Hullform Optimisation
FACTSHEET

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Vessel Technology Advice & Support
VTAS
for Fuel Efficient Shipping

This is one of a series of Energy Saving Technologies (EST) factsheets that provide a brief description of emerging technologies which are available to ship owners and other stakeholders who are aiming to reduce fuel consumption and/or Greenhouse Gas (GHG) emissions.

HISTORY

Shaping vessel hullforms to ease movement through the water has been an objective of ship designers since the first vessels were put in the water. The advent of steam and combustion engines encouraged further interest and understanding of efficient ship design.

William Froude was commissioned to identify the most efficient hull in the shape in the 1860s, and his seminal work produced an understanding of resistance components acting on a hull at varying ship speeds. His empirical equations are still used by naval architects 150 years later to optimise hullforms for reduced resistance. The modern naval architect now has access to ever improving Computational Fluid Dynamics (CFD) to run complex calculations, modelling flow accurately at any given speed across the ship's operational profile to optimise the hullform.

Bulbous bows were first introduced in early 1900s. They became more widely accepted from 1930s as German ocean liners Bremen and Europa took the Blue Riband in 1929 and 1930. The modern bulbous bow was developed throughout the 1950s. By the 1980s it became rare to see any large ocean going trading vessel without a bulbous bow.

Wave piercing bow designs, such as the 'Axe,' were present in early ship design. Comparison in efficiency to other hull types was not so easy to clarify as the modelling tools were not available to refine hullforms. Many wave piercing axe and inverse bow designs are appearing into the market as benefits in efficiency are being understood with modern CFD tools.

HOW DO THEY WORK?

Hullform optimisation is a complex, but essential, part of minimising the amount of energy required to push the ship through water. The various components that comprise the total hull resistance have varying levels of influence depending on hull design, the wetted surface area, hull roughness, ship speed, and sea states.

Simplistically, wave-making/added resistance from waves and frictional resistance are usually the most prominent types of resistance to consider with typical hull shapes.

Wave-making resistance, predominant at higher speeds, is a drag force from the pressure field of the waves created by the vessel (at bow and stern) as it is propelled through the water. Froude studied the ways in which wave systems were generated over the length of a ship and how they could augment or partially cancel out the drag effects as speed increased. Frictional resistance, predominant at lower speeds, comes from the water's viscosity at the wetted surface.

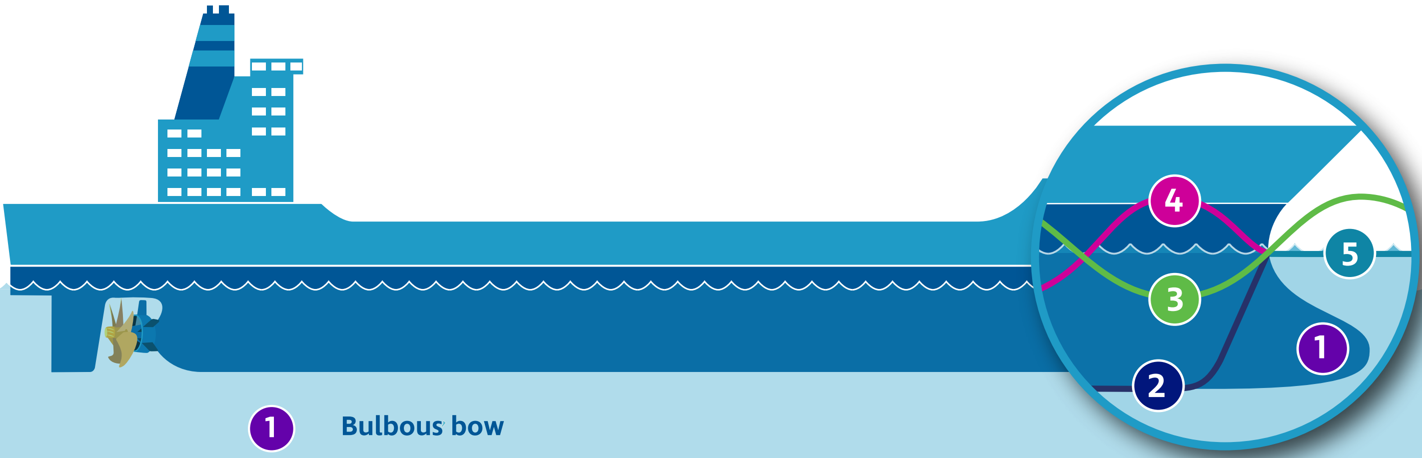
Typically long, slender hullforms reduce wave pressure drag by streamlining, while short, rounder bodies, reduce frictional drag. Therefore, the optimal design depends on operating conditions and speed whilst ensuring a minimum surface area of smooth hull is in the water.

