



# THE NAVAL ARCHITECT

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Ferries / Environmental legislation / Germany  
China / Cranes, deck & cargo equipment /

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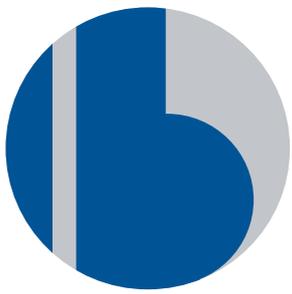
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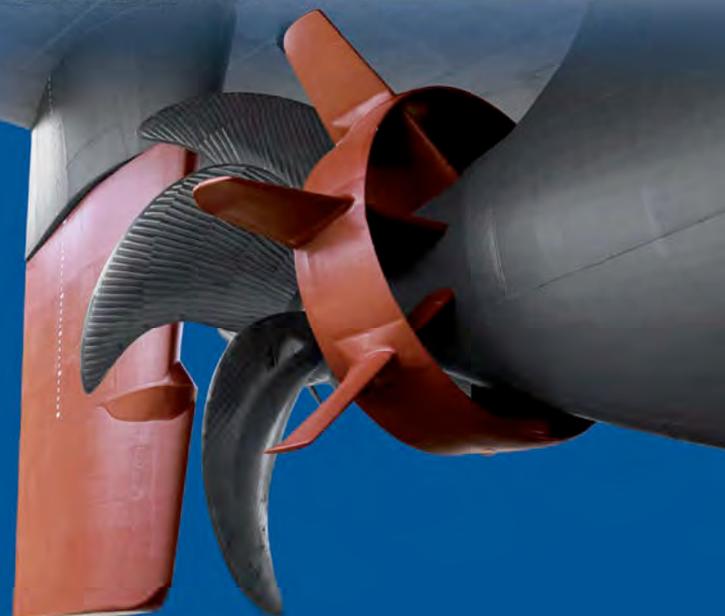


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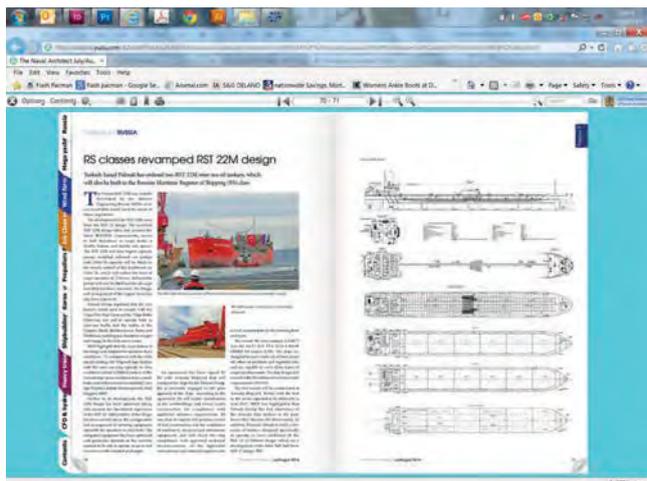
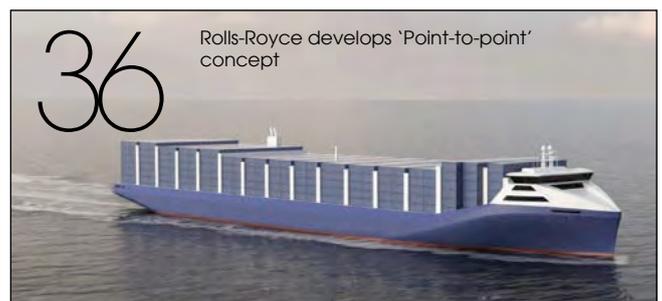
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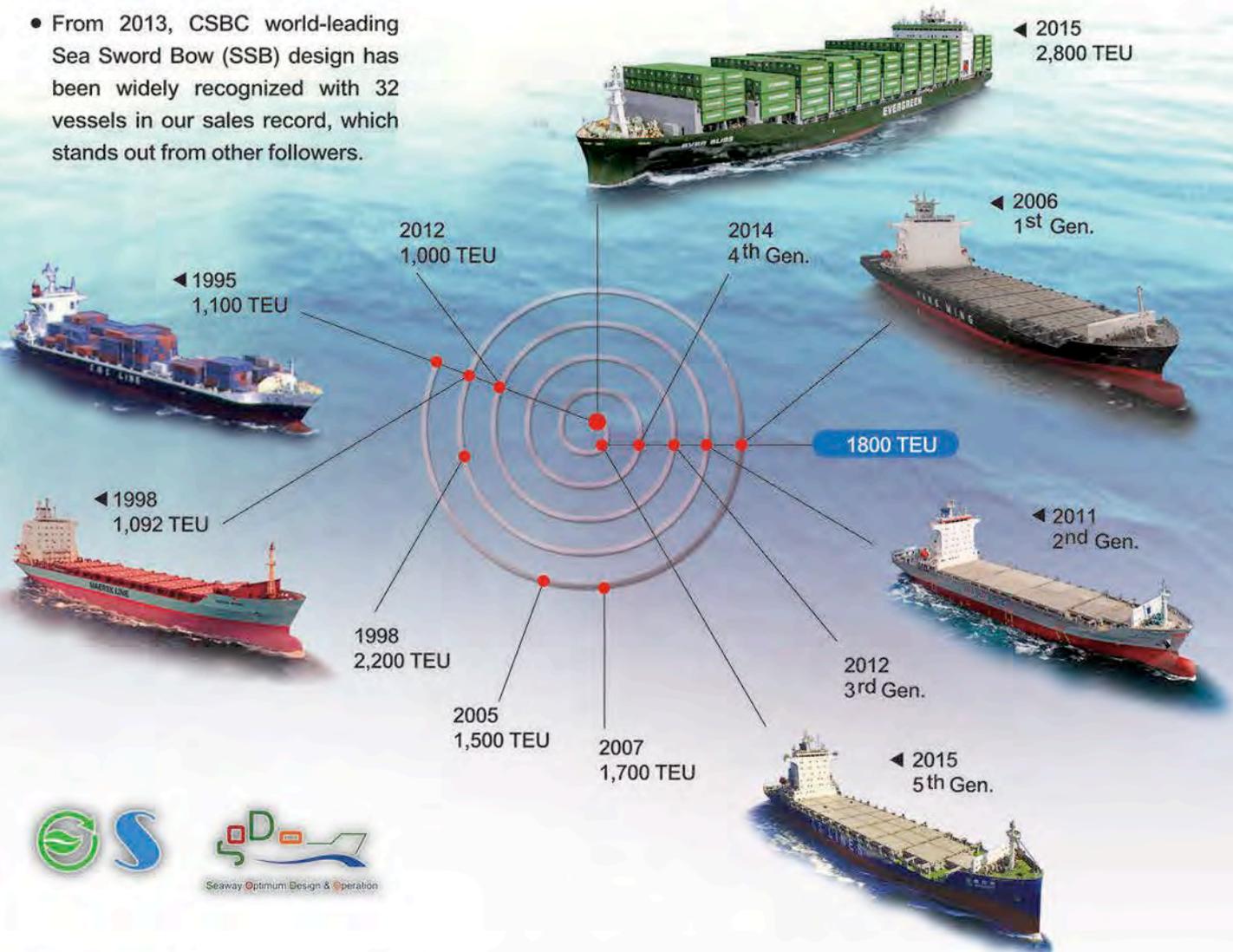
OWNERS' FEEDBACK

Ship Size	Number
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2,200~2,800 TEU	48
Total	138



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## Is shipping switched on to disruption?

Flettner assisted unmanned bulk carriers have been proposed by Rolls-Royce

The story goes, and perhaps it's slightly exaggerated, that Thomas Edison failed more than 10,000 times before finally developing the world's first commercial lightbulb. Edison's famous riposte to his 10,000th failure was that he hadn't failed once, but rather identified 10,000 ways which wouldn't work.

When it comes to innovation in marine design and technology there's seldom the latitude for 10,000 bites at the cherry. But the fact remains the vast majority of bright ideas never really get off the ground or, whether through lack of investment and promotion, or perhaps as a result of more underhand tactics by competitors, are crowded out by inferior solutions. On the subject of lightbulbs, many will have heard the old tale of the patent for an everlasting bulb that was supposedly acquired by an unscrupulous manufacturer, concerned by the potential impact on sales, so that it could never be produced. It's apocryphal – there is in fact an actual lightbulb in California that's been burning continuously since 1901 – but resonates maybe because it contains a grain of realpolitik truth.

More to the point perhaps, in many cases the potential gains may appear too negligible to justify the disruption they would bring to existing business models. To play devil's advocate for a moment, a number of the concepts and innovations we've featured in this issue of *The Naval Architect* could well end up falling into this category. 'Blue sky thinking' has long been encouraged at Rolls-Royce Marine, but can it persuade the industry of the business case for smaller ships or ultra-slow steaming (p.36), even if they could represent viable solutions for (at least some sectors) achiev-

ing future CO<sub>2</sub> targets? Possibly not in the short term, but one hopes the division's pending acquisition by Kongsberg won't impact too greatly upon its propensity to think big.

Conversely, there are those maritime influencers who are keen to stress that we're living in disruptive times. The global orderbook remains distinctly tempered (p.80-81) and this may be influencing companies to diversify their portfolios of services given a shortfall in orders for their core products. There's also some evidence of a greater willingness to invest in innovative smaller projects, such as Damen's signing of a co-operation agreement with Skoon, a start-up looking to promote electrification through a network of containerised battery packs (see Equipment News p.14). It's a solution more likely to appeal to short-sea and coastal vessels, although might have some application with peak shaving.

Many of the new solutions are empowered by the Internet of Things, and Inmarsat's recent survey (p. 84) might be read not only as an indicator of attitudes and anxieties towards all things cyber, but assimilating change in general. Most appreciate the benefits but there are also risks related to the adoption of any new technology and methods of operation. Investing in the wrong equipment, or signing a contract with an untested business partner, could prove catastrophic.

Computational fluid dynamics and simulations are areas where shipping, albeit tangentially, has successfully embraced new technology. But of course these are self-contained environments, with defined rules and parameters, not subject to the unquantifiable vagaries of economics.

Bright ideas will come and go; through accident or design one can only hope that some of the better ones might change shipping for the better.

As touched upon in last month's Editorial Comment, Germany itself has enjoyed resurgence in its shipbuilding in recent years, albeit largely within the cruise and superyachts sectors. Yet perhaps more importantly its expertise in marine engineering remains arguably second to none. Coinciding with the launch of the UK's new flagship polar research vessel, the RRS *Sir David Attenborough*, in July we are delighted to present a special report from the Hamburg Ship Model Basin (HSVA) on the investigation it undertook, in collaboration with Rolls-Royce and the British Antarctic Survey, into the vessel's aerodynamic performance using Detached-Eddy Simulation, or virtual wind tunnel.

Chiming with the above, the leitmotif of this year's SMM in Hamburg is 'SMMart Shipping' [sic], and numerous innovations will be showcased, but one suspects there will be somewhat more emphasis on the exigencies of compliance with ballast water treatment and sulphur compliance. The latter in particular represents a particular quandary for the shipowner, given that nobody can guarantee what exactly the post 2020 bunkering landscape will look like.

Unsurprisingly scrubber manufacturers themselves (p.46 and p.54), advocate they represent the safest solution for newbuildings and the Exhaust Gas Cleaning Systems Association estimates newbuilds account 40% of orders and installations this year. A more balanced perspective might be that it will depend partly on the vessel's trading area and operational profile. *NA*

LNG

## Uniper to operate new LNG carrier

Uniper Global Commodities, a subsidiary of Germany utility group Uniper, has signed a contract with Mitsui O.S.K Lines to carry out a number of journeys using the Japanese company's newly delivered LNG carrier *LNG Schneeweisschen*, which it owns jointly with Itochu.

*LNG Schneeweisschen* was delivered on 31 July by Daewoo Shipbuilding and Marine Engineering's Okpo shipyard in South Korea. The vessel is 297.7m long, and 47.9m wide. Its maximum speed is 19.5knots.

The 180,000m<sup>3</sup> LNGC is notable for its use of WinGD X-DF engines, a low-pressure, dual-fuel, two-stroke plant based on Otto-cycle combustion that is IMO Tier III compliant.

Working in tandem with the X-DF engines is a DSME-developed methane refrigeration system-full re-liquefaction (MRS-F) unit. MRS-F enables the full re-liquefaction of *LNG Schneeweisschen's* boil-off gas, at both higher and lower speeds, returning it to the cargo tank as LNG. The technology is stated to offer considerable cost savings, and will be fitted to all LNGCs ordered at DSME in 2018.

The LNGC will reportedly be used by Uniper Global Commodities to transport LNG from the Freeport LNG project based in Texas once the site opens in September 2019.

USA

## New con-ro ship for Crowley

Jacksonville, FL-headquartered Crowley Maritime took delivery in late July of the first of two new Commitment-class con-ro vessels from Pascagoula, MS shipyard VT Halter Marine. Christened *El Coquí*, the 219.5m-long, 26,500dwt vessel will transport both containers and vehicles between Jacksonville and San Juan in Puerto Rico.

Notable about *El Coquí* is the fact that it will use

LNG, rendering it one of a very small number of con-ro vessels to utilise gas. The choice was inspired by the strong emissions reduction potential of LNG on a per container basis, including the complete removal of SOx emissions, allowing the vessel to comply with the 2020 cap. Convenience was also a factor, with a shore side fuel depot located in Jacksonville from which the vessel will bunker in collaboration with Eagle LNG Partners.

Capacity-wise, the vessel will be able to hold up to 2,400 TEU. It is flexible, however, and able to accommodate a variety of different container types including refrigerated containers and 53ft x 102in wide high-capacity boxes. The maximum vehicle complement is 400, including both cars and larger commercial vehicles.

The construction of *El Coquí* in Mississippi reflects the Jones Act, which states that as US-flagged vessel trading in US coastal waters must be built in the nation. *Taino*, the vessel's sister ship, is also under construction and will enter service towards the end of 2018.

Norway

## Kongsberg acquires Rolls-Royce Commercial Marine

Rolls-Royce entered an agreement to sell their Commercial Marine business on 6 July 2018 to Norwegian company Kongsberg Gruppen ASA. This comes following Rolls-Royce's announcement in January 2018 to streamline its business structure from five units down to three leading to the decision to sell Commercial Marine (as discussed in March's *The Naval Architect*).

Kongsberg, who provide automation, navigation and control systems to customers in the oil and gas industry, merchant marine, defence and aerospace sectors agreed a value of £500 million for Rolls-Royce Commercial Marine. The final price of the transaction will be based on Rolls-Royce Commercial Marine's cash, debt and working capital at the time of completion.

Warren East, chief executive of Rolls-Royce, said: "The sale of our Commercial Marine business will enable us to focus on our three core businesses [Civil Aerospace, Defence and Power Systems] and on meeting the vital power needs of our customers."

The acquisition includes propulsion, deck machinery, automation and control, a service network active in 34 countries and ship intelligence activities such as developing technologies for remote and autonomous operation of commercial vessels.

Geir Håøy, CEO and president of Kongsberg said: "The maritime industry is becoming increasingly globalized and is undergoing considerable technological and market driven changes. With this acquisition we will [be] strengthening our strategic position with ship

Up to 400 vehicles will be able to board *El Coquí*



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The deal is expected to close in Q1 of next year, subject to regulatory clearance. Rolls-Royce anticipates net proceeds of £350m to £400m that will be used to “judiciously pursue opportunities that will drive greater returns for the group.”

It now remains to be seen whether Kongsberg can turn the recently loss making Commercial Marine into a profitable enterprise, and continue Rolls-Royce’s market-leading development of autonomous solutions.

UK

## RRS *Sir David Attenborough* launched

The 10,000tonne hull of RRS *Sir David Attenborough*, the UK’s newest polar ship, was launched into the River Mersey on 14 July 2018. The structure was then moved down the river to Cammell Laird’s wet basin.

The £200 million *Attenborough* is the biggest civilian ship built in the UK for 30 years, with a length of 129m and a beam of 24m. It will replace RRS *James Clark Ross* and RRS *Ernest Shackleton* which have collectively operated for nearly 50 years.

Rolls-Royce was responsible for the vessel design, placing emphasis on quiet running to prevent disturbance to marine life. It is claimed that the vessel has an endurance of up to 60 days and the ability to break through up to 1m thick ice.

