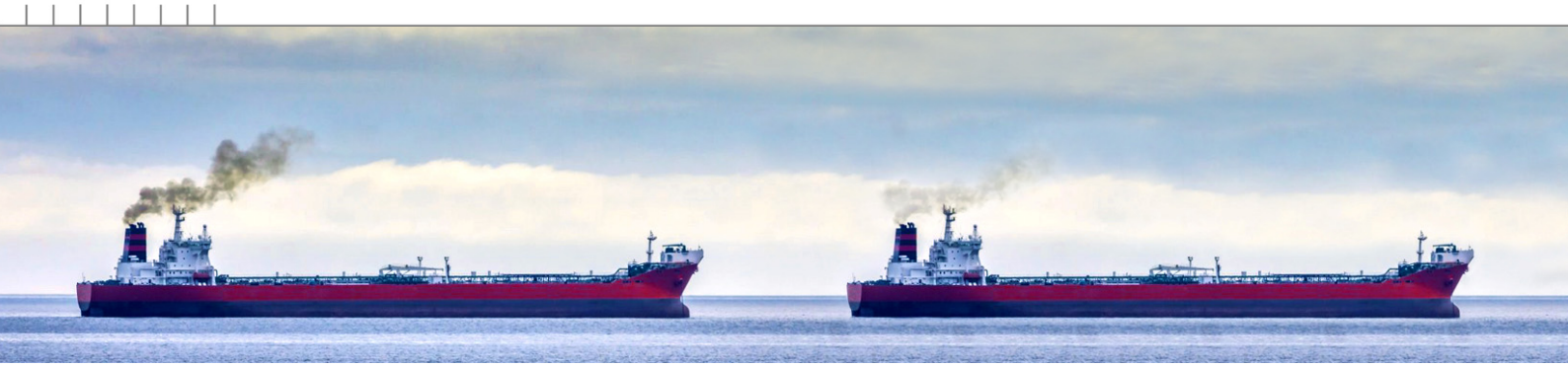


# IMPROVE-JIP

## Innovative Methods for Power Reduction and Optimisation of Vessels

**Automatic calculation-based optimisation procedures are becoming mainstream in practical ship design. Many (commercial) tools are available coupling optimizers with computational fluid dynamics (CFD) codes enabling automated ship optimisation. How to apply such tools effectively and reliably? Within this Joint industry Project (JIP) MARIN wants to answer that question by enabling the JIP-partners to effectively apply new optimisation tools, speed up their ship design process and deliver better ships.**

IMPROVE

**Objectives & Benefits**

- Learn to use optimisation in practical ship design using your own or MARIN tools.
- Learn about the different optimisation techniques and their applicability.
- Get additional tools for pre-processing (CAD, meshing), post-processing (analysis, visualisation) and CFD during the JIP.
- Gain ship design knowledge; effectively determining key design parameters.
- Make Better Ships & Blue Oceans

### Scope of Work

The JIP consists of three work packages dealing with increasingly more complicated ship optimisation cases. The details of these cases (ship type, sailing conditions, objectives) will be determined with the JIP-partners in the beginning of the JIP, typically with power as one of the objectives.
The JIP-partners are encouraged, but free, to take up the cases themselves. They can either use their own hydrodynamic, optimisation, and pre-/post processing tools or make use of the MARIN tools for e.g. geometry manipulation, data handling, and/or the link to an optimizer. MARIN will provide support how to use the tools by one-to-one contact and workshops. MARIN will apply the newly developed optimisation strategies and tools coming from their background research programme, which will be further improved where needed.
To facilitate a proper comparison of the optimization results the partners will follow some pre-described optimisation steps (see work packages) under supervision of MARIN. The validation of the optimal design and optimisation method will be done by means of cross-validation with the results of all JIP-partners.

### Work Packages

The work packages relate to several levels of complexity to perform the optimisation cases and are structured as follows:
**Work package 1** addresses the single level, single fidelity optimisation in which a ship is optimized for one or multiple objectives. In this Work package the basics of the optimisation tools are addressed.
**Work package 2** addresses the step to multi fidelity optimisation in which e.g. a high number of low fidelity potential flow calculations and a low number of higher fidelity RANS calculations are combined.

**Work package 3** addresses multi-level optimisation in which the hull and propeller are simultaneously optimized using a nested procedure.

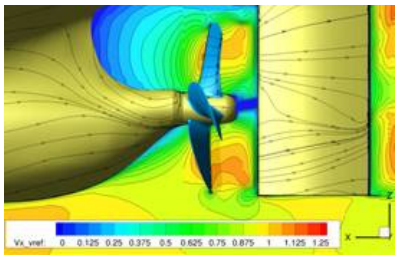
Preferably the optimisation cases are set up such that they can easily grow in complexity and be used in all work packages. However, the number of actual cases is not known on forehand and depends on the desired focus in the JIP, which will be set in close cooperation with all partners. In all Work Packages MARIN will first investigate the use of newly developed optimisation strategies and tools, improve them if needed, and perform the actual optimisation case. All results and developments become available to the partners after which they can start the optimisation case. The first optimisation case will be set up such that all partners can perform calculations with their tools in Work Package 1. All geometric variants will be made by MARIN. Hence, similar input to all hydrodynamic tools and optimizers is guaranteed enabling a good comparison of the optimisation results and used methods. In the other work packages the partners can use their own geometrical variation methodologies followed by the calculations with their tools. By means of cross-validation the optimal designs will be compared, revealing possible differences in the optimisation approaches. The incentive is to have as many partners as possible performing calculations up to Work Package 3, either with in-house tools or with tools provided by MARIN. In all cases the optimisation process will be guided by means of 1 to1 support and workshops lead by MARIN. In case MARIN is the only partner performing the most complex optimisation case(s) the focus is on exploring the opportunities of using such techniques in future design projects.

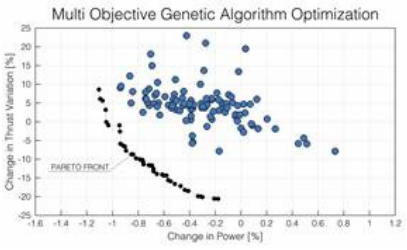
## State of the art tools

MARIN uses a number of state-of-the-art software packages. Geometry handling, parametric modelling, and preparation for gridding is done with MARIN's Rhino and Grasshopper modules. Several hydrodynamic (CFD) tools are used for powering including the URANS code ReFRESCO. For optimisation MARIN uses the Sandia Labs DAKOTA toolkit and for analysis dedicated Python and Matlab routines are being developed. Although each participant may use their own grid generator, solver, optimizer, etc., they are free to use the MARIN tools during the JIP for research purposes. Outside the scope of the JIP usage of some of these tools is subject to license fees.

## Organisation

The IMPROVE-JIP will be conducted as a 2-year Joint Industry Project in which MARIN will act as JIP manager and sign participation agreements with all members. The JIP chairman is elected by the members. Regular meetings and workshops will be arranged with a minimum of twice per year. All partners have full and exclusive access to the project reports and other relevant information through the confidential project website, till two years after project closure.






**Optimization terminology**

- Single objective deals with one aim. Multi objective aims for a trade off between objectives.
- Single fidelity uses one hydrodynamic approach. Multi fidelity uses computational results of different complexity preventing exhaustive time consuming calculations.
- Multi level incorporates an optimization inside an optimization (nested optimization).

**Costs**

The anticipated costs are 25kE per participant.

**Schedule**

The JIP started in March 2019 and will run for 2 years.

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