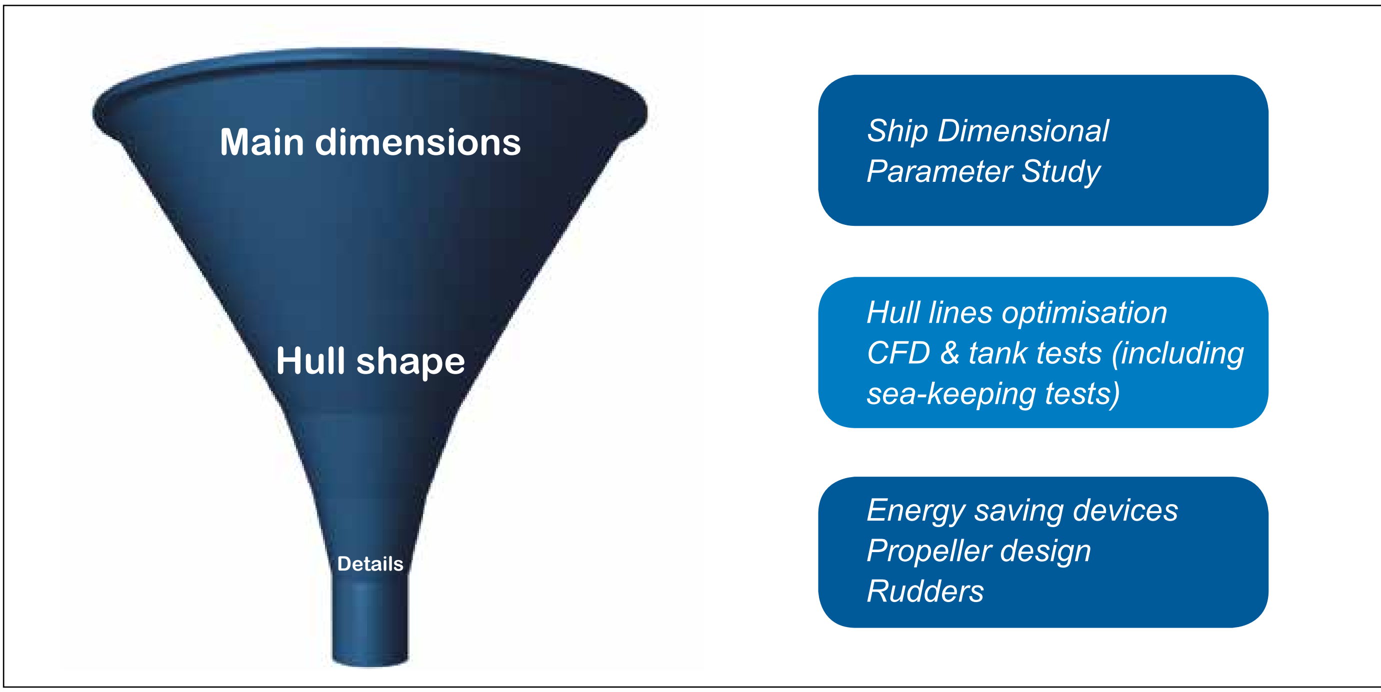
Cutting edge tanker design requires out of the box thinking

Keep the cargo flow constant, fulfil the IMO regulations set by the Energy Efficiency Design Index (EEDI) and respect limitations set by harbours and docks. These are just a selection of requirements for a state of the art tanker new building project, all of which must be met with the same hull design. SSPA takes bigger steps towards these targets by thinking out of the box and by applying unconventional concepts and dimensions to a new Panamax Tanker.



The chart above depicts the relative importance and performance improvement possible at each individual step in the design process. The first step of selecting the ship's basic characteristics and form – where the funnel's diameter is greatest – is also the step in the design process that has the greatest impact towards improving (and impairing) the ship's overall performance. As the design progresses through each successive step the funnel grows increasingly narrow as more and more of the design is finalized and the performance improvement and impairment potential similarly decreases.

Identifying the big gains

One of the common problems in naval architecture and ship design is that the main decisions, those that have the most influence on what the ship will look like and how it will perform, are made at a point in time where almost no knowledge of the design's behaviour, appearance, and characteristics are available. The more time spent on the project, the more knowledge is gathered but less room is available for changes and improvements.

A ship's power consumption, for example, is primarily influenced by the main dimensions selected, which is done at a very early stage of the project and mainly driven by financial constraints and the dimensions of existing vessels. A commonly carried out hull form optimisation might gain some 5% in power saving as well as the application of state-of-the-art energy saving devices, but neither can provide the larger gains that can be achieved by optimising the main dimensions.

Hull designers workbench

The previously mentioned problems can be solved in two ways. The first is to adopt the traditional and well-known design spiral, i.e. repeating every step and every decision until the results are sufficient. This way of working requires a lot of time and money since every step in the design process is repeated several times. Finally the optimal result will only be reached if every decision is questioned after every single design loop.

The second way is to gather as much knowledge as possible at the very start of the project. This way of working requires a huge amount of information available from other ships and the opportunity of using state-of-the-art tools for hull design and evaluation, but will ensure an optimised result with fewer working steps by making the necessary information available when the important decisions have to be made.

