SimVal NEWSLETTER

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This is the seventh newsletter of the Knowledge-building Project for the Industry "Sea Trials and Model Tests for Validation of Shiphandling Simulation Models", supported by the 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. This newsletter describes work done in the period January – July 2016 and a brief description of planned work for the second half of 2016.

Work done during January - July 2016

OMAE 2016 papers and presentations

OMAE 2016 took place in Busan, South Korea, 19 – 24 June 2016. Sergey Gavrilin and Sverre Steen wrote the paper **OMAE2016-54276** *"An Alternative Approach To Validation Of Ship Manoeuvring Models"* which was presented by Sergey in the session "6-1-2 Advanced Ship Hydromechanics and Marine Technology II", "Ocean Engineering" section, 20.06.2016. The paper describes an alternative approach to validation of manoeuvring models. The approach is based on the calculation of a residual force component using simulation model and experimental velocities, acceleration and control actions as inputs. The paper presents a case study where a full-integration approach and the alternative approach are applied to evaluate three different models of R/V Gunnerus based on the results of free-running model tests (20° turning circle and 20°/20° zigzag trial). The conclusions from both approaches coincide in general, which supports potential applicability of the proposed approach.

Another OMAE paper prepared by Abbasi Hoseini, A., and Steen, S., *"A data mining approach to identify maneuvers in ship in-service measurements"*, **OMAE2016-54180**, was presented by Afshin in the session "6-12-1 Ocean Engineering Technology". The paper presents a framework for multivariate time series data mining to identify ship manoeuvres 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 specific manoeuvres. The results are based on ship monitoring data of NTNU's research vessel, Gunnerus. It is shown that this approach is effective to detect prior unknown ship states with acceptable accuracy. The framework proposed and the results of this work can be of interest to those involved in ship administration, marine traffic flow engineering, ship maneuvering studies and assessment of ship design.

PhD and PostDoc work at NTNU

NTNU (Sergey Gavrilin, Sverre Steen) has prepared a journal paper and submitted it to Applied Ocean Research journal. The paper summarizes the results of previously conducted research on the uncertainty of full-scale trials estimated using simulation model. He is also working on a paper on metamodels. Ship's dynamics in real operation is affected by changing and often unknown operation conditions, for instance, environmental disturbances or changes in loading conditions. However, for validation one needs experimental measurements which are "cleaned" from these disturbances. One possible approach to cleaning is averaging. This approach demands precise synchronization of trials. An alternative approach is to use metamodels (see Figure 1). A metamodel can be explained as a simplified model of a ship for particular narrow range of operation, identified from full-scale experimental data.

