

Nautical research

Ship manoeuvring simulator



The premises of the simulator 360+

The most important aspect of harbour and waterway design is the accessibility for shipping. A ship-manoevring simulator is a tool for testing waterway designs in a virtual environment where human experience is of uttermost importance.

Flanders Hydraulic Research uses two full bridge simulators for research and training: SIM225 with a visual system of 225° view and SIM360+ with 360° view and lateral view of the ship's hull.

Description

A full bridge simulator consists of

- A mock-up of a ship's navigation bridge with telegraph, rudder, tiller, etc.
- Bridge instruments, including radar and ECDIS, AIS pilot plug
- Communication equipment
- Simulation of tug assistance
- An immersive visual environment showing the scenery as seen through the bridge windows

- A mathematical model of the forces acting on the ship, to calculate the position, course and speed of the vessel

Operation principle

The navigator (pilot, captain, trainee) has to perform an imposed manoeuvre. From the bridge the ship's behaviour can be monitored on the bridge instruments, the radar, ECDIS and through the bridge windows. By changing rudder and telegraph settings, and by giving orders to tug masters, the navigator controls the observed ship behaviour. By setting telegraph and rudder tiller, electrical signals are transmitted to the simulation computer where the balance of all forces on the ship is calculated. This results in a continuous update of ship's acceleration, speed and position. Signals are sent to the bridge in order to display this information on the instruments. Also the radar, ECDIS and outside view are

continuously updated in real time.

All this is meant to give the navigator the impression of being in charge of a real ship, to make him/her act as natural as possible while executing the manoeuvre.

The human aspect of navigation is so important that the human being is the only element which is not schematised. It is necessary to take account of the navigator's experience, but also of the human reactions on ship and environment, which are not always logical or predictable.

Nautical research Simulator 360+



Ship's bridge simulator SIM 360+

Simulator SIM360+ has following features:

Ship's bridge:

- Digital instruments to be customised for each own ship
- Navigation equipment for steering the different vessel types, including a Voith tractor tug,
- Quadraphonic sound system;
- Communication through VHF;
- ECDIS.

Instructor's room:

- Operator console for selecting, developing, starting, stopping voyages, controlling target ships, atmospheric conditions, time of day, opening and closing bridges and lock doors, setting traffic lights;
- bridge interface with visualisation of ship's instruments and controls;
- tug console with electronic map for steering tugs;
- outside view screens and radar screen repeats;

- video registration: reviewing
- VHF communication.

Classroom:

- Replay station for reviewing voyages (ship route, towboats, forces, speeds, orders);
- material for video screening.

Radar:

- A generic ARPA radar simulation (SINDEL) with echoes of the surroundings, buoys, other vessels, bridges, lock doors;

Visuals:

- The computer-generated perspective image of the surroundings is projected onto the transparent screen around the ship's bridge by means of 8 Barco projectors;
- image angle: 360 degrees horizontally and 35 degrees vertically;
- At both sides of the bridge a horizontal screen lighted by a Barco projector each, represents the view down to the water along the ship's

hull;

- The eye point can be positioned to the sides of the bridge on the virtual ship and to a position just outside the bridge window on the bridge mock-up. At the same time the projector settings are changed. As a result the pilot has from this eye point a correct perspective view alongside the ship, including the ship's hull. This gives the exact visual information for a lock entrance manoeuvre or a berthing manoeuvre.
- image speed: 20 times a second;
- realistic water surface with waves in function of position, ships' wake;
- movement according to 6 degrees of freedom of buoys, ships, towboats;
- fog, mist, twilight, night vision;
- animated bridges and lock doors, traffic lights;
- plumes of smoke and banners according to the wind direction;
- buoys and sector lights with the correct features and colours.

Nautical research Simulator 360+



The instructor's room

Ship's equipment:

- propulsion by diesel engine or turbine;
- limited number of starts;
- rudder or connected double rudder with possible defects of rudder pumps;
- single or double screw propeller;
- constant or variable pitch;
- bow thruster, stern thruster with possible defects due to overheating;

Registration:

- recording forces, orders, position and speeds for subsequent analysis;
- in case of a collision: registration of the collision (location, impact-forces);
- plotting the ship's track after the voyage.

