SIMULATIONS

FOR SHIP HANDLING TRAINING

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The use of simulation tools is a proven method for many applications in the domain of ship manoeuvring. It has been found highly useful in the form of huge full mission ship handling simulators for training, as well as for port and fairway investigation. These simulators, however, are designed based on real time simulations to mimic real processes as closely as possible and are therefore very time consuming to use. Tests using portable simulators on board ships, to try out manoeuvring concepts before they are undertaken in real life, have not been successful as they have not been manageable to use.

Although the IMO's e-Navigation concept requires voyage planning from berth-to-berth, there are no electronic tools available to design an effective manoeuvring plan for port arrival or departure yet, or to efficiently demonstrate the use of manoeuvring characteristics.

With this in mind, the 'Fast Time Simulation' (FTS) method has been developed at the Institute for Innovative Ship Simulation & Maritime Systems (ISSIMS Institute) at Wismar University in Germany. It has now been tested at the Maritime Simulation Centre Warnemuende (MSCW), the World Maritime University Malmö, and the CSMART Training Centre, Almere.

This technology is the foundation of a unique software system for simulation-augmented manoeuvring design monitoring and conning, better known as 'SAMMON'. The basic principle of this system is to condense full information from trial results into a dynamic model, capable of simulating wind, current and restricted water effects.

This software has the potential to replace conventional paper information for the following reasons:

- The simulation is carried out at a very high speed: the system is continuously calculating every second of the 24 minutes of the vessel's manoeuvring time by using innovative simulation methods and complex math ship models; the same ones used in the Full Mission Ship Handling Simulator
- The simulated manoeuvres are each displayed in their respective sea chart: scaled to the ranges of that Electronic Navigational Chart (ENC) system and in the desired waterway environment to allow for the precise judgement of manoeuvring opportunities and decisions for actions and discussion of limiting factors
- The smart interface allows the ship to be steered by a human navigator and to use the software for various applications

This opens up a great variety of opportunities for:

- Demonstration of manoeuvring characteristics to familiarise crew with the ship, and for discussing alternative manoeuvring strategies. In contrast to the limited set of manoeuvres in a Manoeuvring Booklet, nearly any effect of a ship's control setting and environmental effects can now be displayed [1]
- Offline manoeuvring forward planning: a new part of voyage planning involving developing strategies before voyages
- Online manoeuvring support during the execution of manoeuvres through dynamic predictions of manoeuvres related to the actual control handles on the bridge
- Recording and replay for assessment of the execution

PLANNING FOR ARRIVAL/DEPARTURE

Voyage planning is key to prepare for a safe journey. With the new FTS technology, it is now possible to design a full manoeuvring plan to ascertain possible rudder, engine

and thruster manoeuvres, and also to take into consideration actual or potential environmental conditions [2].

The basic idea is to visualize and display the mental manoeuvring planning of an experienced navigator. As an example for creating a berth plan and briefing, here is an arrival for a berthing scenario: Figure 1 shows the start of creating a manoeuvring plan, shown from the SAMMON planning module for the cruise ship Royal Princess which is slated for arrival at Marseille and berthing at Pier 163. The plan will be made based on a route plan (red dotted lines) imported from NACOS.

The smart interface of the planning module combines the following windows:

- The right window: for the virtual control panel of the ship for adjusting the controls for the selected manouevre point (MP)
- The centre window: displays the manoeuvring motion and status of the ship at the MPs and during the manoeuvres
- The left window and top row: displays the status of the current actual ship manoeuvring data at the position of the next MP which is indicated as a blue ship with a red frame

The planning module is shown in "Create Mode": The red shape represents the initial situation at MP0. Within the module, the first task is to quickly find the balance condition by means of the control panel. This can easily be done by trial and error because the results of the control changes can be seen immediately in the following specs:

