Ship Energy Performance Framework

Case Study: Optimization of Bulbous Bow Retrofit of a Containership

Tier 3: Improvement Investigation



CASE

A containership operator requested ABS to conduct a bulbous bow optimization study to improve the vessel's propulsion energy efficiency. The vessel had a cargo-carrying capacity of approximately 10k TEU. The vessel operator provided an operational profile, i.e., the percentages of time the vessel would be operating at certain speed-draft combinations.

METHODOLOGY

As the three-dimensional hull geometry was not available, ABS started from the lines plan and rebuilt the three-dimensional model. Particular attention was paid to the fairness of the geometry surfaces and the close matching of hydrostatic parameters. A stock propeller with key parameters close to the original propeller was selected, and the open-water performance curves were calculated using propeller analysis tools. To create variants of the bulbous bow geometries, the original bow was first parameterized with control parameters to be varied for optimization. ABS applied the in-house computational fluid dynamics (CFD) tool and simulation procedure to model the existing hull, appendages and propeller. The first round of CFD-based screening targeted minimal resistance, while the refined round of search used self-propulsion tests. The optimization goal was to minimize the weighted average delivered power over the given operational profile. Finally, the hull that achieved the minimal delivered power was reevaluated using full self-propulsion simulations for all conditions in the operating profile. The speed-power curves obtained were compared between the optimized and the baseline (original) hulls.

As a result, CFD-based bulbous bow optimization achieved a 4.2 percent reduction in weighted average delivered power over the entire operational profile compared to the original bow.

DELIVERABLES

- The three-dimensional geometry model for the optimized bulbous bow.
- The comparison of the speed-power curves between the original and the optimized hull.
- Graphical output about the hull pressure distributions on the hull surface, free surface patterns about the hull and wake distributions forward of the propeller plane.

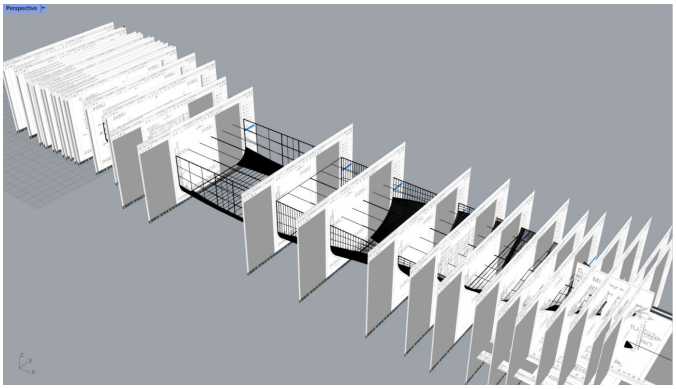


Figure 1: Creation of the 3D hull geometry model from drawings.

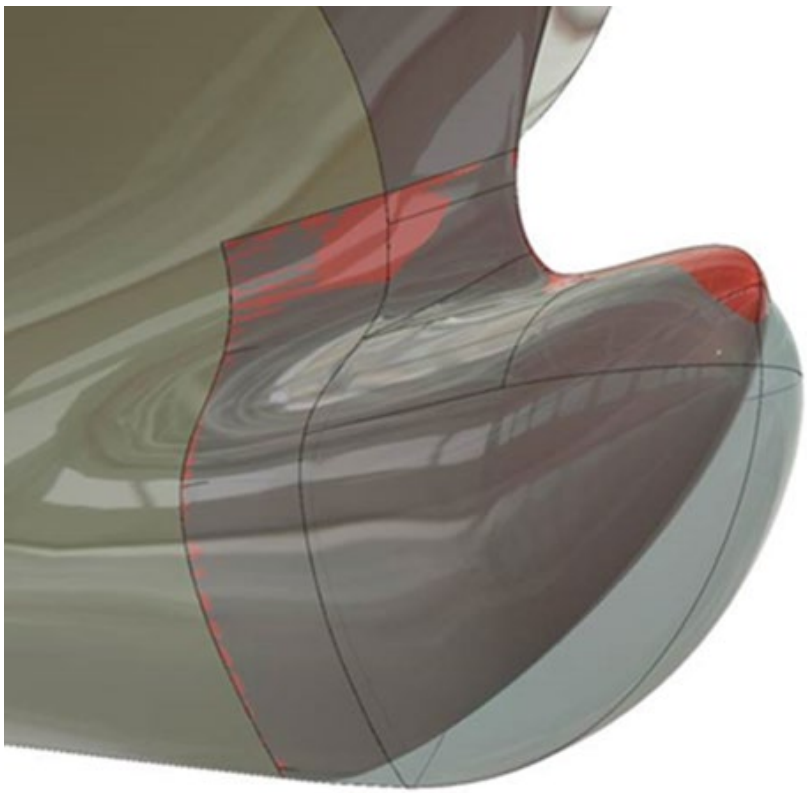


Figure 2: Optimized bulbous bow geometry (the darker shape) and the original one (the lighter shape).

CONCLUSION AND RECOMMENDATIONS

- The retrofitting of a new bulbous bow can be implemented at a scheduled drydocking.
- While model tests might tell an owner what the projected fuel savings will be for a given design or operational change, CFD can investigate and analyze a broader range of changes in a shorter time.
- Computational fluid dynamics is regularly used to quantify fuel savings derived from changing a bulb, adding a propulsive improvement device or redesigning the propeller. It identifies where an operator's resources are best allocated to provide the greatest return, the lowest upfront investment or the shortest payback period.