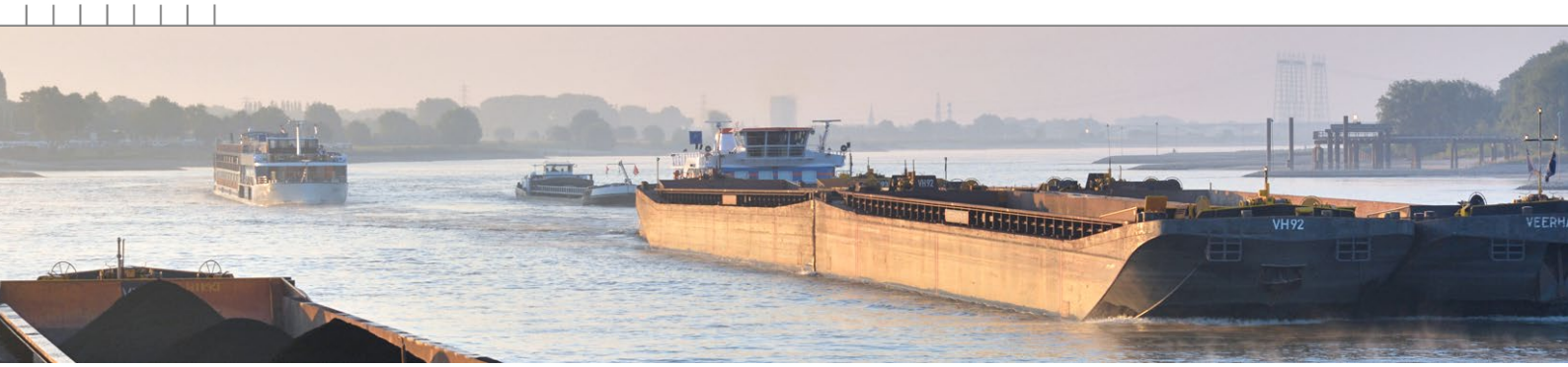
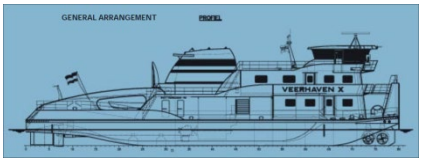


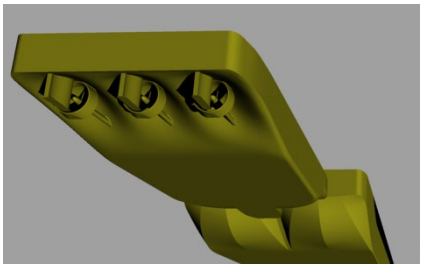

# Improving towboat design

## Balancing powering performance versus manoeuvrability

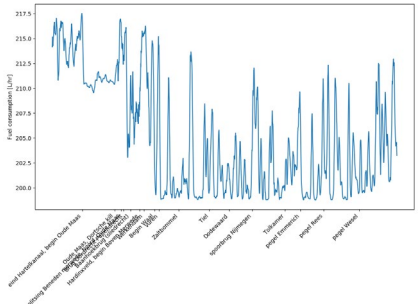
**Inland shipping in Western Europe consists of a variety of inland ships, including pusher boats, barges, tow boats, transport vessels and many other types of working ships. In North and South America more and more towboats are powered by Azimuthing Stern Drive or Z-drive propulsion. In Western Europe inland ship operators face long periods of low water, restricting draught to UKC values less than 2' for ships and barges transiting between Rotterdam and Duisburg. To help operators improve performance in these challenging situations, MARIN started a research program to investigate the powering and manoeuvring performance of push tows. In this research a conventional propelled towboat (fixed ducted propeller) will be compared with a Z-drive towboat.**




*Side view of "river Rhine" push boat*



*Stern configuration conventional towboat*



*Example calculated fuel consumption along trajectory*

### Towboat

An existing towboat with conventional diesel-direct propulsion system is used as a starting point. The boat's length, breadth and draught are 130', 49', 5.7' respectively. The boat is powered by three 1,360 kW engines, driving three fixed 6.7' propellers in nozzles. The hull has been adapted in order to obtain a comparable towboat design with three Z-drives.