The ship’s role includes supporting scientists working at both poles by delivering supplies to British bases, and serving as a platform for scientists to conduct research into the environment of Arctic and Antarctica. *Attenborough* will carry advanced scientific equipment including ocean survey and sampling kit, as well as on board laboratories, cranes and a helipad.

The vessel will be further equipped with an enclosed ‘moon pool’, a hole running the hull which allows instruments access to the sea even during challenging conditions and thick ice.

Sir David Attenborough, who launched the ship, said of his namesake: “Our future will be affected by what people working on this ship will be discovering in years to come.”

Initially the ship was going to be named ‘Boaty McBoatface’, as a result of a public poll in the UK last year, but this was deemed inappropriate with the vessel being named after the broadcaster instead. However, when a sub is launched from *Attenborough* it will be referred to as *Boaty McBoatface* in honour of the public vote.

*Attenborough* is scheduled to be completed by October 2018, two years after construction of the vessel began. The next step is for the upper decks to be attached, together with internal fixtures and fittings such as cabins and laboratories. It will then conduct sea trials, and be officially handed over to the British Antarctic Survey.

Classification

## Bureau Veritas releases FSU/FSRU notations and guidelines

The French Class society Bureau Veritas has issued both new and updated notations regarding Floating Storage Units (FSU), as well as a set of guidelines addressing the conversion of existing LNG Carriers into FSUs or Floating Storage Regasification Units (FSRUs).

One of the notations, ‘FSU – LNG’, provides requirements relating to structure and safety for FSUs designed and built to store LNG but not to transport it. The other, ‘Liquefied Gas Carrier – FSU’ provides similar requirements, but for FSUs designed and built to transport LNG as well as store it.

The guidelines, called ‘LNG Carrier Conversion to FSRU or FSU’, give advice on common issues that arise during such a conversion, and address the requirements surrounding the process.

Both follow on from NR645, a set of rules published by Bureau Veritas last November relating to FSRUs. The Class society considers itself a leader in the segment, with the original FSRU newbuild from 2005, and the largest-ever FSRU – delivered to MOL in 2017 – both classed by BV. Across the global FSRU fleet, 40% are BV-classed.

FSU and FSRUs offer a more economical and flexible alternative to conventional onshore LNG terminals, and both can either be built as new or converted from existing LNG Carriers. Both types consist of the floating vessel itself and a permanent marine mooring berth, and receive LNG from an LNG Carrier in a ship-ship transfer. Similarly, they both store the LNG in hull tanks. However, on an FSRU, the regasification unit (high-pressure LNG pumps plus a vaporiser) is located on-board, whereas on an FSU, this unit is located on the marine berth.

The popularity of such vessels is increasing, as demand for LNG grows. According to figures from the International Group of LNG Importers, 28 FSRUs were in service at the close of 2017, with a further 12 on order. [NA](#)

The hull of RRS *Sir David Attenborough* prior to launch at Cammell Laird



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# PSC preparing for 2020

Malcolm Latache reflects on the results of the most recent Port State Control concentrated inspection campaign and its forthcoming emissions drive

Who should enforce IMO rules and regulations is something that those within and outside of the industry constantly question. The answer, as things currently stand, is that policing and enforcement are shared between flag and port states – the IMO has no power of sanction against offenders. With a lot of new environmental regulation about to require enforcement and some shipowners fearing unfair competition, it would seem that PSC is preparing to step up to the plate.

Enforcement by PSC authorities, whether part of the Paris, Tokyo or other regional MoUs or as in the case of the US Coast Guard from individual states, is usually done by targeting ships using various criteria. Another weapon is the use of concentrated inspection campaigns (CICs) by one or other MoU, sometimes acting in tandem. At the end of July, the result of one such CIC was released and the following day a new one announced.

The result was that of a CIC undertaken late in 2017 by the Paris and Tokyo MoUs, which focussed on navigation rather than environmental factors, in particular on ECDIS and passage planning. During the CIC 4,288 inspections were conducted on 4,217 individual ships and of the 146 ships detained during the CIC, 47 were related to the CIC topic representing 32.2% of total detentions and 1.1% of all inspections.

In several of the most recent CICs, a series of questions have been put to the ship's officers and deficiencies and detentions made on the basis of the answers and subsequent inspections. In each case the questions to be asked were well publicised beforehand allowing for ship operators and crews to make preparations.

The focus on ECDIS came as a consequence of the penultimate tranche of vessels – dry cargo ships above 20,000gt – becoming subject to the rollout of mandatory ECDIS in July last year. However, the full report of the CIC shows that the most pertinent questions did not apply to almost a third of vessels inspected.

The report makes the point that 'Industry should endeavour to implement ECDIS as it will become a mandatory system on board all vessels (1 July 2018). The implementation and use of ECDIS provides a wide range of advantages'. It is hard to know if the high number of ships involved reporting that the questions did not apply was a result of poor selection of vessels, but the report is wrong in making the statement. The last rollout did indeed begin in July this year, but it only

affects vessels over 10,000gt that were in service prior to the start of the rollout programme. Even once this last slice is completed no dry cargo vessel under 10,000gt is obliged to install ECDIS and neither are tankers under 3,000gt or passenger vessels under 500gt.

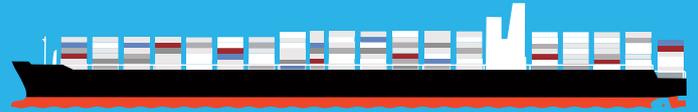
In the new CIC which begins on 1 September, the two MoUs involved (again Paris and Tokyo) have several declared aims including establishing a level of compliance with MARPOL Annex VI (Emissions to the Atmosphere), creating awareness amongst ships' crew and shipowners with regard to the importance of compliance with the provisions of MARPOL Annex VI, and to send a signal to the industry that prevention of air pollution and enforcement of compliance with applicable requirements is high on the agenda of member States of both MoUs. They seek to underline the responsibility of the PSC regime with regards to harmonised enforcement and ensuring a level playing field. The two MoUs expect to carry out around 10,000 inspections over the three months of the campaign.

Once again the 10 questions are being publicised and can be found on both MoU's websites. A negative answer to any question can lead to a deficiency being recorded and for three of the questions could result in a ship being detained. Of the three questions, one related to the sulphur content being shown on bunker delivery notes applies to all vessels, but the other two are specific to vessels with a scrubber or crude carriers alone. The questions seem rather innocuous and assuming normal practices are adhered to the detention rate should be quite low.

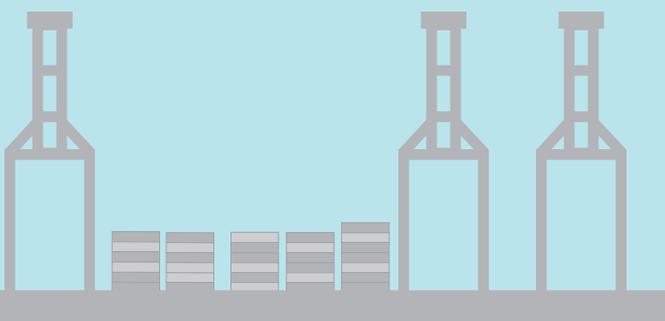
Many of the questions relate to ships operating in SECAs so will not apply to vessels operating away from the four IMO established ECAs (two in North America and two SECAs in Europe) or any locally regulated areas including all EU ports. Several of the other questions will also apply only to some specific vessels so the likelihood of the final report showing that once again the questions were not applicable is quite high.

As an enforcement tool, this CIC would seem not to be particularly effective but as a warning shot to shipowners it should focus minds on the need to work out a strategy to cope with the impending SOx reduction in 2020. As to the aim of ensuring a level playing field, that is something that will require rather more than PSC acting alone to secure. [NA](#)

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Netherlands

## Damen and Skoon to collaborate

Two Dutch companies – one a global conglomerate, the other a start-up founded by two recent TU Delft graduates – have signed a co-operation agreement regarding the advancement of energy transition in shipping, specifically via electrification.

Damen, known for building sustainable vessels, and Skoon, who aim to promote the large-scale electrification of shipping by creating a network to share battery packs, have decided to work together, combining ‘Damen’s 90 years of experience with the dynamism of a new start-up.’

For Skoon, a new and young company, the agreement is likely to be highly beneficial as it gives them access to Damen’s commercial network and its knowledge. For Damen, it represents their belief that ‘sharing knowledge and ideas is a crucial factor in stimulating innovation’, and aligns with the company’s focus on green shipping.

Skoon’s core offering is ‘swappable’ containerised batteries dubbed Skoonboxes, which will be charged with electricity derived from sustainable sources across a network of ‘strategically located’ charging hubs. Shipowners will be able to book a Skoonbox using an dedicated application called Skoon Sailor.

Although Skoon Energy is in its infancy, the start-up has attracted considerable attention and is set to trial a Skoonbox later this year aboard an inland diesel-electric vessel.

[damen.com](http://damen.com), [skoon.world](http://skoon.world)

Skoon’s Daan Geldermans and Pieter Paul van Voorst with Arnout Damen



Additive manufacturing

## SMM to feature 3D printing exhibition

In recognition of the significant potential additive manufacturing / 3D printing has for the maritime industry, SMM 2018 is set to include a special exhibition on the technology. Dubbed the Maritime 3D Printing Show Area@SMM, the exhibition will feature companies

demonstrating their particular solutions, including Gefertec, MMG, and Rolf Lenk.

These demonstrations will include live additive manufacturing processes, which already have the ability to create “designs of any level of complexity, far beyond anything anyone could have imagine in the past,” according to Claus Emmelmann of the Fraunhofer Institute for Additive Production Technologies.

Benefits of the process include weight reductions of up to 80% for common components, quick turnaround times, and the ability to create spare parts at any time and place, revolutionising the shiprepair sector. As well as being useful, the technology is also becoming increasingly lucrative; according to the International Data Corporation, the 3D printing industry is set to grow by 15% annually for the next three years.

Whilst maritime is somewhat behind sectors such as automotive and aerospace, the impetus to develop and utilise additive manufacturing in the sector is growing. In November, Damen showcased their Bureau Veritas-classed WAAMPeller, made in collaboration with RAMLAB (the Port of Rotterdam’s additive manufacturing lab), Promarin and Autodesk. The propeller is particularly large for a 3D printed object at 1.35m, and is made of Nickel Aluminium Bronze.

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AIS

## Helm CONNECT to integrate AIS data

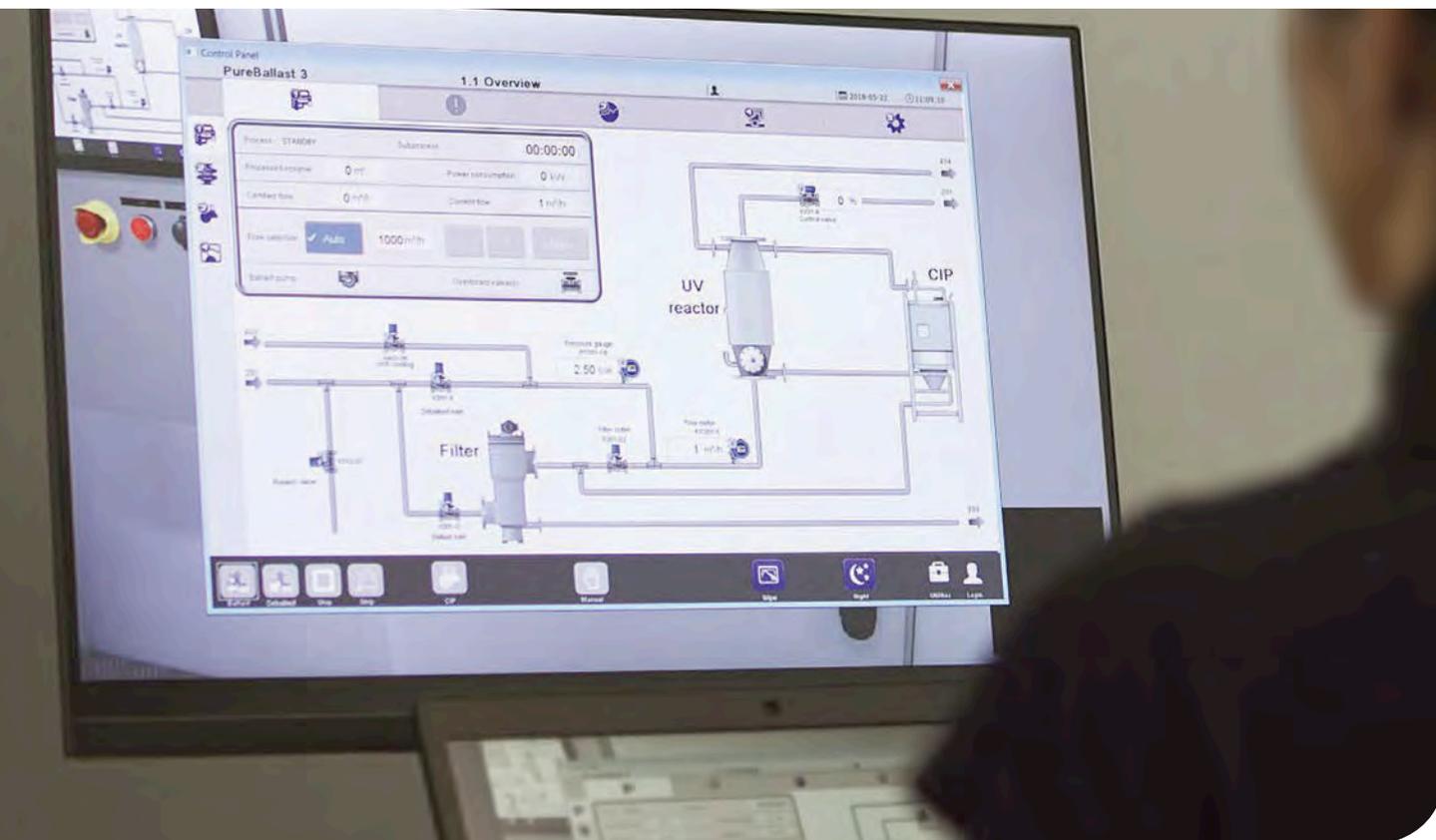
Helm Operations, a Canadian maritime software developer owned by ClassNK, and ShipTracks, a data services provider based in New Orleans, have announced an integration partnership. The deal will see ShipTracks’ AIS data on vessel location and routing become available in Helm CONNECT, Helm Operations’ maritime operations platform.

Helm Operations foresee the integration of the data as being of benefit to all subscribers, but in particular users of Helm CONNECT Jobs, a dispatch and billing system within the operations platform. Personnel required to perform these tasks will now, the company says, have “quick access to exact ship/resource positions, [helping them] to make more informed decisions about which resources to use on a job and how to best schedule their vessel operations.”

For ShipTracks, the partnership is indicative of their goal to help vessel operators “run their businesses and their assets more effectively and efficiently,” according to CEO Charles Riley.

The availability of AIS data in Helm CONNECT represents the next step in the growth of the successful platform, which reports 3,000 assets using the software after being on the market for two years.

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At the time of going to press, users are now able to access the first version of the new integrated features. Further collaboration has been slated between the two companies, including adopting ShipTracks-developed geo-fencing technology and operational alarms.

[helmoperations.com](http://helmoperations.com), [shiptracks.com](http://shiptracks.com)

#### Blockchain

## Blockchain bunkering consortium considers fuel supply chain

Maritime Blockchain Labs (MBL), a partnership formed by blockchain technology company Blockchain Labs for Open Collaboration (BLOC) and Lloyd's Register (LR) earlier this year, has announced the establishment of a consortium to address the "traceability and transparency in the marine fuel supply chain", it was announced in late July.

The consortium brings together a number of organisations and service providers: LR, BIMCO, the International Bunker Industry Association (IBIA), ship operators Precious Shipping and Bostomar and bunkering services provider Goodfuels. Its aim is to evaluate how blockchain technologies might be implemented within the bunkering industry as a means of increasing transparency and stronger governance concerning fuel quality.

With IMO's pending 0.5% sulphur limit from 2020 there are growing concerns about the availability of fuel and the type of fuel blending which may occur. It is hoped that blockchain, which is essentially a form of encrypted data exchange, could be used to create an auditable chain of custody for fuel quality and quantity so that shipowners and regulators alike can have greater confidence in the fuel being purchased.