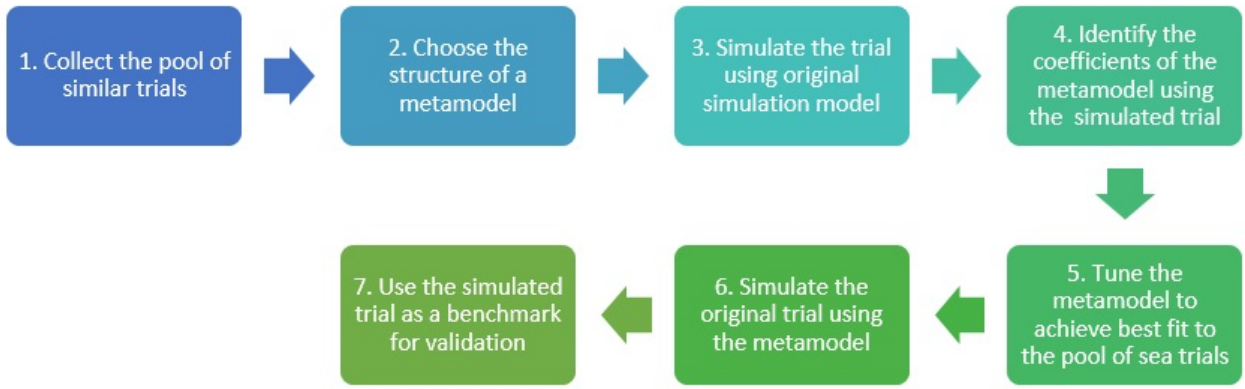


Figure 1 Validation process using metamodels

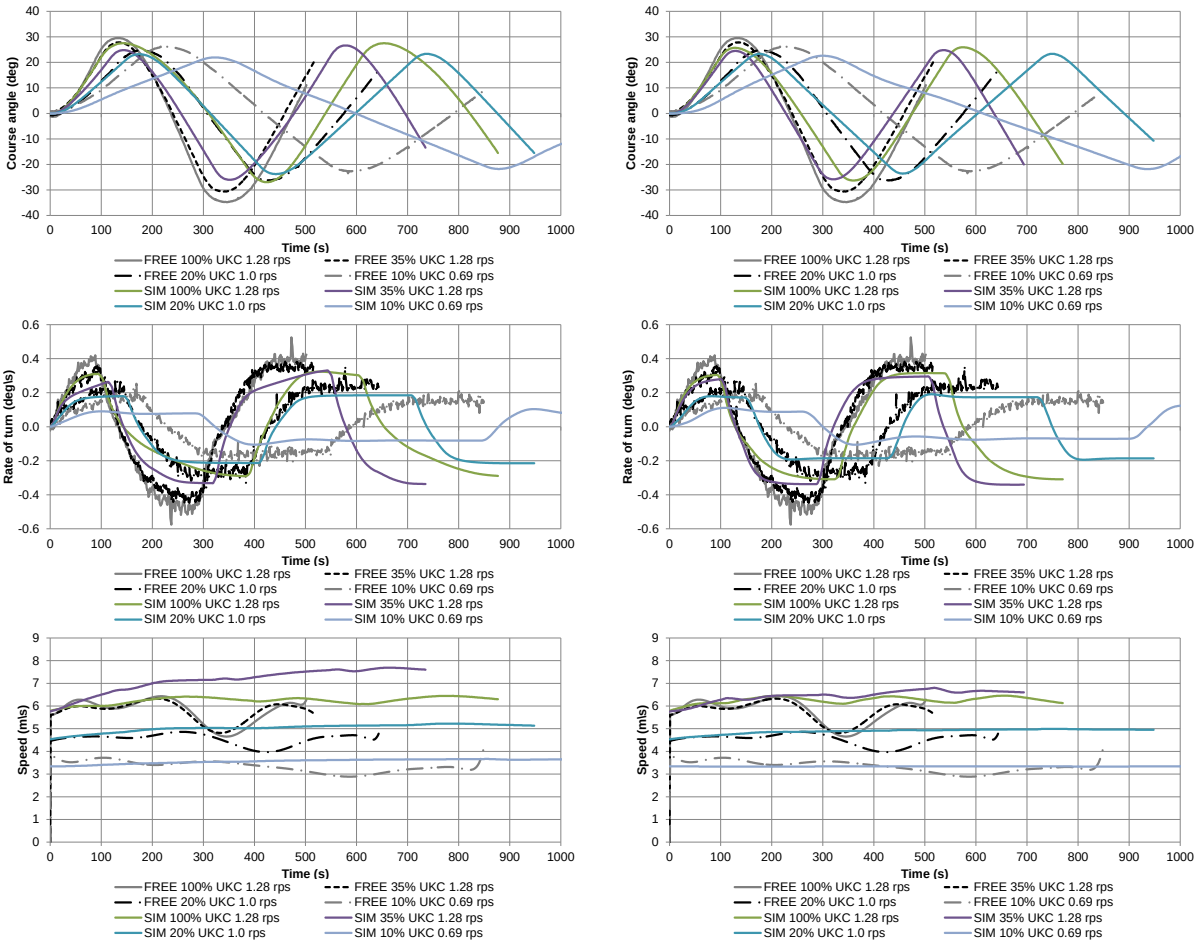
The PostDoc fellow Afshin Abbasi Hoseini has developed the framework for identifying manoeuvres in a huge collection of ship in-service data. The extension is in many aspects of work and it was planned to publish the results of completed work in related journals. In addition, he has continued his work on validating ship manoeuvring simulation models using data collected over hours of ship service, instead validating against standardized manoeuvers such as zigzag tests and turning circles. The methods are initially developed using data from NTNU research vessel "Gunnerus".

