



# THE NAVAL ARCHITECT

International journal of the Royal Institution of Naval Architects | [www.rina.org.uk/tna](http://www.rina.org.uk/tna)

Denmark / CAD/CAM /  
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Published by:  
 The Royal Institution of Naval Architects  
 Editorial & Advertisement Office:  
 8-9 Northumberland Street  
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Printed in Wales by Stephens & George Magazines.

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A 2017 subscription to *The Naval Architect* costs:

NAVAL ARCHITECT (10 issues per year)			
12 months	Print only†	Digital Only*	Print + Digital
UK	£182	£182	£232
Rest of Europe	£190	£182	£240
Rest of World	£204	£182	£254

†Includes p+p  
 \*Inclusive of VAT

The Naval Architect Group (English & Chinese Editions)  
 Average Net Circulation 16,694 (total)  
 1 January to 31 December 2016  
 ISSN 0306 0209



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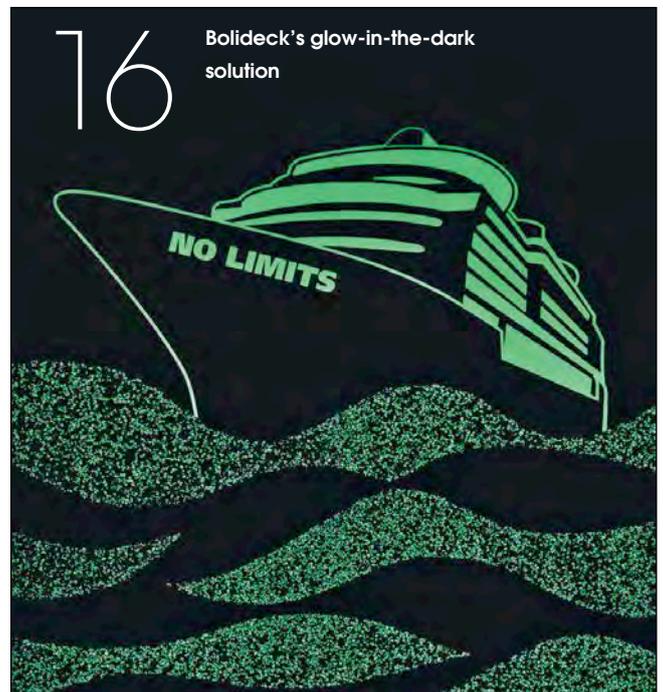
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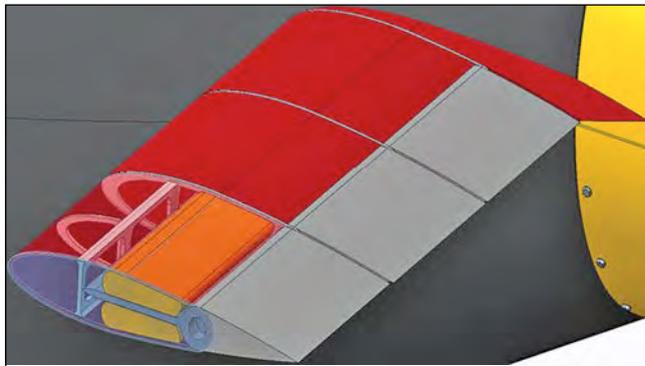
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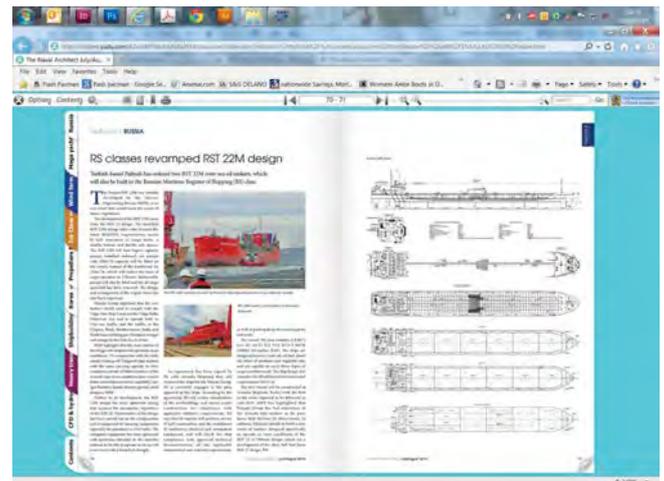


Green feeder realises eco-friendly present

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## The big short

NCE Maritime Cleantech's Short Sea Pioneer concept

There are encouraging signs that short-sea shipping may be undergoing a renaissance. In this month's *Naval Architect* we look at two Scandinavian initiatives with aspirations of revitalising the sector. In Norway, the NCE Maritime Cleantech cluster of companies are halfway through an ambitious project to develop complementary 'mother' and 'daughter' vessels which it believes might transform European goods transportation. The Short Sea Pioneer could be an ideal solution for Norway in particular, with the smaller daughter vessels able to operate through fjords unable to accommodate the large vessels we have become accustomed to today.

Elsewhere, the Danish-led Regional ECOFeeder project is exploring the potential of a wide-beam open-top feeder ship concept from Odense Maritime Technology. Superficially, Regional ECOFeeder's design is somewhat utilitarian, with an emphasis on packing the containers as closely as possible and a view to quick turnarounds at port calls, but plans to incorporate sensor-based navigation (tellingly Rolls-Royce is a partner in the project) indicate it's a little bit 'smarter' than that.

It goes without saying that emissions reductions are central to both concepts. Regional ECOFeeder's proponents claim that while truly alternative fuels have been ruled impractical at this stage, the design could offer at least a 30% reduction in CO<sub>2</sub> per container, as well as fulfilling current and pending NO<sub>x</sub> and SO<sub>x</sub> requirements. NCE Maritime Cleantech isn't quite so granular in its estimates yet (at least publicly), but plans to

incorporate multiple hybrid energy systems and be emission-free in coastal areas.

The Norwegian cluster has taken to heart the European Commission's (EC's) projection back in 2010 that cargo transportation by sea will increase by 60% by the end of the decade. Given the prolonged period of recovery from the earlier economic downturn that immediately preceded it the estimate seems to have been rather optimistic. However, the EC has repeatedly stressed its "strategic interest" in promoting short-sea shipping, searching to achieve a 30% reduction in road freight by 2030 and a 60% drop in CO<sub>2</sub> emissions across all transportation by 2050.

"The challenge is twofold: not merely the much-referenced age of the short-sea fleet but also the systemic overhaul of logistics chains"

The challenge is twofold: not merely the much-referenced age of the short-sea fleet but also the systemic overhaul of logistics chains that will allow shipping to make a meaningful difference to emission reduction. While the

EC has been advocating more extensive use of maritime transportation since the nineties, its own figures (published by Eurostat) show that the gross weight of goods transported by short-sea was almost exactly the same in 2015 as it had been a decade earlier: 1.8 million tonnes. It suggests a chicken and egg scenario: without growth in trade, how can short-sea operators be persuaded of the advantages of fleet renewal, and thereby improve that fleet's environmental efficiency? And without such progress how can freight forwarders ever be persuaded of the advantages of transporting more goods by sea instead of land?

Necessity may be the mother of invention but it's a bigger jump towards realisation. Efficiency and emissions targets and requirements abound, but short-sea shipping has been wanting for more constructive patrician guidance on the part of national and international bodies. One of the EC's priorities has been the nurturing of Shortsea Promotion Centres (SPC) and their coordination through the European Shortsea Network (ESN). In the ESN's most recent annual report (2015-16), the Danish SPC highlighted analysis being conducted by the Technical University of Denmark on the different cost elements in freight transport chains.

Academic studies probably won't lead many freight operators toward a Damascene conversion in their attitudes towards sea transportation, but it's the sort of groundwork needed to persuade them of the economic benefits. Perhaps then we will see more eye-catching designs make the transition from concept to reality. *NA*

CFD & hydrodynamics

## Farewell tour for innovative conference

CD-adapco's final STAR Global Conference took place in Berlin on 6-8 March, bringing 600 simulation experts together to present and discuss cutting-edge technology and its uses in the field of computational fluid dynamics (CFD).

Its focus, to "Discover Better Designs, Faster", did not disappoint, providing much food for thought. Automated design exploration was a particular front runner in terms of concepts, with a variety of different industries illustrating its potential (the conference featured over 10 industry streams, everything from aerospace and marine, to life sciences, electronics & electrification and nuclear applications).

The automated approach was shown to provide "virtual prototyping" that can dramatically reduce the amount of time taken to research different design variants when testing a digital model. Emile Arens, senior application engineer at CD-adapco, demonstrated the technology with a design exploration of an offshore supply vessel. In it he revealed how the design space can be more thoroughly analysed with an intelligent system that more easily computes different design variants.

A full day's worth of marine presentations highlighted an array of innovative uses for STAR-CCM+, including the automated design exploration of the British

America's Cup yacht entry; how CFD can be used to simulate ship manoeuvrability and manoeuvring; and a new step in the journey to validate full-scale CFD.

Thomas Guiard, head of energy-saving devices at ibmv Maritime, presented his company's approach to full-scale self-propulsion calculations including roughness effects and validation with sea trial data. This approach topped the results at Lloyd's Register's 2016 workshop on ship scale hydrodynamic computer simulation, which sought to test and validate various CFD approaches at full scale.

Looking to the future, Siemens, which acquired CD-adapco last year, will repackage the STAR Global Conference as part of its Simcenter Connections events. The first of these events was held in China, attracting more than 4,000 delegates.

Regulation

## Hydrogen carriers approach

ClassNK has released guidelines on the safe construction and operation of liquefied hydrogen (LH<sub>2</sub>) carriers based on IMO Interim Recommendations.

With hydrogen circling as a potential solution to (most) world powers' demands for green fuel, rules and regulation are still generally lacking when it comes to the use and transportation of liquefied hydrogen by ship. "In order to realise the best and practical use of hydrogen, its production in [an] economically viable

Goodnight Berlin: CD-adapco pays a fond farewell to its Star Global Conference format





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and environmentally friendly method and a secure supply chain to transport hydrogen to the place of consumption are essential,” says a spokesperson for ClassNK. “As the most efficient way for long distance and large volume transportation, carriage of LH<sub>2</sub> by a ship is anticipated to expand and the relative technologies developed.”

Kawasaki Heavy Industries, as reported in this year’s January issue of *The Naval Architect* (pages 24-25), is in the midst of developing a 110m prototype LH<sub>2</sub> carrier. The guidelines produced by ClassNK will surely aid in safely designing the vessel.

At present, the IGC code, which outlines safety requirements for gas carriers such as LNG carriers, has no consideration of requirements for LH<sub>2</sub> carriers and the transportation of LH<sub>2</sub>. IMO developed Interim Recommendations for Carriage of Liquefied Hydrogen in Bulk that were adopted at MSC 97. ClassNK’s new guidelines provide safety requirements for the design and construction of LH<sub>2</sub> carriers. The guidelines consider the specific hazards posed by the gas, such as the safe transportation and handling of it at temperatures below -253 °C.

#### Markets

### “Huge change” coming

Speaking at a media briefing in London, Mikael Mäkinen, president of marine at Rolls-Royce, and Kevin Daffey, the company’s director of marine engineering and technology, outlined their vision for the near-future and Rolls-Royce’s response to the present.

As can be expected of the company of late, technological change and disruption were at the heart of that discussed, with Mäkinen stating that the industry is “in for a huge change right now” and that “after this downturn we have to talk about post-oil and post-marine.”

With a downturn unlike any other, says Mäkinen, featuring low oil prices and freight rates and a period in which global transportations isn’t growing, business strategies must change. As a result, he believes a restructuring of the entire industry is ahead, with shifts towards service-based models (think power by the hour – something Rolls-Royce is beginning to offer for marine engines) becoming more common.

For Rolls-Royce’s part, he outlines a four point strategy: unique products; an advanced solutions approach with a Marine 4.0 vision; simplifying the business and bringing it in line with the current state of the global market (i.e. utilising experience from the offshore segment to benefit others, for example, Rolls-Royce’s approach to the new Hurtigruten vessel, *Roald Amundsen*, which features a bow from an offshore ship design); and improved customer engagement that involves utilising data to optimise the value of customers’ assets.

Moving forward, two new partnerships were announced at the briefing, with both Finland-based Tampere University of Technology (TUT) and Technology Centre for Offshore and Marine Singapore (TCOMS) agreeing to collaborate with Rolls-Royce on the development of autonomous systems in marine and smart ships respectively.

TUT’s strategic partnership with the company will aim to develop and test support systems necessary for autonomous navigation and consequently the first generation of autonomous ships using the University’s purpose-built autonomous ship simulator.

“We have been working with Rolls-Royce in the AAWA Project on the development of remote controlled and autonomous ships since 2015,” says Dr Kuosmanen, dean of the faculty of engineering sciences at Tampere University of Technology. “This collaboration moves us a step closer to making our vision of an autonomous vessel in operation a reality in the near future.”

TCOMS have signed a memorandum of understanding to form a strategic partnership that will focus on developing smart sensing, digital twinning and integrated modelling for future data based solutions.

“By developing demonstrator technology around sensors, data analytics and the Marine Internet of Things we will see ships become more reliable, more efficient and more closely integrated into global supply chains, generating cost savings and improving revenue generations,” says Daffey.

Professor Chan Eng Soon, CEO of TCOMS hopes the co-creation of smart ship technologies will “play a pivotal role in elevating Singapore’s position as a key hub for marine and offshore engineering research globally.”

It was also announced that Rolls-Royce will work with MacGregor to explore the implications of autonomy for cargo ship navigation and cargo handling systems onboard containerships.