Deanna MacDonald, founder and CEO of BLOC, says that MBL will facilitate governance but the actual testing of the technology will be entirely driven by the industry, with the consortium approach key to crossing regulatory boundaries and developing a consensus. She adds: "Too often with blockchain, and digital initiatives in general, we see a top-down approach where technology is forced on the industry. However, this means that complex

human and governance elements are ignored, limiting the eventual adoption and usefulness of the technology."

MLB was formed in March 2018, after an extensive feasibility study in 2017, with a view to establishing a network and develop three demonstrator projects. Speaking to *The Naval Architect* earlier this year, MacDonald explained that while blockchain is more commonly associated with cryptocurrencies such as Bitcoin, it is essentially a mechanism by which to timestamp transactions between parties.

She explained: "In terms of where we think it will be beneficial for the maritime space in particular is facilitating a global digital infrastructure. We have all these fragmented IT systems and intermediaries that book for shipping lines... if we are to create frictionless trade we believe [blockchain] can play a role in at least being able to provide traceability and transparency of transactions in maritime.

"We're educating the industry that it's still early days and that there are quite a lot of developments happening that won't affect you, such as speculative investments and cryptocurrencies."

[un-bloc.com](http://un-bloc.com), [lr.org](http://lr.org), [bimco.org](http://bimco.org)

#### Propulsion

## Fuel-saving device achieves 500th installation

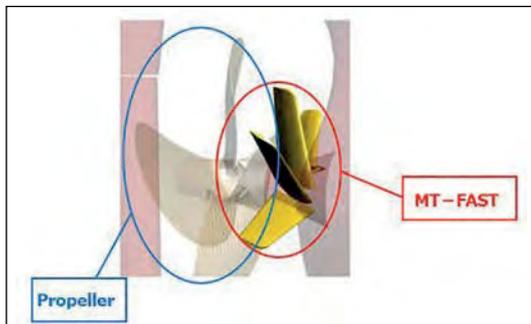
The MT-FAST, a hull appendage designed to improve propulsion efficiency and therefore save fuel, has now been installed on 500 vessels since its introduction in 2008. The device was jointly developed by Japanese companies MTI Co. Ltd. (part of NYK Group) and Tsuneishi Holdings Corporation, and can be found on bulk carriers and containerships operated by NYK Group, as well as on vessels built at Tsuneishi shipyards.

Featuring multiple blades, the MT-FAST is attached to the hull behind the ship's propeller. It is designed to counteract the swirling flow that results as the propeller converts rotational power into propulsive force, improving propulsion efficiency and leading to a fuel consumption reduction of approximately 4%. According to NYK, the 500 MT-FAST units have to date saved 447,000 tons of fuel, and therefore 1,341,000 tons of CO<sub>2</sub>.

NYK, using their proprietary Ship Information Management System (SIMS) – a remote monitoring and management technology – conducted a trial on two vessels to verify the performance of the MT-FAST. With one vessel fitted with the appendage and the other without, the vessels were monitored as they sailed an identical route in the same weather and wave conditions. According to the data received from SIMS, a fuel saving of 4.8% was achieved for the vessel fitted with the MT-FAST, tallying with the 4% figure claimed for the unit.

[nyk.com](http://nyk.com)

The MT-FAST is attached to the hull just forward of the propeller



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# 2018 naval architect employment review

A survey of employers and naval architects by a specialist recruitment firm reveals a gulf between what employers want and what employees can offer

In what is still a very challenging market for many businesses, maritime, shipping and offshore recruitment specialist Faststream asked: ‘What is the outlook in employment for new graduates and experienced naval architects in 2018? Are the expectations and ambitions of naval architects and employers aligned, or will there be growing disparity between the two parties?’ The company surveyed 4,500 naval architects and 500 employers, from over 100 countries, in an attempt to answer these questions. Some very interesting themes were identified; these findings are reported below:

## You need to be client-facing

Over 40% of employers surveyed identified ‘client-facing skills’ as the area in which they expected to see the most prevalent skill shortages.

However, it was also conclusive from our survey that employees who possess natural commercial, client-facing attributes will find their CVs at the top of the pile. ‘Client-facing skills’ were rated as the most important factor employers look for when considering a new hire (out of ten items), ahead of any technical skills.

It was interesting to see this listed as the number one area that employers were concerned about. Naval architects reported they were brimming with



Adam Graves, Associate Director, Faststream

confidence in this area, but employers recognised it as a future skill shortage. Where has this uncertainty come from? In an industry built on credibility, is this a sign of uncertain times? Given weaker market conditions and uncertainty about future trends, has this encouraged employers to target individuals who can make a stronger impression in front of their customer base? In this climate we can understand that naval architects with natural commercial attributes would be seen as strong additions to any business worried about the future.

## Academic credentials remain important

Whilst employers are focusing heavily on customer facing skills, they continue to look for a high level of ‘academic credentials’ in prospective employees. This was true for both experienced and graduate naval architects. Academics were rated as the third most important factor in hiring experienced naval architects. According to Adam Graves, associate director for the Naval Architecture division, Faststream’s recruiters see this every day, with many employers looking for candidates with 1st class degrees and Masters (MEng) degrees. Not only that, but often they’re looking specifically at the institutions where they studied.

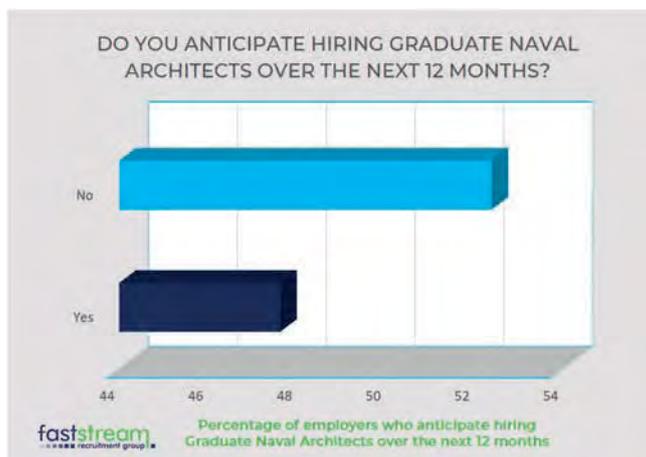
Naval architects in our employee survey were very confident about their academic qualifications and rated this item as the single highest factor (out of 10) when we asked them about their experience. Clearly there is unanimous importance placed on academics from both employers and naval architects.

## ‘Rising stars’ – hiring future leaders low on the agenda

It was fantastic to see an employee base with self-assurance in their level of management and leadership ability. Employers, however, did not rate it with high priority for their new graduate hires (less than 20% rated it with a high level of importance).

In an engineering sector such as naval architecture, we were astonished to discover that less than 50% of the employers in our survey indicated that they were looking to hire graduates in the next 12 months, whereas more than 60% confirmed they would be looking for an experienced hire in the same year.

With technology advancing at an alarming rate and with no let-up in sight, in a market saturated by degree qualified engineers, it seems unusual that more companies wouldn’t be looking to bring on fresh graduates into their businesses.



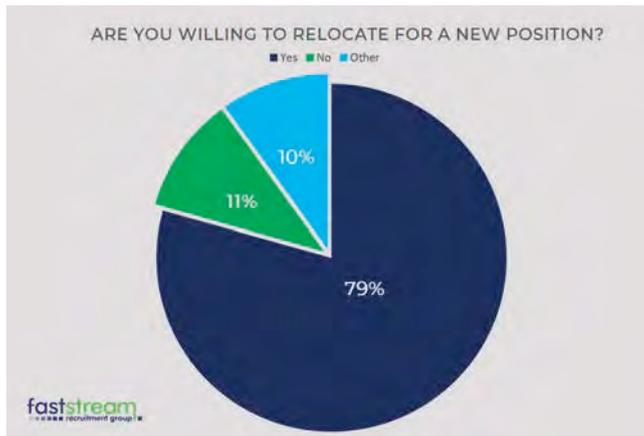
As well as naval architects, 500 employers were surveyed about their recruitment needs



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The overwhelming majority of naval architects are prepared to relocate for the right job

With an unrelenting surge in cruise ship orders (currently standing at 113, as of 24 July 2018), it is unsurprising that naval architects want a piece of the action. We were a little concerned to see employers reporting confidence in attracting cruise ship candidates. In our experience as an agency candidates for this sector are becoming more and more scarce.

### LNG/LPG skills shortage

LNG/LPG experience was highly sought after by employers and this proved to be a skill short area from our candidate survey. Nearly 60% of employers were keen to see LNG/LPG experience in a CV, whereas only 16% of candidates had this knowledge. Further skill shortages were identified in the O&G sector; 'FPSO/FLNG/FSRU' experience in particular was highly desirable by employers (66% wanted it). However, only 29% of those surveyed had this experience to offer.

Will employers be able to consider naval architects who have experience in other areas, for example Tankers or Offshore (which featured high in candidate experience levels)? The tanker market in particular was not seen as an attractive sector, with only 23% identifying it as a vessel type of interest.

It is apparent from our survey that there are significant disconnections between the experience of naval architects in the market and the future demand. Most alarming was that high-demand vessel types sectors (as rated by employers) were often rated as the lowest areas in terms of candidates' experience. This was true for the FPSO/FLNG/FSRU, LNG/LPG and Cruise Sectors.

We also saw from our survey that employers were concerned about future skill shortages in naval architects' design skills; this was also backed up by a lack of confidence from candidates in this area. We suggest that this is linked to the vessel type findings above as more and more specialist design skills across the high demand sectors are required, especially in what is becoming an increasingly technologically advanced market.

### Technology issues

Current talk of big data and the digital revolution across many maritime disciplines, particularly naval architecture, is creating

Should more employers not be looking at graduate intakes as future leaders? Whilst employers are looking for tried and tested, 'client-facing' engineers, succession planning (at the graduate level) could be the key to combatting an ageing workforce in what is becoming an increasingly skill short market. Surely as an industry, we should be looking to invest in the future generation in this way?

### Plug and play hiring

The employers surveyed gave strong indications that they were looking for client-facing employees with specialist 'plug and play' skill sets. Adam Graves agreed: "This is a hugely specialised market, and the employees and employers in this sector are detail-orientated engineers. Most companies we work with are highly specialist; even the market sectors they work in have sub-sectors with different specialisms. From a hiring perspective our clients are typically looking for an exact match on skills and experience."

It was interesting to see that, in the employee survey we conducted, naval architects indicated they would be looking to work for the same type of company if they were looking to change jobs. For example, from our research it appears unlikely for a candidate who has predominantly worked in a consultancy setting to want to take the leap and apply for jobs in shipyards.

We also see employers being very specific in terms of the person specification – almost a 'wish list' of attributes. This can mean they feel comfortable in holding out for longer periods in their hiring process to ensure that they hire the perfect 'plug

and play' candidate. Graves added that his team were seeing an increased ratio of interview to placement, which has caused some frustration in terms of candidate experiences during a recruitment process.

When you combine candidates who are reluctant to change the type of company they work for, and an employer who is looking to find the perfect CV, we will potentially continue to see a slow recruitment market. If both candidates and employers alike in this sector were more flexible, it could open the doors to a transfer of skills and knowledge across the industry.

### Offshore oil and gas still hot

Oil and gas (O&G) at the top! As part of our survey, we asked naval architects "what vessel types would you be most interested in working with going forwards?" The responses unanimously highlighted the O&G sectors ('Offshore Vessels' and 'FPSO/FLNG/FSRU') as attractive. These vessel types took the number one and number three spots respectively (out of 10 sectors). We naturally looked at whether our survey demographics showed any bias towards candidates from the O&G market and discovered this was not the case; moreover we saw an even distribution across sectors.

Interestingly, the number two spot went jointly to 'Superyachts' and 'Cruise', whereas 'Ro-Ro', 'Container' and 'Dry Cargo' all scored in the bottom three sectors. Our experience tells us that the highly specialist nature of the offshore, superyacht and cruise industries are likely to be very attractive to naval architects and engineers, versus the more standard 'off-the-shelf' vessel designs in other areas.

confusion. Many employees feel short in their knowledge of these applications, backed up by our survey, where out of ten knowledge factors 'technology and software' was rated as the second lowest. On the other hand, employers felt that because this is a contemporary topic, the knowledge must be there. Less than 10% of employers were concerned with a future skill shortage in this area.

Some employers, however, are forward thinking and rated technology and software knowledge in the top three of their priority areas when recruiting graduates. Nonetheless, with a smaller number of employers anticipating hiring graduates and experienced naval architects' evident lack of confidence in this area, we predict storms ahead.

### A globally mobile workforce

A staggering 80% of candidates confirmed they would relocate globally for the right role. However, although globally mobile,

candidates are unlikely to apply for roles that they feel are outside their comfort zone, in particular with regards to the company type they would like to work for. We found that candidates have a tendency to look at prospective employers who are of a similar company type to their main experience.

### A thirst for training

In a sector where academic credentials are high, we were delighted that although our respondents were highly educated, they chose training and development as their primary need. This was rated higher than salary, career progression, work-life balance and company culture. It was refreshing to see that naval architects wanted to develop their knowledge.

This thirst for knowledge and training was emphasised further by candidates indicating that they would like to see more learning and development offered in skill areas where their aptitude was lower, for example software and new technology.

What are employers doing to bridge this training gap? Our evidence is that they are not looking to bring in more graduates, and our research did not indicate that they are planning on implementing more training with their experienced naval architects. Are employers pinning the future on finding the small minority who will fit almost identically to their requirements and hold off until they find them? This seems like risky business to us.

### About Faststream

Established in 1999, Faststream are specialist recruiters in the maritime, shipping and offshore sectors, with over 130 employees operating from three key maritime locations in the UK, Singapore and North America. They source hard to find talent for clients across the globe and offer services including permanent recruitment, contract and interim recruitment, payroll services, executive search, benchmarking and salary surveys. **NA**  
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Shipping is vital to the world economy. It is a critical part of international import and export markets and supports the global distribution of goods. As for all industries, concerns about climate change require the reduction of greenhouse gas emissions from the shipping sector. This entails to reduce the amount of fossil fuel used or use cleaner fuels. It means that the industry must prepare for the new future and investigate alternative, more economic ship propulsion systems. This conference seeks to investigate some of these alternatives, including;

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# Digitalisation of PLM processes is the key to shipping's future

Technology that makes innovation easier and more affordable accelerates change, says Jan van Os, Siemens PLM Software

The shipping industry received a wake-up call in April 2018 when the IMO adopted regulations that aim to halve greenhouse gas emissions (per 2008 levels) by 2050. In summary, the regulations call for:

- Reduced atmospheric emissions
- Minimised noise pollution for zero impact on marine life
- Discontinued waste release in the ocean
- Restrained approach to particularly sensitive sea areas
- Responsible ballast water management

Shipping would do well to learn from the innovative practices found in automotive and aerospace in order to meet these demands. These industries lead the way in the adoption of product and process applications created to speed up development and application of new designs of sustainable solutions.

## Gauging the sustainable shipping opportunity

Ninety percent of global trade is carried by ships. As of 1 March, 2018, 94,300 merchant ships were operating worldwide, with 3,500 additional ships on order.<sup>[1]</sup> In addition, thousands of service, government and military vessels add to the 938 million tons of annual CO<sub>2</sub> emissions from shipping.<sup>[2]</sup> By comparison, the total CO<sub>2</sub> emissions of the United Kingdom are 380 million tons.

Environmental responsibility is directly linked to design. Product Lifecycle Management (PLM) technologies help many industrial companies produce higher-performing products that use less fuel, release fewer emissions and require less physical testing and materials.

For ships and other big machines, PLM engineering can increase the cargo carried per the current unit of power, achieving greater output with the same energy resource. Alternatively, it can reduce the fuel consumption for current cargo loads, thus meeting the same output with less



Jan van Os

energy. Design-driven improvements can also help minimise the likelihood of spills, reduce the amount of ballast water ships take on and reduce noise pollution that harms marine life.

## Covering the cost of more sustainable shipping

One thing holding back potential efficiency improvements in future ship designs is the cost of change. Conservative by nature, the shipping industry does not prioritise technology and process improvements. Instead, many shipbuilders still use antiquated methods, such as building scale-models and running towing tank tests.

Some drawbacks with this approach are:

- High uncertainty: Physics varies at model scale versus full scale, so there's a significant risk of getting the performance expectations of the vessel wrong.
- Speed: Tests for conditions and components occur separately, presenting integration challenges.
- Cost: Test series require the most expensive process component – engineering time.