Shallow and confined water work package

The Shallow Water Work Package focus on the modelling and validation of the ship behaviour of a E-type container ship of Maersk Sealand (398.0 m x 56.4 m) in medium deep and shallow water.In 2016, all model tests at drafts of 15.3 m and 13.1 m have been completed and the 6 DOF manoeuvring models for both drafts are being validated at model scale using the free-running test results. A comparison between 20/20 zigzag test results (14.5 m draft free-running and 15.3 m and 13.1 m draft simulation), shown in Figure 2, learns that the zigzag time series of course angle, rate of turn and speed during simulation do not correspond with the time series during free-running. Generally, it is recognised that the simulated behaviour is far more course stable than the free-running behaviour. It can be concluded that shallow water validation is a difficult task and

scale effects and modelling inaccuracies influence the full-scale behaviour.

A full-scale trial measurement campaign was planned on the 30th of June but due to technical problems with the battery of the equipment the campaign will be redone at the end of September.



15.3 m draft 13.1 m draft

Figure 2 – Time series of course angle, rate of turn and speed V for 20/20 zigzag results of free-running tests (14.5 m draft) and simulations (15.3 m and 13.1 m draft, C0W) for different under keel clearances and propeller rates

Case vessel related activities

VeSim model for gas ferry Landegode

The simulation work on the Torghatten Nord vessel, Landegode, was completed in the first half of 2016. These results comprise extensive planar-motion-model testing, and full-scale measurements. The manoeuvring model was calculated based on a large database of model tests, and was combined with Rolls-Royce's model of Landegode's rudder-propeller model. The results were very promising, and were validated against a large set of full-scale tests, including multiple zig-zags and turning circles. The behaviour

of the rudder-propeller-model was furthermore validated against test data gathered by MARINTEK. A validation is shown in Figure 3, in which the complete spiral test for MARINTEK's VeSim model is shown compared to the spiral gathered through fullscale measurements.

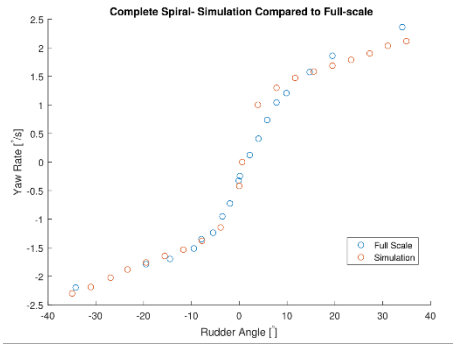


Figure 3- Complete Spiral Test: simulated and measured.

VeSim model for offshore vessel Island Condor

MARINTEK completed its simulation validation program of the Island Offshore PSV, *Island Condor*, in May 2016. The work program consisted of utilising extensive model scale and fullscale tests, in order to both create the VeSim model, and then validate it through comparison with the fullscale tests. The vessel model proved to be of a good accuracy, and showed good similarity with fullscale zig-zag and turning circle tests, which were performed in moderate weather.

VeSim model for Havyard's case vessels

MARINTEK began its work on both Havyard case vessels, the *Polarsyssel* and *Vestland Mira*, in April 2016. The work consists of utilising planar motion mechanism tests, provided by Havyard, with a thruster model created by MARINTEK, and based on propulsion testing performed internally at MARINTEK, to generate an effective simulation model both at forward and low speeds for each vessel. Initial work took place in 2015 by carrying out these propulsion tests, and full work on the manoeuvring data followed shortly after. Manoeuvring models are scheduled for completion in August 2016, to be combined with propulsion modules shortly thereafter.