“In the segments where we operate, we see a lot of unnecessary waste in the forms of inefficiency, damage to cargo, and continuously dangerous working conditions,” says Pasi Lehtonen, senior vice president of strategy, business development and marketing at MacGregor. “Our aim is to minimise this waste from the value network and this collaboration on autonomy for containerships is a good example of where industry leaders work together to transform the industry.” **NA**

#### Correction:

In the February issue, page 8, the news article titled ‘Potential for Wind Propulsion’ incorrectly said that “3.5-7.5tonnes” of CO<sub>2</sub> savings could be seen in 2030 if the market potential for wind propulsion is achieved. It should have read that “3.5-7.5 million tonnes” of CO<sub>2</sub> savings could be seen by 2030. Please accept our apologies for any confusion caused.

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# Ro-pax fire risk demands practical measures

Fire hazards on ro-pax vessels have been coming under the spotlight with advice from clubs, EU guidance and discussion at the IMO Sub-Committee on Ship Systems and Equipment (SSE) last month [March], writes *Sandra Speares*.

The potentially devastating effect of fires on ro-pax vessels has been a source of considerable concern in the industry, and while guidance has been produced, many observers acknowledge that a modus operandi for dealing with the problem is needed going forward. One of the issues to be tackled is how to combat fires that may involve alternative fuels.

Ro-ro vessels are estimated to be twice as likely to catch fire as other ships and vehicle deck fires are notoriously difficult to contain and put out, as North P&I Club pointed out in its recent advice on the topic.

While SOLAS rules specify the use of A60 class bulkheads on ships, these can quickly be overwhelmed by fires on the vehicle deck, the club warned. The UK Marine Accident Investigation Branch has reported an increase in the number of serious incidents involving fires on vehicle decks.

Fires involving new vehicles often involve hybrid or electrical issues, while the club warns that personal possessions left in cars, which might include gas canisters or jerry cans, could exacerbate a fire situation. Dangers also exist from use of water drenching systems to fight fires if they lead to a loss of stability due to build-up of water on the vehicle deck.

Once detected, North says it is vital to contain a fire, which means making sure all ventilators are properly closed – particularly if a carbon dioxide suppression system is being used. “Just a small gap in one louvre housing can render the system ineffective,” says Colin Gillespie, deputy loss prevention director at North. “If water drenching systems or fire hoses are used – including for boundary cooling – it is vital to check the water is draining away and not destabilising the vessel through free-surface effects.”

While there have been studies into the dangers of fires on ro-pax vessels, for example the FIRESAFE study produced for the European Commission, specific action is needed going forward.

Jane Jenkins, lead specialist in the passenger ship support centre at Lloyd’s Register said ahead of the SSE meeting that it was vital to thrash out more concrete strategy proposals than have emerged from debate so far.

One problem in deciding the approach is the sheer scale of the issues to be tackled. These potentially involve not only the general design of the ship, but also structural

fire issues and active protection measures including safety centres as well as human factors and improving knowledge of fire science. Training is evidently a key component. Once a pathway is established for tackling the issues, a further step will be how they can be effectively incorporated into existing regulation like SOLAS.

In his opening speech at SSE, IMO secretary-general Kitack Lim underlined the development of plans on fire protection on ro-ro passenger ships and on further work related to test and performance standards for life-saving appliances and arrangements onboard ships operating in polar waters. New rules were introduced on 1 January this year covering a range of issues relating to safety in extreme temperatures, including enclosed lifeboats and ice removal.

International requirements for onboard lifting appliances and winches were to be finalised during SSE, and draft amendments to SOLAS as well as any necessary related guidelines will be submitted to the IMO’s Maritime Safety Committee in June for consideration.

The Sub-Committee’s agenda also included work on life-saving appliances and arrangements, including new requirements for ventilation of survival craft and finalisation of functional requirements for SOLAS Chapter III.

As Mr Lim pointed out in his opening speech: “Among the recommendations of the *MOL Comfort* casualty investigation report, the need for developing new requirements for ventilation of survival crafts was highlighted. In this context, the Sub-Committee will have to consider possible methods for improving the microclimate inside survival craft and whether the provisions to be developed should, from the very beginning, be applicable to all craft and not only to totally enclosed lifeboats.”

Informal meetings were also due to take place during SSE to discuss damage stability following an incident. The issue has been on the agenda for the industry for a number of years since the *Estonia* disaster in 1994 with a number of regulatory initiatives. Interferry, who produced its own guidance on fire safety issues in 2016, is one body to have raised concerns over EU proposals on damage stability, notably the proposed increases in deck sub-division under Index R — a theoretical measure of damage survivability — that the trade association believes might present problems for ro-ro vehicle deck procedures.

The hope going forward is that practical measures can be introduced that gain wide acceptance in the ferry industry, an industry which is, by its nature, far more fragmented than the cruise segment. *NA*

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## Wind power

## Maersk Tankers collaborates on wind propulsion trial

Flettner rotor sails are to be installed onboard a Maersk Tankers-owned vessel as part of a test scheme in partnership with Norsepower Oy Ltd, The Energy Technologies Institute (ETI), and Shell Shipping & Maritime, it was announced in March.

The project marks the first time that rotor sails have been fitted on a product tanker and it is hoped it can provide insight into the operational effects and potential fuel savings wind technology may have to offer. Maersk will supply a 109,647dwt LR2 product tanker that will be retrofitted with two 30m tall by 5m diameter Norsepower rotor sails during the first half of 2018. Testing and data analysis at sea is then expected to run until the end of 2019.

The ETI, a public-private partnership between the British government and global energy and engineering companies which promotes the development of low-carbon technologies, is providing the majority of funding for the project.

Andrew Scott, ETI's programme manager for HDV marine and offshore renewable energy explained: "Flettner rotors have the potential to reduce ship fuel consumption substantially, especially on tankers and dry bulk carriers. It is one of the few fuel saving technologies that could offer double digit percentage improvements. To date, there has been insufficient full scale demonstration on a suitable ocean going marine vessel to prove the technology benefits and operational impact."

As reported in February's *Naval Architect*, Norsepower Oy Ltd recently signed an agreement to install a 24m rotor sail onboard Viking Line's LNG cruise ferry *Viking Grace*.

[www.norsepower.com](http://www.norsepower.com)

Artist's impression of the rotor sail-fitted chemical tanker



## Safety

## Viking upgrades evacuation system

Safety equipment specialists Viking used March's Seatrade expo to unveil the VEC Plus, a redesign of its fully-enclosed high-capacity marine evacuation system. The Danish-headquartered firm says it has simplified both the maintenance and long-term durability of the product, completely rethinking the equipment's components. This involved reducing the container height, but keeping the same footprint as the earlier VEC series, as well as the 565-person capacity.



Viking's VEC Plus

Niels Fraende, director of VIKING's passenger division, explains: "Recently, we re-examined every aspect of today's evacuation solutions, cutting down the number of components and introducing new access and servicing methods. For example, now you can simply swap part-elements, rather than uninstall the entire system for servicing; and this saves on logistics, time and costs."

The company also announced the launch of the Drop-In-Ball lifeboat release system for the cruise market. The technology was developed by former Maersk subsidiary Nadiro, which was taken over by Viking in 2015. It is hoped the system can help address the notorious accident record of lifeboat release systems, with fatalities occurring during several drills last year.

[www.VIKING-life.com](http://www.VIKING-life.com)

## Smart ships

## Stena and Rolls-Royce share 'intelligent awareness'

Stena Line AB has announced it will collaborate with Rolls-Royce in the development of the Swedish ferry operator's first Intelligent Awareness System.

As discussed in last month's *Naval Architect* (p.38-39) Rolls-Royce's intelligent awareness system fuses information from a variety of onboard sensors and systems



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including high-definition cameras, night vision, LIDARs and AIS to facilitate enhanced situational awareness. Rolls-Royce has already been trialling the technology onboard *Stella*, a 65m double-ended ferry operated by Finferries. This in turn evolved from Rolls-Royce's Advanced Autonomous Waterborne Applications Initiative (AAWA), which has been running since 2015.

According to Harry Robertsson, director of the operator's technical division Stena Teknik: "This project gives us an opportunity to explore how new technologies can be integrated with the systems we already have on-board and to provide a more informed view of a vessel's surroundings in an accessible and user friendly way. This will give our crew an enhanced decision support tool, increasing the safety of our vessels."

Asbjørn Skaro, director of Digital & Systems – Marine for Rolls-Royce, says: "Pilot projects such as this will allow us to see how they can be best adapted to the needs of a commercial vessel and its crew and allow us to develop a product which better serves both."

Skaro adds that such programmes represent an important stepping stone in the development of autonomous vessels as Roll-Royce targets having a remote controlled ship in general use by the end of the decade. The intelligent awareness system is expected to become commercially available by the end of 2017.

[www.stenateknik.com](http://www.stenateknik.com)

Stabilisers

## SKF boosts stabiliser production capacity

SKF has announced plans to increase production of stabiliser fins to meet growing demand from the passenger ship and offshore exploration sectors.

Capacity at the company's Hamburg plant will be doubled as part of a €1 million (US\$1.1 million) investment programme which will see the installation of a 130-tonne capacity heavy duty overhead crane, two new assembly stations for large stabilisers, and expanded production space for the manufacture of smaller units.

The company is currently able to manufacture eight sets of its largest stabiliser system, the S800, annually. The 12m long, 4m wide fins are widely used on large cruiseships to improve customer comfort during rough seas.

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Decking

## Glow-in-the-dark decking for cruiseships

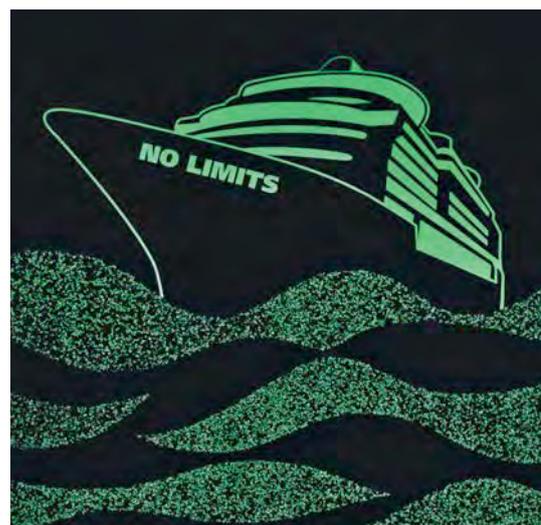
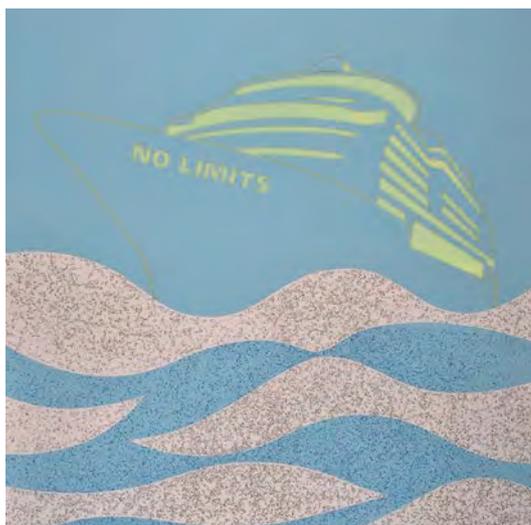
Netherlands-based flooring specialist Bolidit has developed what it says is the world's first luminous decking solution for the cruise industry. "Bolideck Glow" harvests solar energy during the day for use in features such as signage, onboard jogging tracks and other decorative purposes.

The product, which was launched at the 2017 Seatrade Cruise Global exhibition in Fort Lauderdale follows two years of research and development at Bolidit's Henrik Ido Ambacht innovation centre. It is intended to complement Bolidit's existing Bolideck Select and Bolideck Future Teak decking systems.

Bolideck Glow has already attracted the interest of Royal Caribbean International and will be installed on the in-service *Harmony of the Seas* as well as the forthcoming Oasis-class vessel *Symphony of the Seas* currently being built by STX France.

[www.bolidt.com](http://www.bolidt.com)

Bolideck Glow by day (left) and by night (right)





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# Validating design improvements at full scale

Dutch sensor specialist VAF Instruments puts forward its method of choice for evaluating the benefits of a new propeller and bulbous bow on a large containership

Energy-saving designs have always been important, but the hardening of environmental regulation and tightening of emission controls is pushing them further and further to the fore. Questions remain, however, of how efficient these designs really are at full scale, and how best to monitor their performance while a ship is in operation.

In 2016, VAF presented an approach based on full scale thrust measurements that aimed to validate performance efficiency to a greater degree of accuracy.

Now, the company has increased its list of reference vessels for the approach with a new study authored by Erik van Ballegooijen, technical consultant of hydrodynamics: “Measuring the full scale performance of a propeller and bulbous bow retrofit via propeller thrust measurements on a large containership”.

The mission statement was to differentiate between initial performance measurements and post-retrofit measurements at full scale, and to substantiate the best possible (most detailed) method from those investigated.

## Method

Three approaches to monitoring ship propulsion performance in terms of the propeller and hull (resistance) were compared, each featuring different types of measurements (see Figure 1). The first approach was the most basic, relying on readings of engine fuel consumption alone. The second combined fuel consumption measurements with torque measurements, while the third, which VAF argues is the most effective way to understand propeller performance and ship hull performance separately, added thrust measurements to torque and fuel consumption readings.