Bulbous bows provide a wave ahead of the creation of the conventional bow wave. At a specific design speed the wave crest induced by the bulbous bow is out of phase with the wave created by the bow of the vessel and thus cancel each other out, reducing the energy lost to wave making. This can have a significant effect on reducing wave resistance, where a ship is operating at its design speed for the majority of the time.

In recent years due to slow steaming, varying vessel drafts and other fuel saving behaviours, there has been a trend in vessels removing or altering bulbous bows to suit modern operating conditions.

Bulbous Bows can also be designed to add volume forward, which can allow for fairing of a streamlined angle of entry for the hull.

Some efficient bow designs may focus on wave piercing features. For example, reverse bows, X bows or axe bows use a sharp bow design to pierce waves better. Some of these bows are designed to minimise spray and green water, cutting through the waves instead of pitching over them. These bows can also reduce slamming in comparison to traditional flared bow designs.



1. Bulbous bow
2. Profile of bow without bulb
3. Wave created from bulb
4. Wave created by bow
5. Waterline & cancelled waveform

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SELECTING THIS TECHNOLOGY

The actual operation profile, particularly the ship's ability to predict and maintain a constant operating speed, establishes if there is benefit to adding or modifying a bulbous bow on a vessel.

A smaller vessel operating in heavy sea states may benefit more from a wave piercing design.

The length of the vessel will help establish the benefits of altering bow designs. Significant positive results are generally only seen with bulbous bows on vessels over 20m.

Corrective bow modifications generally require significant steel work during a dry docking, but these costs can be recouped in fuel savings if the existing bow design is not optimised for the ship's operational profile.

KEY INTEGRATION FACTORS

- The majority of benefits come from good hull design based on accurately predicted operational conditions & speeds at new build.
- Bow design is something considered as part of initial new vessel design & is a key design factor. Any later major bow modification requires significant design & implementation investment.
- A bow design is often specific to certain operating conditions & speeds, a careful study of the anticipated results/savings should be conducted to ascertain the return of investment.
- No requirement for system integration & training.
- Other requirements must be considered as they may have operational ramifications (e.g. anchor handling, waterline length, key manoeuvring limitations manoeuvring characteristics)

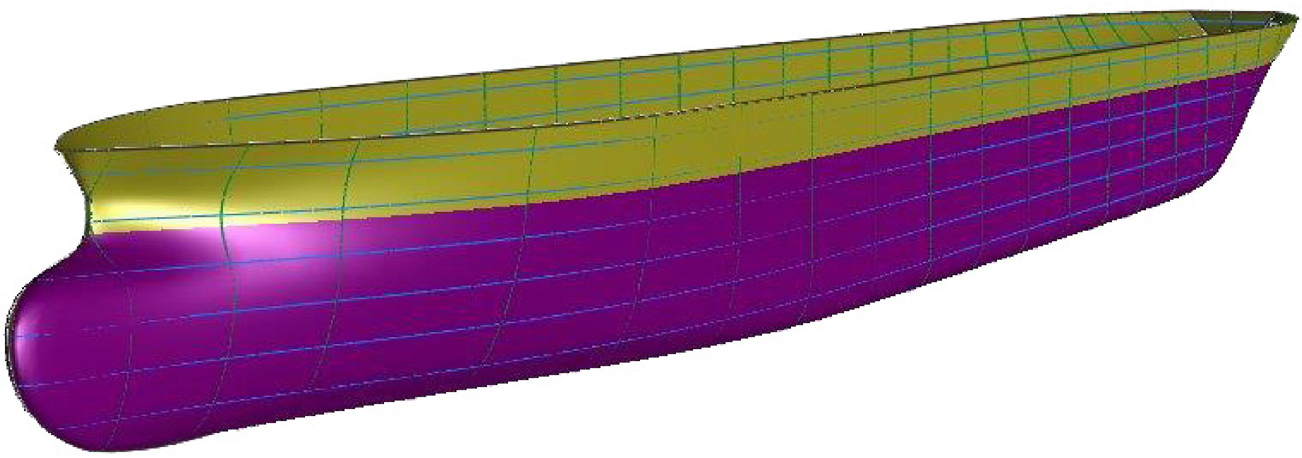
TYPICAL APPLICATIONS

- Vessels maintaining steady cruising speeds.
- Proven hullforms where speed is known.
- Larger vessels, particularly those with full hullforms
- Vessels operating away from their design point, particularly container vessels with limited other scope for energy saving.
- Vessels working in unfavourable seas or different operational circumstances (wave piercing).

BENEFITS SUMMARY

- Fuel savings & greenhouse gas emission reductions.
- No system interfacing challenges.
- No moving parts.
- Improved trim and stability.
- Increasing speed and/or range.
- Improved seakeeping characteristics.
- Reduction in slamming behaviour.

