types comprises 8 different types of machinery systems among them the diesel electrical propulsion system and azimuth thruster models.

The Maritime Simulation Centre Warnemünde has proven high standard and reliable equipment since its inauguration in 1998 and was upgraded just recently for a budget of more than 4 Million Euro in 2007. The innovative equipment is based on latest on-board technology and guarantees to meet up-to date challenges to extend and refresh practical skills of ship personnel. The complete assembly sets new international standards for improving maritime training by not only providing comprehensive simulation of separate procedures alone: due to the interfacing of the simulators there is a higher realism in simulation of operational interchanges e.g. between navigators and engineers which can be reached by interfacing the Shiphandling simulator to the ships engine simulator.

It has been successfully operated by the staff of the Department and its Maritime Education and Training Centre METC since 1998 both for students training to get licensed ship officers on management level as masters or chief engineers and for commercial courses. The sound basis of its personnel allows for a wide spread content of maritime

courses delivered for shipping companies and maritime authorities. Competent instructors are able to deliver highly qualified courses based on practical expertise and sound academic background of the professors and instructors. In parallel to the permanent staff for education & training there is always a group of about 10-15 junior and senior researchers working in numerous national and international projects which could be attracted from industry administrations or EU commission due to the competitiveness and reputation of the department in research over the years.

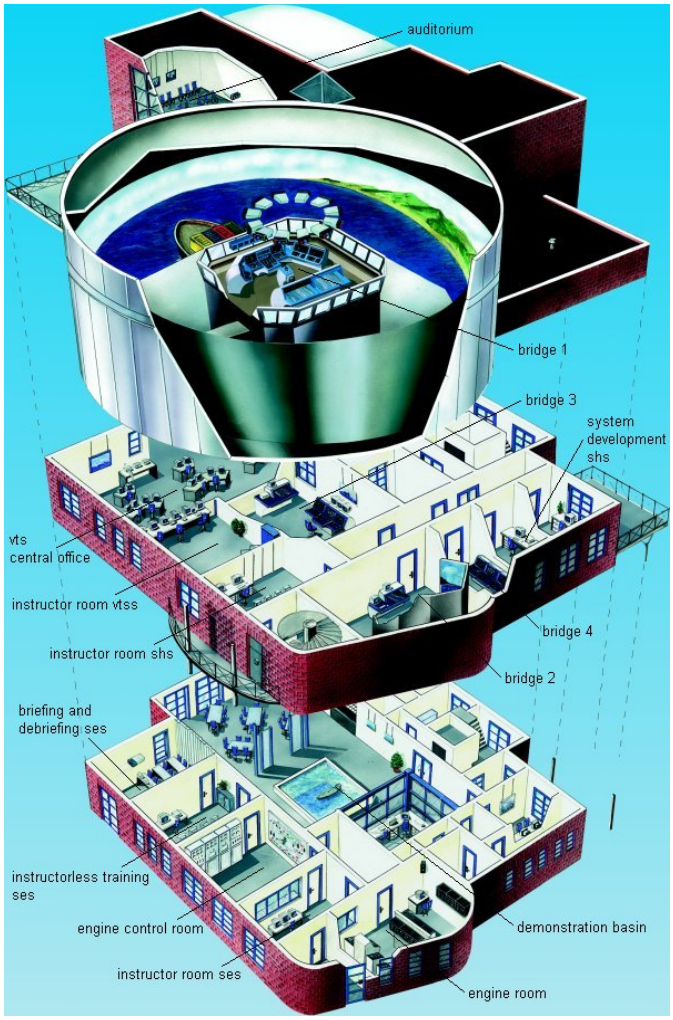

Fig. 1: Wismar University's Maritime Simulation Centre at Warnemünde (MSCW) which comprises a series of 4 Ship handling / Bridge Simulators and a Safety and Security Simulator (top and middle floor), Ship Engine Simulator (basement) and VTS simulator (middle floor).

In the following chapters a detailed description of the simulators will be given and some activities will be mentioned as examples for the work in the centre.