Van Ballegooijen says: “When looking at propeller theory the propeller

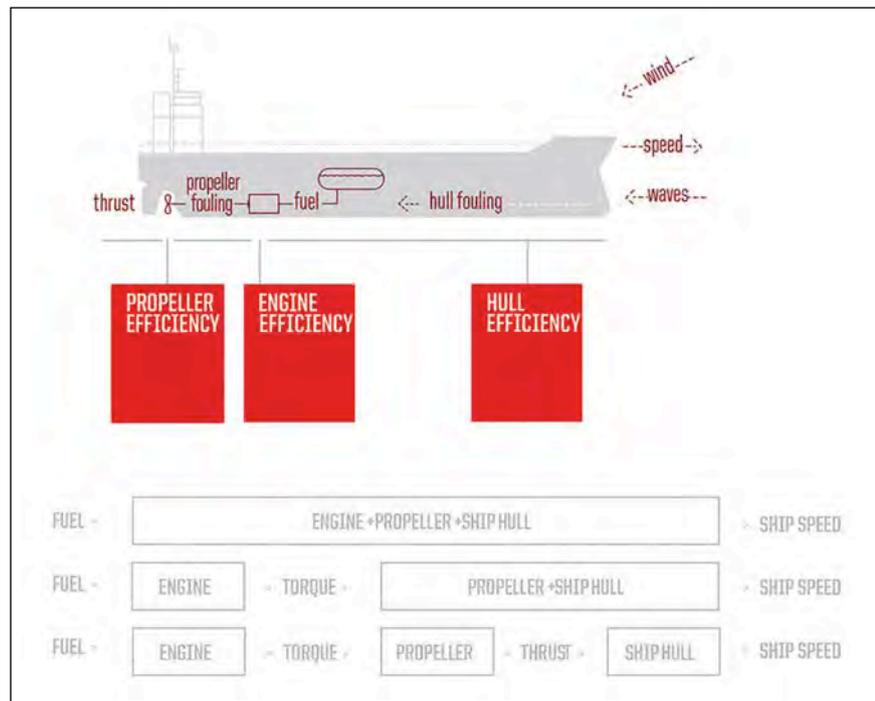


Figure 1: The three investigated approaches to measuring propeller and hull performance. 1) Fuel-based; 2) Torque-based; 3) Thrust-based

efficiency ( $\eta_{p-o}$ ) is clearly defined as the ratio between dimensionless propeller thrust ( $K_t$ ) and dimensionless propeller torque ( $K_q$ ), where  $J$  is the advance ratio of the propeller through the water:

$$\eta_{p-o} = J K_t / 2\pi K_q$$

“[This] indicates that both thrust and torque needs to be measured in order to measure the propeller efficiency. As such, the only proper way to measure the performance of the propeller separately from the performance/resistance of the hull is via measuring thrust.”

Regarding the determination of hull resistance, Van Ballegooijen adds: “A direct measurement of the hull performance is the amount of propeller thrust ( $T_{prop}$ ) needed to

overcome the hull resistance ( $R_{hull}$ ) at a certain ship speed. For this the following function applies:

$$T_{prop} = f(R_{hull})$$

“If for instance only the propeller power is used to ‘measure’ hull resistance (approach 2 in Figure 1), there is an underlying assumption that the conversion of power to the propeller into thrust from the propeller is always a non-changing constant.”

This, as the author points out, is not the case in reality, as the conversion of propeller power to thrust is inextricably related to the efficiency of the propeller. This can change over time and with different sailing conditions, as for example with fixed RPM CPPs.

The study included parameter measurements of thrust, torque and RPM for the original and replacement propeller; speedlog (STW); GPS location; ships draught; sea state; and wind.

“Propeller power via torque and RPM is nowadays a rather common measurement onboard of a ship,” suggests Van Ballegooijen. “But in order to be able to separate the propeller performance from the ship hull performance, the propeller thrust needs to be measured as well. This asks for an additional propeller thrust sensor.” The company utilised its TT-Sense sensor to separately measure the torsion (torque) and compression (thrust) of the propeller shaft via optical sensors. Measurements were taken at the vessel’s light draught and design draught for each area of study (i.e original propeller design, original bulbous bow design, new propeller design, new bulbous bow design).

Following a two and a half year analysis of the vessel’s performance – of which one and a half years was spent evaluating the original propeller and bulbous bow and six months was spent measuring the replacement propeller and bulbous bow – VAF was able to quantify the benefits of the later designs and compare them to earlier model test predictions.

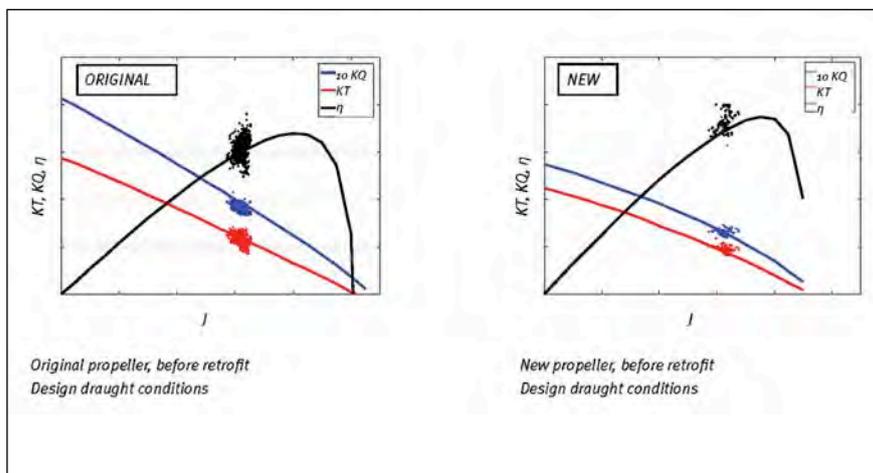


Figure 2: Design draught - Full scale sensor measurements (dots) for the original propeller (left) and new propeller (right) compared with the model test open water curves (lines)

### Propeller results

Figure 2 compares the results of the full scale propeller performance measurements with the model test predicted open water curves for both the original propeller and the new propeller designs at design draught. It ultimately shows a good comparison of measurements taken for each propeller before the vessel received its bulbous bow retrofit. Similar results were seen when measuring at light draught, highlighting a fairly good correlation between model test predictions and full scale measurements.

Next to the original model tests, the full scale measurements revealed a

relative improvement in performance with the new propeller across three slow steaming ship speeds (Figure 3). Ship speed ( $V_s$ ) is shown as a fraction of the original vessel design speed ( $V_{design}$ ) on the graph.

### Bulbous bow results

Because the vessel’s propeller thrust was measured with the TT-Sense thrust sensor, the total hull resistance was also measured, points out VAF. This allows a design team to evaluate the efficacy of the retrofitted bulbous bow at full scale. Figure 4 illustrates the gains made in reducing resistance

Figure 3: Improvement based on full scale thrust measurements of the new propeller compared with the original design

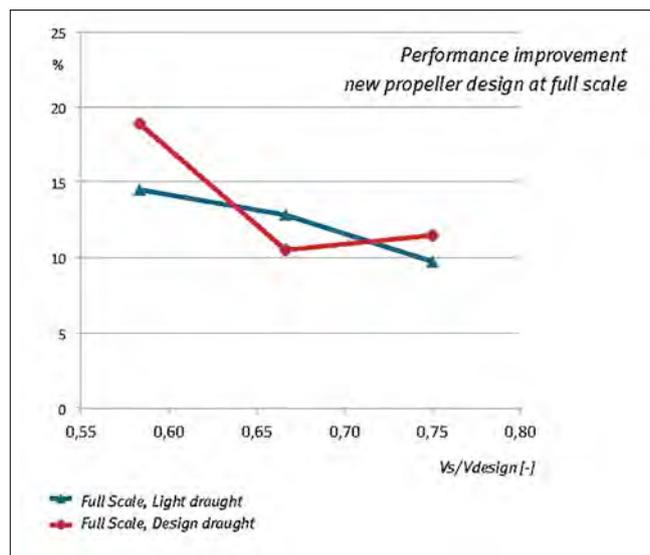
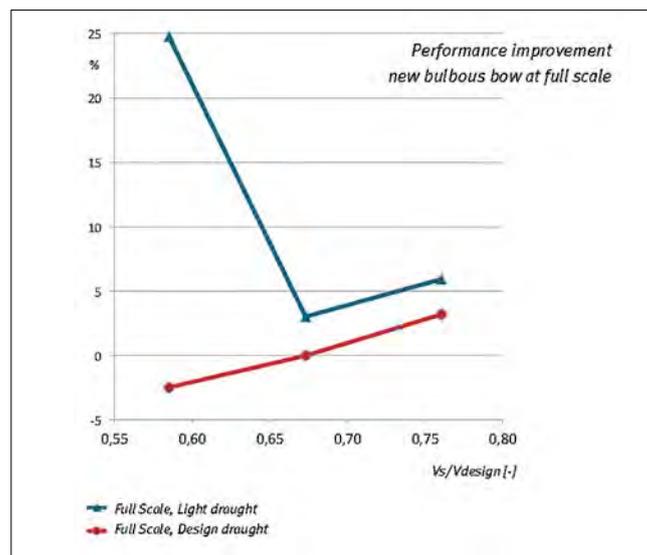


Figure 4: Improvement based on full scale thrust measurements of the new bulbous bow compared with the original design



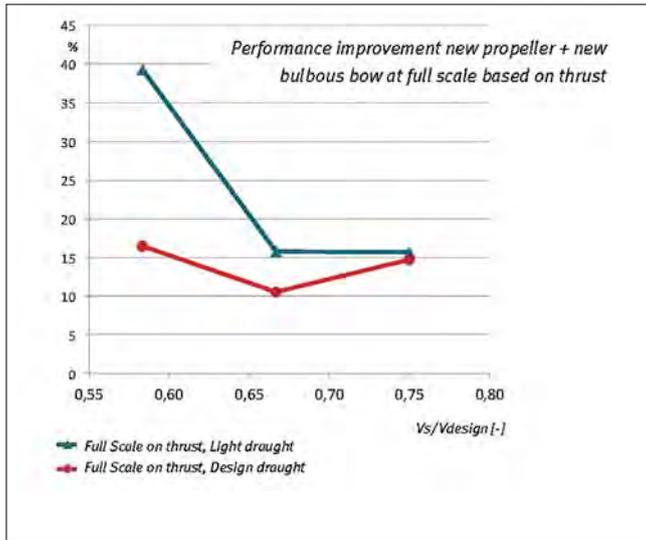


Figure 5: Total full scale retrofit performance based on thrust measurements

Measurements based on fuel consumption alone are more limited, presenting information that is far less detailed, yet ultimately comparable to the trends seen in methods 2 and 3. Van Ballegooijen explains: "When measuring the fuel consumption of the engine, not only the change in performance of the new propeller design and the new bulbous bow design is summed, but now also the engine efficiency is incorporated as well."

"Based on earlier investigations engine efficiency is changing over time due to, for instance, engine deterioration, changes in calorific value in the fuels used, and [the] operational conditions of the engine, like the RPM dependability of the efficiency of the engine," continues Van Ballegooijen. "Variations in engine efficiency of several percent [can be] seen from past data," and this ultimately has the effect of clouding the information taken and the analysis performed.

because of the bulbous bow, and how the improvement is highly dependent on the ship speed and draught of the vessel. As can be seen, improvements in hull resistance are limited at the vessel's design draught when compared with the original design.

### Overall gains as shown by each monitoring approach

Figure 5 shows the combined gains of the new propeller and retrofitted bulbous bow following measurements with a thrust sensor at full scale.

This graph and the picture it paints of the vessel's performance can be compared with those established by investigations relying on torque measurements (approach 2) and engine fuel consumption (approach 1). See Figures 6 and 7 respectively.

The full scale total performance improvement based on torque (power) measurements is nearly identical to the total performance improvement based on thrust, but has the drawback of amalgamating the individual performances of the propeller and hull so that they are indistinguishable.

### Conclusion

Comparison of the three independent measurement approaches indicates the relative accuracy and benefit of each method. VAF ultimately argues that the thrust measurement approach provides the greatest insight and therefore value to shipowners and designers looking to monitor the performance of designs at full scale, delivering a view that can isolate the impact of propeller and hull resistance on efficiency. **NA**

Figure 6: Total full scale retrofit performance based on torque (power) measurements

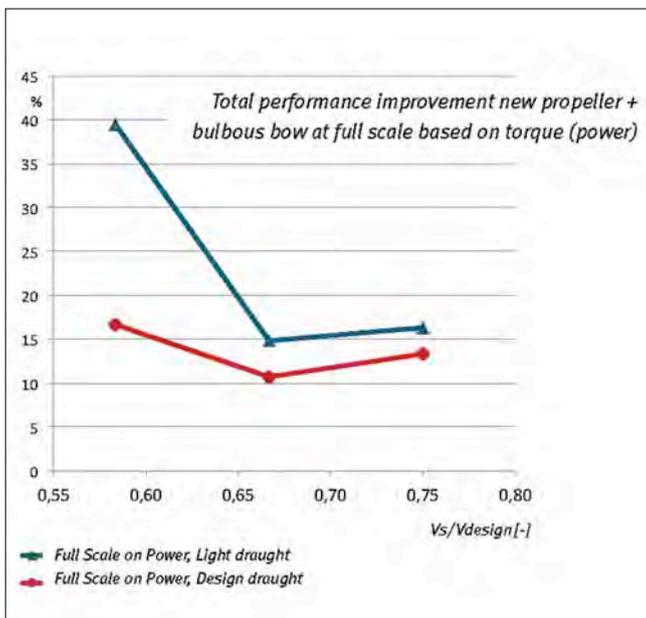
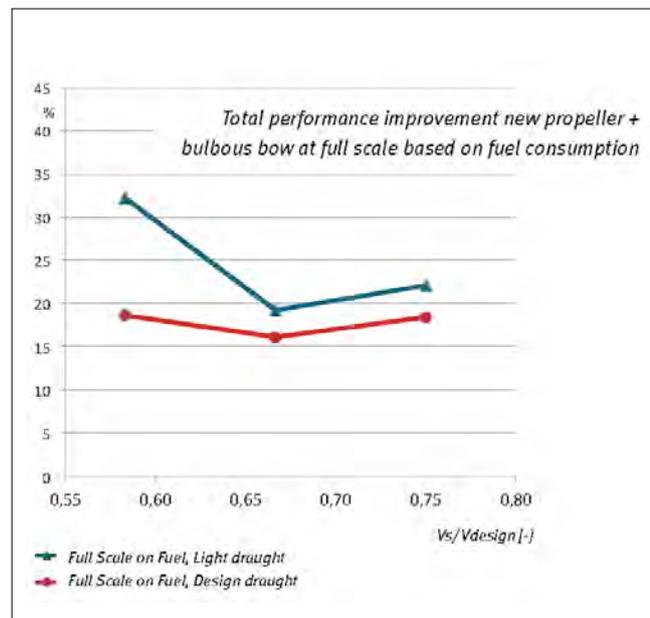


