



The ships are accurately constructed to conform with the principles of similitude and are fitted with indicators showing the ship's parameters. Information given by the indicators is at **full scale**.

Most models are fitted with **diesel motor and steam turbine**, and the Normandie can be controlled from the front deck like a car carrier and a cruise ship, so that the fleet in fact reproduces over **20 different vessels**.

One ship is fitted with an optional **Becker** rudder and another ship has a **Schilling** rudder.

On two ships, it is possible to have the **bridge forward**.

One ship can be fitted with **optional "pods"** in order to reproduce the behaviour of a 900 ft cruise ship. This means that the ship can be fitted either with a conventional rudder/propeller or with two pods.

All but one are fitted with a bow thruster. Most ships are fitted with **bow and stern thrusters**.

All ships but one have fully operational **anchors**.

Several ships have **variable draught**.

Each model is designed so that **the Master is at bridge level**. He calls out his instructions to the "crew", i.e. the helmsman, who steers the ship and operates the engine room telegraph. An instrument panel gives continuous **full scale** indications of propeller r.p.m, rudder angle, ship's heading and speed, and wind velocity and direction.

The sliding cover is positioned to correctly reproduce the effect of wind.

Nothing virtual at Port Revel

Similitude of manned models

Many research workers, hydraulics specialists and engineers have used scale models for over a century, in particular in towing tanks.

Port Revel has chosen to apply the similitude law of William Froude (1810-1879) for its manned models. This means that gravity is considered to be preponderant over the other forces acting on the hull (viscosity, capillarity, cavitation, compressibility, etc.).

The different aspects of similitude may thus be defined as follows:

Similitude of shape: The model has exactly the same geometric shape as the real ship. This means that all the dimensions of the real ship are divided by the same factor, the scale factor. The designers of Port Revel chose a scale of 1:25, so

$$S_{(L)} = 25$$

It should be noted that in this similitude, the proportions are kept (the ratios between the various dimensions of the ship are identical). This is also the case with the block coefficient. Furthermore, the angles are a length ratio, so they are also identical to the original ones. The scale factors of the areas and volumes are deduced from this, i.e.:

$$S^2_{(L)} = 25^2 = 625$$

$$S^3_{(L)} = 25^3 = 15\,625$$

Similitude of mass: The model used for shiphandling training must not only resemble the original but also move in the same way as the original when subjected to similar forces. Moreover, the density of the lake water is almost the same as the density of sea water. Consequently, the scale factor for the mass and displacement is the same as that for the volumes, i.e.:

$$S_{(M)} = S^3_{(L)} = 25^3 = 15\,625$$

Similitude of forces: If the external forces on the model are in similitude, like the shapes, masses and inertia, the model's movement will be in similitude. It can thus be shown that the forces must be at the same scale as the masses and weights, so:

$$S_{(F)} = S_{(M)} = 25^3 = 15\,625$$

Similitude of time: In agreement with Froude's law, the time scale is the square root of the length scale, so:

$$S_{(T)} = S^{1/2}_{(L)} = \sqrt{25} = 5$$

Similitude of power: Similarly, it can be shown that:

$$S_{(P)} = S^{7/2}_{(L)} = 25^{7/2} = 78\,125$$

In conclusion, by choosing a scale of 1:25 for the lengths and by complying with Froude's law, the engineers at Sogreah – Port Revel built models 25 times smaller,

operating 5 times more slowly, but as the distances are 25 times less, things occur 5 times faster. The ships are 78 125 times less powerful.

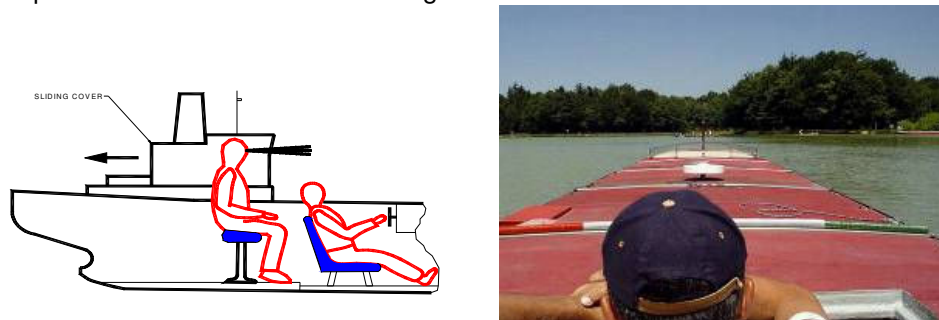
Similitude of manoeuvres

While the models must be in correct similitude, this is not enough. Other factors can affect the correct reproduction of the manoeuvres, such as the field of vision, on-board equipment and wind.

First, it should be noted that manoeuvres on a model require the same pilot's orders as those on a real ship. The only difference is that they are executed five times faster on the model, so there is no time to discuss them. In fact, the rate of operation is such that the captain and helmsman swap roles every hour to avoid fatigue.

The captain's position gives him a true field of vision from the bridge. He gives his orders to the helmsman, who is seated in front of him and operates the wheel and engine.

Captain's vision from the model bridge



Control panels show the usual information (engine speed, rudder angle, heading, log, wind speed and direction, shackles of chain lowered). This information is shown in real-life values to help the trainee forget as far as possible that he is on a scale model.

The ships are fitted with bow and stern thrusters and perfectly operational anchors. They behave like real ships from this point of view as well.

Tugs are under the captain's orders via remote control, and are handled by a real tug captain.

As far as the wind is concerned, it should be recalled that as the speed scale factor is 1 in 5, a wind of 10 knots on the lake is equivalent to a 50 knot squall in reality. Ripples on the surface of the water and the movement of leaves on the trees are therefore unreliable indicators. The wind and ship speeds displayed on the control panel are therefore very important for trainees. However, the lake is situated in a forest in a region with little wind, so that uncontrollable wind effects are minimised.

40 years' experience have shown that students quickly learn how to control the models just as they do the real ships that they are used to manoeuvring.

Those who have trained on both claim that scale models are complementary to electronic simulators. While manoeuvres with currents, waves, tugs, anchors, bank effects, etc. are reproduced more accurately on scale models, numerical simulators are more realistic when it comes to the bridge environment.