Force modules:

- hydrodynamic forces: powers on hull, rudder ...;
- shallow water effects (bottom level in function of location, water level in

function of tides);

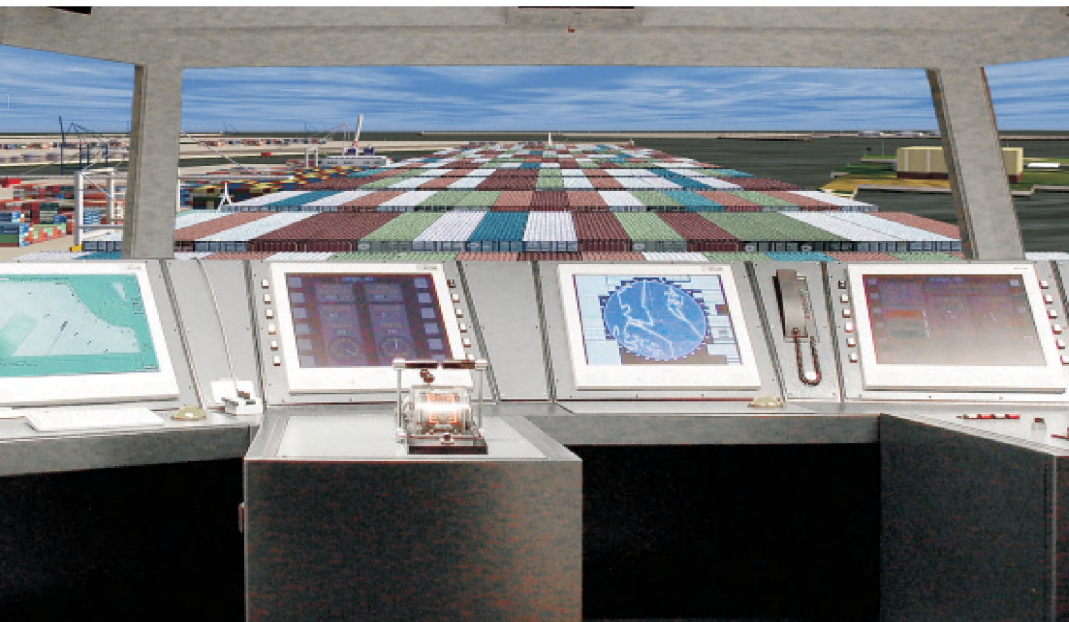
- propulsion (propeller, engine dynamics, bow propeller, stern propeller, defects);
- restricted water effects (bank suction, in function of the relative position against banks);
- aerodynamic forces (gusts of wind, wind direction and wind speed in function of location, shielding effect of large constructions or ships);
- wave drift (wave height and direction in function of the position);
- effects of non-uniform current (current speed and direction in function of position);
- contact forces (reaction and friction powers of fenders, pole and quays) with non-stationary hydrodynamic powers (current effects), in function of distance to quay-wall;
- interaction with meeting and overtaking target ships.

Analysis:

- plot of ship's track with rudder, tugs and tug forces;
- listing parameters as function of time;
- plotting parameters as function of the distance covered;
- calculation of required shipping lane width and extrapolations for probabilities of exceeding (10, 1, 0.1 and 0.01%)
- calculation of probability for a ship to hit an obstacle alongside the shipping lane.

The simulator can also be converted in, a Voith tug simulator

Nautical research Simulator SIM 225



Ship's bridge simulator SIM 225

This is the older of the two simulators.

The visuals are not as sophisticated as for SIM360+, the field of view is 225° horizontal and 35° vertical.

The eyepoint can be positioned to the wings of the virtual ship, but remains in the middle of the bridge mock-up.

Turning the eye-direction with dials on

the bridge console of SIM225 is a useful help, but changes the relative position between the mock-up bridge and the ship, which disoriented some pilots. To look at the waterline, a vertical tilt of the image is possible.

In the short future the SIM225 will be upgraded with an ECDIS. A few features as winches, changing the length of towing lines, customised digital bridge

instruments will be taken from the SIM360+ simulator. As a result the only difference will be the visuals.

Nautical research Nautical training



The classroom

The International Marine Organisation through the STCW 1995 convention regulates the training of seamen internationally. This convention also provides a role for simulator training on the condition that the simulator and the training programme meet the IMO requirements.

Flanders Hydraulics makes its simulators available for the training of the Flemish Pilots, the Antwerp harbour pilots, the Antwerp Port Authority tug masters and the students of the Antwerp Maritime Academy. Occasionally also Dutch pilots are trained. The training is given by the client's own instructors.

The Maritime Inspectorate certified the simulator in 2004. The installation conforms to rule 1/12 of the STCW 95 Convention and the performance standards imposed by STCW Code, Section A-I/12. As such the simulator can be used in the STCW 95 framework for training deck officers for ship handling and ship manoeuvring.

The instructors design the training programmes. Flanders Hydraulics creates the exercise area, the scenario's, ships, environmental conditions, visuals etc. on the simulator.

The exercise areas listed below are now available for training:

- The river Scheldt between Baalhoek and Antwerp, including the Deurganckdock;
- The approach to Wintam maritime lock leading to Brussels;
- The Antwerp harbour locks and docks;
- The approach and harbour of Ostend;
- The approach to Zeebrugge and the outer harbour and lock;
- The approach of Terneuzen outer