Using design software with digital simulation, designers can efficiently

complete simulations at ship scale and under 'real' operating conditions. Moreover, designers can test multiple factors (hydrodynamics, aerodynamics, propulsion) in one environment for a holistic, realistic view of what will happen in real life.

Take Havyard Group ASA, a Norwegian ship technology company approaching a deadline to submit a response to a tender offer. It committed to a performance requirement: a cruise speed of 20 knots with minimal fuel consumption. The lower consumption Havyard committed to, the greater chance it had of winning the contract. However, if it failed to deliver on the commitment during sea trials, it would face significant penalties.

Due to the short deadline and the fact that it was a tender, towing tank testing was neither possible nor practical. Using Siemens' Simcenter portfolio, the project was turned around in less than one week, with three design loops that further improved the design.

## Doing the impossible with simulation

By combining a full-scale simulation with generative design, design automation and intelligent design exploration, designers can:

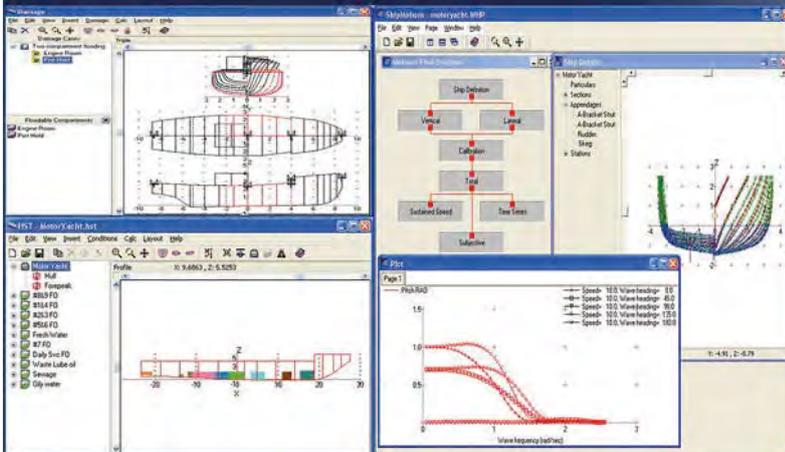
- Test multiple factors (hydrodynamics, aerodynamics, propulsion) in one environment.
- Obtain a holistic and realistic view of what will happen in real life, unlike traditional methods where you test conditions and components separately.
- Get more accurate results – especially for novel design.

PLM can improve speed-to-market and reduce costs of innovating designs, helping companies to achieve sustainability goals, margin increases and market expansion.

<sup>[1]</sup> Source: Clarkson's Research

<sup>[2]</sup> Source: IMO

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To meet new emission standards and regulations, the shipping industry would do well to adopt applications created to speed sustainable solutions.

Such digital simulation capabilities enable design engineers to test hundreds of geometric variants to find the best performance for future ships.

### Digital twin wins for ship maintenance

Modern PLM technology can also improve shipping sustainability through more efficient ship maintenance. A real-time digital record of the ship and its system in a digital twin sets a foundation for accelerated and effective maintenance, major overhauls and fleet modernisation with less ship downtime. A digital twin also benefits ships already in use through retrofits along a ship's multi-decade lifespan.

Connecting digital design tools gives a much greater understanding of ship performance and can lead to significant design refinements. For example, Wärtsilä, which manufactures and services propulsion systems and other equipment in the marine market, uses advanced

PLM and simulation technology to understand and boost performance early in the design process.

The company uses digital twins of proposed vessel designs, combining a system-simulation of the engine and propulsion system with a CFD model of the vessel at full scale. The approach enables performance prediction, new fuel efficiency and increased innovation.

### Business benefits of sustainable shipping designs

Digitalisation benefits the future of shipping for individual companies and the industry. In addition to advancing the move toward sustainable shipping, opportunities include:

- **First-to-market breakthroughs:** The industry faces ongoing challenges in both designing new vessels such as ballast-free ships and improving, or retrofitting, existing ones. Digitalisation can help in each pursuit. It enabled Becker Marine, for instance, to design innovative energy-

saving devices to improve existing ship performance on a systems level.

- **Traceability and visibility:** As pressure on sustainable practices mounts within supply chains, the shipping industry will benefit from better visibility and traceability into goods transport. Traceability guarantees accurate records that enable measurement of improvement efforts and root-cause identification for fast corrections, and link responsibility to individual suppliers.
- **More efficient and sustainable shipyards:** Shipbuilding consumes a vast amount of resources. A complete rethinking of ship design and construction to focus on longevity, refurbishment and materials recovery and reuse is possible with today's technology.

### Shipping industry innovation - accelerated

To achieve sustainable targets and become more competitive, companies must proactively design, build and maintain compliant ships. Advanced PLM technologies make these aims manageable and affordable.

Digital design solutions can predict and optimise ship performance early in the design process, allowing better, safer and greener ship development – cheaper and faster.

The shipping industry has no choice but to change course. It must innovate or face penalties and growing public scrutiny. By investing in modern PLM tools, participants all along the marine supply chain will not only gain cost-effective strategies to meet sustainability goals, but also enter a competitive future that will leverage generative design, intelligent design exploration and optimisation capabilities at full scale under real operating conditions.

### About the author

Jan van Os, vice president of marine industry strategy for Siemens PLM Software, helps the company define industry-specific market solutions for marine customers. Jan has also been employed at Damen Shipyards since 1988. From 2009-2017 he was product director of offshore and transport. Jan was born in the Netherlands in 1964 and completed his technical studies in naval architecture in 1987. **NA**



The future of shipping rests on digital design solutions that can predict and optimize ship performance, allowing greener – and cheaper – ship development.



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# Europe's resurgent ro-ro sector

The European shortsea sector is fertile ground for innovation in ro-pax and ro-ro freight ferry design and engineering, writes David Tinsley

Surging investment in almost every sphere of European ro-ro operations, with the accent on higher capacity, more energy efficient and environmentally compliant tonnage, indicates a powerful rebound of the sector, against the backdrop of overall improvement in freight volumes and financial performance.

The industrial effect of the current scale of modernisation and development of shortsea ro-pax and ro-ro fleets is magnified by the attendant demand for design, equipment and engineering 'tailoring', resulting in comparatively high production values and capital intensity.

Further impetus to the implementation of newbuild schemes was afforded by IMO's confirmation in April this year of a 20% correction to its Energy Efficiency Design Index (EEDI) calculation formula for ro-ro and ro-pax vessels, assuring a much needed margin for projects inhibited by the previous, problematic EEDI criteria.

Home-grown technical know-how underpins newbuild programmes, irrespective of where ships have been ordered. Notwithstanding fresh contractual successes in the European market by leading lights in ro-ro construction in Germany, Norway and Croatia, the emergence of Chinese yards as facilitators of European ferry fleet renewal programmes is especially significant.

European rejuvenation is accompanied by a new wave of consolidation in the sector, exemplified by the impending amalgamation of Spain's two largest operators through the Naviera Armas takeover of Trasmediterranea, and by the DFDS acquisition of Turkey's pre-eminent ro-ro freight company UN Ro-Ro.

## Stena superiority

The Stena Group is renowned for its skill in developing and operating new designs of shortsea ro-ro ferry conducive to series production, lower unit costs and adaptability to differing service routes and demands. The latest stage in its contribution to the advance of ro-pax technology is encapsulated by



Stena RoRo's E-Flexer generation will be used by Brittany Ferries and DFDS as well as Stena Line

the nascent E-Flexer series, dimensioned for 3,100 lane-metres of freight and up to 1,000 passengers. Economies of scale in conjunction with the most circumspect consideration of power, propulsion and underwater design issues promise a class of ship offering about 25% less CO<sub>2</sub> per freight unit than existing ferries, plus the wherewithal to meet exacting criteria regarding NO<sub>x</sub> and SO<sub>x</sub> emissions.

The Swedish group initially identified a requirement for eight vessels of the new generation, and moved a stage closer to realising that objective in mid 2018 when a sixth E-Flexer was ordered. It subsequently exercised options on seventh and eighth, larger newbuilds and laid the ground for an even more extensive programme by taking out options on the construction of four further E-Flexers.

The entire series has been placed with the AVIC Weihai yard in China. Deltamarin, the Finnish-founded technical consultancy arm of the contractor's parent AVIC Group, developed the design and is supplying the comprehensive engineering, procurement, construction and management (EPCM) package.

The seventh and eighth E-Flexers will be some 25m longer than the first six, giving an increased maximum payload of 3,600 lane-metres and 1,200 passengers.

Rather than the more usual four-engine layout in a ferry of this size and type, the E-Flexer has a two-engine installation, in the form of a 'gas ready' plant based on two MaK 12-cylinder VM43C diesels, to ensure a speed of 22knots. MaK's dual-fuel technology can be applied by converting the machinery to the M46DF model. Operating in gas mode would achieve IMO Tier III compliance, while the 'future-proofing' measures adopted in the E-Flexer include options for retrofitting scrubber plant or selective catalytic reduction (SCR) systems.

E-Flexer deliveries are scheduled from early 2020 onwards. The first, second and fourth newbuilds in the series from AVIC Weihai will be allotted to Stena Line's Irish Sea network, while the three other firmly-booked vessels have attracted long-term charter deals from other prominent players in the north European ro-ro market.

DFDS has signed a 10-year charter on one of the newbuilds, to be phased into service on the Strait of Dover in 2021, while Brittany Ferries has secured two of the ships on respective five- and 10-year bareboat charters for the long-haul routes connecting Portsmouth with Santander and Bilbao.

## From Brittany to the Baltic

Meanwhile, the ro-pax earlier ordered by Brittany Ferries to its own account at

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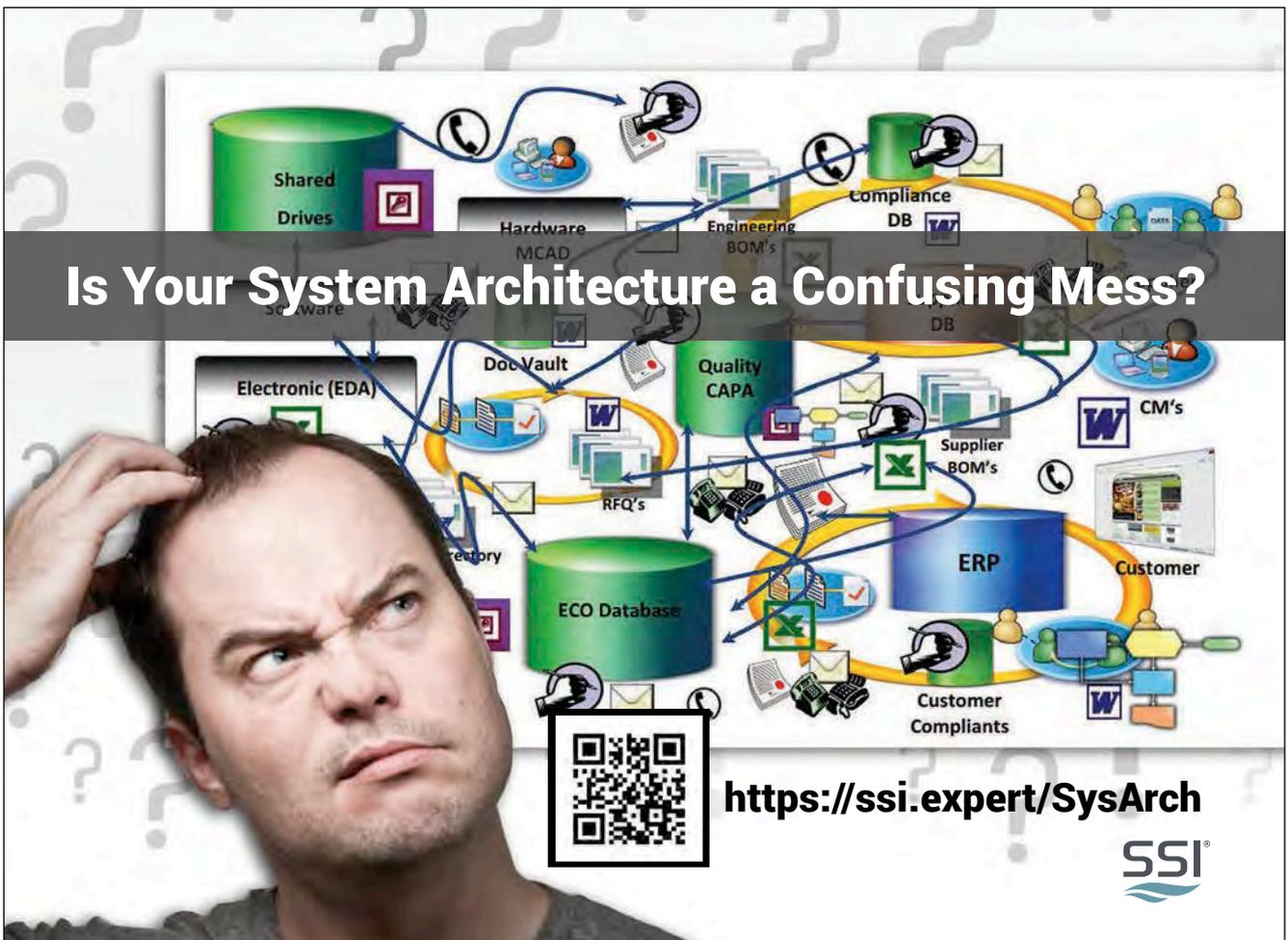
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Flensburger Schiffbau-Gesellschaft (FSG), and due in the spring of 2019, will break new technical ground in the cross-Channel market on two counts, through the nomination of electrical propulsion and the selection of LNG dual-fuel engines. Arranged for 1,680 passengers and 550 cars plus 64 trailers, or an all-freight ro-ro payload of 130 trailers, the 42,400gt *Honfleur* will replace the 1992-built *Normandie* on the Ouistreham(Caen)/Portsmouth service, the Breton company's busiest route.

The southern Baltic is the setting for an initiative whereby Polish Steamship Company (PZM) subsidiary Unity Line is planning a series of shortsea ro-pax ferries of novel design, incorporating a hybrid powering system featuring wind generators.

The vessel concept has been devised by the owning group and operator in cooperation with Wärtsilä and the Gdansk-based firm of consulting naval architects NED Project. The proposed design incorporates LNG dual-fuel main machinery and electric propulsion motors, augmented by banks of batteries charged by four vertical wind generators mounted towards the stern. Up to four newbuilds could be involved, the first of which would be assigned to the longstanding service between the western Polish port of Świnoujście and Trelleborg, at the southern tip of Sweden.

The basic configuration offers a 3,600 lane-metre ro-ro intake plus 521 passenger cabin berths within main dimensions of 204m x 31.8m, although the design lends itself to longer variants up to 225m. The envisaged four-engine layout would employ Wärtsilä 6L50DF prime movers, each rated at 5,850kW, while the four vertical rotors are expected to deliver up to about 1,200kW in strong wind conditions of 20m/s.

Besides the commitment to one of the E-Flexer series, DFDS has augmented its own newbuild programme this year, entrusting three more ships to Chinese builders. Guangzhou Shipyard International has been awarded two 4,500 lane-metre/600-passenger ro-pax ferries, for the Baltic route network, and a fifth 6,700 lane-metre/500-trailer ro-ro has been placed with Jinling Shipyard.

### Skirting the border

Cobelfret-associated Compagnie Luxembourgeoise de Navigation (CLdN) put down a new marker for intra-European



The South Korean-built *Celine* has brought new scale economies to CLdN's shortsea network

logistics last October through the introduction of the 74,300gt *Celine* to routes linking mainland Europe with Ireland and the UK. Laid out for 7,800 lane-metres of rolling cargo within main dimensions of 234m x 35m, *Celine* is claimed to be the largest shortsea freight carrier built to date. She was followed by second-of-class *Delphine* from South Korea's Hyundai Mipo Dockyard (HMD) early on in 2018.

Complemented by the expansion of terminals run by sister company C.RO Ports, the new breed offers flexibility as to service allocation, and provides importers and exporters with greater scope for direct Ireland/continent routings as an alternative to using the UK 'landbridge', an option which may gain in relevance following the UK's secession from the EU.