Figure 7: Total full scale retrofit performance based on engine fuel consumption measurements



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# Democratising propeller design

A new propeller design tool aims to be more inclusive of naval architects, empowering them with greater investigative capabilities

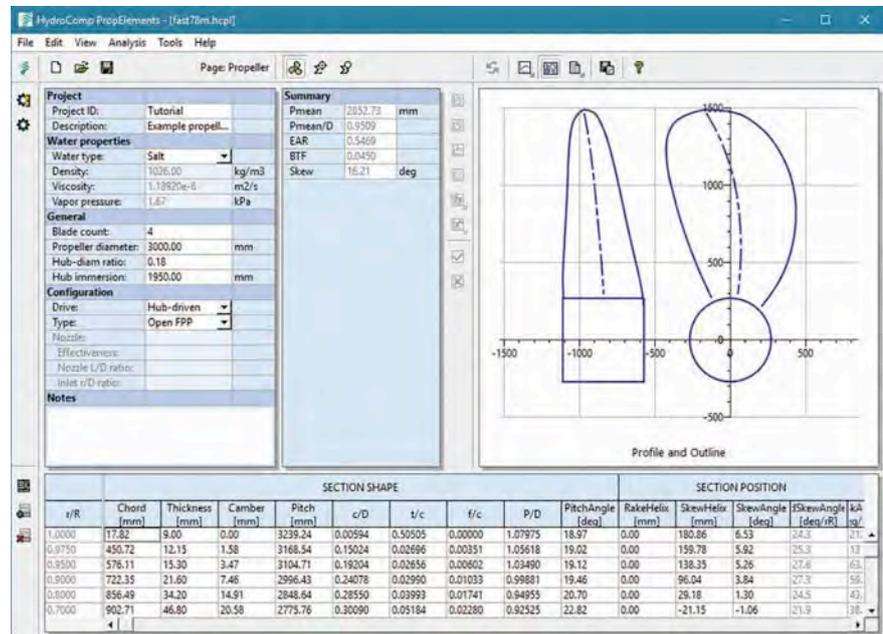
**H**ydroComp, a US-based company specialising in predictive software for naval architects and shipbuilders, has substantially re-tooled its PropElements software to make it easier for naval architects and specialists alike to investigate propeller iterations at later design stages.

PropElements is used for wake-adapted propeller design and possesses a unique, distributed blade foil code with empirical connections at its core for viscous and full-scalable analyses. Donald MacPherson, technical director at HydroComp explains that the latest major update is a response to the identification of two issues: a disconnect in the design process and demand for a predictive tool that can handle custom and semi-custom propeller analysis.

Naval architects have historically dissociated themselves from propeller design, says MacPherson, allowing specialists and manufacturers to take the reins following the identification of principal propeller parameters (diameter, pitch, blade area, number of blades etc.) and the occasional assessment of certain performance details, such as hydroacoustics. This can be quite limiting for naval architects, he continues, as it distances them from a crucial part of the ship system, i.e. the propeller as a component piece of a wider hydro-efficient system. By improving the investigative tools available to naval architects, they will be able to explore more iterations that are also a better fit for each vessel's operational profile.

PropElements 2017 aims to do just this, providing a means to discover system improvements over component improvements. "A basic propeller doesn't necessarily improve by more than few percent", points out MacPherson, but big gains can be found with improvements in the system as a whole. Naval architects rely on an accurate system perspective, MacPherson emphasises, and this tool will aid them to assess "what am I giving up [with each iteration] and does this proposal make sense from the noise and vibration issue?"

Crucially, "naval architects can become a meaningful participant in the design and analysis of these contemporary propellers at later design stages," according to the software



A propeller outline in PropElements

company. "For example, they can employ PropElements to conduct studies of alternatives prior to development of the final design, as well as to confirm and check these designs."

MacPherson says the rising popularity of custom or semi-custom propellers is necessitating a more intricate analysis of wake-adapted propellers by naval architects, as these kinds of propellers are designed using contemporary foil geometries and are optimised and fitted to individual vessels. The traditional propeller models and studies, methods naval architects have relied on for some time, are consequently less than ideal for predicting how these unique propellers will perform. However, it must be said that there is still some preoccupation with the risk involved in computational methods, similarly in respect of modelling new propeller types.

## How it works

In wake-adapted propeller design, a custom propeller is optimally matched to the unique inflow properties of the vessel or its wake field. PropElements is able to consider axial and tangential inflow properties, and to ascertain optimised distributions of pitch and camber

for prescribed foil characteristics. The design process takes blade strength, tip and hub loading, and cavitation into account, and calculation pages include propeller, performance and strength; supplemental calculations are available for the creation of KT-QQ curves.

PropElements can also be used for analysis and the forensic investigation of blade failure. The ability to investigate radial values of foil lift and cavitation number can help to identify potential sources of root cavitation or blade impulse excitation, while the ability to evaluate tip loading can be used to understand hydroacoustics – a topic of increased interest as shown by the Port Of Vancouver's move to provide discounts to validated 'quiet ships' in port.

To clarify, these capabilities are already available to those who need them, i.e. specialists and manufacturers, explains MacPherson, but this update can cater to a different audience that hasn't known it can be invested in the later stages of wake-adapted propeller designs.

In order to bring this audience onboard, the company has taken an interesting approach that sits between simple and advanced computations. To put this in perspective,

MacPherson describes where the new approach lies in relation to three categories: 1D, 2D and 3D.

A 3D approach is the most advanced, using real geometry that has empirically based 3D analysis from a towing tank or higher order CFD to observe the full 3D geometry of a ship propulsor system. The drawback is that both 3D approaches are time consuming and expensive.

Compare this to a 1D approach, which can be achieved using HydroComp's NavCad software (a tool for the prediction and analysis of vessel speed and power performance). It involves representing a ship by parameters and using statistical methods to predict performance. Obviously this is very quick and immediately accessible – the technique principally being used to date – but it also has limitations. For example, modelling propellers and hulls in this way lacks detail, which ultimately means that the models presented are not really characteristic of the shapes involved.

PropElements' 2D approach, on the other hand, is positioned in a flexible relationship with 1D and 3D approaches, explains MacPherson. It offers an intermediate level of analysis of

propellers, with a more detailed definition of the propeller than a 1D approach. This means "it is not limited to the standard propeller types found in 1D calculations and [instead] allows for better definition of the radial nature of the hull-propulsor interaction," says MacPherson.

Speed is a further benefit. "A calculation in PropElements using a standard business-grade computer is on the order of 1/100-th of the calculation time of a comparable CFD calculation on a high-performance cluster," says MacPherson. "This allows for rapid initial convergence of an analysis when conducted with PropElements' 'reduced order' calculations, making the application of CFD much more effective because you are closer to the final answer when you 'flip the switch' on CFD."

The tool can also be used to set the table for CFD calculations in a 3D approach, creating a benchmark to ensure the right CFD studies are being investigated. According to MacPherson, 100s of options can be investigated by PropElements, which helps to map out the design space for a more refined CFD search if necessary. "In short, it can evaluate a propeller or

walk a design much closer to 3D CFD with the cost and user requirements of a 1D calculation," says Macpherson. "In many cases, the PropElements 2D solution provides enough fidelity that a 3D CFD calculation may be unnecessary for anything other than a single validation run (and even this may not be needed)."

### Conclusion

Users have the capability to understand velocities, blade loads, cavitation levels and hydroacoustic levels with the 2D approach. Once complete, the PropElements 2D component calculations can be reconnected with NavCad's system analysis, which provides a higher fidelity model of the propeller's performance for NavCad's "whole ship" calculations.

MacPherson concludes: "Once you run CFD or conduct model testing, many of the important decisions are already locked in. By incorporating a 2D propeller calculation at the system design level, naval architects can take control of their own destiny and achieve better and more cost-effective outcomes." **NA**



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# Mid-term approval for Blue INNOShip

Launched two years ago, Denmark's Blue INNOShip initiative is halfway through its planned four-year cycle. *The Naval Architect* checks in on its progress so far

The initiative, which evolved out of the Danish government's Plan for Growth in Blue Denmark (first published in 2012), brings around 40 diverse partners together to promote energy efficiency and greener shipping.

"Overall it's progressing very well," says Magnus Gary, Blue INNOShip's program manager, whose role is to oversee the various projects under its umbrella. "The results in some projects they're not as brilliant as we had hoped they would be, but others, such as the shore-based liquefaction plant, have exceeded expectations. Collaboration between the partners has gone ok, as it usually does when companies work together.

"But in my personal view it could be better. They could work together more closely together and achieve more. From the things that you can control it goes fine, in terms of milestones, and people are achieving what they promised to do. So, results and progress-wise everything is going more or less as planned, and some of the projects have shown better results than we expected from the offset."

Including an already complete pre-study on the use of fibre-reinforced plastic in Danish shipbuilding, Blue INNOShip comprises 15 projects. These are categorised in five 'Work Packages': Ship Design & Propeller Solutions, Performance & Monitoring, Alternative Fuel Solutions, Emission Reduction Technologies and Servitisation & Retrofit. April 2016's edition of *The Naval Architect* (p.26-28) took a closer look at the Trailer CAT project to build a low-emission catamaran trailer ferry, which is scheduled for completion in the middle of 2018.

Another project – due to be concluded this year – is the Dynamic Propeller Shaft Speed Control concept. Led by Maersk in partnership with Propelco, Wärtsilä Lyngsø Marine and the Technical University of Denmark (DTU), the project has revealed that significant inflow variations to the propeller occur in waves and in beam seas. In response, a control system has been



Magnus Gary, Blue INNOShip's program manager

developed to dynamically regulate propeller shaft speed to counteract efficiency losses caused by wave inflow variations. An initial sea trial has determined that the technology could represent a fuel saving of >0.7% on Pacific voyages. The results of a second trial are now being analysed.

Remarking on the development process, Gary says that larger companies are committed, but tend to take a pragmatic approach to their investments in the projects. "When we created Blue INNOShip we had to have a certain number of key partners who were willing to invest a particular sum of money; for example Alfa Laval, Maersk, TORM, MAN Diesel & Turbo and OSK-ShipTech ... Maersk are very focused on participating [in] projects where it's in their line of business and they see a clear benefit and there's a measurable result. With some of the other projects, for example MAN Diesel are participating in a Gas Valve Train project – a small component going into the engine parts and their portfolio of solutions – they're more open-minded about what can be done. But shipowners need something that works here-and-now, whereas MAN Diesel is a technology provider and therefore

also need to explore technologies to be able to stay on top of the market."

This means that some of the more ambitious projects fall by the wayside. "There was for example a project for capturing waste heat and using [it] on different places onboard the ship but there weren't any key partners for whom the technology was close enough to their core business, which was sad as the concept appeared interesting."

Indeed, as a fully-matured model for promoting green innovation Gary admits that the technologies explored in Blue INNOShip could be more radical: "I'd also be so blunt as to say that some of the projects we are doing are not pushing the limits for the technology very far. It's more next step than two steps ahead. We could, for example, be looking at real alternative energy sources instead of creating LNG from natural gas or how to improve LNG engines. But that is of course what you get when a large part of the focus is on commercialisation and job creation."

In general the consensus has been positive and it's likely there will be future iterations of the initiative. Gary reflects: "If you asked me a couple of months ago I would say I don't know, but it seems there's a lot of interest in continuing both commercially and politically."

Gary is hopeful that improvements can be made to the overall collaborative process. In his view, project partners should have a vested (financial) interest in each other's work, but steps could be taken to ensure that commercial partners planning to exploit any resultant technology receive a smaller allocation of the funding. In addition, he would like a new emphasis on the educational benefits Blue INNOShip was designed to stimulate. "The way we've set up collaboration both in this industry and others is inefficient from a learning point of view. It works from a 'get things done' point of view but you miss a lot of learning opportunities. When we're talking about a publicly-funded project there could be more focus on the process of how to get to the results rather than the results themselves." **NA**

# Pre-swirl goes with the flow

A Blue INNOShip project for controllable pre-swirl fins is showing encouraging results

**P**re-swirl or Stator fins fitted in front of the propeller have been a regular appendage on full body ship types such as bulker and tankers for some years now and have been demonstrated to improve the propeller's working environment. However, one of their drawbacks is that they can only be optimised for one condition, which neglects the variety of scenarios a vessel travels in, be it at design draught, partly in ballast or slow steaming.

A possible solution is being explored as part of the Blue INNOShip initiative: a new type of controllable pre-swirl fin (CPSF) that can be manipulated to suit a vessel's operating profile. Preliminary investigations suggest the CPSF could improve fuel efficiency by between 3 and 6% by adjusting to different propeller loads.

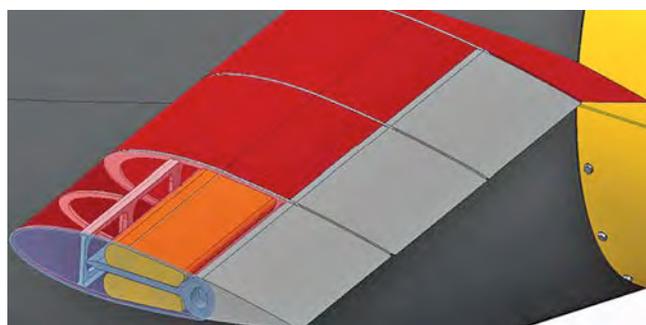
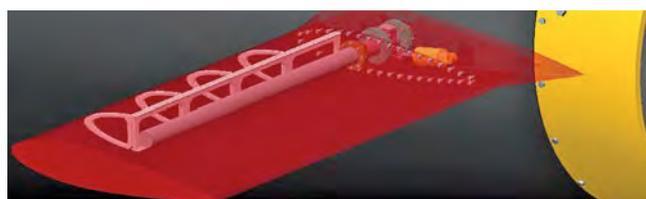
Aside from the fuel saving potential of the fins, CPSF could also solve the problem of 'heavy running' propellers – a serious issue on many vessels. If proven successful, the fins could be applied as an active way to secure sufficient light running for longer periods and thereby extend intervals between dry docking.

