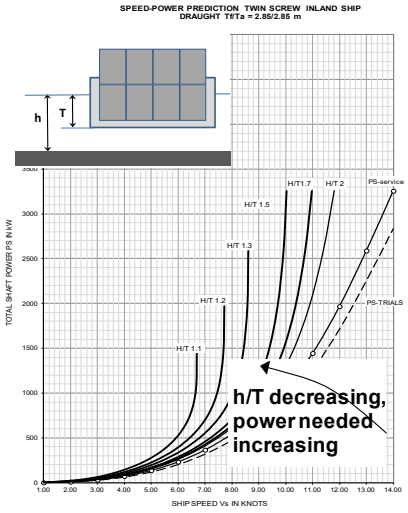
Inland Waterway Transport

From concept design to detailed flow optimisation

In developing transport over water and improving the efficiency of your ship, MARIN is able to assist in various ways. From a logistics point of view, the flow(s) of goods in combination with the characteristics of the fairway are the most important factors. In the concept stage data concerning the conditions of the fairway involved need to be collected: the cross sections of the fairway, water levels and current speeds over a year, dimensions of locks bridges, etc. Subsequently, various ship types and dimensions are explored, including different compositions of a fleet capable of transporting the required volume. In this way the operational profile is defined as starting point for the design of the hull and propulsion of the ship.

Coupled unit

The under keel clearance of a ship (water depth 'h' minus draught 'T') effects the power needed to sail with a certain speed. This is illustrated in the figure below.

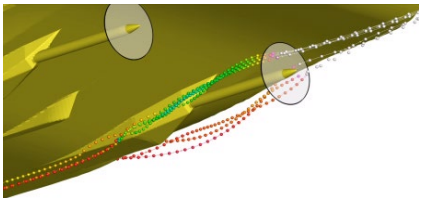


Inland waterway transport: part of the logistic chain

The development of inland waterway transport (IWT) starts with the flow of goods to be transported in combination with the presence of waterways. In most cases IWT is part of a logistics chain. The volume and value of goods determine the possibilities and economic viability of transport solutions. Multiple options can be considered if IWT is feasible; single ships, coupled units (ships pushing one or more barges) and push-tows. Given the volume of goods and the characteristics of the fairway, ports and terminals, the most feasible combinations are identified. From an economic viewpoint, manning regulations should be considered as well.

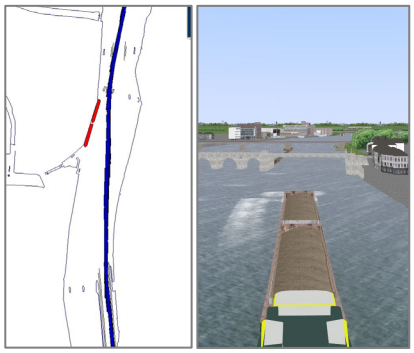
Operational performance

Bottom levels and currents can vary during an inland trip. These conditions change during the year. Fast-time full-trip simulations can be used to determine the ships overall performance during operation. Effects of varying water depth and current-speeds are taken into account. In this way situations with different river conditions are simulated. This provides valuable insight in the operational performance during the design stage, in order to determine the critical conditions and/or aspects to focus on in the design of the ship.



Example of calculated vortices along the aft body of an inland push boat.

Manoeuvring simulation push-barge convoy entering a lock



Two barge push-tows passing bridges. Sailed track vs. view from the bridge simulator

Model tests of an estuary ship in waves

Design and optimisation

The starting point for the design of a ship or push-tow is its operational profile. Gains in the design pay off during operation. The amount of propulsion power needed depends on the design of the hull and the propeller. Important considerations for reducing this amount of power are:

- Reducing the generation of waves
- Low pressure variations and generating minimal vorticity
- Optimal flow around the aft ship and towards the propellers and rudders

A well designed hull, plus an optimised propeller, results in a reduction of needed propulsion power, and therefore less fuel, regardless the type of engine/fuel. To obtain this, MARIN has different design tools available: empirical power prediction methods, advanced Computational Fluid Dynamics (CFD) models as well as model testing facilities.

Inland ships operate in many different conditions, including multiple water depths, varying currents and wind speeds. All this has to be taken into account to ensure adequate performance and safety.

Ship manoeuvring

Apart of this, manoeuvring performance is an important aspect as the ship has to cope with narrow margins in harbours, at the entrance of locks and near terminals. Depending on the importance of the aforementioned aspects, the design project may comprise of performance optimisation for one or more conditions, also include the full operational profile while assessing manoeuvring performance and controllability.

To include all the conditions an inland ship has to cope with, fast-time simulations can be applied to analyse the impact of different propulsion configurations, rudder systems and bow/stern thrusters. An autopilot is applied in these simulations to identify critical situations. These situations can be investigated further in a full mission simulator, which can also be used to train.

Model tests

The most accurate performance prediction of a design can be realised by performing model tests. Model tests can be used to verify contract requirements before the building of a ship starts. For these purposes MARIN offers resistance and propulsion tests in the Shallow Water Basin if the water depth is restricted, or in the Deep Water Towing Tank if the ship is intended to sail in deep water. Behaviour of a ship in waves and free sailing manoeuvring tests are performed in our Seakeeping and Manoeuvring Basin.

For more information contact MARIN:
the department Inland Ship
T +31 317 49 34 72
E inlandship@marin.nl

Nicole van Spronsen
T +31 317 49 36 64
E n.v.spronsen@marin.nl