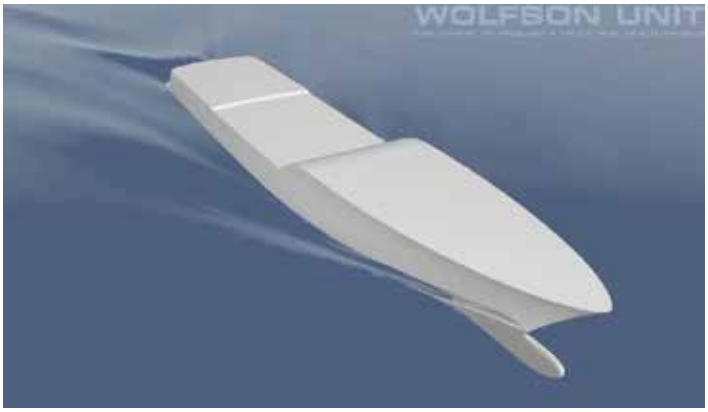
Flow simulation with CFD - Free Surface Hydrodynamics

WOLFSON UNIT

FOR MARINE TECHNOLOGY AND INDUSTRIAL AERODYNAMICS

Background

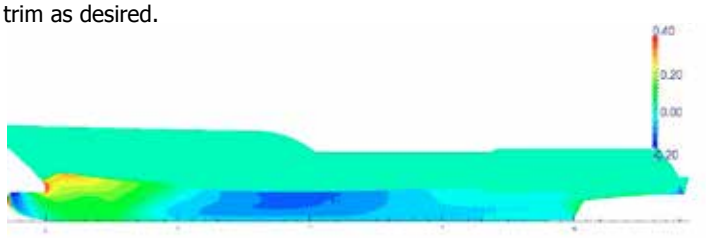
The Wolfson Unit's range of consultancy services encompasses Computational Fluid Dynamics (CFD), as well as experimentally based methods. We have developed our CFD capabilities in order to compliment the experimental testing and other services we provide, offering a cost and time effective solution to hydrodynamic design studies. Wolfson Unit engineers have experience of conducting hull form optimisations on a variety of vessel types based on strong in-house R&D efforts and understanding of the physics involved.



Calm water optimisation free surface - Burger Boat 54m Semi-displacment Motor

CFD capabilities

For predicting hull performance we use RANS based CFD with a free-surface model using the volume-of-fluid (VOF) method. This approach includes turbulence modelling, allows for breaking waves and will provide both the viscous drag and residuary resistance breakdown. Simulations can be run free to heave and trim, or with fixed heave and trim as desired.



Calm water optimisation pressure contours - 24m SWATH catamaran

Free-surface simulations are recommended principally for problems where wave-drag is important (e.g. hull design).

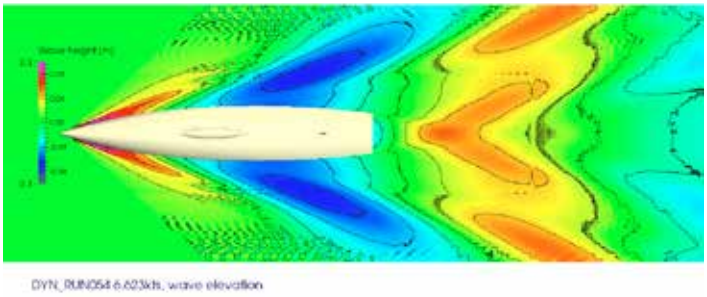
For appendage optimisation it is recommended that the free-surface is not modelled, rather it can be represented by a fixed upper-boundary, the shape of which may be obtained by a precursory free-surface simulation. This approach enables a larger number of simulations to be conducted, hence is more suited to the optimisation process.

Hull form optimisation

The Wolfson Unit evaluates the original lines by conducting CFD simulations at the desired speeds and reviewing its extensive database of towing tank results, making use of its Power Prediction tools and regression series. Driven by the naval architect design requirements the Wolfson Unit's engineers provide expertise in improving the lines over the optimisation cycle using CFD to validate each step or design iteration.

Outcomes of a typical hull form optimisation study are –

- Prediction of Effective Power and Resistance
- Prediction of dynamic behavior (running trim and heave)
- Prediction of dynamic wetted surface area
- Prediction of wave pattern and elevation
- Prediction of wave drag
- Prediction of viscous drag
- Streamline pattern
- Pressure distribution
- Prediction of wake field
- Prediction of appendage drag
- Hull / appendages interaction studies



Calm water resistance study - Sailing Yacht Research Forum

CFD Vs. Experimental methods

The Wolfson unit are experts in both computational and physical modelling, and recognise that choice of which method to use depends strongly on the nature of the problem itself. Experimental methods are excellent at obtaining large sets of highly accurate data rapidly, whereas CFD provides a greater understanding of the flow behaviour behind the results and can be useful for comparing geometry variations without the need for constructing multiple models. The Wolfson unit are in the rare position of being able to offer both experimental and CFD analysis, and where appropriate can combine the two to utilise their individual strengths to provide the maximum benefit to the design process.

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