"The idea behind this invention was initially proposed by me and then discussed internally in the company," explains Jens Ring Nielsen, a senior manager for the propulsion division of MAN Diesel & Turbo, who are leading the project. The concept was presented at a Blue INNOShip start-up meeting and led to the formation of a partnership including naval architects OSK-Skip Tech, Maersk Line and the Technical University of Denmark (DTU).

The partners then subdivided responsibilities into a number of work packages with each of these in turn having a designated manager responsible for following-up on progress and fulfilling the defined goals. Quarterly meetings continue to be held between the partners, with Blue INNOShip's program manager, Magnus Gary, also in attendance. In addition, there have been a number of workshops focused on CFD issues relating to the CPSF.

Early on in the project it was decided that bulkers, tankers and containerships would form the focus of the study as these ship types

The fins act as guide vanes that give a preswirl into the propeller and thereby an increase in efficiency



were most likely to have variable operating profiles. For similar reasons it was decided to focus on fixed-pitch propellers rather than controllable pitch propellers which are less commonly used on larger commercial vessels.

In order to conduct comprehensive analysis, detailed information about the ship's particulars is needed – data such as the hull definition, propeller geometry and model tests – for the entire range of speeds and operating conditions.

However, while applicable data for a containership was readily available from one of the project partners, there was no such equivalent for bulkers or tankers, which caused some delays. "In the end it was only made possible through an agreement with a shipowner outside the group," explains Nielsen. In one case it even meant conducting a laser scan of the vessel while it was docked in China in order to obtain the hull and propeller geometry.

As of March 2017 the project was approaching its halfway point. Following

extensive CFD calculations the indications are "promising," says Nielsen. Ironically given the earlier data problems, the group's most recent update reported that the initial CFD simulations for the CPSF show better than expected results for bulkers, but less improvement for the test container vessel.

"It is believed in the project group that adjustable fins makes most sense in the bulk/tank types segment due to their distinctive difference in operating conditions when sailing in design and ballast," says Nielsen. "The preliminary gain in efficiency for the containers still shows it to be of interest, but [it is] less attractive, from an economical point of view, for the smaller container vessels."

An extensive model test program will be conducted during the first half of 2018 to verify the CFD analysis. When these are finalised the partnership plans to make a full presentation of the invention and their research results. The project is scheduled for completion in early 2019; a patent has already been filed for the actuation of the fins. **NA**

# Green feeding from Denmark

Next generation fuels are one thing, but today's technology is not to be underestimated or overlooked for efficiency gains. A new, wide-beam Regional ECOFeeder design combines available technologies to great effect, offering CO<sub>2</sub> reductions of at least 30% per container compared to the average feeder fleet

The shipping industry's ageing and polluting feeder fleet is in need of an emissions angel. In 2005, 35% of Sulphur deposition in coastal areas originated from international shipping while 20% of Nitrogen deposits in coastal areas came from ships, according to the same report (Main Report Shipping, 2013).

Danish-led initiative, Green Ship of the Future (GSF), set out to change this, undertaking the Regional ECOFeeder project in 2016 to inspire a "responsible" renewal of the feeder fleet.

The project involved an array of participants from every strata of the maritime industry and has now concluded with the release of a feeder ship design from Odense Maritime Technology (OMT), a Danish design, production engineering and project managing company for the maritime industry.

The overarching aim was to demonstrate that a large proportion of necessary emissions reductions from shipping can already be obtained by applying available technology. "From the beginning we were not after a 'fantasy ship'" says Thomas Eefsen, business development director for containerships at OMT. "We wanted something that is ready for now, or at least the very near future". However, this sentiment does not mean that ongoing searches for the next generation of fuels will grind to a halt; rather that shipping has the power to be substantially more efficient right now with the promise of even greater gains in the future.

According to those involved in the project, the Regional ECOFeeder design achieves at least a 30% reduction of CO<sub>2</sub> per transported container compared to world fleet average, Sulphur 2020 compliance (0.5% S), NOx Tier III compliance, as well as reduced particulate matter and a reduced black carbon footprint.

A second aim was to reduce the cost per TEU per nautical mile compared to



*Regional ECOFeeder has been designed to be controlled from the vessel's aft*



*Simplicity is key for this operationally efficient design*

current levels in terms of operation and manning, adding financial weight to the environmental argument for change.

OMT defined the project's main objectives in terms of emission targets, but left the identification of solutions to the partners to encourage creativity. Suggested technologies were then assessed in combination with others in order to ensure their benefit to the ship system as a whole. Through three phases, the partners ideated, shared knowledge and evaluated the suggested solutions in

order to reach the project's main objective and emission targets.

## Design

*Regional ECOFeeder* has been conceptualised to provide basic container carrier functionality with a design that centres on operational simplicity and possesses a compact arrangement. This called for a box-shaped, open top design with containers stowed as closely as possible in cell guides. The nominal capacity is 2,500TEU without LNG tanks and 2,422TEU with LNG tanks,

while for transit of the Kiel Canal it can be loaded with 1,100TEU at 14t/TEU.

A wide-beam, maximised to 32.5m for passage of the Kiel Canal, has been used to optimise container capacity. Eefsen explains that “considering speeds are lower than 5-10 years ago, wide beam designs have become more effective.” The design choice improves intake, both by directly providing more space for containers, but also by increasing stability, which reduces the need for ballast water and increases the vessel’s payload. Slim ballast tanks have been selected as a corollary design feature, offering a lower vertical centre of gravity that also helps to improve container intake; container positions below can be maximised as a result.

The 32.5m beam is said to improve container intake by more than 10% compared with a typical containerships of the same length. In terms of drawbacks, propulsion power must be increased because of the wider beam, but partners in the project say: “considering the operational speeds of the vessel design, the net fuel reduction per transported container is still positive”.

*Regional ECOFeeder’s* open top allows for easy loading and lashing with the aim

of reducing time spent in port. The vessel has five open cargo holds with cell guides to the 13th tier and semi-automatic stack splitters at the 10th tier of containers. In this way, 20 or 40 foot containers may be loaded to the 13th tier of containers without hatches and without lashing. This application reduces harbour turn-around time by up to two hours per port call. According to GSF, feeder vessels can spend up to 50% of their time in harbour, so by cutting this time vessels will be able to improve their efficiency between itinerary stops, travelling slower and using less fuel.

The vessel’s high coamings/ side-structures serve the following purposes. Firstly, to ensure the flooding angle is large enough to allow hatch covers to be omitted; secondly, to support the top of the stack-cells; and, thirdly, to provide necessary hull girder strength without excessive scantlings.

In order to save cost and space, the ship’s crew was reduced and a major overhaul of the vessel’s accommodation was undertaken. This involved shrinking and sinking the accommodation block within the ship to allow containers to be stored above it. The crew cabins are located along the ships side at A-deck

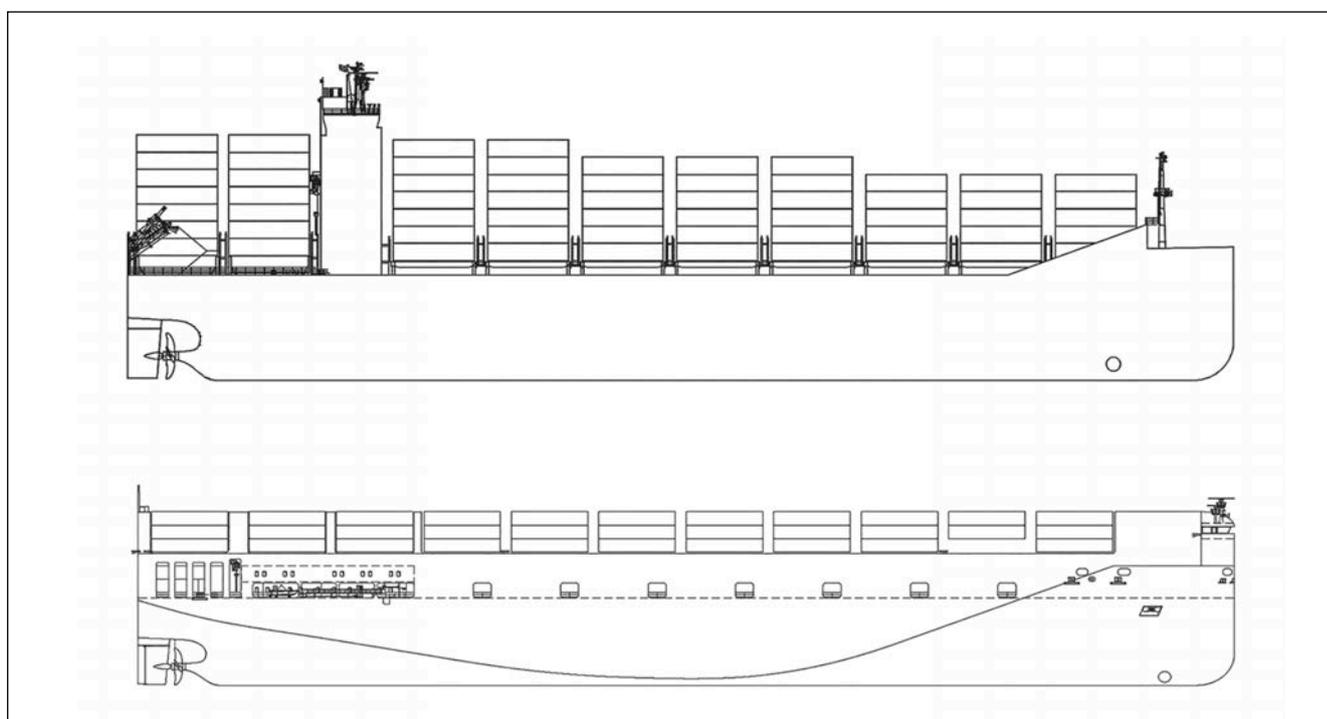
level, with five cabins in each side. The cabins occupy the outboard two rows in each side, leaving the remaining eight rows for cargo or LNG-fuel tanks.

A particularly novel arrangement of the deckhouse was formulated. Following hotly on the heels of developments in the fields of smart and autonomous shipping, cameras and sensors (though not allowed by SOLAS and flag states currently) in the front, aft and side of the vessel are replacing the traditional bridge layout for officers on the bridge. A control room located in a lower and optimised deck house arrangement allows the vessel to be controlled from the aft of the vessel and is intended to be used by on-duty officers to manage look-out duties. Container gains as a result of these measures stack up to approximately 100TEU, while the arrangement of the accommodation is optimised with fewer staircases.

## Power

The vessel is designed with LNG powering based on a 2-stroke dual fuel engine, which reduces direct CO<sub>2</sub> emissions by approximately 20% per transported container and almost eliminates sulphur emissions. Eefsen says: “Discussions were held about hybrid systems, but our conclusion was that

Comparison: A 166.7m reference vessel with a 27.7m beam and the 175m *Regional ECOFeeder*, which has a 32.5m beam



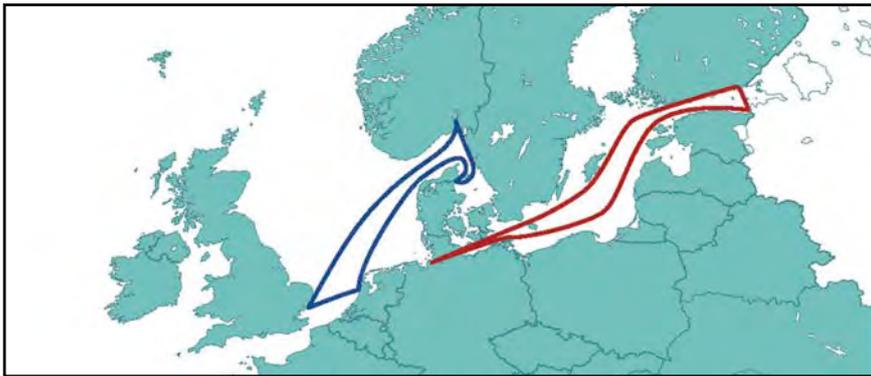


Figure 1: Regional ECOFeeder's emissions savings were predicted for two Northern European feeder ship schedules

when you have the space [for a 2-stroke engine] it is very hard for other systems to compete, as there are too many transmission losses in electric systems." NOx Tier III requirements are met by an EGR NOx abatement system. The vessel has four cylindrical C-type tanks with total capacity of 1,300m<sup>3</sup>, which provides endurance of around 15 days or around 5,000nm.

The oil fuel tanks are located forward of the engine room and below the chain lockers, outside of useful cargo space. LNG is carried in four cylindrical tanks located above the accommodation, but larger LNG tanks may be adopted at the cost of more container slots.

Power is generated by an in-line shaft-generator to improve fuel efficiency and is backed up by two diesel gen-sets.

"The power for auxiliary systems and reefer containers is approximately 10-15% of the total installed power," explains GSF. "Considering the 20% higher energy efficiency of 2-stroke engines compared to 4-stroke engines, auxiliary power is provided by a 2,000kW PTO shaft generator producing electric power for the auxiliary systems and reefer containers. Compared with typical electric power generator systems with separate 4-stroke auxiliary engines, the estimated overall energy efficiency is around 6% higher for a roundtrip."

A 1MW battery pack is included in order to reduce generator load peaks. The engine load on the auxiliaries is continuously optimised for optimum specific fuel consumption, and in harbour mode the electric bow thruster is effectively powered by the battery. This has the effect of reducing power consumption by 1-2% and means that

the number of required auxiliary engines is reduced by one auxiliary genset.