The *Celine* type is powered by a single, MAN two-stroke ME-series engine, rated at some 18,600kW, driving a Rolls-Royce controllable pitch propeller, and carries the 'gas ready' class notation from DNV GL. Five Kawasaki tunnel thrusters, three at the stern and two in the foreship, provide exceptional 'crabbing' capabilities. CLdN has also ordered a quartet of 5,400 lane-metre ro-ro from HMD for delivery through 2018 and 2019, and two ships of similar capacity are in hand at Croatia's Uljanik Shipyard, which holds options on several further vessels.

### Italian excellence

Italy's expansion-minded Grimaldi Group has this year implemented a considerable newbuild programme revolving around a ro-ro trailership design on a par in terms of capacity (7,800 lane-metres) with CLdN's *Celine*, but slightly longer at 238m and with a beam of 34m. Dubbed the GG5G, or Grimaldi Green 5th Generation, the design has been developed by the shipowner in conjunction

with Knud E. Hansen of Copenhagen and features hybrid powering arrangements.

The initial tranche of six vessels was contracted with Jinling Shipyard of China in April, and a second batch of six was firmed-up the following month. Total investment is in the region of US\$800m and spans deliveries from 2020 to 2022. Nine of the ships will be operated by Grimaldi Lines in the Mediterranean and three vessels of a modified version will be deployed by sister company Finnlines in the North Sea and Baltic trades.

The scrubber-equipped ro-ros will burn heavy fuel oil (HFO) during navigation, and the energy requirement when alongside will be met using lithium-ion batteries. The batteries will be recharged while under way via shaft generators, supplemented by 600m<sup>2</sup> of solar panels. The other main technical innovation to be embraced by the GG5G trailerships will be an under-hull bubbling system reducing frictional resistance and saving fuel.

The ro-ro mode has also been championed in a further Mediterranean endeavour jointly launched by Italy's Onorato Armatori and the Swiss-headquartered MSC Group, which also has Neapolitan roots. The deal signed in early 2018 with Guangzhou Shipyard International and China Shipbuilding Trading Co (CSTC) encompasses four ro-pax vessels to cruise ferry standard, plus four options.

Due from 2020 onwards, the ships will be of 229.5m length overall and 32.2m breadth, and will be fitted out with 534 cabins. A service speed of 23.5knots has been specified, and the engineering design will be to 'LNG-ready' class stipulations. The first and third ferries in the series will be allocated to Genoa-based Grandi Navi Veloci (GNV), while Onorato, whose interests include Moby Line, has been assigned the second and fourth ships. **NA**

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# Swedish study looks into broad range of electrification challenges

Swedish ferry company Stena Line has decided to introduce battery power on board 29,861 gt ro-pax *Stena Jutlandica* as part of a project to study the use of electric propulsion on board, reports Kari Reinikainen

A new three-stage battery power project on *Stena Jutlandica* is to be conducted as part of a pre-study between a number of Swedish companies and research institutions that aims to chart the challenges that lie ahead for the use of electric power on board vessels and to prepare for future projects to solve these challenges.

Sweden has committed itself to becoming carbon neutral in net terms in 2045, so electrification of shipping is part of this wider policy objective. The project's aim is to bring together input from ship owners and ports, suppliers of batteries, ship designers, ship-to-shore power connection providers, classification societies and national authorities plus research institutes and universities.

The first stage of the *Stena Jutlandica* project calls for the use of battery power for the vessel's bow thrusters and peak shaving of the electrical power plant during departure and arrival. This requires a battery of 1MWh to be installed on board. At the project's second stage, anticipated to begin within the next few years, batteries will power sea passage in the Gothenburg archipelago, requiring a plant of about 20MWh. The third stage, launching in 2030, will see the vessel's entire crossing between Gothenburg and Frederikshavn made on battery power, necessitating batteries with a capacity of about 50MWh.

Built in 1996, *Stena Jutlandica* has a power plant commonly used on ferries that comprises medium speed diesels and gearboxes. The work to install the equipment for stage one of the project took place in mid-May. The concept utilises a large energy storage system, including automation and interfaces to the ship's existing power distribution. All essential components were fitted into one container unit at the start of the programme, giving the option to move the whole unit to



The battery project represents a key step in Stena Line's sustainability strategy

another vessel if the route or requirements change. The modular design also enables components to be replaced when new technology is available which makes the system sustainable for the future.

The battery unit will be located on the weather deck and have the capacity to supply up to 3,000kW instantaneously, with an energy content of approximately 1,000kWh. "The solution will contain all components required to be fully automated, including battery banks, converters, transformers and control systems," Stena Line said in a statement.

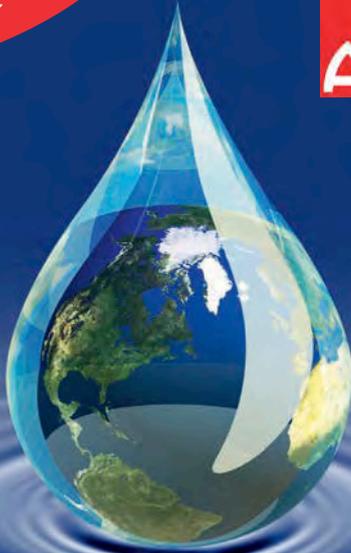
The batteries will be charged both via a shore-based power supply and the auxiliary engines on board the ship should the need arise, says Per-Erik Larsson of Trident Technology. This makes sense, because

they can be run at optimal operating conditions to charge the batteries whilst the ship is at sea.

"The first two stages of the project are feasible already today, but for the third one, technology will have to develop further. The question is about space requirement of the batteries and cost. Decreased resistance and weight of the ships are under development at Stena Teknik to reduce the needed power onboard. Also we need the regulators to increase pace in this paradigm shift," said Per Wimby, Project Manager at Stena Teknik.

The total cost of the three stages of the project will be in the region of SEK25 million, of which Stena Line will provide half and the other half will come jointly from Swedish authorities and the EU, said

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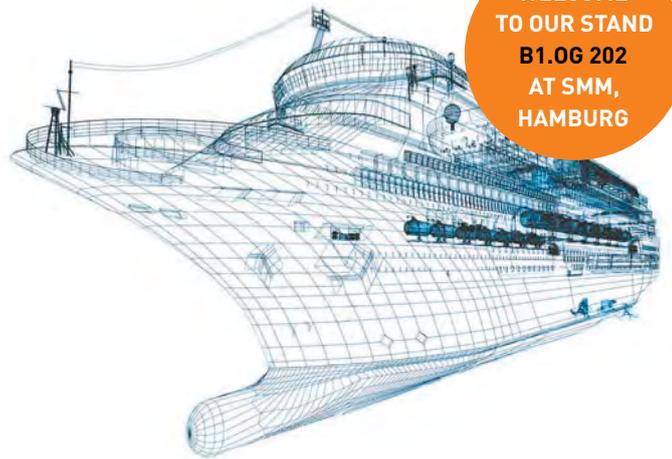
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Jesper Waltersson, Stena Line's Head of Corporate Communications.

### Use of batteries in port

Maritime regulations stipulate that a ship must have adequate power to operate in port areas. In practice, this means that two to four auxiliary engines can be idling as a spinning reserve in order to provide the power when needed for the bow thrusters, for example. This is not only an inefficient way to produce energy, but also a source of increased pollution and cost, both of which can be eliminated by using battery power solutions.

The vessel makes three crossings each day in peak season to Frederikshavn, which means that the environmental and cost benefits of the use of battery power become even more important than in the case of a vessel that operates on a longer route and consequently has a lower frequency of calls at port.

Among the reasons why *Stena Jutlandica* was chosen as the test bed for the technology are its frequent calls at Gothenburg, where Stena Line has its headquarters, meaning that technical staff from the office will be able to easily visit the ship during its calls at the Swedish port.

### Technological and financial challenges

At the moment, the largest batteries on the commercial market can store 4MWh of energy, which is a great deal shy of the 50MWh needed to progress the project to the third stage.

Moreover, the optimal temperature of the batteries is between +20°C and +25°C, but the number of solutions on the market to retain the temperature at this range indicates that manufacturers are not quite sure how to achieve this. In case of a fire, batteries can release toxic fumes in large quantities, which means that safety of installations is an important aspect. At the moment, there is limited experience of how the various safety systems would actually work in various emergency situations.

Further, charging batteries from shore based power supply can be a challenge in cases of short turnaround times, which highlights the importance of both efficient and safe operations, including the connection of the vessel to the land based power grid.

Aside from technology, the work will also look into potential future business models, financial incitements to invest in this area, how the use of electric power and questions related to this can be studied in simulated environments, what practical experience is already available and how electrification of shipping works as part of the electrification of a wider transport system.

“Several major challenges have been identified following discussions with the various parties. In today’s situation, a maritime electrification initiative involves a major financial risk and it is difficult to strike a business deal in this area, so that public part-funding is often necessary,” the project report said.

At the moment, there are no templates regarding the business model of how

electrification of shipping should proceed and progress is likely to remain slow unless parties in a project are fully committed to ensure its success. There is no major cost difference between electricity generated on board and bought from the grid ashore. As the cost of converting a vessel to electric power is a substantial issue, this alone cannot be a driver in the matter. However, by approaching the question from the perspective of ship operation, the picture can change: some of the equipment needed could be provided by ports rather than fitted onboard the ship and thereby reduce costs.

Already today, the electricity consumption of buses can be simulated, which can be used to determine the power storage and battery recharging time requirements. None of this is available for ships and an individual owner is unlikely to finance such an investment, but the need for such simulation is obvious. It will also be important to standardise land based power points and connections on board ships, so that vessels of different owners can use the same facilities to charge their batteries.

Finally, there is limited knowledge of the costs and potential safety concerns that rise from the conversion of a ship to electric power. All experience at the moment is based on unique solutions. However, the project team still wants to build a data bank on this subject for use as case studies, which again could be used as a base for a solution to demonstrate how such a project could be done, using the accrued knowledge as its base. **NA**



*Stena Jutlandica* is the test bed for the three-stage battery project



# Rolls-Royce contemplates the winds of change

While grabbing the headlines for its work on remote and autonomous shipping, Rolls-Royce Marine has also been applying its thinking to eco-friendly solutions for cutting CO<sub>2</sub> levels

Only a few months have passed since the agreement at IMO's MEPC 73 that shipping should target an overall 50% reduction in carbon emissions by 2050, but for many within maritime it hardly came as a surprise and already industry innovators are drawing together plans on how these figures might be reached.

In a presentation at Rolls-Royce Marine's headquarters in Ålesund, Norway (which took place shortly before the announcement of the division's imminent acquisition by Kongsberg), Oskar Levander, VP of Innovation, outlined a possible solution, synergising the division's much-publicised work in the development of remote and autonomous vessels with analysis of current sources of waste in the transportation and logistics process.

Like many prognosticating on shipping's tomorrows, Levander anticipates a 'disruptive' future and the emergence of new business models. This digital transition is likely to take place much faster than previous redefining trends, such as steam to diesel or containerisation. That it coincides with an unprecedented drive towards emissions reduction be it NO<sub>x</sub>, SO<sub>x</sub> or CO<sub>2</sub>, puts the industry on the cusp of a new epoch.

Levander reflects: "Shipping transports 90% of the world's goods and only gives rise to 3.1% of CO<sub>2</sub>, but is that good enough? One of the key things is not only to improve the performance of emission reduction technologies but to ask: are we producing value?"

'Waste' can cover a multitude of sins, whether emissions or auxiliary cargo which, while it might be essential to ship operations, is not providing any value. Levander takes inspiration from the Japanese philosophy of 'lean leadership' – the concept known as 'Muda' – which identifies seven different types of waste: Transport, Inventory, Movement, Waiting and delays, Overproduction, Overprocessing and

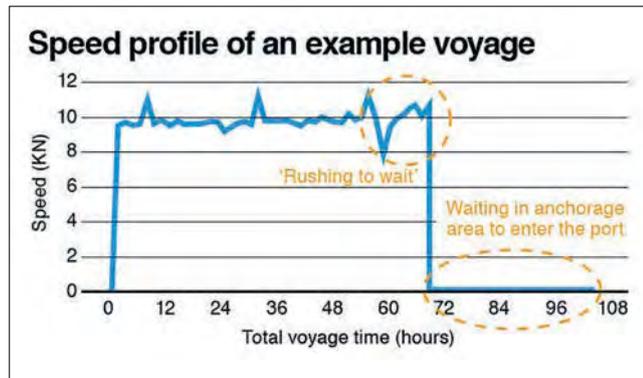


Fig 1. An Åbo Akademi University report found that Baltic vessels typically accelerate as they near port, only to spend long hours in anchorage

Defects; remembered as 'TIM WOOD'.

Applied and redefined to the context of shipping, Levander has devised his own acronym, IMO WORD:

- Inventory relates to the various goods and equipment stored on ships or at ports, such as spare parts.
- Movement refers to ships travelling too far, for instance stops at multiple ports which do not bring sufficient value to the operation.
- Overproduction and capacity, in particular relates to too many ships, often far larger than they need to be.
- Waiting denotes delays at ports, creating further expense.
- Overprocessing waste is created by

systems needed for the crew, such as galley facilities and lifesaving appliances.

- Resource utilisation applies to the efficiency with which the asset (i.e. vessel) is being deployed.
- Defects and non-availability relates to the lack of standardisation of ship systems and components making it more challenging to manage the asset's health through trending.

### Waste not

By way of illustration, Levander points to a study published by Åbo Akademi University [1], which calculated that on average bulk and general cargo vessels operating in the Baltic spent 34% of their time in ballast without any cargo. He believes the solution

Fig 2. Rolls-Royce's 'Point-to-point' 4,000 TEU container vessel concept



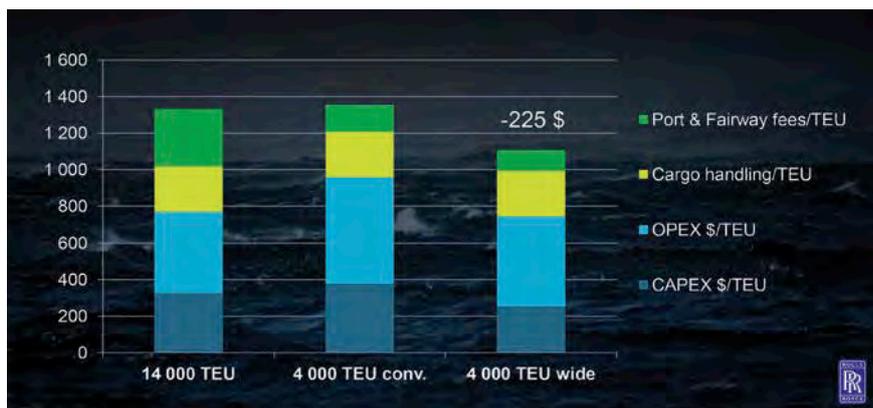


Fig 3. Estimated cost per roundtrip for the 'Point-to-point' compared with conventional 14,000 TEU and 4,000 TEU container ships

lies in using the digital domain to facilitate more effective co-ordination, supplanting the traditional manual booking of slots by brokers with more efficient pooling of resources by cargo owners, but concedes it may be easier said than done.

But crewing is quite another matter. Levander says: "We have a lot of captains and officers onboard ships, but when they are in the middle of the Atlantic or Pacific they are sitting and watching the autopilot. Of course, what I'm saying is that if we do it remotely or autonomously the machine could take over in open water and let the crew only manoeuvre when it comes into port. Working from a remote operations centre a captain can drive many ships, just focusing on the part where he really brings value."

In the case of a large container vessel travelling from China to Europe it is not uncommon for it to call at five to seven ports

in China, a further stop in Singapore, then another in the Middle East, and a further five ports when it gets to Europe. Delays at port are also a significant factor, with the aforementioned Åbo Akademi University report concluding that the vessels monitored spent 40% of their lives in port. Moreover, many ships spend hours held in anchorage waiting for a berth despite having sped up before they reach the port (see Fig 1). In terms of efficiency, significant gains could be made if the vessel operated at a constant speed to arrive at exactly the scheduled time, but human nature leads to a tendency to rush.

Levander also notes that captains don't always follow the best advice, but with autonomous technology, such as Roll-Royce's own autocrossing system (see May 2018's *The Naval Architect*) the ship automatically travels by the optimum route, accelerating and decelerating as needed.

Rolls-Royce estimates there can be efficiency gains of anything up to 10%. In the medium term though, the benefits of remote and autonomous systems are more likely to be in the offshore sector, where remote operation of an autonomous ROV can clearly slash manpower costs.

