

Fast-time simulation program for ship manoeuvring

SHIPMA 7

Introduction SHIPMA model (version 7)

The latest version of the fast-time simulation program SHIPMA is a joint development of MARIN's nautical centre MSCN and Deltares. The combined contribution of these institutes is leading to a fit for purpose program to simulate the manoeuvring behaviour of vessels in ports and fairways.

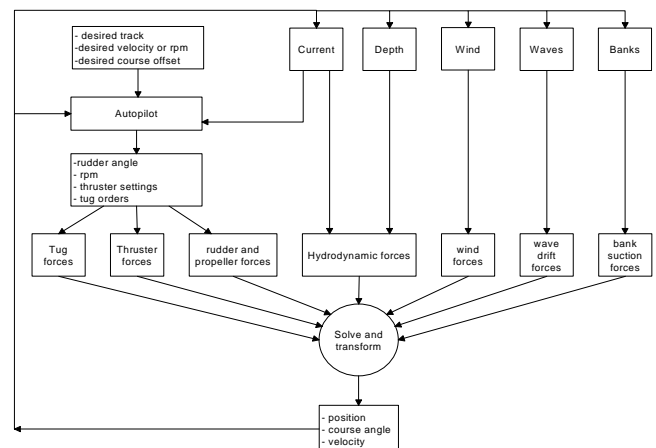
In SHIPMA the vessels are steered by an autopilot which is capable of operating in the track keeping mode and the harbour manoeuvring mode, making it possible to perform typical harbour manoeuvres like turning, reverse sailing and berthing.



SHIPMA applications

The application of SHIPMA is primarily in port and fairway design, referring to both approach channels and inland waterways. According to PIANC [1] a first estimate of the required channel width based on their methodology has to be followed by ship manoeuvring simulations. These simulations give insight into the inherent possibilities and/or restrictions of vessels, infrastructure and environmental conditions including the effect of additional manoeuvring devices like bow and stern thrusters and the role of tugs. Based on the insights gained, mitigations, if needed, of the infrastructure design (channel layout, manoeuvring basin and terminal layout) and/or the admittance policy

can be proposed. In the final stage of the design the SHIPMA study can be followed by a study on a real-time simulator. The flow diagram below gives an overview of the program structure.



Flow diagram of the SHIPMA model

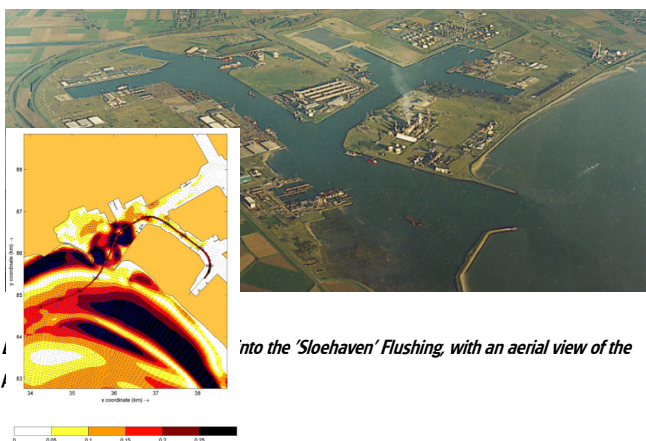
Methodology of SHIPMA use

SHIPMA relies on the use of an autopilot, which also includes a tug and thruster allocation algorithm. The choice for using an autopilot rather than hands-on steering by a pilot or Master allows the engineer to clearly judge and compare the results of different simulations on technical and physical aspects. The use of an automatic pilot in desktop simulation assures repeatability and a consistent nautical assessment procedure. The hands-on mode often seen in other models (actively steering the ship over a chart displayed on a screen) would put a civil engineer in a position where he is in fact playing the role of a pilot or Master. Alternatively, one could ask a pilot to do the runs, but the chart display offered to him is rather different from his normal sailing practice. This will jeopardise the result of the manoeuvres. Furthermore, runs have to be repeated to guarantee consistency.



Ship characteristics

The mathematical ship models, consisting of sets of hydrodynamic derivatives (Abkowitz type [2]), are specific for each ship. They are determined either by scale model test, through scaling from other models or by calculation (SURSIM [3]). Models can be chosen from an existing list of over 100 high-quality ship models covering the latest ship designs. Specific models can be made according to the client's wishes. The models include wind coefficients, bank suction coefficients, second-order wave drift forces and shallow water effects.



