Manoeuvring and seakeeping simulations, and the importance of high-quality data

Simulations are an efficient tool for gaining valuable insights for decision-making. To perform high-quality ship simulations, high-quality input data is required. Without good input data, the output from the simulations will not be a reliable source of support for decision-making. Thanks to SSPA’s test facilities, and the development and use of Computational Fluid Dynamics (CFD), we have access to extremely good data which supports the simulation models in the SEAMAN Simulation toolbox.

Knowing how a vessel will behave in certain conditions can help answer many questions, for example:
- What is the operational window for ship-to-ship transfer?
- What size and number of tugs are needed for safe berthing?
- Will the vessel roll heavily in the forecasted weather?
- In what conditions can the ship be safely moored?
- What engine power is required to be on schedule 98% of the time?

One way to address these types of questions is to use advanced simulations. At SSPA, we have developed a toolbox, called SEAMAN Simulation, which can provide a solution for the issues above and much more.

The SEAMAN Simulation toolbox

For many decades, experts at SSPA have developed well-known and advanced ship models, which have formed the basis for today’s simulations. The SEAMAN Simulation is a versatile manoeuvring and seakeeping simulation toolbox. It is based on a semi-empirical approach. This means that the models that form the simulation system are based on a combination of fundamental physical principals and measurements of the properties to be modelled. This technique is not just used at SSPA, but is the dominant technique used worldwide for real- and fast-time manoeuvring and seakeeping simulations.

The challenge with the semi-empirical method is that it is highly dependent on the quality of data that the models use. Access to relevant and validated mathematical models is always an important factor for successful simulations. SSPA’s models originate from our comprehensive databases derived from model tests conducted over the last 75 years. Thanks to SSPA’s test facilities, and the development and use of CFD, such as Shipflow from Flowtech International, we have access to extremely good data which supports the simulation models.

Data from a variety of areas are compiled in SEAMAN and this has resulted in a wide range of applications such as:
- Manoeuvring prediction
- Port and fairway manoeuvring studies
- Seakeeping – motion and acceleration
- Assessment of roll prevention devices, such as stabilising fins and anti-roll tanks
- Monte Carlo simulations: a fast-time simulation where environmental and operational conditions are randomised according to statistic distributions
- Mooring safety assessment
- Ship-to-Ship operations
- Operation of ships in locks and narrow canals
- etc.

Experts cooperate closely with clients

For each simulation assignment, SSPA communicates with the client to ensure that the simulation has the right level of details regarding both accuracy and cost-efficiency. To ensure the appropriate level, there are several areas that SSPA will tailor to the client’s needs. Depending on where a project is in the design phase, delivery time, budget and precision requirements for the models, our experts can select what data sources shall be used.

If a short delivery time is requested, we can use parametric data from our databases for ship resistance, manoeuvring and seakeeping properties. If the design details must be accurately reflected in the simulation model, a physical model test and/or CFD computation are recommended to determine the parameter input and model validation.
**Using the correct input will give the correct output**

Ship model tests in SSPA’s Towing Tank, such as resistance and self-propulsion tests, provide important input data: resistance curve, wake fraction, trust deduction, speed-power prediction, etc. Using these tests, together with propeller open water tests where propeller thrust and torque characteristic are measured in different working conditions, an accurate simulation model of the propeller and hull can be obtained.

If wave performance data are needed, the wave makers at the end of the towing tank allow for tests to be carried out with head-on and following waves. These measurements provide information on added resistance in waves that can be used in the simulations. Along with wave statistics and engine data, these provide assessments of route performance in different operational profiles.

If manoeuvring properties are needed, for example for harbour manoeuvring prediction, captive tests in the towing tank are one way of obtaining ship data for the manoeuvring properties. The results are direct measurements of manoeuvring coefficients for hull and steering devices, including propeller side forces.

SSPA’s Maritime Dynamic Laboratory (MDL) is a facility that contributes to the important input for the simulation toolbox. Several systematic test series have been carried out in order to formulate models for manoeuvring in confined water such as bank and canal effects, and shallow water effects, including squat prediction. The most common tests are standard manoeuvring tests, such as turning circle and zig-zag tests, and seakeeping. The results of these tests can be used to tune and validate simulation models.

With high-quality input data, the simulation models can be used for predicting a wider range of test scenarios and producing complete manoeuvring documentation.

With the above high-quality input data, the simulation models can be used for predicting a wider range of test scenarios and producing complete manoeuvring documentation (e.g. a manoeuvring booklet according to IMO 601).

The seakeeping tests are used in the same way to validate and tune the model, and to expand the test matrix to include different speeds, headings, wave conditions, etc.

**Maritime Dynamic Laboratory (MDL) contributes with important inputs to the simulations. In this example we perform tests with a free-sailing tanker in a generic S-shaped fairway with sloped banks.**
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Through commitment, integrity, insight and expertise, we facilitate our customers’ path to success.

SSPA is a dedicated partner that offers a wide range of maritime services, including ship design, energy optimisation, finding the most effective ways to interact with other types of transportation, and conducting maritime infrastructure studies together with safety and environmental risk assessments.

Our experts have a broad range of knowledge and profound expertise, and we use our resources such as databases, analysis and calculation capabilities, laboratories, collaborative platforms and skills to create value.