- Ship is set on course COG=50° with ship speed SOG 9.9 knots (kn), according to EOT 48%
- Wind is set to 320° and 25 kn (i.e. about 2.5 time more wind than ship speed)
- Therefore heading adjustment is needed to be about HDG=44° to keep the course (by means of drift angle, which is about 6°, i.e. the swept path width can immediately be seen and is about 82m)
- Additionally rudder 5°STB is required to prevent from turning into the wind

The predicted ship contours are displayed as black dotted shapes, calculated for the next 6 minutes from MP0 (this period can be changed in the left top window by up to 24 minutes). The time slider at the bottom moves the blue ship shape with the red frame to the position where the next manoeuvre will start: this position will be then MP1. From there, the next manoeuvring segment will follow, and so forth, until the berth is finally reached.

Figure 2 presents the final version of such a plan where blue lines and ship shapes indicate the manoeuvring concept. Additional text windows explain the actions at distinguished MPs. The planning module is in "Edit Mode", which is made to change a plan – or to display the settings on every MP for briefing. The

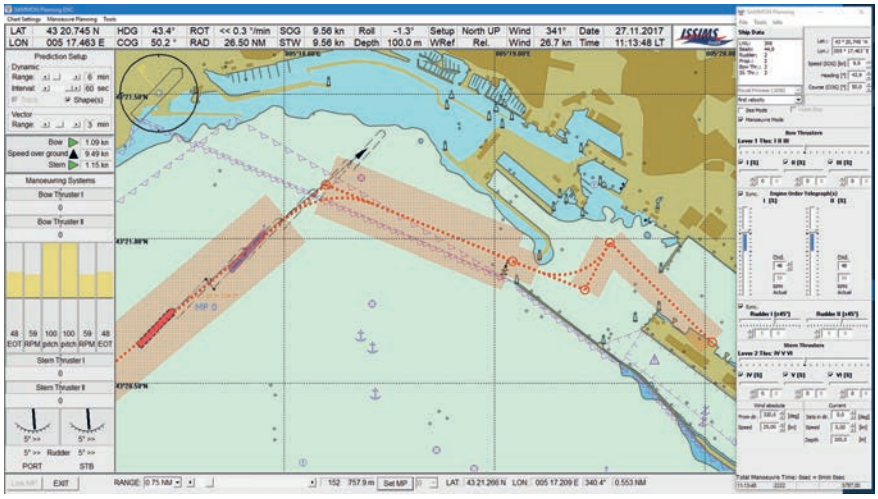

Figure 1: SAMMON Planning Module: Route plan imported from NACOS (red dotted lines and circular segments) and Start of Manoeuvring Planning at MP0 (red shape); predicted manoeuvring track for 6 min (black dotted contours every minute) and shifted position for the next MP (blue shape with red frame) for the cruise ship Royal Princess

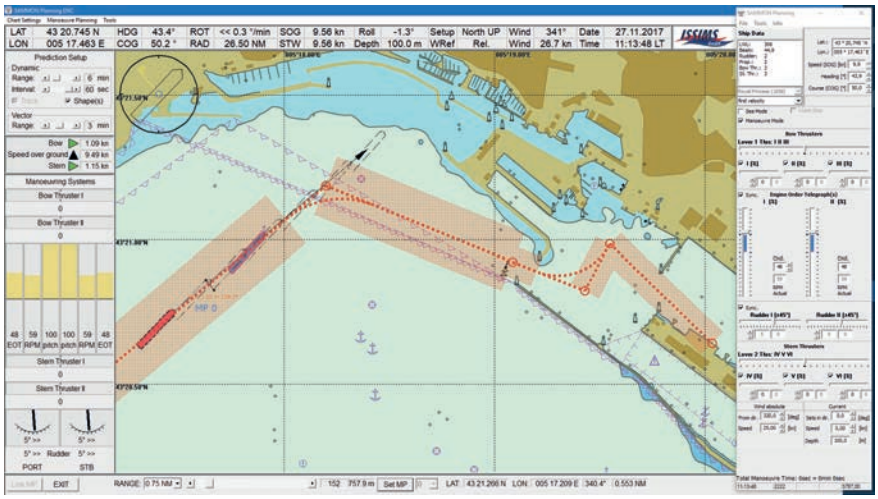

Figure 2: SAMMON Planning Module: Complete Manoeuvring Plan for cruise ship Royal Princess for arrival at Marseille (berthing at Pier 163), based on route plan (red dotted lines) imported from NACOS. The planning module is in "Edit Mode", which is made to change a plan or to display the settings on every MP for briefing