On a further note, Levander is a longtime advocate of the need for increased standardisation in ship construction. With Rolls-Royce's Electric Blue concept last year he suggested that the short-sea container ships of the future could be built to a modular design, with off-the-shelf sub-optimal hullforms that had most of their components 'containerised'. The challenge, however, is the many competing interests and agendas during the construction of a vessel; shipyards typically shop around for the cheapest systems on the market, meaning that even vessels in a series won't be exactly alike.

Such variations restrict the possibilities for identifying trends, although Levander believes that the phasing in of increased shore-based monitoring could give rise to a different mindset. He says: "The key to it is intelligence. It's about health management, fleet management and using our resources better. On the health side we have already brought onto the market our Intelligent Awareness (IA) system, by 2020 we are aiming for autonomous ships in operation."

### Smaller vessels

The overriding dogma of shipping in recent years, particularly within the containers sector, has been the benefits of economies of scale. One of the driving factors behind multiple port calls is that it's logistically impossible for a single port to handle cargoes of 20,000 TEU upwards. But while cargo owners may benefit by paying less, a voyage that might have taken four weeks may now be twice that length. So might it be not be more cost efficient to operate direct services, using smaller vessels?

With this in mind, Rolls-Royce has been developing the 'Point-to-point', a 4,000 TEU LNG-powered container ship concept which incorporates a number of distinctive features. While the vessel would still be manned it utilises Rolls-Royce's IA system to facilitate increased remote support and thereby reduce manning requirements. The concept includes other distinctive features, such as a wider hullform that makes possible

Fig 4. 'Blue Breeze' is an unmanned bulkier concept equipped with Flettner rotors



a ballast-free design and an open top.

Levander explains: “We want to make it simple so we’ve taken away the cargo hatches and have cell guides all the way up for all containers, connected to lashing bridges. We end up with a very wide vessel that can handle a full load of containers. Operating it point-to-point means we can actually slow it down. A normal vessel might travel at 19-20knots but ours can go slower and still offer a faster round trip.”

Through a combination of reduced power, steel costs and equipment Rolls-Royce believes it will be possible to drive down the cost significantly. While a conventional 4,000 TEU vessel would be unable to compete with a larger container ship on cost per TEU, Rolls-Royce has conducted analysis which indicates a saving of US\$225 (see Fig 3). Levander says that one of the big contributing factors to these savings are port and fairway fees, given that these rise proportionately to the ship’s size and number of containers it is carrying, whereas a smaller vessel going to a single port would just pay once at each end of its journey.

**Autonomous bulker**

Not content with this Rolls-Royce has now started turning its attention towards the potential of wind power which, Levander says, combined with autonomous shipping could be the key to achieving future carbon targets. The concept, named Blue Breeze (see Fig. 4), takes a standard 40,000dwt handysize bulker, removes the deckhouse, and integrates four 30m Flettner rotors (which would be sourced from one of the current Flettner manufacturers).

Levander says that while Rolls-Royce is also looking into other wind based technology such as wings, the advantage of Flettners is they offer 10 times more lift than a soft sail would for the same area. To assess the potential savings Rolls-Royce has been exploring how this model might perform on a typical northern Atlantic route (Rotterdam – Boston), calculating the potential thrust at different wind speeds and angles (see Fig 5).

A variety of different scenarios were analysed, ranging from a manned conventional bulker travelling at 14 knots to an unmanned wind-assisted bulker travelling at 6 knots. It was found that in most scenarios the vessel would still require an independent fuel source, with the Flettners reducing power

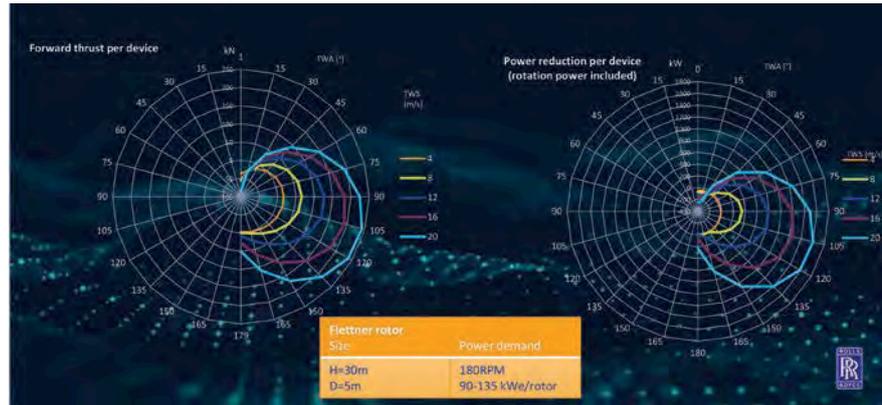


Fig 5. Roll-Royce’s analysis concluded the most favourable wind direction for a 40,000 dwt bulker travelling at a service speed of 14knots would be in the range of 90° - 135° TWA

consumption, and in headwinds they actually result in negative power.

Such drastically slower speeds are not commercially feasible for a manned vessel due to cost of crew, but even by cutting speed to 10knots results in a 20% reduction in operating costs for a wind-assisted vessel, albeit with a slightly higher investment cost for the Flettner installations (US\$23.7m, compared with US\$22m for a conventional design).

Yet more dramatic still are the potential fuel savings and environmental performance of a wind-assisted unmanned vessel (see Fig 6). A simple drop in speed from 14knots to 10knots cuts fuel by 20%, but if an unmanned vessel were to travel at 8knots it would halve its fuel demand and thereby meet IMO’s 50% CO<sub>2</sub> reduction targets, while dropping further to 6knots could equate to operating at as little as 40% of current fuel requirements.

Although the habitual commercial imperatives for speedy delivery perhaps weigh against this model, Levander notes that the advantage is this approach is that the shipowner would have greater

flexibility when there is lower demand. A vessel might effectively amble its way across the ocean autonomously during a lull or set to a faster course if it was needed sooner. The shore-based captain would then remotely guide the ship to port when it draws near. A further advantage is that as the bridge team is not onboard they can take responsibility for multiple vessels from the remote operations base.

Rolls-Royce is confident there will be interest, but for now the work is ongoing and further investment is being contemplated on other wind alternatives. Summing up, Levander says: “This is more a conceptual thing, but it’s something the industry should look into further. There is great potential to reduce waste and inefficiency and it’s intelligence that’s the solution to help us become better.” NA

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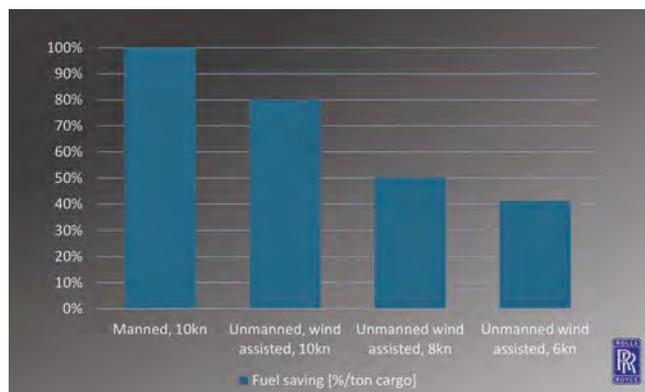


Fig 6. An unmanned wind assisted bulker could save 60% of the fuels of a manned equivalent travelling at 10knots

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# Speed and emission reduction from ships

Slow steaming may seem like the solution for cutting CO<sub>2</sub> but the numbers require more careful analysis, warns Hans Otto Kristensen of HOK Marineconsult Aps

With more and more focus on the enhanced greenhouse gas (GHG) strategy adopted at the MEPC 72 meeting in IMO in April this year, the shipping industry has to strengthen its efforts to find new ways for reduction of the energy demand for propulsion of ships in order to reduce its CO<sub>2</sub> emissions. For a long time speed reduction has been one of the measures as in principle it is a simple way to reduce the energy demand per nautical mile, which is why it has been classified as one of the 'low hanging fruits' for saving on the energy consumption of ships. At first sight this seems simple, but it's not quite as simple as some stakeholders assume.

When the speed is reduced, the cargo carried per time unit is reduced and this has to be taken into account, as more ships are needed to carry out the constant transport work at reduced speed. Another factor which is often forgotten in the debate is the fact that when speed

is reduced, the resistance due to wind and waves increases relatively as a percentage of the total resistance. Therefore more power is needed to compensate for this relatively larger sea margin. Furthermore the auxiliary power will nearly be constant and will therefore also become relatively larger at low speed. These three factors, i.e. correction for extra tonnage and the larger sea margin at lower speed and nearly constant auxiliary power, have to be taken into account in the total energy calculations for ships operating at reduced speed and this issue will be illustrated by some examples in this article.

## Back to basics about speed dependency

To begin with, let's take a look at the basic equations for determination of the emissions per transport unit. Exhaust gas emissions from ships are directly proportional to the main engine power for propulsion i.e. (eq1):

$$\begin{aligned} \text{Emissions per transport unit} \\ = \text{constant1} \cdot \frac{\text{Main engine power}}{\text{Payload} \cdot \text{speed}} \end{aligned}$$

The propulsion power is proportional to the speed, V, raised to the power of N, where N normally is in the range from 3 to 5. In special cases N can be up to a maximum of 6 or 7 (see Figs. 1 and 2 according to Kristensen, 2010). This means that the emissions can be calculated as follows (eq2):

$$\begin{aligned} \text{Emissions per transport work unit} \\ = \text{constant1} \cdot \frac{\text{constant2} \cdot V^N}{\text{Payload} \cdot \text{speed}} \\ = \frac{\text{constant3} \cdot V^{N-1}}{\text{Payload}} \end{aligned}$$

If the speed is reduced, more ships are needed to carry out the same transport work per time unit, meaning that the amount of emissions per transport work unit has to be multiplied with the

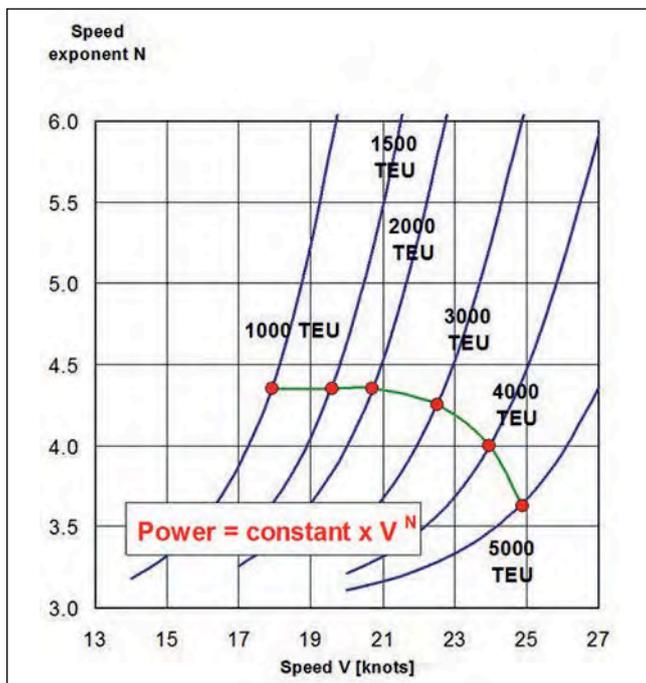


Fig. 1 Speed exponent for smaller container ships

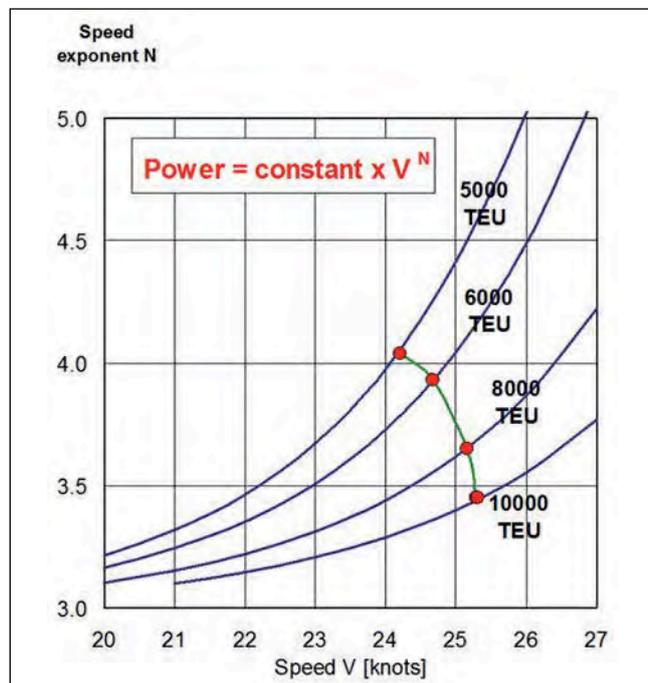


Fig. 2 Speed exponent for larger container ships

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# LIEBHERR

Deadweight (t)	70,000	Payload = 95% of DESIGN deadweight (which is 90% of MAXIMUM deadweight)
Payload (t)	59,850	
Sailing distance (nm)	9,000	

Calculations according to Beaufort 4.3 sea conditions ( $H_s = 1.3$  and  $V_{wind} = 7.7$  m/s)

Speed (knots)	Total transport work (t x nm)	Transport work per hour per ship (t x nm)/hour	Sailing time (hours)	Number of ships for constant transport work per hour	CO <sub>2</sub> emissions per ton payload per nm (gt/nm)	CO <sub>2</sub> emissions per trip (tons)	Propulsion power (kW)
15.0	538,650,000	897,750	600	1	6.45	3,474	10,017
12.0	538,650,000	718,200	750	1.25	4.17	2,808	4,950
9.0	538,650,000	538,650	1,000	1.67	3.12	2,801	2,414
7.5	538,650,000	448,875	1,200	2.00	2.7	2,909	1,585
6.0	538,650,000	359,100	1,500	2.50	2.44	3,286	988

Calculations with constant sea margin (15% added resistance)

Speed (knots)	Total transport work (t x nm)	Transport work per hour per ship (t x nm)/hour	Sailing time (hours)	Number of ships for constant transport work per hour	CO <sub>2</sub> emissions per ton payload per nm (gt/nm)	CO <sub>2</sub> emissions per trip (tons)	Propulsion power (kW)
15.0	538,650,000	897,750	600	1	6.45	3,474	10,017
12.0	538,650,000	718,200	750	1.25	3.86	2,599	4,514
9.0	538,650,000	538,650	1,000	1.67	2.61	2,343	1,922
7.5	538,650,000	448,875	1,200	2.00	2.13	2,295	1,127
6.0	538,650,000	359,100	1,500	2.50	1.82	2,451	588

Table 1: Calculations for a 70,000dwt Panamax tanker

larger number of ships to calculate the real emission burden of the necessary transport work per hour.

The revised number of ships at the reduced speed is (eq3):

$$\text{Revised number of ships} = \frac{\text{Original speed}}{\text{Reduced speed}}$$

The corrected amount of emissions per transport work unit, where the extra number of ships are taken into account, is given by following equation (eq4):

$$\begin{aligned} \text{Corrected emissions} &= \text{Emissions at original speed} \cdot \frac{\text{Original speed}}{\text{Reduced speed} (=V)} \\ &= \frac{\text{Constant} \cdot V^{N-2}}{\text{Payload}} \end{aligned}$$

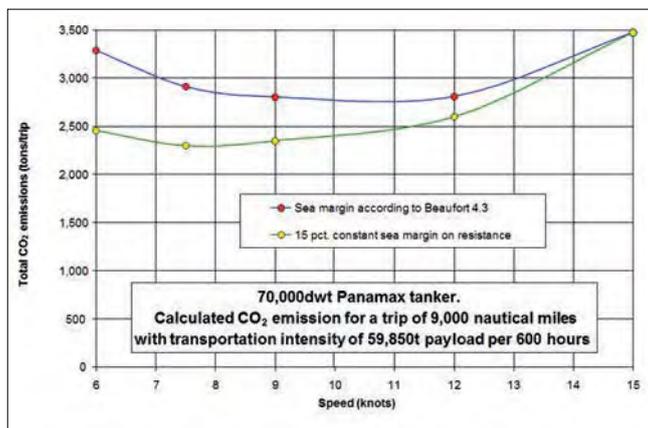


Fig. 3 Calculated CO<sub>2</sub> emissions for a trip of 9,000 nm with a transport capacity of 897750t x nm/hour

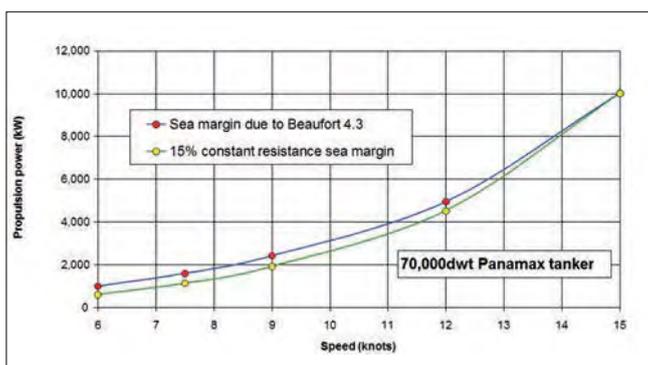


Fig. 4 Calculated propulsion power according to the two different service conditions

$N = 2.9$  at low speeds, if no sea margin is added to the resistance. But adding a sea margin changes the situation which will be explained in the following.