In addition, an Organic Rankine Cycle (ORC) unit has been considered for *Regional ECOFeeder* that utilises exhaust gas heat to produce electricity. Use of low-sulphur (<0.1%) fuel enables cooling of the exhaust gases without issues of sulphuric acid formation on the boiler tubes. The ORC unit is designed based on the assumption that no service steam is required for HFO preheating, etc. due to the use of low-sulphur fuel. Space heating demands are covered by heat from the HT cooling water. For ISO conditions, fuel savings of 3.3% compared to the fuel energy used in the main engine can be obtained. For winter conditions, fuel savings of 2.3% can be obtained. By including scavenge air and EGR cooler heat, the fuel saving potential will increase.

### Propulsion

The ship is propelled by a single large controllable pitch propeller with high efficiency Kappel propeller blades. It is directly coupled to the engine and possesses a similar propeller efficiency to a fixed pitch propeller, according to Eefsen. The solution also offers improved load flexibility in combination with the shaft generator as well as significantly better manoeuvring characteristics – an important feature for container feeder vessels with numerous terminal calls.

Air lubrication has also been included in the design, utilising corporate partner Silverstream Technologies to provide a solution tailored to the vessel. Silverstream's solution uses micro bubbles to reduce resistance working on the ship's hull. CO<sub>2</sub> reductions for *Regional*

*ECOFeeder* are estimated to be around 6% at speeds above 15knots.

In addition to the above-mentioned technologies and solutions selected, the design includes frequency control of pumps and fans, which are already widely accepted by the industry, and the vessel may be supplied with necessary equipment for cold ironing in ports, should this be available at the terminals. GSF clarifies that these technologies have not been considered when calculating the reduction potential in terms of energy and CO<sub>2</sub> emissions in this project (the results of which can be found below). However, they proceed to add, it is proven that relatively large electric power savings can be obtained by including frequency control of selected pumps and fans.

### Emissions reductions for two case study schedules

Emissions reductions have been predicted for two typical feeder schedules in Northern Europe (shown in Figure 1) based on the dimensions and capabilities of the *Regional ECOFeeder* design.

The blue route illustrates a schedule between Netherlands, UK and Scandinavian countries, while the red route illustrates a schedule between Hamburg and Baltic countries including transit of the Kiel Canal.

In terms of IMO's Energy Efficiency Operational Indicator (EEOI), there is an estimated reduction of 35% for the blue schedule and 30% for the red route compared with the typical reference vessel, which is based on MGO.

Following suit, the Energy Efficiency Design Index (EEDI) for *Regional ECOFeeder* shows a significant reduction compared with the IMO baseline and reference design. A reduction of almost 40% is achieved compared with the IMO baseline, while a reduction of approximately 30% is achieved compared with the reference vessel. *NA*

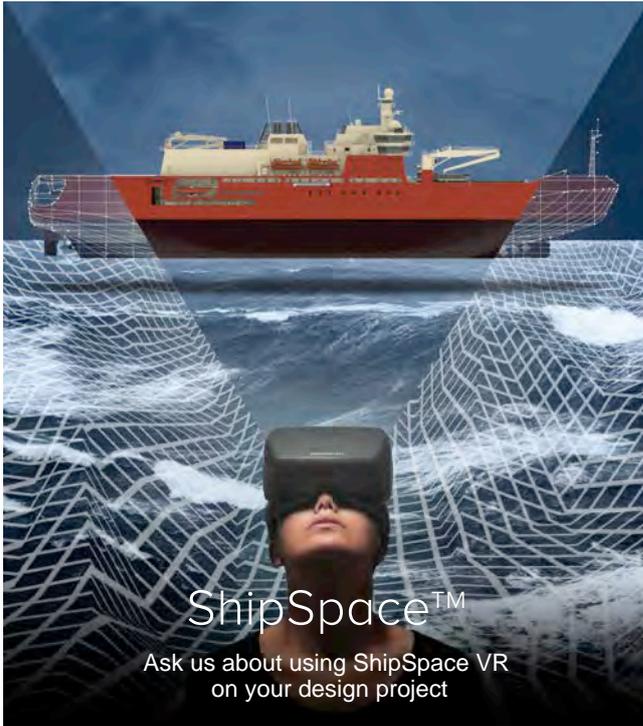
### Note

Green Ship of the Future is a public private partnership working to reduce emissions from the maritime industry. Members include: ABB, Alfa Laval, Bureau Veritas, Corvus Energy, Danfoss VLT Drives, Danish Maritime, DNV GL, DTU Mechanical Engineering, HOK Marineconsult, Lloyd's Register, MAN Diesel & Turbo, Rolls Royce Marine, Silverstream Technologies, and VP Solutions.



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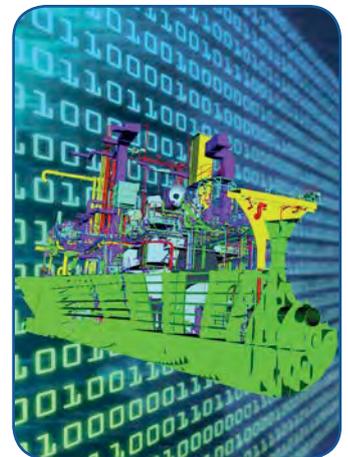
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# Modular design system re-galvanized

Programme structure, data exchange and pipe modelling are the main focus of SARC's major PIAS software update, writes Herbert Koelman, founder and managing director of SARC

A seminal version of PIAS was released in the last week of 2016, marking the beginning of the end for the ongoing large-scale renewal of the software, which started in 2011. The core design of PIAS originates from the early 1990s. While the core functionality of design and computation functions have frequently been enhanced and kept state-of-the-art, the user interface was deemed to require a major overhaul following over 20 years of service.

PIAS was originally subdivided into many distinct modules, each for a separate task, such as hydrostatics, cross curves, Bonjean, damage stability etc. The new programme structure contains a much more concentrated set of modules – shown in its main menu (Figure 1) – such as for hull design, design of internal layout (compartments, bulkheads and decks), and loading still & intact & deterministic damage stability. Beyond this core set, PIAS retains auxiliary modules, including for freeboard, tonnage, maximum allowable AHTS vessel anchor chain forces, and inclining test reports. Hopper dredger stability is still a separate module, but will be integrated into the intact stability module during Q1 of 2017, marking a final step in the software integration process.

However, why subdivide the software into modules? Why can't there be just one user interface, a single point of contact between user and software? The simple answer is that a program as comprehensive as PIAS contains so many features, functions and computation settings that it would be impossible to present them all on one monitor, and secondly that it would be utterly confusing for the user if it was achievable. After all, such a 'design' of the interface would include a blend of everything: surface modelling tools, sounding pipes, pendulum strokes during an inclining test, detailed settings of importing DXF files, specifics of intermediates stages of flooding, etc. So,

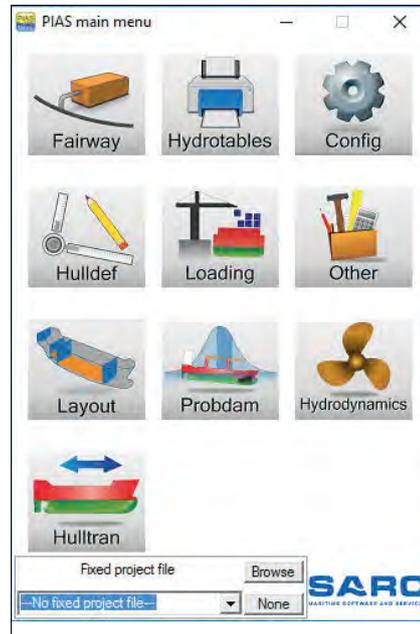


Figure 1: PIAS's new program structure as represented by its main menu

although there is no software-related reason to organise the software in modules, for the benefit and overview of the user it is better to do so.

It could be argued that one drawback of such a modular design would be the lack of harmonisation between the modules, but PIAS tackles this by sharing all of a ship's design data between modules. This facility – baptised *local cloud*, and scheduled for release later in 2017 – enables a hull form modification to be directly (directly!) processed in the assessment of a loading condition against the applicable stability criteria. The local cloud permanently synchronises data in the background, hidden away from the user. This offers the best of both worlds: a single data model shared by the entire program and a well-arranged program focused on the main ship design tasks.

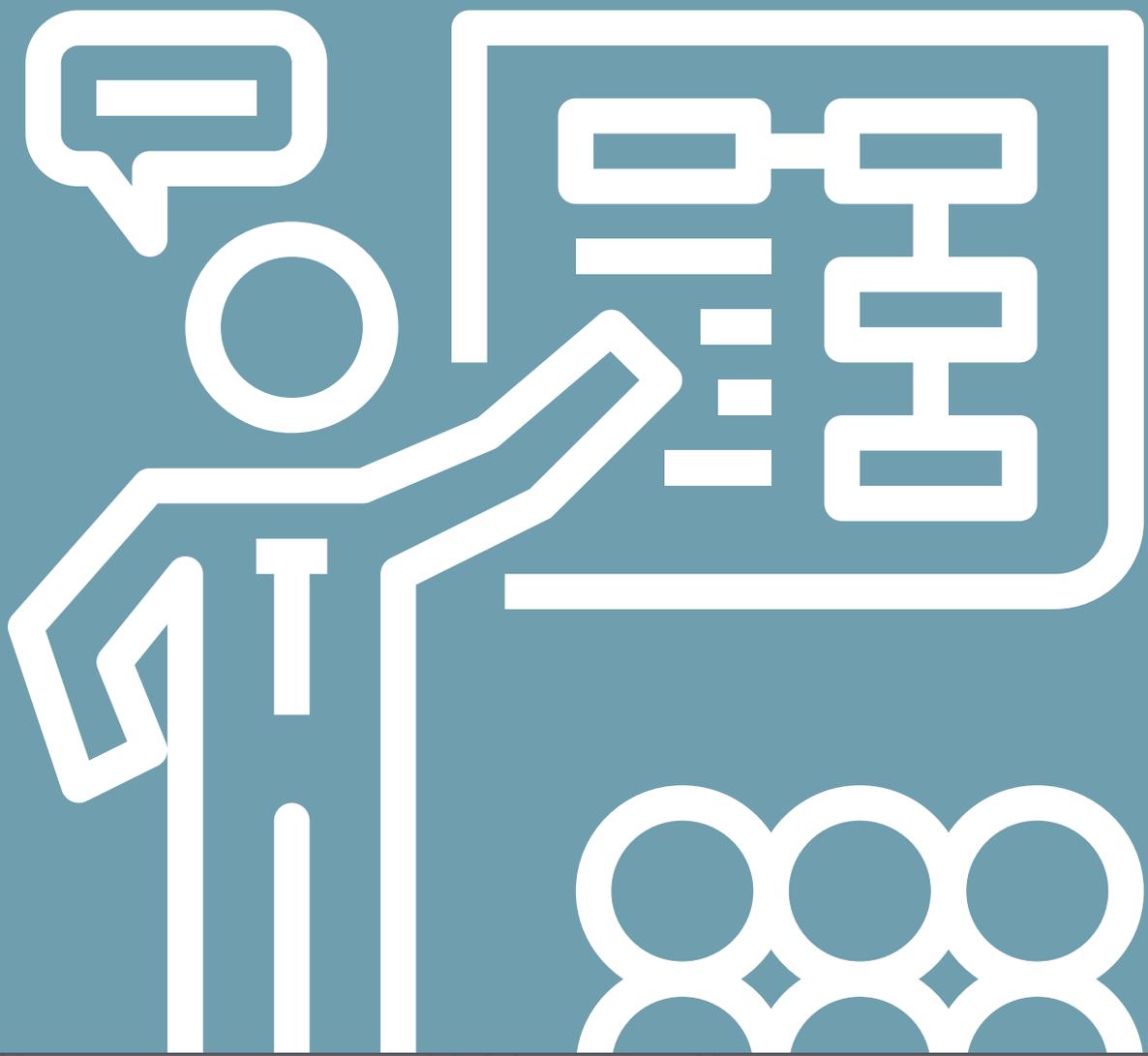
Apart from this structural reform, the opportunity has been used to enhance the software with:

- An integrated manual, which pops up with the corresponding section if the users hit F1 in a particular menu
- More use of dedicated Graphical User Interfaces
- A cleaner set of functions. In the past, SARC was occasionally seduced to include, on user request, some very specific functions that were sometimes applicable to only a single user or project. In hindsight, the program overview is sometimes better without, so some of them have been removed (or made invisible to the general user).

## Conventional data exchange

The primal form of data exchange is by means of 'the file'. Although many data sharing alternatives exist, the file concept remains appealing for many people. One reason may be that a file is somewhat tangible; it can be copied, encrypted, stored on a USB stick or taken home. So, although file-based data exchange might not always be the most optimal alternative, it continues to be in vogue. PIAS already contains file-based import and export facilities, and this set-up is constantly being extended.

Recently, a pre-existing but separate function to import hull shapes from DXF or IGES formats was integrated into PIAS's Fairway hull form modeller. This is less trivial than it might seem; Fairway uses a genuine solid model, while DXF and IGES formats generally only contain curve or surface representations. This incompatibility has been solved by extending the capability of Fairway to manage unconnected curves, which are used to contain the imported curve shapes. If this set of curves has some coherence and connectivity, they can be converted into a solid model automatically so that the whole shape model is ready to be further processed by Fairway. The newly added functionality is also available without an imported hull shape, and offers more topological freedom at the very first hull design stage. Figure 2 shows an example of



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the Fairway GUI just after importing a set of IGES surfaces.

The export of surfaces to IGES has been the topic of some drama at SARC. After having reached the conclusion in the 1990s that NURBS surfaces were essentially unsuitable for effective ship hull design – the reasons for which have been duly reported in literature – SARC developed an improved method, which found its place in the Fairway modeller. However, a wide variety of tools are used in ship design, and so in areas such as engineering, CFD and FEM, importing in the NURBS format remains the preference. NURBS consequently re-enter through a backdoor, even though they are still sub-optimal. To cope with this, Fairway can convert its internal representation into a NURBS model and export it through the IGES standard.

