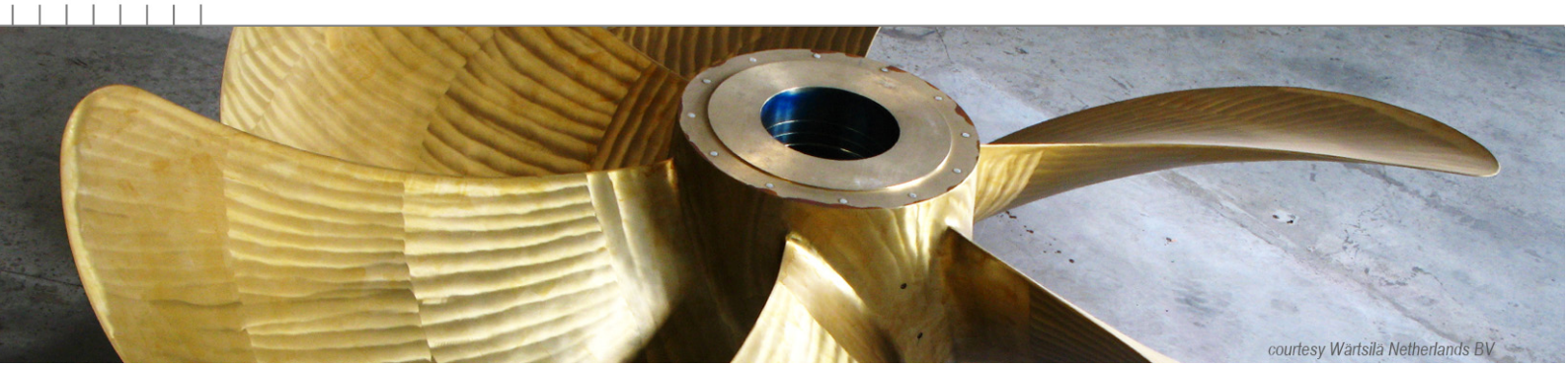


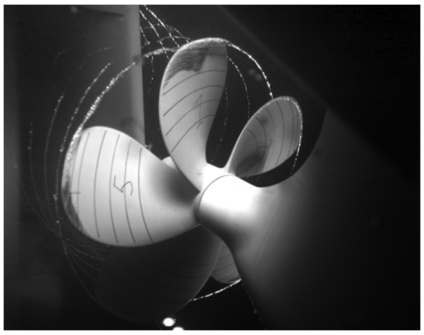
The Wageningen F-series Propellers

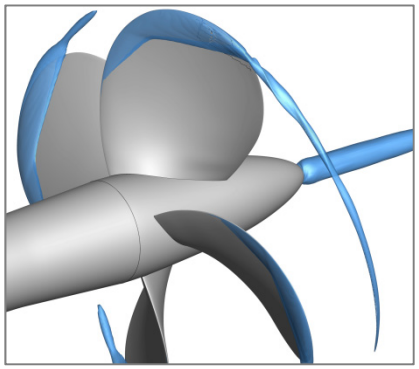
Systematic fixed-pitch propeller series for high efficiency

In a Joint Industry Project (JIP) a standard series of fixed-pitch propellers will be developed which encompasses design features of contemporary propellers. The new series will be designed for best achievable efficiency, while simultaneously taking into account requirements on cavitation, noise and vibrations. The need for the series results from the growing awareness of safety, ecological and comfort aspects in ship design, and the increasing electrification of ship propulsion systems.