### Sea margin and sample calculations

Normally speed and power calculations are carried out taking into account an assumed sea margin for the added power due to wind and waves. The sea margin is often given as a percentage margin added to the still water resistance, which is typically in the range of 10-25% depending on the expected sailing route for the ship.

Two examples have been investigated using the so-called SHIP-DESMO model developed by the author and professor Harry Bingham at The Technical University of Denmark. Calculations for a 70,000dwt Panamax tanker and a 10,000 TEU container ship have been carried out to see which emission reductions can be achieved by lowering the normal service speed.

### 70,000dwt Panamax tanker

As you will see in Table 1, CO<sub>2</sub> emissions have been calculated at different service speeds from 6 to 15knots, at two different sea margin assumptions (which can be specified in the SHIP-DESMO calculation model):

1. Sea margin as extra wave and wind resistance according to Beaufort 4.3 corresponding to a significant wave height of 1.3 m and a wind speed of 7.7 m/s.
2. Constant sea margin of 15% on the still water ship resistance.

Using the Beaufort related sea margin according to BF 4.3 results in exactly 15% sea margin on the calm water resistance at max. speed of 15knots, whereas the sea margin due to wind and waves becomes an increasing factor in percentage of the calm water resistance at lower speeds according to Fig. 5. Due to the extra propeller loading the sea margin on propulsion power is higher than the sea margin on the calm water resistance.

From a propulsion point of view it is most correct to calculate the sea margin individually by adding the resistance due to the specified wave and wind condition for the actual speed instead of using a

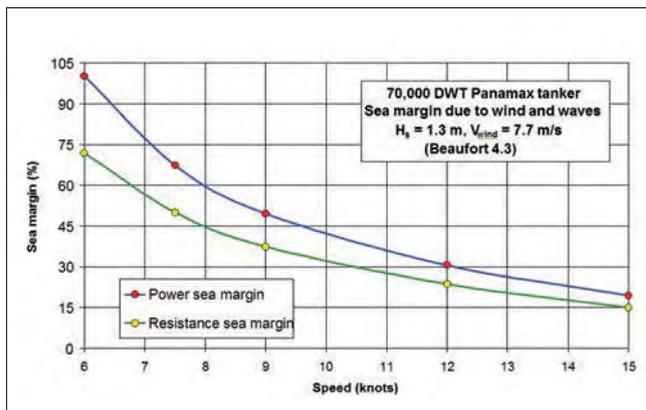


Fig. 5 Sea margin in percentage of the calm water resistance and in percentage of the propulsion power at Beaufort 4.3.

constant sea margin over the whole speed range.

Based on Fig. 3 it is seen that the maximum CO<sub>2</sub> emission reduction by lowering the service speed is approximately 21% obtained at 11.3knots, i.e. at 25% speed reduction.

### 10,000 TEU container ship

Table 2 shows CO<sub>2</sub> emissions calculated at service speeds from 8 to 23.5knots, under two different sea margin assumptions (which can be specified in the SHIP-DESMO calculation model):

1. Sea margin as extra wave and wind resistance according to Beaufort 4.7 corresponding to a significant wave height of 1.5 m and a wind speed of 8.8 m/s.
2. Constant sea margin of 15% on the service resistance.

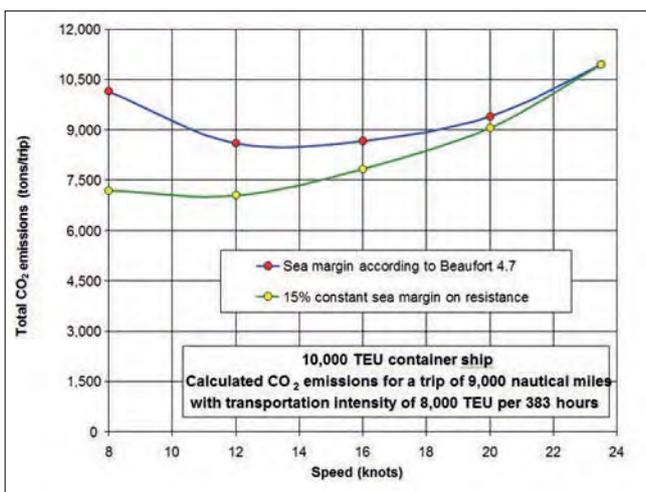


Fig. 6 Calculated CO<sub>2</sub> emissions for a trip of 9,000nm with a transport capacity of 188,000 TEU x nm/hour

Using the Beaufort related sea margin according to Beaufort 4.7 results in exactly 15% sea margin on the calm water resistance at max. speed of 23.5knots, whereas the sea margin in percent increases at lower speeds, as the added resistance due to wind and waves becomes a more and more dominating factor at lower speeds according to Fig. 8. Due to a heavy propeller loading the sea margin on propulsion power is higher than the sea margin on the calm water resistance.

From a propulsion point of view it is most correct to calculate the sea margin individually for the actual speed instead of using a constant sea margin over the whole speed range.

Based on Fig. 6 it is seen that the maximum CO<sub>2</sub> emission reduction by lowering the service speed is approximately 23%. obtained at 13.5knots, i.e. at 43% speed reduction.

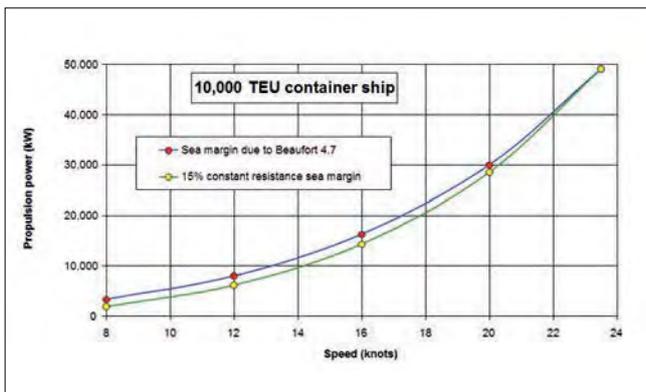


Fig. 7 Calculated propulsion power according to the two different service conditions

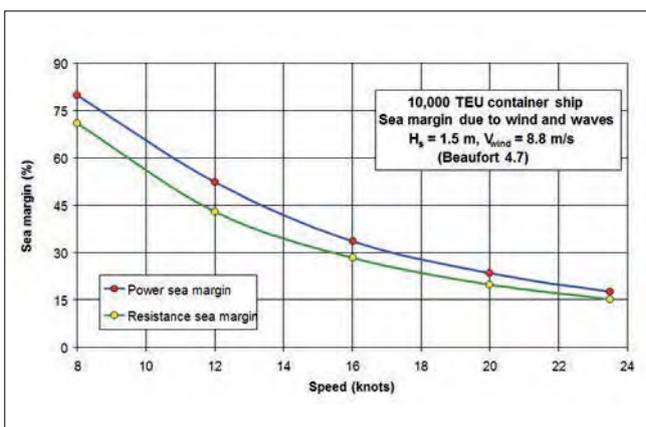


Fig. 8 Sea margin in percentage of the calm water resistance and in percentage of the propulsion power at Beaufort 4.7

### Summary of calculations and conclusions

On the following page is a summary of the calculation results, where the relative reduction of CO<sub>2</sub> emissions are given as function of the relative speed. The calculations according to a service margin for a given Beaufort Number in Fig. 9 is the correct calculation method, whereas it is wrong to assume a constant percentage resistance sea margin over the whole speed range as shown on Fig. 10.

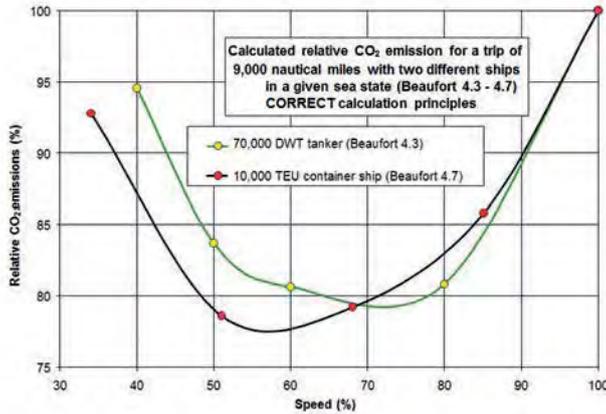


Fig. 9 Calculated emissions at constant Beaufort Number of 4.3 - 4.7 over the whole speed range

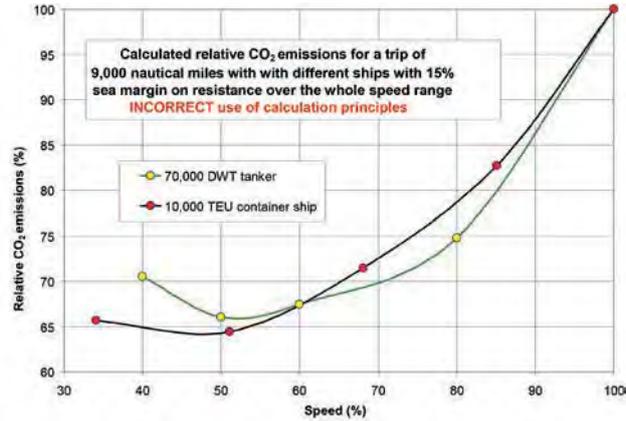


Fig. 10 Calculated emissions at a constant sea margin of 15% over the whole speed range

Based on the two examples for a Panamax tanker and a 10,000 TEU container ship, it is seen that by lowering the ship speed the energy demand and the CO<sub>2</sub> emissions are reduced – but only by approximately 20-25%. This is the maximum obtainable reduction when taking into account realistic assumptions regarding service conditions as a function of a realistic

Beaufort Number (in this case 4.3-4.7) and the extra tonnage needed, when the service speed is reduced. It is seen that excessive speed reductions are not the way to obtain excessive energy reductions/ CO<sub>2</sub> reductions. *NA*

**References**

1. The SHIP-DESMO model can be

down-loaded from following web site: <https://gitlab.gbar.dtu.dk/oceanwave3d/Ship-Desmo>

**Further reading**

Kristensen, H.O: *Model for environmental assessment of container ship transport*. SNAME Transactions 2010.

Table 2: Calculations for 10,000 TEU container ship

Max. containers	10,000
Actual containers	8,000
Sailing distance (nm)	9,000

Calculations according to Beaufort 4.7 sea conditions ( $H_s = 1.5$  and  $V_{wind} = 8.8$  m/s)

Speed (knots)	Total transport work (TEU x nm)	Transport work per hour per ship (TEU x nm)/hour	Sailing time (hours)	Number of ships for constant transport work per hour	CO <sub>2</sub> emissions per ton payload per nm (g/TEU/nm)	CO <sub>2</sub> emissions per trip (tons)	Propulsion power (kW)
23.5	72,000,000	188,000	383.0	1	152	10,944	49,060
20.0	72,000,000	160,000	450	1.18	111	9,391	29,944
16.0	72,000,000	128,000	562.5	1.47	82	8,672	16,291
12.0	72,000,000	96,000	750	1.96	61	8,601	7,984
8.0	72,000,000	64,000	1,125	2.94	48	10,152	3,256

Calculations with constant sea margin (15% added resistance)

Speed (knots)	Total transport work (t x nm)	Transport work per hour per ship (TEU x nm)/hour	Sailing time (hours)	Number of ships for constant transport work per hour	CO <sub>2</sub> emissions per ton payload per nm (g/TEU/nm)	CO <sub>2</sub> emissions per trip (tons)	Propulsion power (kW)
23.5	72,000,000	188,000	383.0	1	152	10,944	49,066
20.0	72,000,000	160,000	450.0	1.18	107	9,052	28,513
16.0	72,000,000	128,000	562.5	1.47	74	7,826	14,321
12.0	72,000,000	96,000	750.0	1.96	50	7,050	6,170
8.0	72,000,000	64,000	1,125.0	2.94	34	7,191	1,904



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# Scrubbers from day one: interest in exhaust gas cleaning solutions grows for newbuild vessels

Scrubber technologies are seeing rapid uptake, despite the inherent complexities of the market for the technology, writes manufacturer LAB

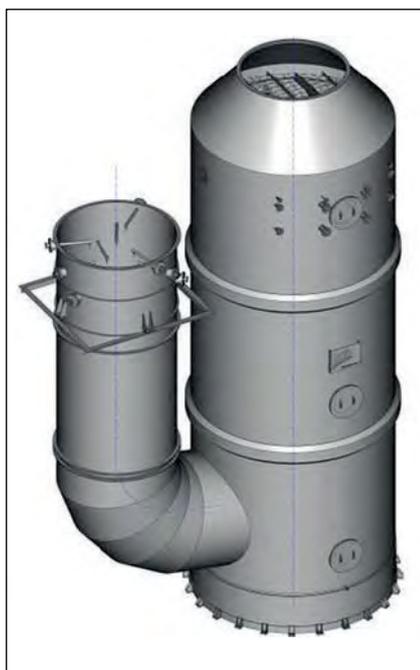
**T**he 1 January 2020 is looming. When it arrives, shipping will experience some of the most substantial change it has undergone in recent memory. The driving force of this change needs no introduction: the International Maritime Organisation’s (IMO) fuel sulphur content cap of 0.5%, mandated under MARPOL Annex VI.

This legislation promises to temper the way that owners and operators confront the design and construction of new vessels and how they approach retrofits alike. It has been given particular prescience thanks to the IMO’s insistence that the deadline is final, and that enforcement will begin in earnest in under 18 months’ time.

This, combined with the fact that owners and operators must choose a compliance pathway in a market still beset by commercial and operational challenges – which in turn create capital problems – makes having to choose a 2020 compliance solution an unenviable problem.

And yet, decide they must – with owners now facing the choice of a range of compliance solutions. As the International Bunker Industry Association (IBIA) points out: “There is general optimism that refiners will have several options to produce marine fuels to comply with the 0.50% sulphur limit and that it will be made available. These fuels will be a mix of relatively familiar marine distillate fuel grades and other products generally referred to as very low sulphur fuel oil (VLSFO).”

Despite this, concerns have been raised about the fuel landscape post-deadline, with much uncertainty placed on fuel availability for vessels trading on less busy routes. For vessels plying routes away from major hubs, or with infrequent stops to refuel, the availability of low sulphur fuel oils might be called



As scrubbers are essentially bespoke, a number of choices must be made about their configuration

in to question, potentially leaving some owners and operators with significantly increased fuel bills.

Indeed, some analysts now believe that the price difference between the two fuels could be as much as US\$400 per tonne, making compliance an expensive task for owners already struggling in a market of low liquidity.

## Scrubber surge

It therefore comes as little surprise that exhaust gas cleaning systems, commonly known as scrubbers, have seen a dramatic surge in uptake in recent months. The Exhaust Gas Cleaning Systems Association (EGCSA) released estimates in July showing that, as of 31 May this year, 983 scrubbers had been bought worldwide – and recent large orders will

have increased that figure further.

This marks a more than doubling of the number of scrubbers that were on the market at the start of 2018. The EGCSA also now estimates that owners are likely to spend more than US\$20 billion over the next five years on scrubbers, reflecting the growing importance of this technology to the market.

Meanwhile, in July, the EGCSA also reported that a growing proportion of this orderbook was for newbuild applications of the technology in open loop configurations. Indeed, of the EGCSA’s 983 reported installed or on order scrubbers, nearly 40% are in newbuild applications.