This ultimately results in a vast number of small NURBS surfaces, and many software packages have problems with the quantity. Manufacturers play the ‘blame game’ – “you should accommodate an unlimited number of surfaces” vs. “the number of surfaces is too large you should reduce it” – while the issue hampers fluent data transfer. In order to ease this process, Fairway is at this moment being equipped with a postprocessor where the user can draw larger four-sided regions (a pre-requisite for NURBS) on the hull. These regions are being converted to NURBS by means of a special algorithm, which produces a set of NURBS surfaces guaranteed to be gap-free. An additional research project is being commenced where methods are evaluated for an automatic subdivision of the hull surface in four-sided regions. All

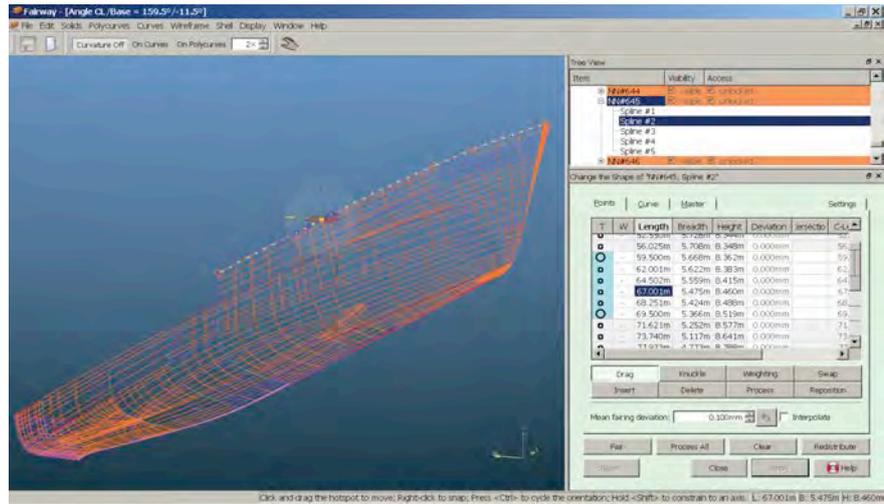


Figure 2: An example of the Fairway GUI just after importing a set of IGES surfaces

these methods share the ultimate goal of making collaboration with other design-support software as hassle-free as possible.

A third new export function is to Poseidon, DNV GL's scantling program. This takes the PIAS hull form, decks, bulkheads, compartments, bending moments and additional data such as local loads and girders, and translates them into Poseidon import format. An example of a PIAS-originated model that has been visualised in Poseidon can be found in Figure 3.

### Non-conventional data exchange

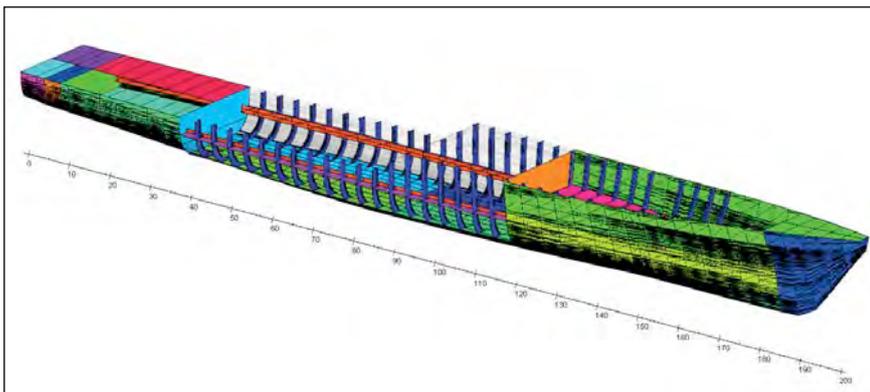
As discussed in the *The Naval Architect's* April 2015 issue (p.40-42), for decades the prevailing software architecture for collaboration has been a neutral data model, preferably stored in a central place that all participating computer programs

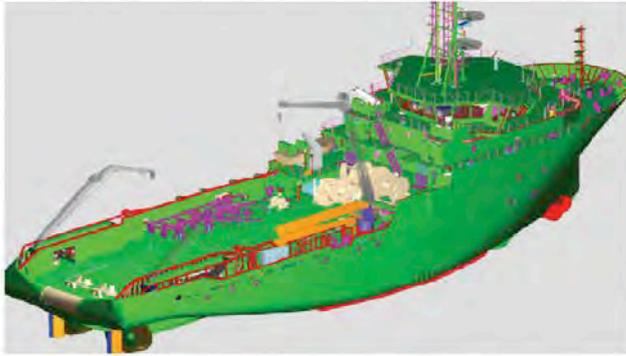
can utilise. Unfortunately, such a design proved hard to conceive in practice. This is not an ideological statement, but simply the conclusion after decades of initiatives with this method and the fact it has not led to a prevailing standard. For example, the much-trumpeted STEP standard has achieved some endorsement, but it has not matured into the data exchange standard. A reason for this might be the so-called “representation variation”, which is the fact that geometric entities can be represented in multiple ways. For example, a circle can be described by centre and radius, or by three points lying on the circle. Likewise, a (hull) surface can be represented as a set of NURBSs, a point cloud or a set of curves.

Standards such as STEP or IGES support many of these alternative representations, which seem ‘friendly’ towards its users, but they require the importing programs to support all of those formats, and to convert them into internal representations. Where some variants can readily be converted, such as the circle example, others are non-trivial or cannot be done without loss of accuracy, such as from a point-cloud to a NURBS surface. Additionally, such standards have the habit of breaking down ship models into elementary constituents. The result of these two tendencies leads to an exponentially growing number of parts and representations, which requires a significant effort to manage.

It could be that the latest PLM solutions offered by major CAD vendors will provide

Figure 3: A PIAS-originated model that has been visualised in DNV GL's Poseidon software





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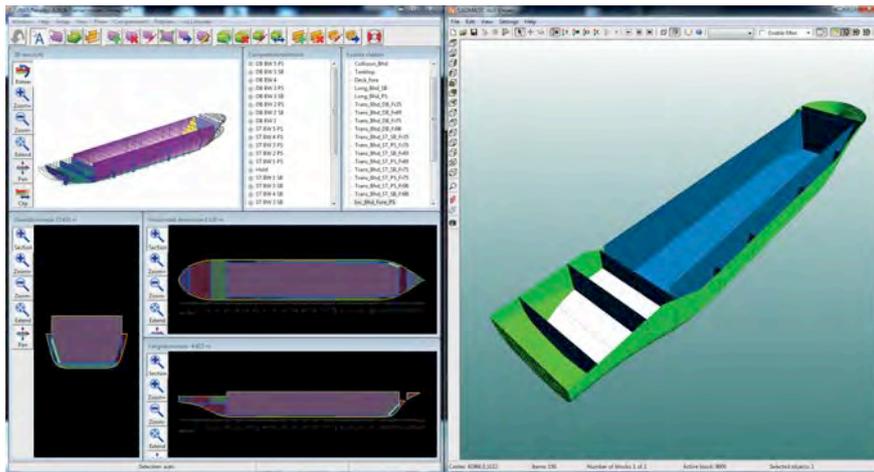


Figure 4: PIAS (left) and CADMATIC Hull (right) in joint collaboration

a solution to this pitfall, but SARC proposes an alternative based on three principles:

**1. Use of higher-level entities**

In the conventional approach, a ship model is broken down rigorously, e.g. a 'bulkhead' will be broken down into plates, stiffeners, girders, brackets and welds, which is for design purposes much too detailed. Alternatively, by simply agreeing on the concept of a 'bulkhead', different software suppliers can exchange essential design particulars – such as its extent, position and watertightness – without sharing its internal representation.

**2. Sharing data, but tasks too**

By this facility several applications can share their capabilities without

sharing all underlying data. If, for example, a table of tank volumes has to be included into a general arrangement plan, the CAD system producing this plan could compute this table, but it would require a full geometric model of hull and compartments, as well as all computation logic. If, on the other hand, a hydrostatic software package is available as a collaborative partner, the CAD system can ask that package to perform this computation and just send the result. Such an approach will strongly reduce the software development effort.

**3. On the fly communication between the collaborating applications over the network**

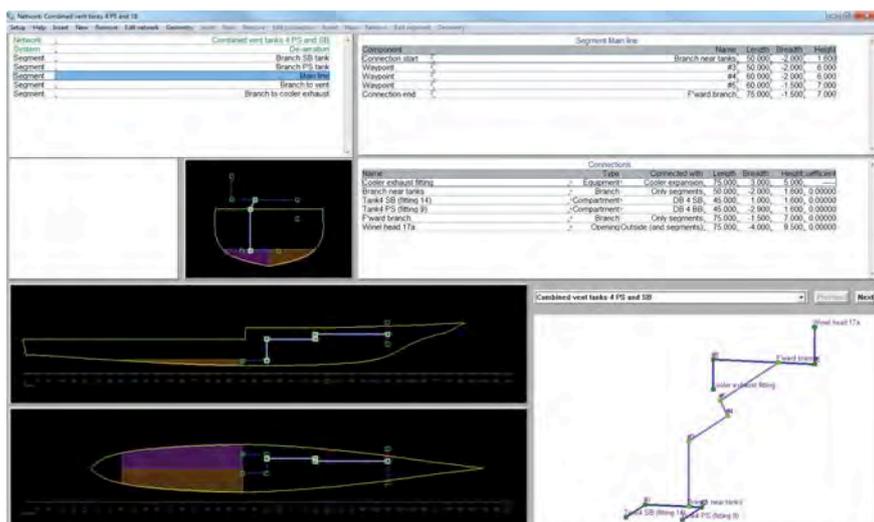
At this moment a collaborative system based on this design is under development by Conoship International ship designers, CADMATIC and SARC. A specific feature of this system is that it deliberately does not produce a single common ship design model. The reason for this lies in the fact that many sidesteps are taken exploring the properties of design variants throughout a ship's design. For instance, moving a bulkhead in the stability software just to see the effect it has on probabilistic damage stability, does not need to be processed by all of the connected systems. In this way, the conceived system is designed to manage this diversity, and is, in fact, much more complicated than maintaining uniformity by means of rigorous permanent synchronisation.

**Integration of piping in design**

Connections between compartments, as well as internal openings, play an ever larger role in the assessment of damage stability. PIAS has been modelling this by so-called "compartment connections" for 20 years, but there has been a drawback: the real geometry of the connections is not available; they are more or less 'virtual' connections. This issue has led to a complete redesign, resulting in an implementation where the real shape and connection properties of the piping system are fully available in PIAS, including components such as pressure relief valves or vent check valves. Once finalised, the information is made available for three purposes:

- To be used in the calculation of deterministic and probabilistic damage. With this new data structure the effects of cross-flooding can be integrated into the probabilistic damage stability calculation.
- To be communicated with other computer programs, such as in the collaborative system with CADMATIC.
- To be utilised in the LOCOPIAS onboard loading software for enhanced damage assessment purposes and, in the future, time-to-evacuate analysis. [NA](#)

Figure 5: Piping GUI under development in PIAS





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## Short measures

The double-headed challenge of replacing an ageing short-sea fleet and meeting the EU's targets for more waterborne and eco-friendly transportation is providing the impetus for a number of next-generation solutions in Scandinavia and beyond

Among the more eye-catching projects of the past couple of years is the Short Sea Pioneer, a dual vessel concept in development by the NCE Maritime Cleantech cluster in Norway.

Taking its inspiration from similar arrangements used in the offshore industry, Short Sea Pioneer consists of two ship types. A larger 'mother' ship used for the long-haul transportation, and multiple smaller 200TEU 'daughter' ships that serve as feeder vessels and are able to dock within the mother ship.

In theory, the mother ship will deploy an automated cargo handling system

capable of sorting containers while in transit. Its daughter, meanwhile, will be capable of independently loading and unloading containers and trailers with minimal need for land-based infrastructure. By virtue of their smaller size it is hoped the arrangement will allow operators to reclaim older shipping routes and facilitate calls to local, easy-to-access ports that have been forsaken because of the trend for upscaling.

Furthermore, the daughter craft's design will be module-based so that capacity may be tailored, while options for remote or autonomous operation are also being explored.

For a country like Norway, with the longest coastline of any country in Western Europe, the advantages and emission reductions this concept could potentially bring to land-based transit are obvious. Both vessels will be equipped with multiple hybrid energy systems to enhance their green credentials, with the aim for the daughter craft of operating with zero emissions, at least when navigating the coast and fjords.

"The Short Sea Pioneer concept was the result of a strategy process where we would discuss what kind of thing would make sea transport more competitive," says Hege Økland, NCE Maritime



Cleantech's founder and CEO. "We applied as [a] cluster organisation for funding from the Norwegian Design Council, which awards grants to projects with a design-driven methodology"

Maritime CleanTech (MCT) was originally established in 2011 with a membership roster including Wärtsilä, Fjellstrand, SKL, Servogear, Eidesvik, Aker Solutions, Mecmar, Oma Baatbyggeri and Apply TB. "All of them had ongoing projects into energy efficiency and the development of new fuels," says Økland. "I saw that the market in this area was quite immature, but that with closer collaboration they could achieve more than as single companies."

Shortly afterwards the group was granted Arena cluster status; a Norwegian initiative to promote collaboration between businesses, R&D institutions and the public sector. Early MCT projects included the development of a hybrid power system for the ferry MS *Følgefonn* and a zero-emission fast-going

ferry: *Urban Water Shuttle*. The cluster received further endorsement in 2015 when it was named as a Norwegian Centre of Expertise.