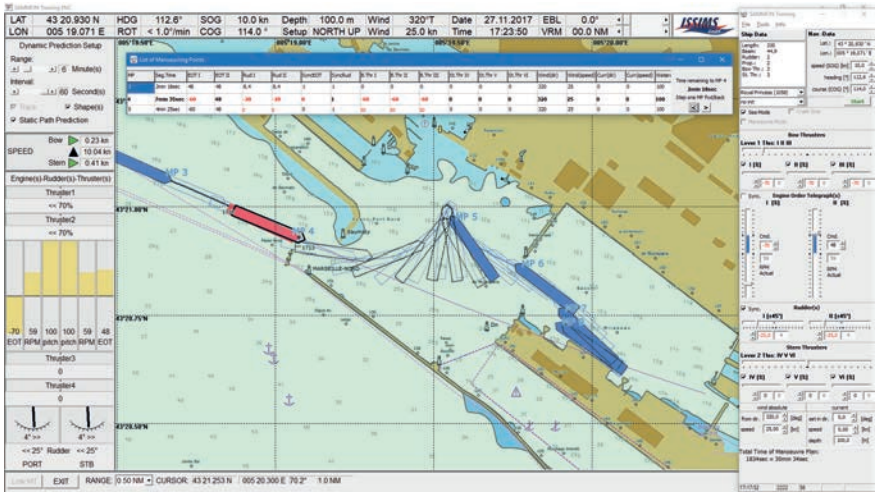

Figure 3: SAMMON 'Trail & Training Tool' with multiple predictions. Real time simulation and manoeuvring prediction integrated into ECDIS with comparison of full dynamic predictions (black dotted ship contours) and the simple static prediction (magenta curve) together with planned manoeuvring track (blue line and ship shapes)

active focus is on MP4, where turning into the port starts with Rudder PT-20°, supported by split engines (EOT: PT-60, SB +48) to reduce speed and maintain steering. The ship turns into the wind and stops, and the following actions are:

- MP5: the turning is stopped with bow thruster STB 50% and rudders amid ships. The ship starts moving astern
- MP6: Reducing the speed astern with split engines (to have some reserves if the rudder might be needed): steering to the berth by bow and stern thruster
- MP7: Stopping astern motion with EOT 30% ahead and thruster about 30% STB to stop transverse motion to the pier

In addition to the planning module there is the "Manoeuvring Simulation Trial & Training Module", which provides ship handling simulation in real time on a laptop in order to check and train the manoeuvring concept (see Figure 3) with the below features:

- Ship steered by virtual handles on screen
- Display of parallel manoeuvring plan and predicted manoeuvres
- Calculation of new multiple dynamic prediction tracks for full ship dynamic simulation
- "Path Prediction" presentation as existing 'Look Ahead' in ECDIS, simply taking the current rate of turn and speed as constant for the prediction time period

PORT RISK STUDIES

As an example of the use of the planning tool in port risk studies, two sample manoeuvres are compared with no wind and with strong wind in Rostock Port. The starting point is MP0 with HDG 161°, the ship has to be turned and brought to the berth with HDG 341°. It can be seen that with 25kn wind the limit is reached. In the fairway, the width is fully used because of the drift angle for the final berthing. The thrusters and rudders are used with full power to counteract the wind effect, but the approaching speed of the drift motion towards the pier is about 0.6kn (for 30kn it would be over 1.5kn).

