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Linking hydrodynamics to safety of maritime operations

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35-years of simulation

As well as celebrating the 75th Jubilee MARIN is also chalking up another milestone – 35-years of MARIN simulation technology. MARIN opened the ship-manoeuvring simulator in 1972, which was one of the first simulators in the world. A picture of this first facility is shown below. It focused on oil tankers which were continually growing in size at the time.

Simulation technology has improved spectacularly since that early start. Technology barriers have been broken down and the application of simulator technology has changed. An illustration of this improved technology is MARIN's latest development, the compact manoeuvring simulator (shown above). Today, our simulators are used for research and training for ports and fairways, maritime-, offshore- and DP-operations. Safety is always the driving force for doing such simulations.

Simulation technology

To be able to make an accurate simulation it is important to have accurate mathematical models. MARIN has a database with approximately 200 ship models. Most of these mathematical models are verified against model tests or full-scale trials. Furthermore, within MARIN there is a database with sea trial results. With this database it is possible to qualify the manoeuvring capabilities of the mathematical models.

For simulations with a specific ship design, the results from model tests are used to determine the mathematical model of the vessel in deep and shallow water. Ship-bank effects, ship-ship effects, thruster efficiencies and thruster bank effects, can be derived from model tests.

Both the modelling of manoeuvring characteristics and environmental effects are important. MARIN's simulator can incorporate a full tidal cycle, up to 24-hours. Flow grids, at 20 to 30 minute intervals, are imported in the database and the simulator interpolates currents in time and space. The wave propagation into the harbour and also wind shielding can be taken into account.

The most recent developments in simulator technology are:

- Ship response in waves: This has been in close co-operation with the Sea-keeping department. State-of-the-art ship motion theory is implemented in the simulator.
- Shielding effects: Using the results of wind tunnel tests a standard shielding algorithm has been developed. Shielding of current and wind behind vessels is computed on a real-time basis.
- Visual system: The new MARIN Visual System uses features from the gaming industry such as light reflections, enhanced water and sky, wind responsive smoke, fire and flags and a realistic visualisation of hull wake and propeller wash.
- Radar: MARIN has developed a very realistic radar antenna simulation module that can be coupled to any commercial ARPA system.

technology

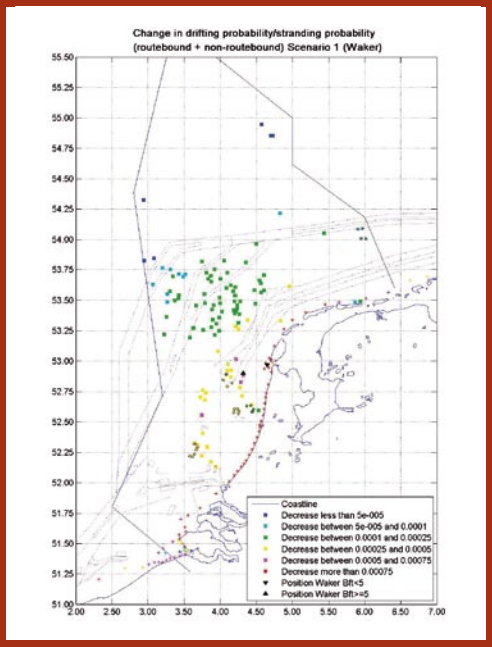
Future developments will focus on the improvement of wave generation in the simulator database and on an enhanced visualisation of interactive waves. Eventually, effects like spray and green water will be visualised and the impact of waves and shock loads on the structure will be brought together.

Simulation and Safety

Safety of navigation is a growing concern. MARIN's ship manoeuvring simulator is a very powerful tool. Under specific environmental conditions, manoeuvres can be studied as well as the impact of operational measures. However, actual safety levels are more difficult to determine from real-time simulations only. These are primarily governed by human error and mechanical failures. For this purpose MARIN uses the Quantitative Risk Assessment model SAMSON.

The most important elements in SAMSON are the traffic and the casualty models. The traffic model describes how the vessels operate within the area. The casualty probability models describe what type of casualties can be expected. In this approach the historical casualty data is used for the validation of the models. Validation is very often difficult because the relevant sets of casualty data are not available for the most part. Certainly this can be the case when the model is used to evaluate the safety of new developments or when changes in traffic intensity or composition have to be assessed. Hence, it is important that the model itself inspires confidence through a sound and solid knowledge of the underlying physical processes.

The SAMSON model is used for supporting policy decisions in the North Sea but in other areas as well. Typical examples are studies executed for the reception of LNG vessels in the Port of Rotterdam, for offshore wind farms and other offshore installations. Recently, studies have been executed for an adapted traffic separation scheme in the approach to Rotterdam and capacity plans for emergency response needs.



At the moment, MARIN is participating in an initiative to develop a new traffic simulation model which aims to improve the safety and efficiency of marine traffic. This model should be capable of simulating complex traffic situations in ports and fairways, including the effect of entry rules, VTS and tug assistance among other things. The model should also be capable of simulating interaction between sea-going and inland waterway vessels. Whether in the last 35-years, or into the future, safety will be the key driver behind simulation technology and MARIN intends to stay at the forefront of this technology.