2. SHIP HANDLING SIMULATORS (SHS)

The Ship Handling Simulator SHS comprises four Full Mission ships' bridges and additional 8 smaller part task simulator stations are available which are able to simulate the steering and manoeuvring behaviour of ships of different types and sizes of vessels. The propulsion systems of the simulator ships offer a great variety – it can be conventional single screw arrangements, twin screw, Voith propellers or Waterjet, or even ships with up to 4 azimuth propellers. All bridges can be operated in the exercises either separately or even all 12 own ships together in one complex scenario. The bridges are equipped with all necessary elements for navigation RADAR/ARPA, ECDIS and communication like GMDSS and AIS facilities.

Fig. 2: Bridge 1 of Ship Handling Simulator with 360° projection system with full Integrated Bridge System NACOS and other features

Fig. 3 Consoles with multiple steering handles 4 Azipod steering handles on exchange panels for bridges

Bridge 1 comprises a fully integrated replica bridge mainly based on the integrated bridge system NACOS developed by SAM Elektronik Hamburg. Suitable for one-man ship operation it permits voyage planning, automated track and speed control, locating, communication and engine monitoring operations. It is also supplemented by a new type of emergency management system for advice on measures to

be adopted in the event of fire, water inrush, evacuation and man over board alerts. A high-performance projector-based 360-degree real time visual display system, the DISI 8M provides panoramic view of ultra-realistic scenarios in both day and night simulation modes. This Bridge A is also able to simulate the entire range of ship operation via networking with the engine simulator.

Fig. 4: Bridge 2 of Ship handling / Bridge Simulators with 260-degree visual display and NACOS (Radar, Conning and Track Radar) as well as handles for twin screw and twin rudder in exchange panel

Fig. 5: Bridge 3 & 4 of Ship handling Bridge Simulators with 120-degree visual screen display and NACOS (Radar, Conning and Track Radar) as well as handles for twin screw and twin rudder and 2 Azipod Handles

Bridge 2 (Fig. 4) is featuring a projector-based 260-degree visual display system which can be specifically used for manoeuvring a ship from bridge wing during going-along-side or tow-boat operations. The remaining two simulation bridges 3 and 4 are equipped with 120-degree visual display screens. All of the Bridges are ready for integrated training carrying ECDIS, RADAR ARPA, track pilots and other elements. The consoles are prepared with multiple steering handles for conventional and sophisticated propulsion systems, bridges 1 & 2 have exchangeable panels for Azipod (Fig. 3), Waterjet and various conventional propulsors.

Networking of all simulators at the Centre in Complex Operation Mode gives a comprehensive overview of all maritime traffic events. At the same time, simulators can be operated either collectively or independently for given exercises so that, for example:

- The 4 bridges 1 - 4 may be used for separate exercises but for more complex Scenarios, they can be combined to operate in one area under the direction of up to four instructor consoles.
- As indicated earlier, Bridge 1 can be interfaced with the Ship Engine Simulator and so replace its own integral ship engine simulation module with the full function of the Full mission SES.
- Simultaneously the briefing and debriefing can be done in extra rooms with special replay equipment at the same time when the next trainee groups are already in the simulators.

Each of the simulators has workstations for the preparation of students by means of individual part-task or instructor-less training (ILT) i.e. 8 places for Shiphandling exercises with steering handles in the SHS briefing area allow manoeuvring of ship in birds eye view conning screens, on ECDIS and additionally with RADAR/ARPA (Fig. 6). Also these stations are suitable for training in voyage planning; the routes prepared on these stations can be transferred to the bridges to be executed in the full mission simulator exercises.

Fig. 6**:** Two samples of the eight Instructorless Training Stations (ILT) as part task simulators at SHS

One of the most important features and competencies for simulation training and research is the capability to model simulator ships and sea / port areas to be used in the Ship Handling Simulator. For this purpose new software tools were developed at MSCW for enhancing the tuning process for simulator ships: The fast time simulation program SIMOPT allows for calculation of series of manoeuvres 100 times faster and the SIMDAT provides a variety of analysis options in assessing the results of the simulations both from fast time simulation and from real time simulation in SHS.

