Design for efficiency

DEFOS A ship optimised for service conditions will undoubtedly consume less energy. In the Design For Sea (DeFoS) joint industry project, a case study is being done to show the impact of a ship designed to comply with the Energy Efficiency Design Index (EEDI), as described by Maarten Flikkema, project manager at the R&D department of MARIN (Maritime Research Institute Netherlands).

Current design methodologies of ships focus on one sailing condition only. In an effort to prepare for ships designed for actual operational conditions, the DeFoS joint industry project (JIP) aims to develop a tool to determine the environmental conditions a ship will encounter on specified routes. DeFoS will additionally address the challenges faced when a ship is designed for service conditions. Importantly, the DeFoS tool can be used at an early design stage to determine the required sea margin or for charter contracts to determine the required power for specific weather conditions.

Over the past couple of centuries, ships have evolved from a hollowed out tree trunk to state-of-the-art machines. Current design and calculation technologies enable ships to reach their required maximum speed in full-load condition with as little power as possible. In a shipping market with more cargo than cargo capacity, these ships frequently operate at maximum speed and maximum load condition. However, in the current shipping market, where ships often sail in part-load condition and when the demand is for a lower speed than the traditional design speed, the optimal ship design may differ from a ship optimised for maximum speed and maximum draught. Therefore, the current shipping market calls for ships designed for flexible opera-

