

# Sea Trials and Model Tests for Validation of Shiphandling Simulation Models

## SimVal NEWSLETTER

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of Norway

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*This is the sixth newsletter of the Knowledge-building Project for the Industry "Sea Trials and Model Tests for Validation of Shiphandling Simulation Models" supported by Research Council of Norway. This project aims to improve present validation methodology for shiphandling simulation models. It includes captive and free-sailing model tests as well as sea trials with selected case vessels. The sixth newsletter describes work done in the period April – December 2015 and a brief description of planned work for the first quarter of 2016.*

## Work done during April - December 2015

### OMAE 2015 papers and presentations

The project partners prepared and presented 5 papers in a special OMAE 2015 session on "Marine Simulation Models and Their Validation Techniques (SESSION 6-1-1)". OMAE 2015 took place in St. Johns, Newfoundland May 31 – June 5. The papers were presented in two separate sessions. Session 6-1-1 contained the following papers:

- *Uncertainty of Sea Trials Results Used for Validation of Ship Manoeuvring Simulation Models.* Sergey Gavrilin and Sverre Steen.
- *Validation of ship manoeuvring in shallow water through free-running tests.* Katrien Eloot, Guillaume Delefortrie, Marc Vantorre and Frans Quadvlieg
- *Validation of a Modular Mathematical Model for Low-Speed Maneuvering using Small Scale Tests with an Oceanographic Research Vessel.* Felipe R. Masetti, Pedro C. de Mello and Eduardo A. Tannuri.
- *Time domain simulation model for research vessel Gunnerus.* Vahid Hassani, Ørjan Selvik, Andrew Ross, Dariusz Fathi, Florian Sprenger, Tor Einar Berg.

In session 6-1-4 Marine Simulation Models II/Canadian Shipbuilding III the paper:

- *Identification of nonlinear manoeuvring model tests for marine vessels using planar motion mechanism tests.* Andrew Ross, Vahid Hassani, Ørjan Selvik, Edvard Ringen, Dariusz Fathi.

## VeSim workshop

Rolls-Royce Marine hosted a workshop at its offices in Ulsteinvik on the 17th of November 2015. This workshop investigated several aspects of simulation, from manoeuvring to DP, of the case vessels analysed in SIMVAL. Presentations were made describing the research work ongoing from both RRM and MARINTEK.

## PhD and PostDoc work at NTNU

PhD student Sergey Gavrilin continued working with R/V "Gunnerus". He developed a simplified model of the ship based on new PMM measurements and implemented it in MatLab. To improve the quality of the model he proposed new types of PMM tests, including accelerated drift test and combined sway-yaw test with changing sway velocity. The main advantage of the new tests is that they better cover the state-space than traditional pure surge, sway, yaw and combined sway-yaw tests.

He also proposed an alternative approach to validation of simulation models. The approach is based on comparison of accelerations measured experimentally during a validation trial with acceleration values calculated using a simulation model (see Figure 1). Experimental values of control parameters and velocities are used as input to a simulation model. The approach is applied to each experimental point separately and therefore can be applied to arbitrary trials or in-service data.

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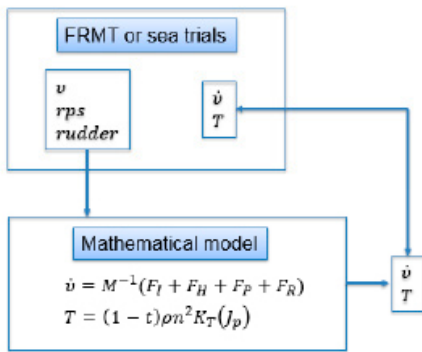
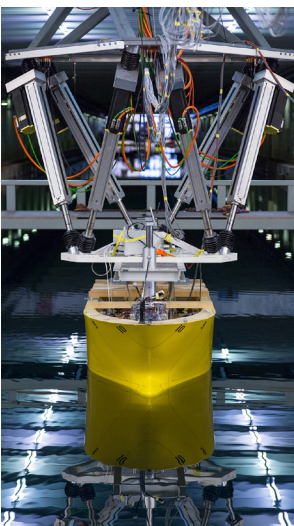


Figure 1 Principle of suggested validation approach (FRMT – Free Running Model Test).

Postdoc fellow Afshin Abbasi Hoseini has continue his work on data mining using logged ship motion and control system data to identify manoeuvres. Nowadays, ships are equipped with vessel monitoring systems logging ship data over hours of normal service. The nature of these collections of observations includes large size and high dimensionality.

Processing and analyzing such huge amounts of measurements have many potential uses such as ship monitoring in its voyages, assessing and optimizing ship performance, and reporting ship manoeuvres. We have developed a framework for multivariate time series data mining to extract the information of vessel behavior from an in-service dataset. The approach is established on unsupervised data clustering using Self-Organizing Map (SOM), K-means, and k-Nearest Neighbors Search (K-NNS) for searching desired manoeuvres.