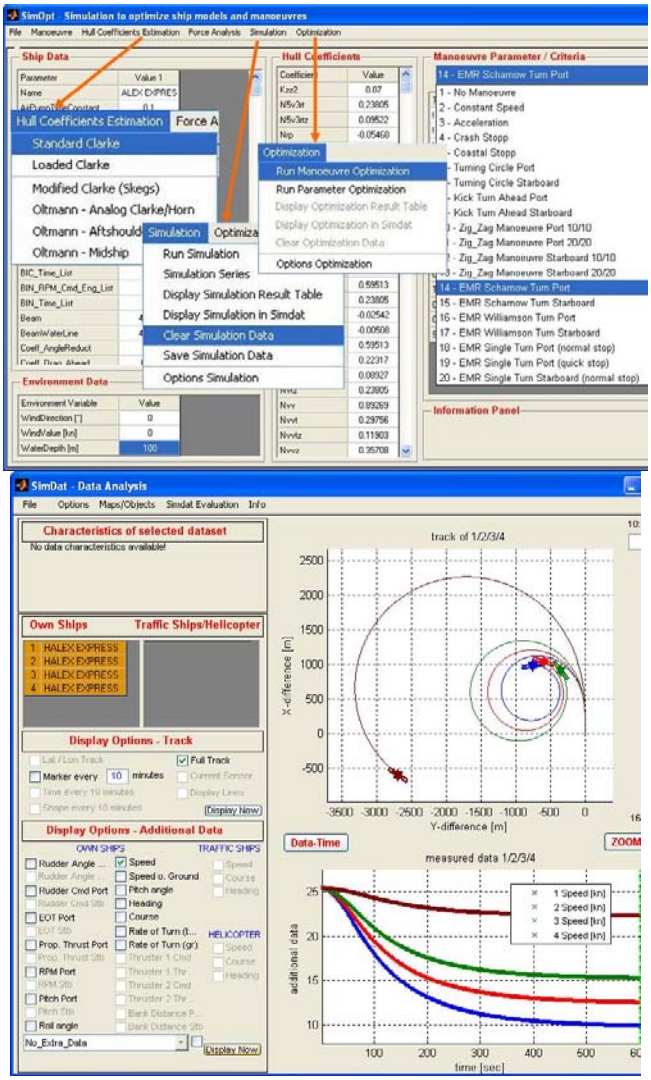

Fig. 7: Fast time simulation and assessment software modules: Top: SIMOPT - Interface Elements as Top Menus - Detailed Selection of Simulation and Analysis Elements from several menus as well as Manoeuvre Command files; Bottom: SIMDAT - Simulation result analysis in plots: Main interface and results for turning circle series varying rudder angles – Tracks and plots of time histories

3. SHIP ENGINE SIMULATOR (SES)

Housed on the basement floor the full mission ship's engine simulator concept replicates typical modern plants of merchant vessels (e.g. in Fig. 8, featuring a slow speed two stroke 5 RTA 84C 102 rpm diesel engine with continuous rating from 20.000 kW). The list of engine and propulsion models comprises:

- Slow Speed 2-stroke Diesel Engine (Sulzer 5RTA84C) with fixed or controllable pitch propeller
- Slow Speed 2-stroke Diesel Engine (MAN B&W 6S60 MC-C) with fixed or controllable pitch propeller
- Medium Speed 4-stroke Diesel Engine (MaK 8M32) with fixed or controllable pitch propeller
- High Speed 4-stroke Diesel Engine (Caterpillar 3616) with fixed or controllable pitch propeller
- Multi plant engine with 2 High Speed 4-stroke Diesel Engine (Caterpillar 3616) with 2 controllable pitch propellers
- Diesel-electric propulsion plant with 6 Diesel generators (Wärtsilä 12V46C), Medium-voltage and Low Voltage Network and propulsion engines for 2 Azimuth propellers

Fig. 8: SES Control room: Electric switchboard of Full Mission Ship Engine Simulator with Medium Voltage panel in the centre (bottom) and engine operation panel (top).

The full mission simulator has typical Control panels and displays while also simulating typical background noise effects and up to 300 types of alarms/ failures. Designed for training ship's engineers, its main features are:

Engine Control room incorporating a machinery Monitoring and Control System (MCS) together with various control platforms for the main engine and auxiliary systems as well as main switching panel.