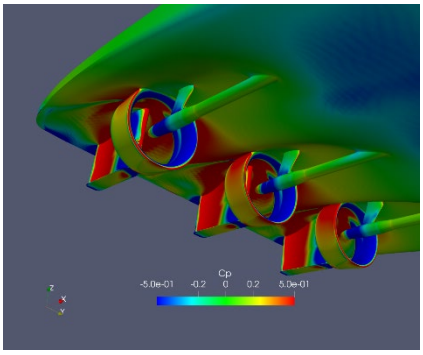
### Detailed CFD calculations

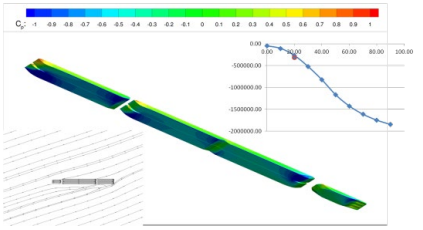
For both towboats, powering calculations using MARIN's CFD code ReFRESCO are in progress. The CFD calculations include propeller effect and will be performed for deep and shallow water situations. The aim is to better understand the flow around the propeller and hull for both designs. The results of the calculations will be used to predict the speed-power performance of the towboat with barges for different water depths.

### Voyage simulation

The speed power relation will be used in a time-domain simulation of the voyage of a loaded six-barge push tow on the route from Europort-Rotterdam to Duisburg. MARIN's voyage and route planning software, Gulliver, will be applied for this. The software simulates a ship sailing a specified route and takes into account a sailing strategy (i.e. specified trip time or fixed propulsion power) and environmental conditions (wind, waves, water depth).

**ReFRESCO**
ReFRESCO is an advanced and flexible flow solver. It requires more computation time but allows adding appendages and rotation propellers, if needed. Therefore, ReFRESCO can be used to optimise the duct and the propeller and can be used to calculate the forces on the hull given combinations of drift angle and yaw rate.



*Developing manoeuvring models: CFD calculation of forces and moments as a function of drift angle*

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The software has been adapted for application on inland waterways to also include waterway width, currents and changing water levels. By taking (changing) environmental conditions into account, the propeller will meet varying operating points. Therefore, Gulliver is a suitable tool for comparing the fixed propeller and z-drive concepts on fuel consumption and average sustained speed.

## Manoeuvring performance

The computer program SURSIM is the tool MARIN applies analysing and/or predicting manoeuvres with displacement ships. It is based on a broad experience with seagoing and inland ships. For the application of SURSIM for push tows additional CFD calculations have been and will be realized in order to analyse and model the forces and moments on the push tow.
Besides additional calculations will be realized in order to model the forces on rudders and on the Z-drive during steering.

These calculations will be used to develop a manoeuvring model of both push tows: the conventional push boat pushing 6 barges and the Z-drive towboat pushing 6 barges. The manoeuvring performance will be compared by fast time manoeuvring simulations in the bends of the river Rhine between Nijmegen and the German border. In the simulations the push tow in controlled by a track controller following a predefined track. A final assessment is not yet defined: a real time simulation on bridge simulator in a difficult/critical situation with both push boats/push tows.

## Extending this research to the American situation

MARIN would like to discuss with you the conditions American operators face in towboat operation. In what situations a Z-drive towboat outperforms a conventional propelled towboat.
What are the main elements that drive cost efficiency of your operation and where could MARIN contribute in analysing these elements in order to increase operating efficiency. This might lead to research and/or JIP proposals (JIP – Joint Industry Project) for further analysis and optimization.

## Feel free to contact us!

Altogether, MARIN offers a range of tools for improving inland ship and towboat design with respect to powering and manoeuvring. And we deepening our knowledge on hydrodynamic and economic analysis of inland ship/towboat design and inland ship and push tow operation.
Interested? Contact us to discuss the possibilities for increasing the energy efficiency of your ship and operation.