The results are based on sea trials of NTNU's research vessel, Gunnerus. It is shown that this approach is functional to detect prior unknown ship states with acceptable accuracy.

The steps proposed for this work are outlined in Figure 2.

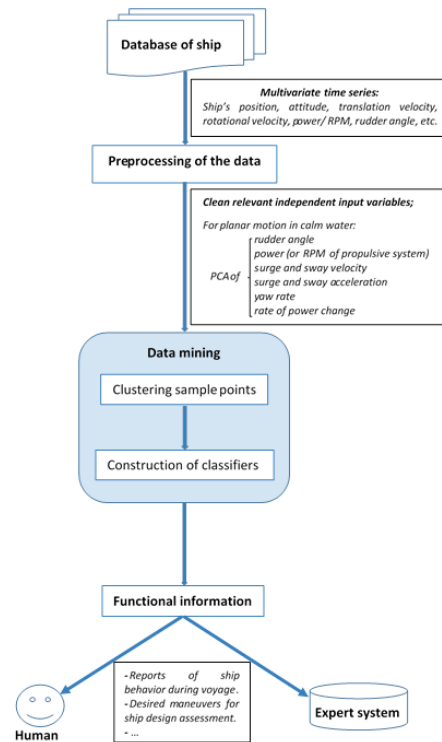
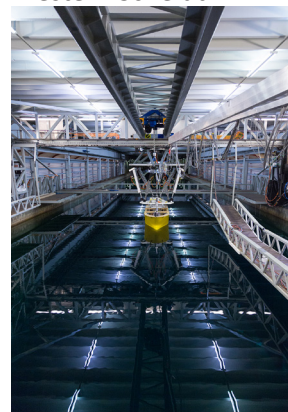


Figure 2. Outline of steps of data mining in ship measurement dataset.

### Shallow and confined water work package

This work package focus on the modelling and validation of the ship behaviour of an E-type container ship of Maersk Sealand (398.0 m x 56.4 m) in medium deep and shallow water. The research is based on three main tasks:

- Execution of model tests in free-running mode and captive mode
- System-based modelling with the development of a 6 degrees of freedom (DOF) manoeuvring model at full scale drafts of 15.3 m and 13.1 m.
- Full-scale measurement during one trial on the Western Scheldt



In 2015, the model tests at a draft of 15.3 m have been completed and a 6 DOF manoeuvring model is being validated at model scale using the free-running test results.



### Case vessel related activities

VeSim model for NTNU's research vessel Gunnerus.

Additional PMM testing was performed on the M3060B model at MARINTEK's Towing Tank. These tests served several purposes. Firstly, they consist of several redone tests, allowing comparisons to earlier tests, to gauge the variability in the tests. Secondly, several new types of tests were performed, in cooperation with the NTNU. Thirdly, certain types of tests were extended greatly, to enable more accurate modelling, primarily of cross-flow drag. These tests were post-processed, and used to further refine MARINTEK's simulation model of the vessel.

### VeSim model for gas ferry Landegode

The MF Landegode has been tested quite comprehensively in MARINTEK's Towing Tank laboratory. The results have been processed, and a manoeuvring model generated. Work is ongoing to add a simulation model of the vessel's Combinator, to properly model its propulsion systems.

### Case vessel Island Condor

A 6-DOF manoeuvring model of the Island Condor, depicted in Figure 3, has been prepared by MARINTEK.



Figure 3. PSV Island Condor

The Island Condor, shown in Figure 3, was tested in MARINTEK's Towing Tank laboratory through the use of PMM testing. These data were processed using MARINTEK's in-house tools, and a manoeuvring model generated utilising IDSIMAN. The fullscale data was gathered as part of the SIMVAL project in late 2014. Both types of tests were compared to one another to investigate the predictive qualities of MARINTEK's approach. Model scale and fullscale zigzag show good congruence.

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### Planning of Singapore case ship trials

MARINTEK is cooperating with Singapore Polytechnic in the planning for fullscale trials of a container vessel, in transit from Singapore to Yangon. MARINTEK will take part through the provision measurement equipment and a workshop, both of which will improve and enhance the possibilities for advanced instrumentation and logging during the voyage.

Planned activities for January - March 2016

- Updating project plan for 2016
- Modelling Havyard vessels
- Heavy weather sea trials with LNG ferry Landegode
- Preparation for collection of in-service data from Island Condor

In the shallow water work package Flanders Hydraulic Research will run captive model tests at a draft of 13.1 m early 2016 to obtain data for the E-container vessels at another draft.

Sergey Gavrilin and Sverre Steen will prepare a paper for the OMAE 2016 conference in Busan, Korea in June 2016. The title of the paper is:

- An alternative approach to validation of ship manoeuvring models

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