SHIP-NAVIGATOR Alkyon's ship manoeuvring simulator

for cost-effective designing and optimising harbours and marine terminals

The construction of new or extended harbours and terminals involve large and expensive infrastructural works such as dredged channels, breakwaters, trestles and fixed or floating mooring systems. The size and location of these infrastructures and sometimes the lay-out of the entire terminal are a function of the nautical requirements (manoeuvring width, navigational aids, tug support) of the ships calling at the port or terminal.

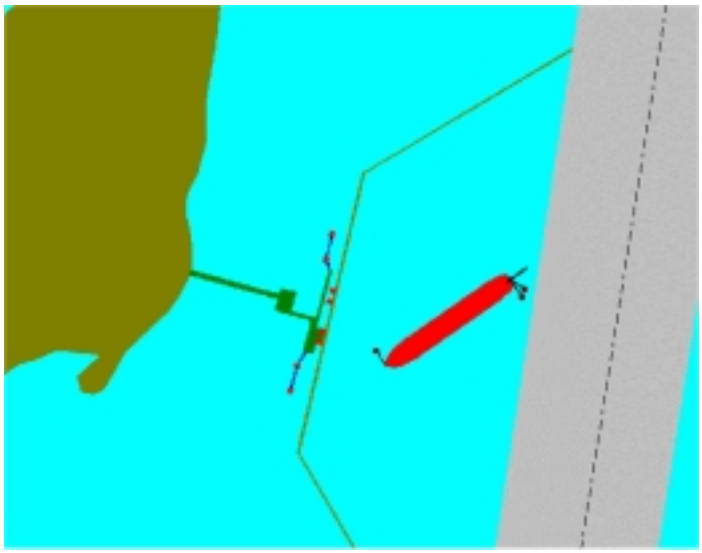

Figure 1 Manoeuvring action

Optimisation of the design from a nautical point of view requires a thorough knowledge and experience in ship handling and harbour design and efficient design tools for ship manoeuvring.

ALKYON's experts have much experience in the design and testing of harbours. They carried out many harbour studies, with more than 50 nautical projects since 1990.

For the nautical assessment and optimisation of designs ALKYON has available the computer program **SHIP-NAVIGATOR**. This is a tool capable of simulating ship manoeuvres in real-time as well as faster than real-time. Also it is possible to exercise the controls manually as well as through a track-following autopilot. With these possibilities the model allows for both a fast analysis of a large number of design alternatives as well as for a detailed analysis of berthing and de-berthing procedures.

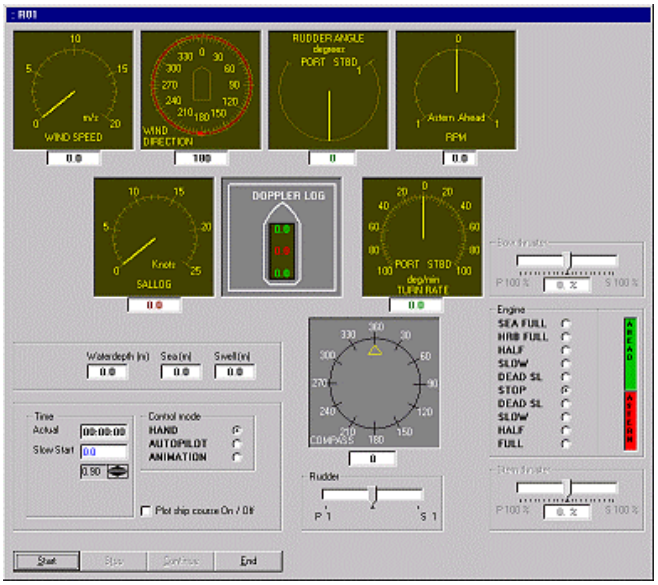

Figure 2 Control Panel

ALKYON Hydraulic Consultancy & Research
P.O. Box 248
8300 AE Emmeloord
The Netherlands

telephone +31 527 248100
telefax +31 527 248111
e-mail info@alkyon.nl
internet site http://www.alkyon.nl

special features

Nowadays the construction of terminals is realised at locations of increasingly difficult environmental conditions. Therefore, **SHIP-NAVIGATOR** has been designed such that it allows for accurate close-quarter manoeuvring characteristics and possibilities. Better than most other fast-time simulators it allows for the following features:

- it models the actual characteristics of rudder and propeller with detailed modelling of the interaction between rudder, propeller and hull. Thus realistic ship manoeuvring is possible in all modes of operation (manoeuvring ahead, astern, sideways, accelerating, stopping, being towed or pushed).
- with double rudder/propeller-ships it is possible to individually control propellers and rudders.
- it has a detailed tug modelling with towing and pushing possibility; control of their towing-line length, towing position and towing angle; tug effectiveness is restricted depending on the speed and relative direction of the tow, of the tugs own speed and of the waves at the tug location. Wave shielding at the lee-side of the ship is taken into account.
- ship and tugs may be handled both manually (interactive) by the user as by a track-following autopilot
- close quarter manoeuvring is facilitated for the user with a user-friendly control panel for ship (Figure 2), winch (Figure 4) and tug control (Figure 3) and with real-time birds-eye-view colour-visualisation of the ship, the tugs and the surroundings (coast, channel, manoeuvring aids, harbour, berths). Also the time-scale is adjustable.
- for debriefing purposes it is possible to replay an earlier executed run.

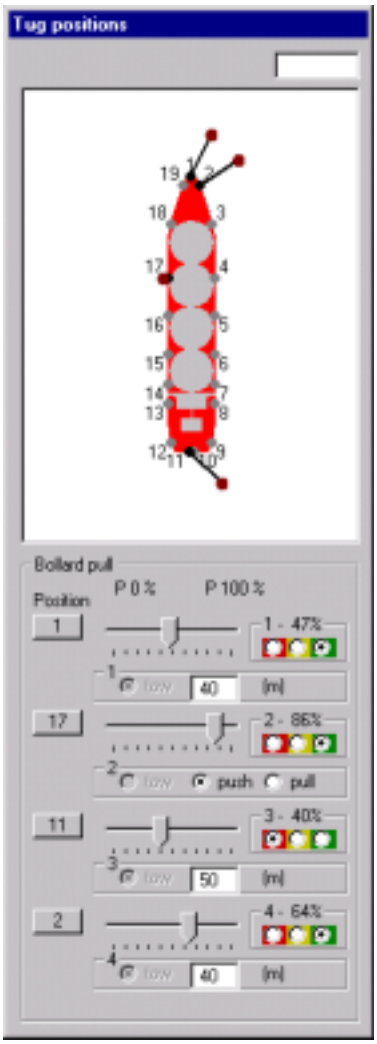

Figure 3 Tugs control panel

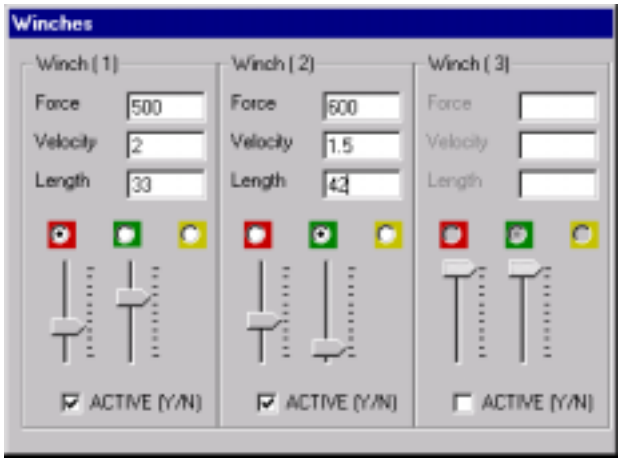

Figure 4 Winches control panel

ALKYON Hydraulic Consultancy & Research
P.O. Box 248
8300 AE Emmeloord
The Netherlands

telephone +31 527 248100
telefax +31 527 248111
e-mail info@alkyon.nl
internet site http://www.alkyon.nl

ALKYON's mathematical model SHIP

SHIP-NAVIGATOR is part of the nautical **SHIP** suite of programs developed by ALKYON. The programs may be used either integrated or in a stand-alone fashion. **SHIP** models:

- the simulation of the manoeuvring of a sailing vessel
- the horizontal and vertical motions of a vessel sailing in waves
- motions and mooring forces of a vessel moored to a jetty, quay, SPM or spread mooring system

In these simulations the effects of in time and space varying wind, waves, currents and water depths can be considered. Also the influence of rudder(s), propeller(s), bow and stern thrusters, tugs, mooring lines and fenders are included.