Singapore case ship trials

Initially the selected vessel was a bunker tanker. In April 2016 it was decided to change this to a small container vessel “KOTA RESTU” which is owned by PIL (Pacific International Lines), see Figure 4. Sea trials took place in Gulf of Thailand, during sailing from Singapore to Bangkok. Due to time restrictions only a set of zig-zag tests were done, see Table 1. Tests were done in a light loaded condition (mean draught 6.99 m, trim by the stern of 1.24 m). Water depth during the tests varied between 20 – 30 m.

Figure 4. Singapore case vessel – container vessel "KOTA RESTU"

Table 1. Zig-zag test parameters for "KOTA RESTU"

Test #	Zig-zag Test	Start Speed (knots)		End Speed (knots)
1	10-10	9.7	Half Ahead +	-
2	20-20	8.7	Half Ahead +	7.1
3	10-10	7.3	Half Ahead -	-
4	20-20	7.6	Half Ahead -	6.0
5	10-10	7.4	Half Ahead -	6.9
6	20-20	6.1	Quarter+	5.1

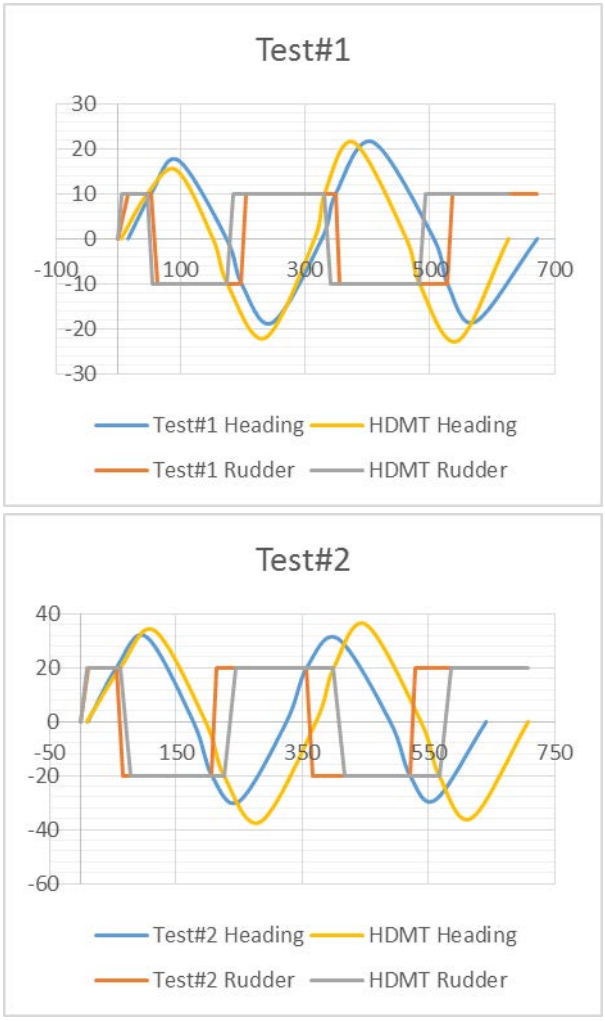


Figure 5. Comparison of sea trials and simulation results

The simulation model was developed using the Ship Model Software package for Kongsberg's bridge simulators (NMS-90 and Polaris). Initial comparisons for two of the zig-zag tests are shown in Figure 5. Further work on tuning of simulation model will take place later this year.

Planned activities for August - December 2016

According to the project plan the project shall be completed by end of December 2016. A final Steering Committee meeting will be held late November. Until then the partners will continue to complete project deliverables, writing abstracts for conference papers and disseminate project results to the industrial project partners

Disclaimer

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