Having a database with several thousand ships' hulls of varying size, shape and type, SSPA can easily predict the performance of a ship with certain dimensions using in-house theoretical prediction programs. Additionally, SSPA recently introduced simulation-driven design to commercial design projects. The close coupling of various in-house tools, parametric geometry modelling, and SSPA's main CFD tool SHIPFLOW, through the cutting edge CAE program FRIENDSHIP-

Framework, allows SSPA to investigate various design approaches and dimensions in a very cost and time-effective manner providing the opportunity for large energy savings even before designing the hull lines.

Future design target

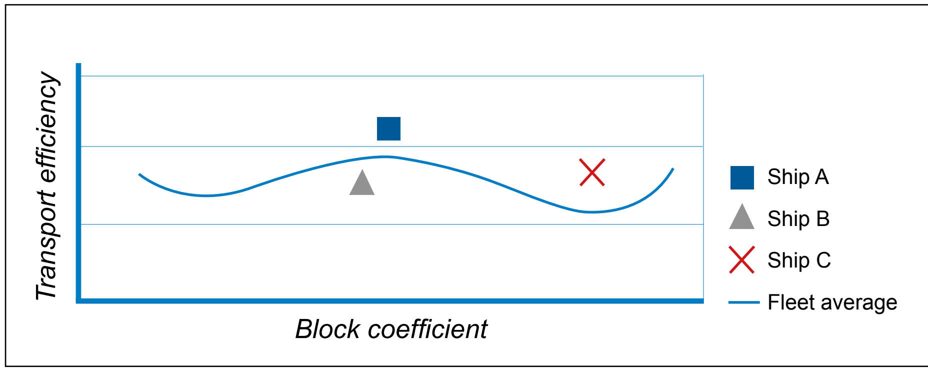
Only a few months ago ships' performances were measured by their speed at a certain power or a power at a certain speed. The class's best ship was the fastest. With the introduction of the Energy Efficiency Design Index (EEDI) the measure of a ship's performance is about to change. Reduced to its absolute simplest form and assuming that the quality of the engines and the required auxiliary engines are the same for several ships, the EEDI is defined as the installed power divided by the transported cargo, which is represented by speed times deadweight.

Unconventional design approaches

Assuming the EEDI as the target function, a ship's main dimension optimisation can be performed in two different directions. Firstly, one can perform a classic optimisation towards the lowest achievable power for a given deadweight and installed power. The second approach would be to keep the power constant and try to increase the deadweight relatively to the reduction of speed. Additional constraints, such as a maximum length might be applied in order to meet harbour requirements. Since such an optimisation might lead to extreme dimensions, like very high B/T ratios, the designer must be open minded towards unconventional design approaches, i.e. twin skeg designs for large tankers.

EEDI optimised Panamax Tanker design

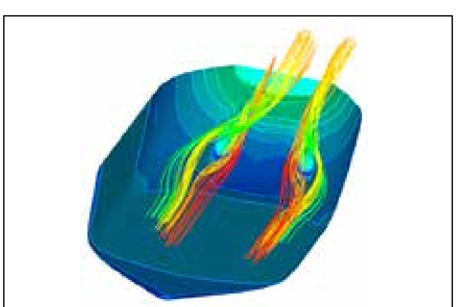
Recently carried out comparison tests of a twin skeg and a single skeg conventional Panamax



The picture shows the transport efficiency (defined by $DWT_D * V_S / P_{DT}$) of three single ships and the fleet average as a function of the block coefficient. The graphic shows, that a ship with comparably poor hull lines (Ship B) can be as good as a ship with superb hull lines (Ship C), if the main dimensions are selected in a better way. Ship A combines favourable main dimensions and high quality hull lines and turns out to be outstanding with regard to transport efficiency.

Model	1	2	3
Beam (m)	32.2	40	40
c_B	0.84	0.84	0.87
speed (kn)	14.6	13.1	12.5
delta (EEDI)	0%	-13.8%	-13.4%

The table shows the attained gains in EEDI. By increasing the beam a reduction in the EEDI of about 13.8% was realized, assuming the power (engines) and the added resistance in a seaway is the same for all three ships.



Visualisation of CFD results for a Twin Skeg Tanker. Pressure distribution and flow lines help the designer to judge the quality of the hull design and find possible areas of improvement.

Tanker showed that the delivered power of the twin skeg design is about 5% lower than that of the single skeg design. These results show that the unconventional approach of a twin skeg tanker seems favourable. Applying the aforementioned methods, a study of five different beams and three block coefficients was carried out to optimise the main dimensions to reach the lowest EEDI. In order to simplify the scope of the study the power and length were kept constant.

The speed at the given power for each of the 15 designs was evaluated using theoretical prediction methods based on SSPA's database. The predictions were checked and calibrated using full viscous CFD resistance and self-propulsion simulations. The results show that an increase in beam of about 20% can gain up to 13.8% in EEDI, even though the hull form used for the CFD computations of the wider ship was only a scaled version of the original one and thus not optimised for the new dimensions.

The tools are available and these exemplary studies prove the validity of this approach: SSPA is ready for holistic optimisations of ships at the earliest design stages. Are you?

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