Engine plant including not only the main engine and its supply systems, but also those for lubricating oil and fuel preparation, power supply, steam generator with turbine, and a cooling system for stores and the cargo area.

Authentic realism realised by the adoption of full thermodynamic process representation based on difference equations - in marked contrast to Look-up-table-driven models used in most simulators. This allows, for example, engine diagnosis by a real off-the-shelf diagnostic system found aboard ships. Thus cylinder and injection pressure as well as angle of crankshaft rotating can be analysed.

In briefing/debriefing rooms students undergo computer-based part-task training for individual system elements in preparation for training on the full mission system, 12 stations are available as Screen based SES simulators with the full coverage of the full mission versions, but operated as desk top simulators. Replay functions allow for visual assessment of results in parallel with all simulated exercises, additional comprehensive tools for detailed assessment and exercise evaluation are included.

4. VTS -SIMULATOR (VTSS) AND OTHER SIMULATION FACILITIES

The VTS simulator is sited on the first floor of the centre, designed for mandatory training of all German VTS operators under the auspices of the Federal Ministry of Transport. It can also be used for demonstration of VTS services to ship officers and training of radar pilots, since it covers all aspects of the operation of radar and AIS-transponder supported traffic surveillance and associated communication procedures.

Its control section comprises 3 instructor consoles with exercise-control displays based on an ECDIS-type presentation. Since communication is crucial for VTS operation each instructor console is equipped with full VHF facilities matching GMDSS A1 standards. In order to minimise the probably high workload due to communication, for the instructors prepared audio samples can be relayed automatically.

The trainee section consists of 9 trainee workstations, or 'VTS basic units'. In effect, these are standard mobile consoles with 2 monitors, VHF and telephone units and which can be configured to form specific working places or alternatively, up to three VTS centres acting in parallel or within the same operating environment. The man-machine-interface at the trainee's workstation with a configurable layout comprise radar pictures and synthetics, ECDIS information, way-time-graphs, ship data processing and display of hydro-meteorological data. The trainee workstations can be configured to build different VTS centre layouts.

Apart from these facilities there are also other simulators available, as for instance Tanker simulator, Liquid Cargo Handling simulator and a GMDSS-simulator for 12 training stations. A new development is the Safety and Security Simulator (Fig. 9) which was just established into the training program for general cargo and container vessels. It can be interfaced with the SHS for complex training scenarios. It is now to model a passenger cruise vessel for this new type of simulation.