Økland says a number of creative solutions were mooted when MCT applied itself to the challenge of shortsea shipping, but the two-vessel concept was finally settled upon with designers Eker Sandvik (now known as Storm Industrial Design) being commissioned to visualise it. Although the project's consultation process involved numerous stakeholders, including the Norwegian Royal Navy and various energy system providers, the driving force throughout has been Norwegian short sea operator and logistical services provider NorthSea Container Lines (NCL). For the past two years the emphasis has been on further refining both the propulsion systems and logistical infrastructure with the assistance of a trimmed-down consortium including Trondheim-based research company SINTEF, the Norwegian Business School

(who are conducting logistics analysis), Wärtsilä Ship Design, power and automation specialists WestCon, and silicon producer Elkem (a major client of NCL). This process is expected to continue until 2019.

"The key to success in these areas is to significantly improve the cargo transfer rate and capability from today's level," NCL's CEO Arne Jakobsen tells *The Naval Architect*.

"We are now working on developing a detailed design to deliver on our core targets such as substantial emission reduction, increased flexibility in [the] shortsea transport chain, and reduction in container slot costs.

"Some of the challenges that we are facing are to enable green propulsion systems, cargo transfer [between the mother and daughter vessel] at sea, and an interconnected network of vessels at a competitive cost level. But I have to add that it is also within these challenges that the greatest innovation and commercial potential resides." NA

Mother and daughter:  
the Short Sea Pioneer  
concept design



# Onboard education lifted

A unique cargo training ship with heavy-lift capability has been delivered to Dalian Marine University to train the next generation of Chinese mariners

The vessel in question, *Yu Peng*, is an advanced modern cargo training ship both designed and built in China by Shanghai Merchant Ship Design & Research Institute (SDARI) and COSCO (Dalian) Shipyard Co. respectively.

Dalian Marine University took delivery of the vessel in October last year and will use it for seafaring education, training and scientific research, as well as for simultaneously

carrying bulk cargo, general cargo, project cargo and containers.

As a training ship, the vessel is mainly used for teaching and training, providing practice for students in the management of cargo loading and discharge, as well as providing opportunities for scientific research and education on marine science and technology, machinery engineering, environmental engineering, and traffic information engineering and control. Many advanced facilities have been installed onboard for this purpose, with a training chart room, multi-media classroom, network centre, library, sailing simulator and radar wave tester included.

As a multi-purpose heavy-lift ocean-going vessel, it was designed with energy-saving, ECO-friendliness and flexibility in mind. It has three electric-hydraulic wire luffing type cranes from TTS' NMF range. Of these three, two sets installed port side have a performance of 240tonnes x 20m and can offer a combined lifting capacity of 500tonnes when using a lifting beam. The third set has a performance of 50tonnes x 28m. An additional hydraulic slewing crane supplied by Zhenjiang Marine Auxiliary Machinery Works features, adding a SWL of 3tonnes x 18m to the vessel's lifting provision.

In terms of cargo capability, *Yu Peng* features a large weather deck area for carrying long objects; its cargo holds have been constructed with a double skin,

double bottom and side tanks; two layers of tweendeck panels of lift-away pontoon type are provided in No.2, 3 and 4 holds and can be placed on four levels; and two layers of tweendeck hatch covers in No.1 hold are operated by a hydraulic system.

The ship complies with the Green Ship-II and EEDI-II class notations of CCS, possessing an array of eco-friendly features. These include a 500m<sup>3</sup>/h capacity ballast water treatment system from COSCO (Weihai) Shipbuilding Marine Technology Co. Ltd.; AMPS; LED lighting; a long-range fuel oil monitoring system; frequency conversion air conditioning; and a cooling water pump.

*Yu Peng* also features advanced communication and navigation equipment, and an integrated bridge console (IBS). The bridge design complies with DNV GL's highest class notation NAUT-AW, and engine room automation complies with CCS's unmanned AUT-0.

The vessel is China's most advanced cargo training ship, according to those involved in the build, offering excellent performance, extensive functionality, advanced technology, and energy saving and eco-friendly features. It is believed that it will play an important role in the education of high-quality nautical trainees for Dalian Marine University, setting a new standard in the education of Chinese seafarers. **NA**

TECHNICAL PARTICULARS	
YU PENG	
Length oa:	199.80m
Length bp:	189.00m
Breadth moulded:	27.80m
Depth moulded	
To main deck:	15.5m
Width of double skin	
Side:	2.95m
Bottom:	1.78m
Draught	
Scantling:	11m
Design:	10.3m
Gross:	27,143gt
Deadweight	
Design:	26,428.3dwt
Scantling:	29,774.5dwt
Speed, service (90% MCR output):	17.97knots
Cargo capacity	
Bale:	32,640m <sup>3</sup>
Grain:	34,000m <sup>3</sup>
Containers	
Total TEU capacity:	1,769TEU
On deck:	997TEU
In holds:	772TEU
Reefer plugs:	64
Tiers/rows (maximum)	
On deck:	6/11
In holds:	6/8
Classification society and notations:	CSA
General Dry Cargo Ship; Training Ship;	
SPS: Strengthened for Heavy Cargoes;	
COMPASS(R,D,F); Grab(20); PSPC(B); SOLAS	
II-2 Reg19; Ice Class B; Equipped with	
Container Securing Arrangements; Loading	
Computer (S.I.G.D); In-Water Survey; Clean;	
FTP; BWMP; Crew Accommodation(MLC)	
CSM AUT-0; OMBO; SCM; GWC; AFS;	
NEC(II); GPR; BWMS; AMPS; Green Ship II	

A new standard is set with *Yu Peng's* advanced training capabilities

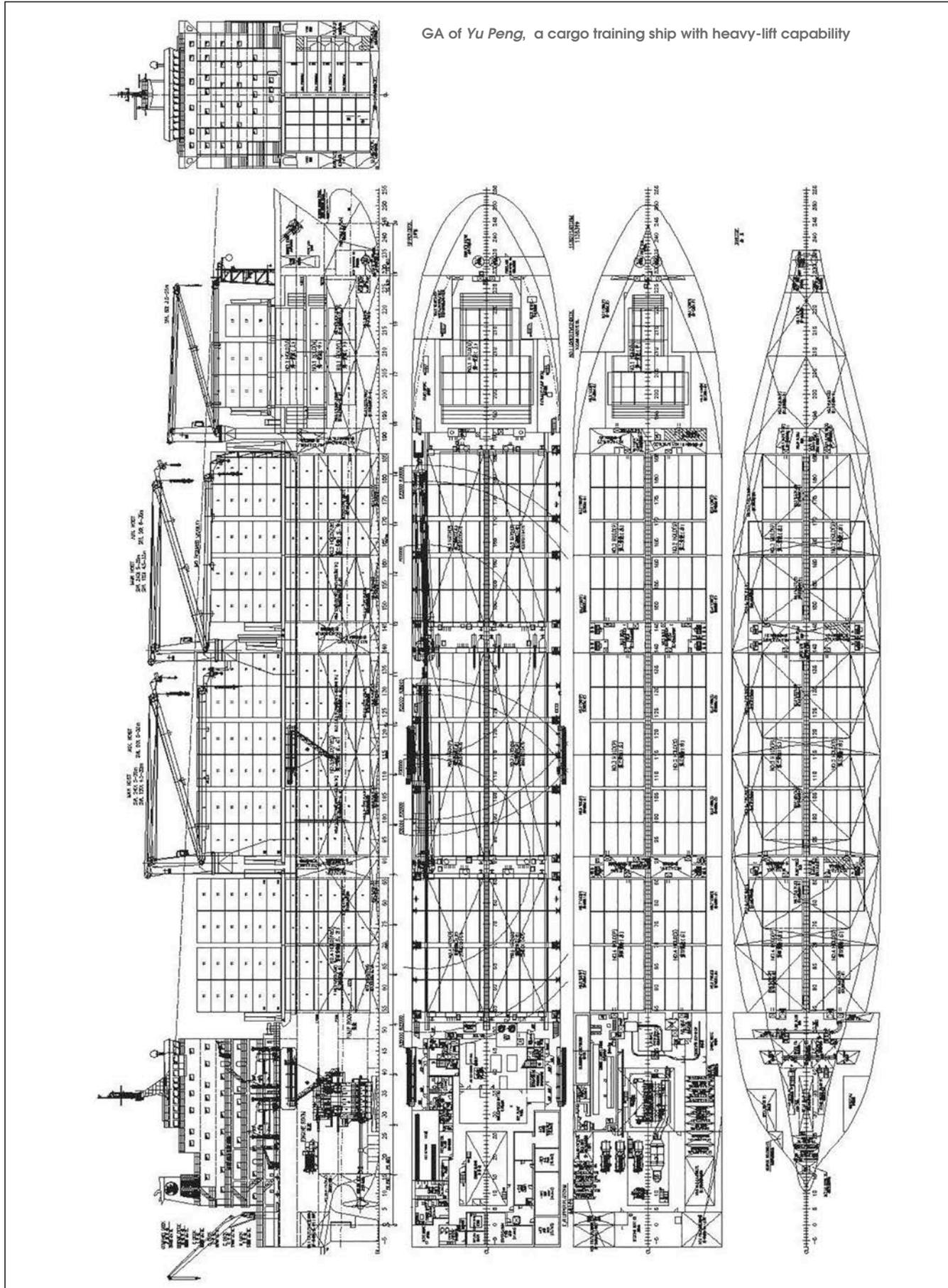


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## **Liebherr Ship Cranes**

Due to the restricted space in harbour areas, operations are more frequently being moved to the open sea especially for dry bulk handling. Floating cranes from Liebherr comprise a range of powerful equipment for dry bulk handling on the open sea for vessels up to Capesize. Even cranes for ocean-going barges and pontoons are included in the comprehensive product portfolio for operation on the open sea.



GA of Yu Peng, a cargo training ship with heavy-lift capability

The Royal Institution of Naval Architects

## International Conference: Influence of EEDI on Ship Design & Operation

13-14 September, London, UK



### Call for Papers

Energy Efficiency Design Index (EEDI) and Ship Energy Efficiency Management Plan (SEEMP) became mandatory in 2013. What impact are they having on ship design and will they really achieve the type of reduction in the shipping industries carbon footprint that many are hoping for?

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8<sup>th</sup> November, Europort, Rotterdam, Netherlands



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- Alternative fuel systems: LNG, methanol, hydrogen, etc
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# Heavy going

The offshore slump of recent years may have dampened enthusiasm for new heavy lift orders, but steady progress is being made

Amsterdam-based operator Spliethoff announced in March that it had placed an order for a series of six multipurpose vessels, the 'R-type', for construction at Zhejiang Ouhua Shipbuilding of China.

Like many operators, Spliethoff is more concerned with evolution than revolution, keeping project cargo for wind energy and the traditional forestry trade as its focus. The R-types, which Spliethoff says optimise the steamline, economy and sustainability from earlier series, will have a LOA of 165m, including a hull length of 100m. The bridge and accommodation will be situated at the bow end to offer additional protection when carrying especially long cargo, such as wind turbines.

Described as "designed in accordance with the Polar Code", the R-types have been designed with versatility in mind and in anticipation of tightened emissions regulations in the Arctic. A spokesperson explained: "Outside the Arctic sulphur abatement technology for these ships is an economically viable way for compliance with the global sulphur cap taking effect in 2020 – and we estimate there to be sufficient supply of HFO380 fuel"

"If there will be a ban on the carriage of HFO in the Arctic [a plan mooted by IMO], the ships can operate on MGO," the spokesperson continues. "Furthermore, we do acknowledge the risks of oil spill and have therefore taken mitigation measures in the ships' design, such as fuel tank separation from the outer shell to minimise the risk of oil spill into sea for the very unlikely event that the ship's hull is perforated."

The first in the series, *Raamgracht*, is scheduled for delivery in January 2019, with the five remaining vessels to be delivered at two-month intervals over the rest of that year.

## C-Job secures Orion

C-Job Naval Architects announced that it will provide the basic design package for DEME's offshore installation vessel *Orion*, to be built by COSCO Shipping Heavy Industry.

The Netherlands-based firm has already built up extensive knowledge about the project, having recently completed *Orion's* concept



A concept illustration of *Orion*

design. Scheduled for delivery in 2019, the 216.5m vessel will be operated by DEME subsidiary GeoSea for wind farm installation and rig decommissioning. Features will include DP3 capability, a waste heat recovery system and accommodation for 131 persons.

The contract for *Orion's* heavy lift crane has been awarded to Liebherr and will have a lifting capacity of 3,000tonnes at a 50m radius and a lifting height in excess of 170m. It will be the biggest crane the German firm has ever built. The contract also includes two of Liebherr's RL-L 4200 knuckle boom cranes and an offshore crane simulator.

## New range emerges

Palfinger Marine has ventured into new territory too. Increased demands for smaller, more compact lifting machinery for offshore construction and subsea handling have spurred the company to develop a new range of active heave compensation (AHC) cranes.

The AHC technology uses real time signals from a Motion Reference Unit and various sensors to compensate the ships movements to keep subsea load steady, thereby increasing the time available for the operator. The new cranes are said to be lightweight, have lower power

consumption, a lower centre of gravity, occupy less deck space, and offer an ergonomically-friendly operator environment.

Palfinger says a high emphasis was placed on safety for cargo, equipment, personnel and environment, with smart system design used to optimise the AHC crane's compensating performance – reducing the movement by up to 98%. A spokesperson told *The Naval Architect*: "Compared to other systems currently on the market, we are in the top level when it comes to performance. This is normally varying, measured in real time from 80%-95% compensation of the load. The best hydraulic AHC systems commercially available today are expected to be in the 95-98% range."

The first AHC crane installation took place onboard the PSV *Vestland Cygnus* in late 2016, but Palfinger says the cranes, which have a safe working load of up to 200tonnes, are equally suited for larger vessels. Palfinger's spokesperson conceded that the market for AHC cranes is somewhat depressed due to the slowdown in development and maintenance of offshore infrastructure, but they are primed for action when activity picks up. **NA**



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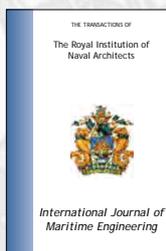
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