Application is relevant for

- Propeller designers
- Ship designers
- Shipyards
- Ship owners
- Classification societies
- Research institutes
- Universities





Multi-dimensional design space

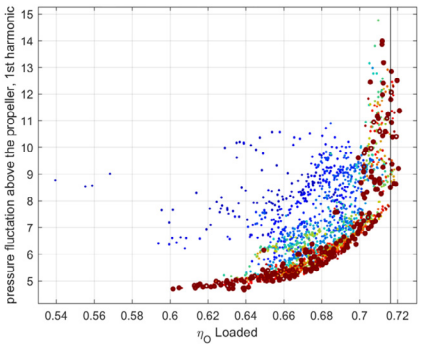
The series will contain more than 100 propellers in the usual design space of blade number, blade area ratio and pitch ratio. Geometry details like skew, radial pitch- and camber distribution and blade section shape will depend on these three main variables. The geometries will form a continuous and smooth design space. The additional dimension consists of a function to find trade-offs between various design requirements (for instance efficiency against noise) for a selected series propeller. The benefit for the users is that each search in this series results in a practical and contemporary propeller design (geometry and performance data are output) that has a high efficiency, and is balanced with cavitation, noise and vibration requirements. In this way the time and costs needed for ship and propeller design are expected to reduce, as risks can be assessed at a very early stage.

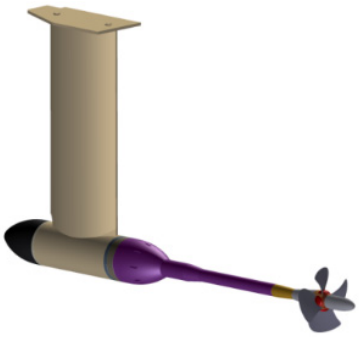
Performance data for any operational condition

For every propeller of the series the full four-quadrant data will be made available. These data can be used to determine ship speed, power, towing force and bollard pull, as well as thrust and torque for crash stop, backing, trailing and blocked shaft conditions. Having reliable performance data available for all these conditions is of great benefit for the users of the series, and may help avoid costly corrections to vessels in service.

Design approach

In an extensive design phase, propellers will first be optimised for seven selected ship types in different wake fields and operational conditions. Efficiency will be maximised within the typical constraints of each ship type and operational condition.





Typical ship types

- Car carriers
- Container ships
- Cruise liners, ferries and yachts
- General cargo vessels and coasters
- LNG carriers
- Research vessels
- Tankers and bulk carriers

Related products

- Wageningen CD-propeller series (2015) of open and ducted controllable pitch propellers
- Wageningen TT-propeller series (2018) of controllable and fixed-pitch tunnel thruster propellers, including rim-driven propellers

Research institute MARIN is a provider of advanced expertise and independent research to the maritime industry. Using the newest test facilities and simulators and working together with an extensive innovation and research network we achieve our goal: the development of cleaner, safer and smarter ships and sustainable use of the sea.

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Next, a local search around the optima found in the first phase will be carried out, using design-of-experiments and free-form deformation techniques. Finally, designs at the nodal points of the blade number – blade area ratio – pitch ratio space will be selected.

State of the art tools

Multi-objective optimisation tools, in combination with both Boundary Element Methods (BEM) and Reynolds-averaged Navier-Stokes (RANS) CFD methods will be used in the design stage. All propeller models will be manufactured on a new 5-axis milling machine, and tested in open water conditions using the quasi-steady measurement technique, which was successfully deployed for the previous CD-series propellers.

Expertise and experience

MARIN's propeller design and research team has quite some expertise in developing and applying propeller design and analysis software. The application of optimisation tools has become standard practise in recent years. MARIN has vast experience in developing systematic propeller series. This ranges from series with standard geometries, to modern series like the CD-series, for which the propeller geometry varies in accordance with the typical operational requirements of the envisaged propeller.

Time schedule

The kick-off meeting is scheduled for November 2018, and the project will take three years to complete.

Organisation

The work is conducted as a Joint Industry Project (JIP), executed by MARIN. Results and costs are shared with participating organisations that have signed the JIP Participation Agreement. Twice a year these participants will be invited to the JIP progress meetings which will be held in conjunction with the Vessel Operator Forum (www.vesseloperatorforum.com). All participants will have full and exclusive access to the project reports, software and other information through the confidential project website.

courtesy Wärtsilä Netherlands BV