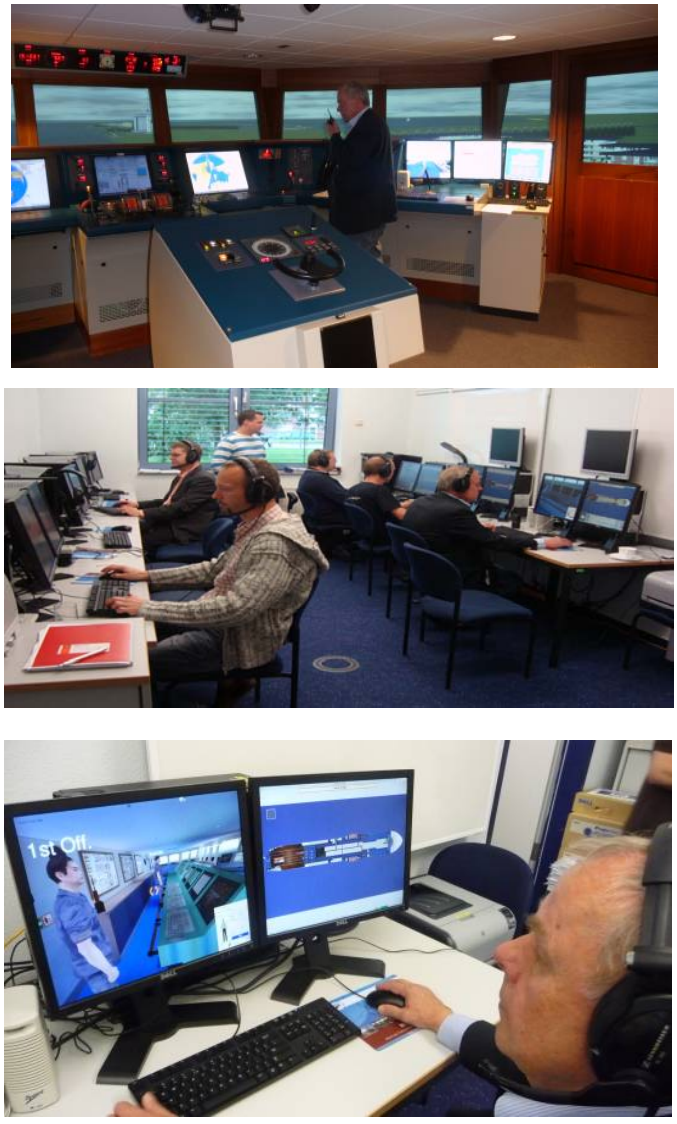

Fig. 9: Bridge 1 of Ship-Handling-Simulator (SHS) with new Displays of Bridge Safety & Security Centre of SST and MADRAS Decision Support System (right top) and Training room of new Safety & Security Trainer of SST (right bottom)

5. EDUCATION, TRAINING & RESEARCH AT MSCW

One of the Centre's primary aims is training of maritime students as well as the further education for ship's officers and pilots. Students undergo training to Bachelor / Master degree level, enabling them to become deck officers or ship engine officers holding unlimited certificates of competency

as well as dual purpose officers on management level. Further courses specialising in bridge team training, Cruise liner and Ro-Ro ship operation and ship engine operation as well as the conduct of high speed vessels (see

The MARITIME EDUCATION AND TRAINING CENTRE (METC) at the Department of Maritime Studies of the Wismar University is a special unit offering further education courses for navigational and technical ships officers and other clients. There are courses according to the STCW-Code and IMO Model Course as well as tailored courses for shipping companies, pilots and other clients from the maritime business. By using the Maritime Simulation Centre Warnemunde reality-like scenarios intensified by various ships models and sea regions can be achieved.

Research is also a key objective and the Centre is excellently prepared for particular large-scale projects. It is well established e.g. with investigations for inland waterway and port design (Fig. 10).

New ship operation technologies were developed using simulation on board as prediction in ECDIS e.g. for effective application of rudders (Fig. 11).

Meanwhile research work carried out under the European Commission's Framework programs continues, current projects include e.g. MARNIS, aimed at enhancing Maritime Navigation and Information Services. There is also a close involvement with EU projects concerned with improving and harmonisation of simulator use and scenario development in MET throughout Europe – projects for which the Centre is now uniquely qualified for advancing state-of-the art maritime technologies and applications.

Fig. 10: Investigations for inland waterway and port design under wind impact - View from Simulator Bridge 1 (loaded coaster) during an encounter situation with another pusher tug-barge system

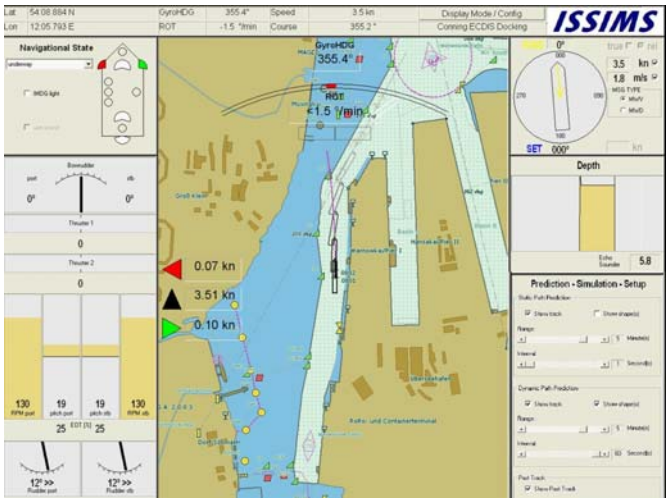

Fig. 11: Layout concept for Manoeuvring Prediction in ECDIS (left) with integrated presentation of different track predictions (centre) for rudder manoeuvres

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