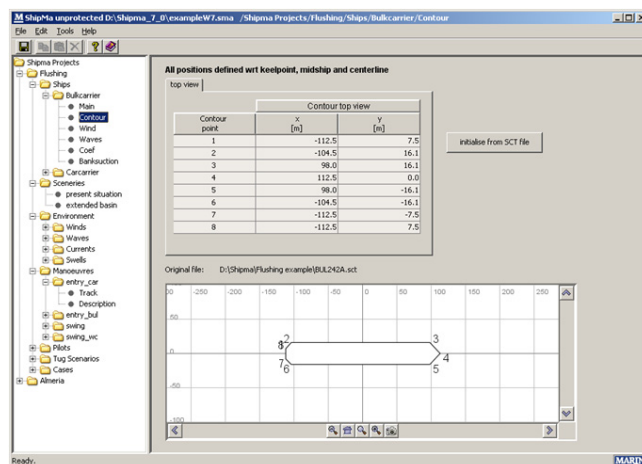
into the 'Sloehaven' Flushing, with an aerial view of the

SHIPMA input and output

The input of the SHIPMA model is organised through the Graphical User Interface. The Shipma GUI organises all data for a project in a hierarchical tree. A Shipma project tree consists of a number of subordinate "nodes", each defining some aspect of the project:

- A set of nodes containing a description of the manoeuvre, desired track, setting of autopilot, time step, starting position, tugs etc.
- A set of nodes in which the ship is represented by dimensions, mass, windage area, etc. and the manoeuvring characteristics of the ship, to be expressed in hydrodynamic derivatives
- Nodes to describe several external conditions such as:
 - bottom level
 - current pattern
 - wind field
 - wave field

Note that for this type of data Shipma offers the possibility of choosing for a simple set-up with constant wind, waves or current or to import self prepared environmental grids in which the number of grid points is practically unlimited.



The main output consists of:

- track, position, course and heading of the ship
- course deviation and distance to the desired track
- rudder angle and number of propeller revolutions
- for wind and waves: direction, velocity/height and forces acting on the ship
- water depth at the centre of gravity
- current velocities on the ship
- bank suction forces
- tug forces

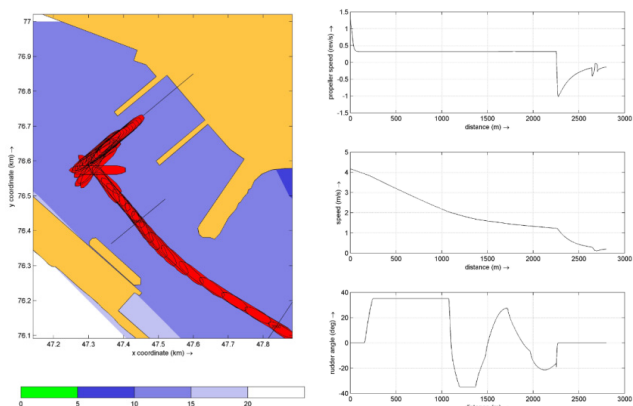
The track and the output data can be plotted using D3D-Quickplot.

Examples

Included are two examples of a computation with the new SHIPMA model. One example (see previous page) shows an entry manoeuvre into the 'Sloehaven', Flushing. The manoeuvre is executed under maximum current conditions, the current is computed with the Delft3d-flow model and imported in SHIPMA, together with bathymetry and the results of wave penetration calculations.



The 2 plots below show another example of an entry and berthing manoeuvre with a twin propeller twin rudder vessel equipped with a bow thruster.



Track plot and Data plot (propeller revolutions, forward speed and rudder angle)

SHIPMA is also capable of simulating inland waterway situations. Mathematical models are available for various types of ships. The algorithm for simulating tug assistance has been improved considerably. Tugs are capable of controlling the ship speed in combination with the track keeping mode.

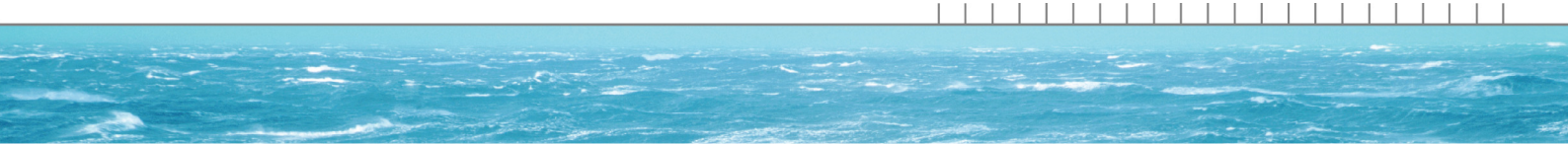


Computer requirements

- Computer with a 2GHz or faster processor
- Microsoft Windows XP with service pack 2, 32 bit operating system or Microsoft Windows 7 Professional with service pack 1, 32 and 64 bit operating system
- 2 GByte of installed memory (RAM) or more
- 2 GByte of available hard-disk space
- DVD-Rom drive
- 1024x768 or higher resolution display with 256 colors
- Keyboard and Microsoft Mouse or compatible pointing device
- Microsoft Internet Explorer 8 or later

References

- [1] PIANC-IAPH Working Group II-30, APPROACH CHANNELS; "A Guide for Design".
- [2] Abkowitz, M.A.; "Lectures on Ship Hydrodynamics, Steering and Manoeuvrability, Hydro- and Aerodynamics Laboratory", Rep. No. HY-5, 1962, Copenhagen, Denmark.
- [3] SURSIM; "Computer Program for the Calculation Hydrodynamic Reaction Forces", MARIN.



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