Model properties

- Modular set-up with special emphasis for hull-propeller-rudder interaction and manoeuvring properties for slow speeds and astern manoeuvres.
- Propeller forces (full four-quadrant modelling).
- Rudder forces (incl. effects of screw race / flow attack for all manoeuvring conditions).
- Bow and stern-thruster forces (with speed-correction).
- Full model of engine-propeller with correct revolutions build-up and reduction.
- Shallow water-effects.
- Wind forces.
- Current; effect of variable current over the length of the ship.
- Multiple wave fields (e.g. sea and swell); effect of diminishing wave forces over the length of the ship when entering a protected area.
- Wave reduction caused by the ship herself (used for operation of tugs on the lee-side of the ship).
- Realistic tugboat usage depending on sailing direction, speed, waveheight at tug location and time required to change tow-direction; tug (schematically) and towline presented on screen
- Clear presentation with birds-eye-view in colour of manoeuvring area, infrastructure, ship and navigational aids.
- Manual or automatic steering.
- Checking of manoeuvring characteristics with standard manoeuvring tests.
- Possibility of modelling of fenders and mooring lines (at jetties etc.)

Input

- Input and checking of ship-coefficients, environmental data, track and autopilot-setting is possible through interactive input-screens or through input-files
- Input of contours and colouring of birds-eye view using an ASCII-file
- Various checking possibilities for environmental conditions (current, wind, waves , depth) by visualisation prior to the simulation and partly also during the simulation

ALKYON Hydraulic Consultancy & Research
P.O. Box 248
8300 AE Emmeloord
The Netherlands

telephone +31 527 248100
telefax +31 527 248111
e-mail info@alkyon.nl
internet site http://www.alkyon.nl

Options

- On-line choice of simulation-speed and control-method (track-following autopilot or manual control)
- Possibility to replay earlier executed runs with all instruments active during the replay; replay-speed adjustable
- Variable orientation of birds-eye-view with respect to North
- Variable number of tugs (maximum four)
- Option to show swept path during simulation or during replay
- Choice for normal simulation or automatic execution of standard manoeuvring tests (turning circles, zig-zag tests)

Controls and instruments

- Manual control with mouse of "buttons" and "handles":
  - telegraph;
  - ruddercontrol;
  - (de)coupling of propellers and rudders in case of twin propulsion;
  - bow-thruster;
  - stern-thruster;
  - tugs (pull; push; push/pull; direction; connection point; line length);
  - winches (pulling, paying out, slipping).
- Instruments and position-indication:
  - time;
  - doppler-log (u,v);
  - sallog;
  - rate-of-turn;
  - water depth;
  - heading;
  - wave heights (sea en swell);
  - wind speed and direction (relative);
  - distance indication rings and heading-line
  - repeaters for RPM, rudder (both double if required), bow and stern thruster

ALKYON Hydraulic Consultancy & Research
P.O. Box 248
8300 AE Emmeloord
The Netherlands

telephone +31 527 248100
telefax +31 527 248111
e-mail info@alkyon.nl
internet site http://www.alkyon.nl

Output

- Interactive output control screen with various possibilities to compile output with 1 to 3 plots per page.
- Track-plots of runs.
- Plot possibilities for e.g. speeds, rudder, propeller, tug usage and site conditions.
- Possibility to plot against time or distance along the track.
- Output files (ASCII) with all parameters and also with all force-contributions exerted on the ship.

The results are presented in the form of track-plots (see figure 7) and plots of parameters such as speed, rate-of-turn, engine settings, tug usage and any other parameters relevant to the particular study (see figures 5 and 6).

The results are used to evaluate accurately, cost-effectively and in a short period of time the down-time and safe manoeuvring conditions for many design alternatives and thus facilitate an optimal design choice.