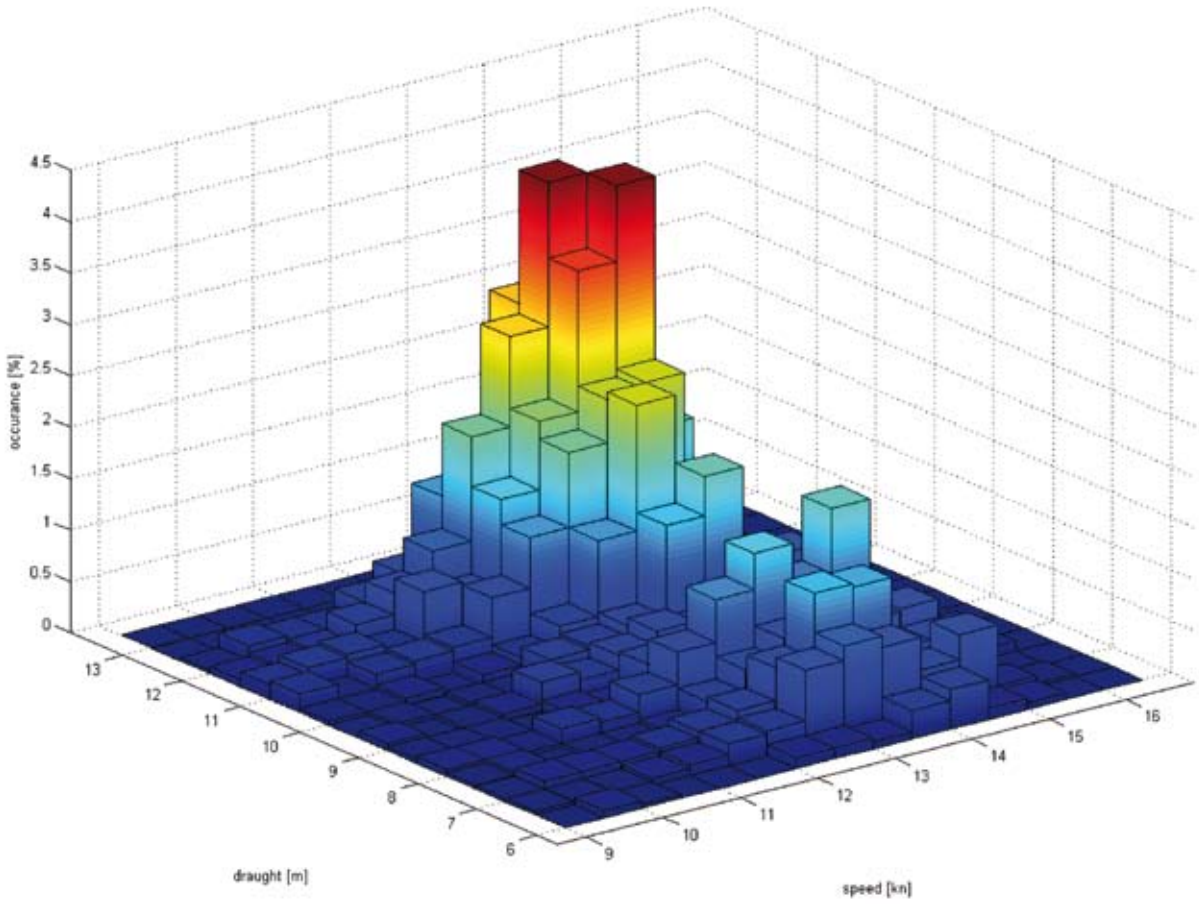

Figure 1: Operational profile of a tanker

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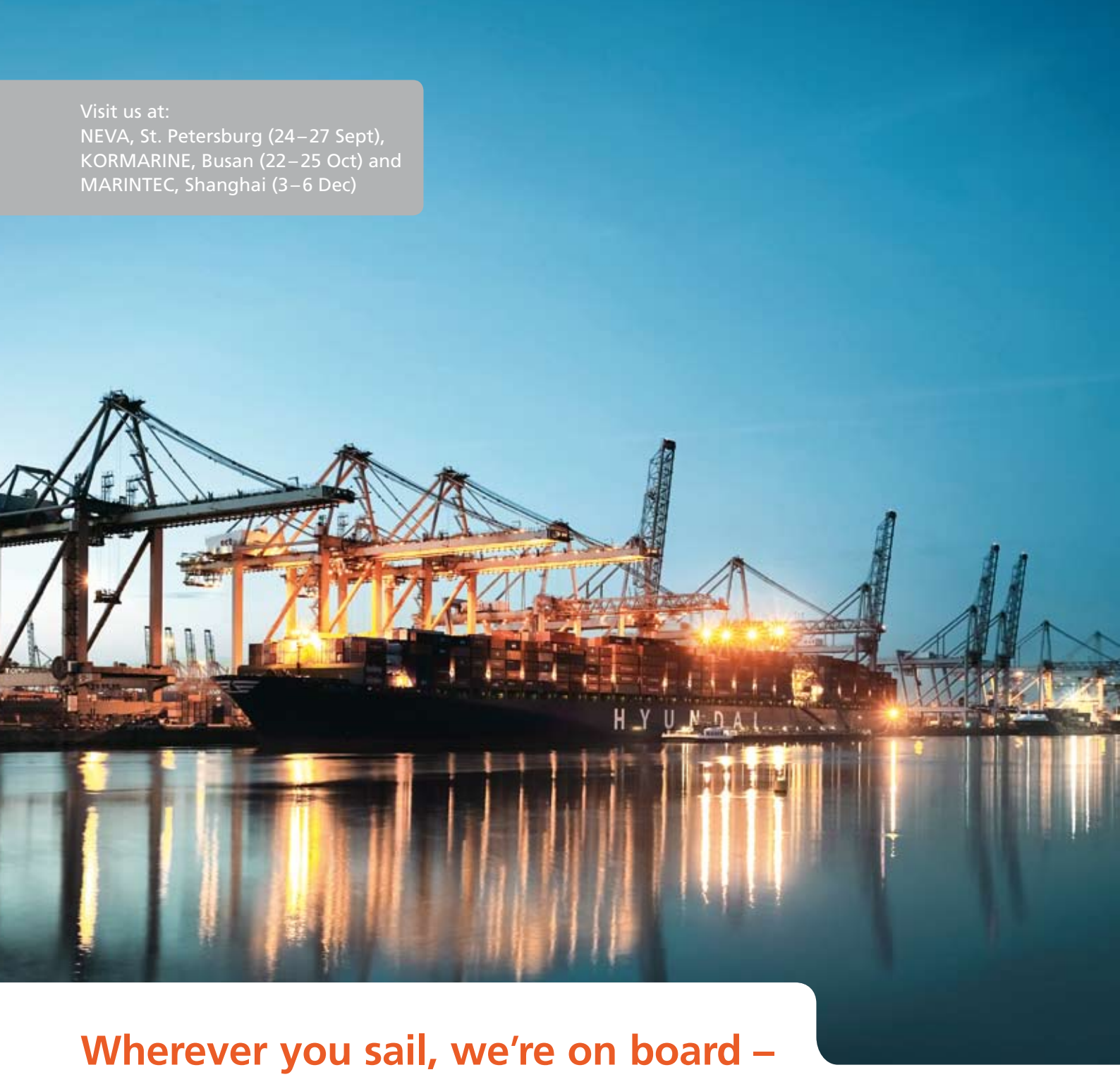