HULL MODELLED BY VTAS



HOW WE CAN HELP?

Selecting the right EST for the trades a vessel will undertake is critical to the investment decision. iTEM, at the heart of the VTAS independent assessment process, will consider the technical features of the vessels, the voyage profile all in combination with candidate EST. This is integrated with the risk and financial evaluation using your parameters or those investors are likely to recognise. Collectively this provides an informed view of how selecting appropriate EST contributes to reducing fuel consumption, lowering your operating costs and reducing your greenhouse gas emissions.

To embed this core offering VTAS is able to support you with independent consulting, analysis, feasibility and design integration advice, vessel performance and whole life cost evaluation.

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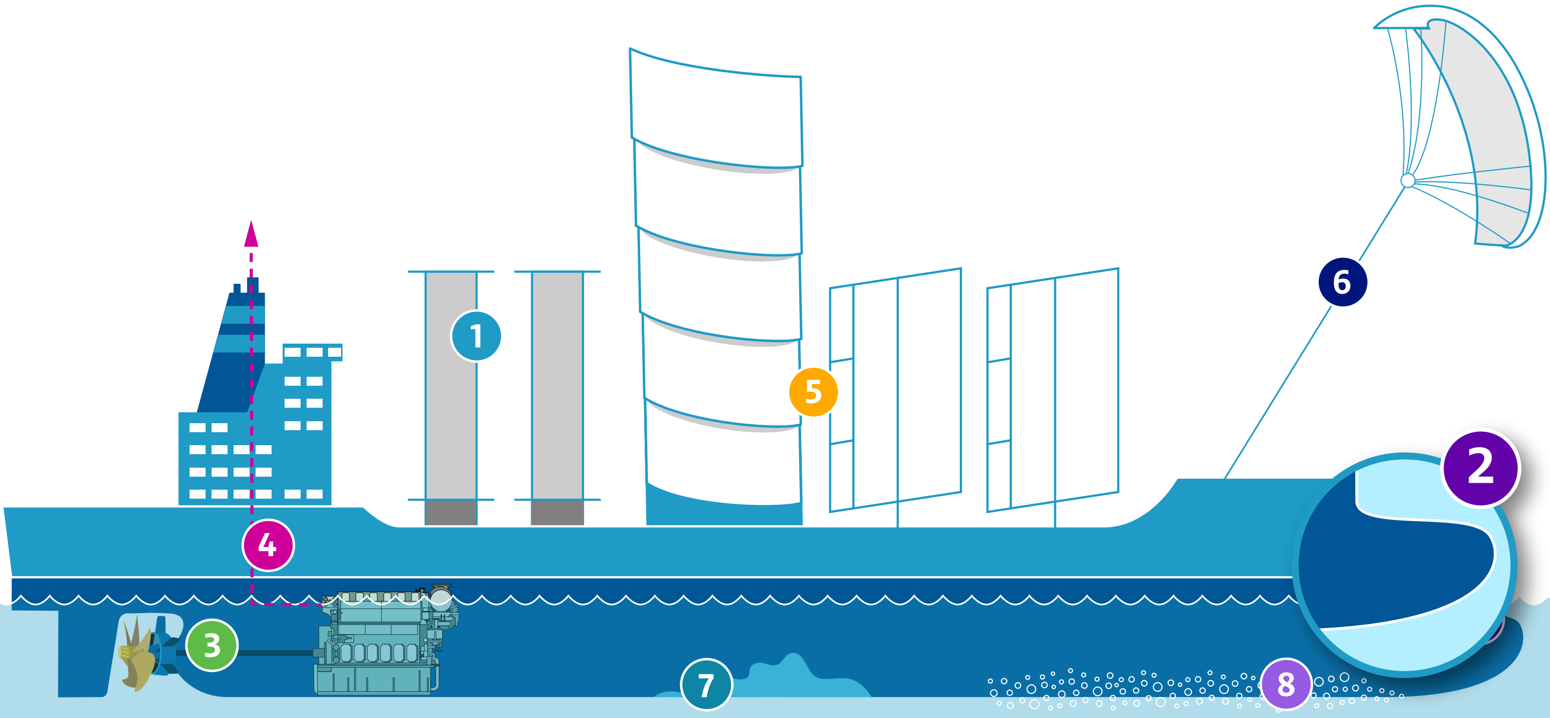
Further information can be found by visiting www.VTAS-fes.com

or contacting us via info@VTAS-fes.com



1. Flettner Rotors
2. Hull Form Optimisation
3. Propulsion Efficiency
4. Waste Heat Recovery
5. High Efficiency Sails
6. Kites
7. Low Friction Hull Coatings
8. Microbubbles