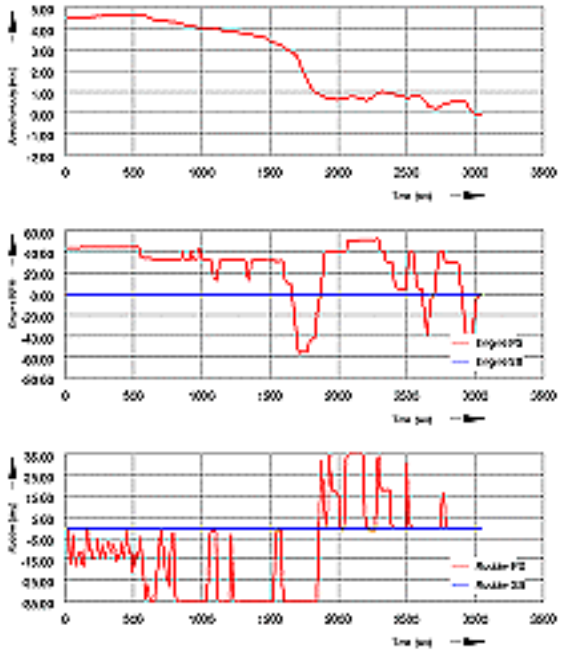

Figure 5 Series of ahead velocity, Engine revolutions and Rudder angle

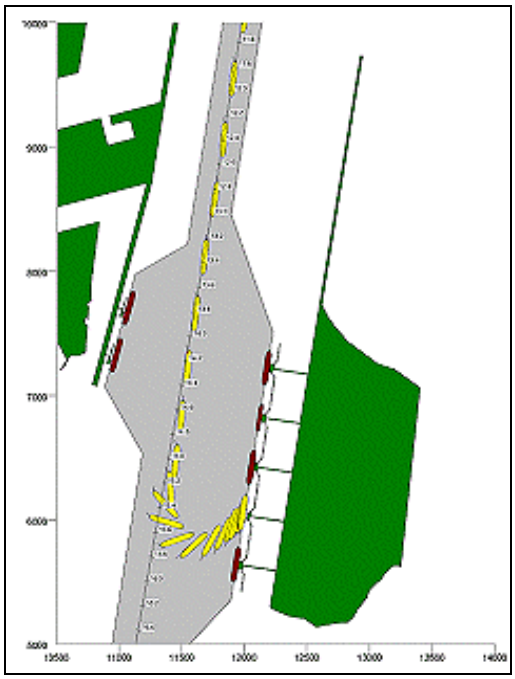

Figure 7 Track plot of simulation

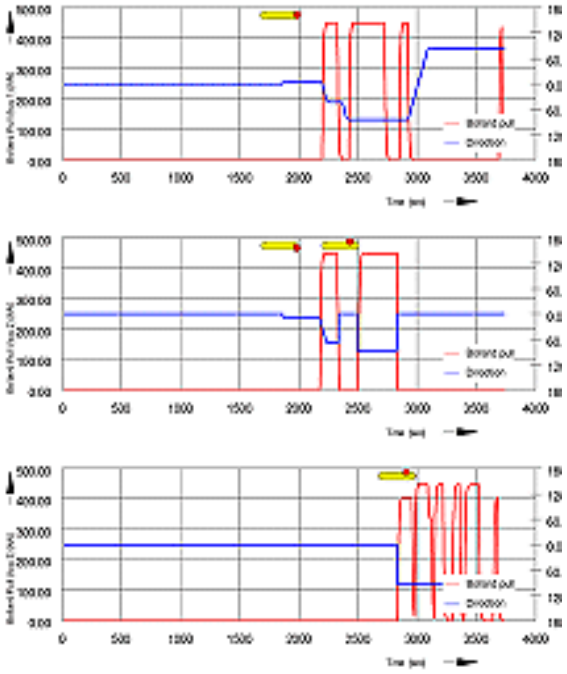

Figure 6 Series of tug parameters

ALKYON Hydraulic Consultancy & Research
P.O. Box 248
8300 AE Emmeloord
The Netherlands

telephone +31 527 248100
telefax +31 527 248111
e-mail info@alkyon.nl
internet site http://www.alkyon.nl

Development

Given the high level of demands on a specialised consultant, we view the development of our software-tools in general and of **SHIP** in particular as a continuous process. Where possible, we directly implement experience and specific know-how gained during our many projects.

SHIP-NAVIGATOR has been developed by a team of engineers in the field of ship hydrodynamics, flow and wave hydrodynamics, applied mathematics and system developers. This team has in-depth expertise and experience both in the nautical field as well as in the design of complex software systems. The team has previous working experience at Delft Hydraulics (including the three former section heads of Harbours, Ship Hydrodynamics and Waves and Currents), the Maritime Research Institute Netherlands (MARIN), The Netherlands Organisation of Applied Scientific Research (TNO) and The National Aerospace Laboratory (NLR). As a team and as individuals they have developed several simulation models, including new or further developments of ship-simulation software for TNO, the Netherlands Royal Navy, Delft Hydraulics and IHC.

SHIP-NAVIGATOR has been programmed by a group of programmers under the supervision of an experienced software system developer. The latter has previously also been responsible for the software design and implementation of complex refraction-diffraction models, of a 3-D finite-element model for the computation of hydrodynamic forces on floating bodies and of a Navier-Stokes model for simulating breaking waves on coastal defences. He also participated in the EU projects ESPRIT and REDO.

ALKYON Hydraulic Consultancy & Research
P.O. Box 248
8300 AE Emmeloord
The Netherlands

telephone +31 527 248100
telefax +31 527 248111
e-mail info@alkyon.nl
internet site http://www.alkyon.nl