FUTURE APPLICATIONS

At this time, FTS Planning has mainly been used for training and developing a mental model for manoeuvring strategies. One new aspect of this manoeuvring plan is that it clearly represents a trainees' intention, meaning that the results of the manoeuvre execution during the simulator training run can be assessed against your own plan.

During the execution of manoeuvres, the FTS can be used in the so called "Monitoring & Conning Module" providing high-level path predictions, taking into account the actual control settings from the bridge handles and real input from sensors. The "Dynamic Prediction" immediately shows future tracks, overcoming the lack of simplified "Path Prediction" which simply represents the current motion status only.

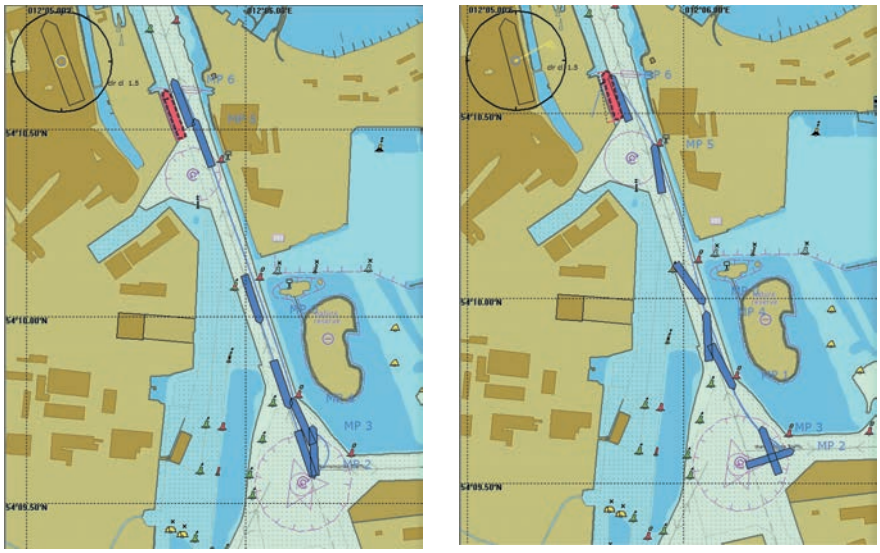

Fig.4: Complete manoeuvring plans for Rostock Port scenario. Focus (data is on the left side) is on the red shape at the last final MP. Left: Manoeuvring plan with no wind. Right: Under strong wind 25 kn from 061°

There is great potential to increase training methods, safety, and the efficiency of manoeuvres on-board because all members of a bridge team immediately see the results of the control settings and they all share the same information. The potential of the new FTS method is huge, but requires sound training.

REFERENCES

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[2] K. Benedict, M. Gluch, M. Kirchhoff, S. Fischer, M. Schaub, S. Klaes, M. Baldauf, B. Müller: Use of Simulation-Augmented Manoeuvring in Ship Handling Simulator Training. 18th International Navigation Simulator Lecturers' Conference; Massachusetts Maritime Academy, Plymouth /USA, September 12-15, 2014

ABOUT THE AUTHOR

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ABOUT THE ORGANIZATION

Hochschule Wismar is a University of Applied Sciences for Technology, Business and Design in Wismar, Germany. The Department of Maritime Studies and its unique Maritime Simulation Centre is located in Rostock-Warnemuende, it is the home of the Institute for Innovative Ship Simulation and Maritime Systems is well known for research in international projects.

The World Maritime University (WMU) in Malmoe, Sweden, is a postgraduate maritime university founded by the IMO. The aim of the WMU is to further enhance the objectives and goals of the IMO and its member states around the world through education, research, and capacity building.

ISSIMS GmbH is a small company at Rostock / Germany and develops high-level software products to increase safety and efficiency in ship operation. Its expertise on Ship-Handling Simulation and Fast-Time Simulation technology has led to unmatched solutions for manoeuvring support.

ENQUIRIES

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