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tional profiles. Environmental conditions are also of interest at an early design stage because they determine the engine size.
It is a real challenge to identify the correct operational profile for a specific route. Distributions of speed and draught shown in Figure 1 can be determined from existing ships. However, experience from the past is no guarantee for the future. An operational profile should ideally exist for a large speed and draught range based on the expected transport demand for the envisaged route. At the same time, the ship design should be flexible so that it is able to change to a different route in line with the cargo demand.
The weather a ship will face on a specific trade can be determined from past weather data. In the DeFoS JIP, MARIN will develop an easy-to-use calculation tool for the sea margin for the main shipping routes and various ship types. The sea margin is based on measured data on board and statistical weather data collected over more than ten years. Using MARIN's voyage simulation tool Gulliver, weather statistics along the main shipping routes are determined. Calculation of the added wind and wave resistance in these weather conditions results in a sea margin that can maintain speed up to a given sea condition.

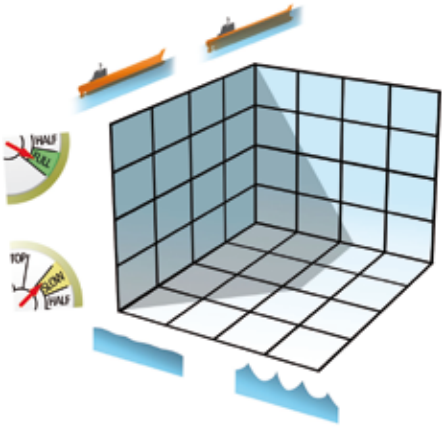

Figure 2: Design space of a ship designed for service

A change in mindset

But knowing the weather conditions is only a first step in creating a ship design for service. Optimisation of the ship hull for a variety of loading conditions and for a speed range requires a large set of calculations. Figure 2 shows a design matrix for a ship designed for service in which the design space is defined by a range of loading, speed and environmental conditions. If this matrix is filled with the expected operational and environmental profile determined by the tool developed in the DeFoS JIP, the hull lines can be optimised for various conditions.
The optimisation criterion is a minimum energy consumption for the complete operational profile instead of just the one design condition. This is calculated by the performance for each point and the expected frequency at which the ship will operate in that condition. However, boundaries of the optimisation are set by stability, manoeuvrability and ship motion limitations. Designing ships for service conditions requires a change in the mindset of shipyards, designers, operators and owners. For example, the validation of building contracts for a ship designed for service will require a different approach since there is not one contract condition but a complete profile. To overcome common challenges in designing for service, shipowners, yards and operators need to work together for a future generation of ships that are ready for the challenges of a widely diverse shipping market. The DeFoS JIP is set to take up these challenges and it is still open to new participants.

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