Additionally, owners are increasingly designing vessels with future installation in mind. Making vessels ‘scrubber ready’ is a new watchword for naval architects, who are now concerned with ensuring there is an adequate sea chest for scrubber wash water supply, and ensuring that there is sufficient space for all pipework and components. By taking this effort, owners are clearly signalling confidence in the technology. Prevailing concerns about the future price differential post-2020 are now taking root in the industry, making the commercial case for scrubbers more robust.

There is also strong evidence that the rest of shipping’s supply chain is taking note of the technology and that it is going so far as to influence purchasing decisions being made by charterers. In July, shipbrokers Gibson revealed research which shows that charterers are “now showing strong interest to time charter tonnage fitted with the technology,” even going so far as to say that charterers are paying “notable premiums for tonnage fitted with scrubbers”. This preferential interest only further shortens the payback time for owners considering scrubber



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According to EGCSA estimates, 40% of scrubber installations or orders relate to newbuilds

operation on their newbuild vessels, many of which will have to immediately find employment after entering service.

These market forces are now achieving widespread recognition within the industry. Scrubbers are now a solution ‘in vogue’ – but many would be surprised to find, upon making the decision to install a system, a technology market that is complex and ever-changing.

### Complex considerations

By their nature, scrubbers are bespoke, which has an impact on considerations surrounding naval architecture, maintenance plans, and the overall lifecycle costs associated with a system. All of these factors create a requirement for owners, not to mention those designing and building the vessel, to work with scrubber manufacturers to determine the right solution for their vessels. Therefore, one could reasonably argue that the best way to adopt these systems on a vessel or fleet-wide basis would be to form a long-term, consultative, partnership-led approach that does not end with the system’s installation, but instead runs for the course of the vessel’s lifetime, with manufacturers working in tandem with

design teams, yards and operational teams working for the owner.

Even greater complexity creeps into the market from the sheer amount of choice in terms of materials and configuration. The majority of scrubbers on the market are constructed from high-end alloys, but the advent of composite scrubber technologies has opened a new avenue for owners to consider. For instance, scrubber manufacturer LAB, a leader in flue gas treatment and desulphurisation and part of CNIM Group, has developed a composite scrubbing solution – available in open, closed or hybrid format – as an alternative to its range of alloy units.

The main benefits of composite scrubbers, such as LAB’s DeepBlueLAB SOx units, are their resistance to corrosion, and lightness compared with alloy scrubbers. Composite scrubber technologies also avoid the potential for unscheduled repairs or downtime, factors which have their own knock-on cost of the loss of commercial opportunities while a vessel is being serviced.

A further consideration is whether to opt for an inline, offline or multi-streaming solution. While inline systems can only be fitted to one engine,

offline multi-streaming solutions offer greater flexibility as they ensure that the scrubber can treat multiple engines, including auxiliary engines and boilers. With one scrubber fitted on one main engine, the funnel may have to be altered to accommodate it, which greatly increases costs. Spanning these decisions, the DeepBlueLAB SOx is the only system that can be manufactured in either composite or high and alloys and available in inline, offline or multi-streaming configurations.

### Time to choose

Scrubbers may be the technology of the moment for the shipping industry at present, but this does not change the inherent complexity of the market for the technology. As owners and operators are forced closer to the cliff-edge decisions they will have to make surrounding 2020 compliance, the early consideration of scrubbers as a solution may well mark out the most commercially successful companies – but only if real consideration is made to the system that is correct for their vessels. **NA**

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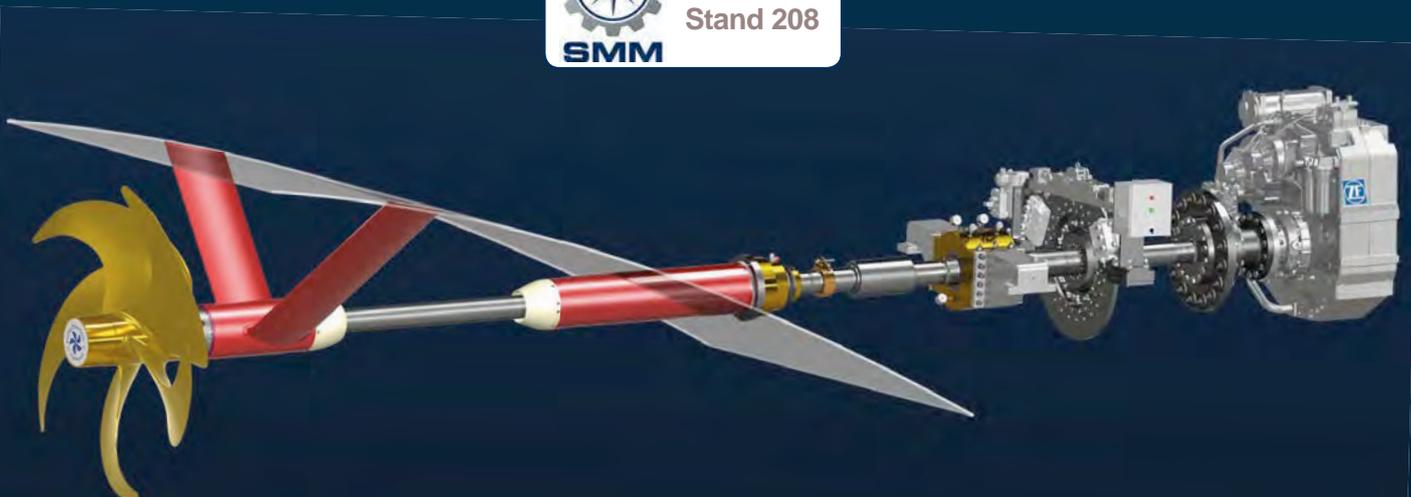
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# Alfa Laval launches large flow version of PureBallast 3

The 1,500m<sup>3</sup>/h reactor, which handles 50% more than its next largest model, offers an alternative for larger ships that previously opted for electrochlorination

Since the establishment of the implementation schedule for the Ballast Water Management Convention at the 71st meeting of IMO's Marine Environment Protection Committee (MEPC 71) last year, the discussion among regulators, manufacturers and shipowners has been squarely focused on compliance.

In the case of newbuildings most, if not all, will be delivered with a ballast water treatment (BWTS) installed, and the schedule makes it mandatory for any vessel keel laid after 8 September 2017. For retrofits it becomes a little more convoluted; shipowners are expected to have a system installed by the time of a vessel's first MARPOL IOPP survey after 8 September 2019, meaning they could have up to 2024 to achieve compliance.

One company that has been present throughout the development and rollout of ballast systems and regulations is Alfa Laval. The Swedish-headquartered engineering solutions provider began exploring the technology more than 20 years ago, releasing its first commercial system in 2006.

Alfa Laval proudly points out that the current generation of its UV-based system, the PureBallast 3, received USCG type approval in December 2016. It was also the first system to receive approval under IMO's more stringent G8 standards in February 2018, which will become mandatory from 28 October 2020.

Anders Lindmark, head of Alfa Laval PureBallast, says the company is very satisfied with the system's performance, and the focus has now turned towards broadening its portfolio: "If you compare ballast water treatment with separators, for instance, it's a very young and immature application in marine. When we started we had just one UV chamber reactor size of 250m<sup>3</sup>, today there are multiple sizes, a smaller footprint and more cost efficient installation."



The 1,500m<sup>3</sup> will join Alfa Laval's suite of smaller UV reactors

In recent years Alfa Laval has seen increased interest from customers for systems with higher flow rates – those of 1,000m<sup>3</sup> upwards – that would be suitable for larger tankers and bulk carriers. Because UV-based systems have higher power consumption and a larger footprint, these sectors have traditionally opted for electrochlorination (EC) treatment systems. But Lindmark says that, thanks to refinements to the technology, the PureBallast 3 compares very favourably on power and actually boasts a footprint smaller than many EC systems.

Moreover, while all systems have limitations, Alfa Laval is confident the PureBallast 3 has fewer complications. "There is no limit when it comes to temperature and salinity, and no use of chemicals or active substances. For example, some tankers operating shorter routes need chemicals to neutralise the chloride content in the water [before discharge], which isn't necessary for PureBallast."

Hitherto, the PureBallast 3 range consisted of the 170, 300, 600 and 1,000m<sup>3</sup> reactor sizes, which used alone or in combination can handle system flows of 32-3,000m<sup>3</sup>/h. But at SMM in Hamburg in September, Alfa Laval will further enhance its offering with the launch its new 1,500m<sup>3</sup> reactor. Lindmark says the new system achieves "the optimal intersection of biological effect, system size and power requirements."

With UV treatment systems, it's not unusual to use a configuration of four or more reactors with large flows which is less than cost effective. To achieve a flow of 1,500m<sup>3</sup> might have previously required a combination of two 2,000m<sup>3</sup> reactors. There's also a knock-on effect with installation costs, given that each reactor requires piping of up to 600mm in diameter. "There is a big difference in connecting pipes to one or two reactors, instead of three or four, especially if the pipes are not straight," Lindmark explains, noting also the additional radius to be accounted for when connecting pipes to a manifold.

Alfa Laval is also keen to stress that the efficacy of biological disinfection hasn't been compromised by the upscaling. "One of the things we've been working on between the generations of PureBallast is the shape of the reactor and maximising the exposure time for every organism that goes through it. This allows us to achieve high performance in even high turbidity waters. But for this to be in line with our certificates we've based it on the same platform."

Installation of the system is supported by a comprehensive set of support and maintenance services called Alfa Laval Total Solutions, including project management, crew training and a third party laboratory testing service to ensure that treated water achieves the D-2 discharge standards. [NA](#)

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# Bridging a gap for the sulphur cap

GreenOil Standard, an eco-friendly oil filtration technology that uses sheep's wool, could represent a low-maintenance solution

**W**ith the introduction of the global 0.5% sulphur cap coming into force in January 2020, IMO estimates up to 70,000 ships may be affected. Consequently, many owners and operators are expected to change from heavy fuel oils to compliant fuels such as marine gas oil, distillates and newly developed hybrid oils.

GreenOil Standard's product lines are generating interest for their ability to treat both lighter fuel oils and engine lubrication oil and are being promoted by the company as an alternative to conventional purifiers/separators. Independently verified oil sample results indicate their water and particle filtration systems to be capable of performing with greater efficiency than other systems, with the additional benefit they can be operated with minimal intervention. Furthermore, several tests conducted in cooperation with engine suppliers such as MAN Energy Solutions have quantified performance of the GreenOil system and its compliance with their engine lubricating oil requirements.

## A win-win for sheep's wool

Uniquely, GreenOil's filtration technology is based on compressed layers of woven sheep's wool and has been developed over a number of years. Sheep's wool has good filtering qualities by virtue of the natural structure of its fibres, which are rough on the surface and under a microscope look a bit like a Christmas tree. One of the biggest challenges during development was identifying a grade of wool that would be suitable for the oil types and various densities were tested between 2003-2008. GreenOil itself was officially formed in 2008 when partners were needed to test the prototype system and prove it could work in reality.

Initially, there was just one system with a filter holding the particles back, much like a coffee filter. The oil then fell through the filter into a water separator chamber, where a heating device heats up the air and evaporates the water, separating it from the oil, before returning it to the system it



GreenOil's filtration systems are easily installed

was connected to. GreenOil patented the technology and then proceeded to develop their first product and the entire range of oil filtration systems over years of testing with major shipowners. This system is today the basis of GreenOil's water and particle separator, which used for hydraulic oils and EAL Bio oils on stern tube and thruster applications.

Traditional purifier/separator technologies are complicated pieces of equipment. The principle of the purifier is to speed up the gravitational process as defined under Stokes law. It spins fast, and hence any particles heavier than the oil will either move to the perimeter of the bowl or to the water to be removed. The water is also pushed to the side of the purifier because of the spinning centrifugal forces it creates. Because water is heavier than oil efficiency will diminish the closer the weight is of the particle or soot to the oil.

A purifier is reliant on getting particles through and separating a small part at a time. The purifier is also viscosity dependent and always set up to maintain a certain viscosity which is temperature controlled by a heater. These fast rotational speeds and temperature control are not only expensive to operate but require

skilled maintenance and servicing, which can result in several hours of downtime.

It is difficult to change the basic physical characteristics of the purifier principle; to achieve denser with ordinary filter requires a denser mesh, and vice versa. GreenOil's system typically has the same minimum flow but filtration through a filter media which the company believes is more efficient.

A further advantage is that because GreenOil's system does not need an additional power source it uses around one tenth of the electrical energy, greatly reducing its carbon footprint. Nor does it use any water or generate any waste oil or sludge. Once used, the sheep's wool filter is either incinerated or (in the case of smaller vessels) disposed of onshore. The filter's lifespan for engine lube oil treatment is dependent on the fuel type used and the contaminating nature of the engine. But with an easy working environment and minimal intervention, the operator simply carries out filter changes within a matter of minutes, without the use of tools, contact with oil or any oil spill.

## Fuel and lube oil treatment

When treating lighter fuels such as ULFO and ULMGO, MGO and DO, a GreenOil

Analysis	Unit	Procedure
Appearance	black	
Viscosity	144	ASTM D7042
	mm <sup>2</sup> /s	
	40°C	
	100°C	ASTM D7042
	mm <sup>2</sup> /s	
Water content	< 0,05	DIN 51777
n-Heptane Insolubles	0,4	DIN 51592
Base number (BN)	11,8	DIN ISO 3771
Asphaltene content	< 0,1	factory standard
Oil oxidation (FTIR)	E/cm (1710)	factory standard
Soot content	< 0,1	DIN 51452
Oxide ash	% (m/m)	ISO 6245
Acid number	mg KOH/g	ASTM D664-01
Sulphated ash	% (m/m)	DIN 51575
Flash point closed cup	°C	EN ISO 2719
mP	0,00	factory standard

Inorganic constituents in mg/kg							
Ca	n.b.	P	340	Ni	< 5	Si	< 5
Mg	19	Zn	400	V	< 5	Fe	< 5
Ba	< 5	Na	< 5	Al	< 5	Cr	< 5
B	< 5	K	< 5				

Table 1. Lube oil sampling for a MAN 9L 27/38 engine using GreenOil's WP1 - P series oil filtration system

formation of bacteria and helps to minimise long-term damage to the tank, piping system and the engine's fuel system and components. The system always maintains a high standard of clean fuel based on the bunkered quality received.

GreenOil's engine lube oil samples, which are independently tested ashore every three months, indicate a greatly reduced particulate/insoluble count than conventional purifiers. It means that the lifetime of an oil lube can be extended further which GreenOil believes can lower maintenance and oil replacement costs by four to eight times. The results for one such test can be seen on Table 1.

GreenOil says the small dimensions of its systems mean they can be easily installed on newbuildings or retrofitted on all types of vessels, including commercial vessels and workboats. A GreenOil system costs EUR1,500-17,000, with sheep's wool filters giving a return of investment (ROI) normally between four to twelve months. *NA*

system uses the sheep's wool filter together with a maintenance-free water removal coalescer system. As well as removing water and fine particle matter, this prevents the



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# Buoyant news about scrubbers for newbuilds

Ramniwas Mourya, co-founder and CTO of Buoyancy Consultants, warns shipowners shouldn't hedge their bets when it comes to the dilemma of how best to prepare for the sulphur cap

Most people will be familiar with the common arguments. “Scrubbers are an outdated technology”; “The costs are immense and finance options are limited”; “There are alternatives to scrubbers. Fuel (low sulphur fuel oil and ultra low sulphur fuel oil) will be available.”

Yet the regulations are an unflinching gunman poised to draw the second the clock strikes 00:00 on the first day of January 2020. And every second after will reverberate the immortal Dirty Harry phrase “Do you feel lucky?” Shipowners can no longer sit on the fence hoping the winds of favour will blow their way, and ship managers cannot afford to be undecided on the best option forward. While the declining number of newbuilds has even shipyards scrambling for more low cost compliance options, the indecision and the wait and see approach only compound the situation. An estimated 3,000- 4,000 vessels have already been outfitted, a number that includes newbuilds.

Though particularly essential for ships operating in Emission Control Areas (ECAs), the myopic market sentiment discounts the impending arrival of further emission controls. International Maritime Organisation's (IMO) maritime law requires ships to reduce their Sulphur Oxides (SOx) emissions to 0.1% especially in SOx Emission Control Areas (SECA). Scrubbers are the optimal option.

## Considerations for newbuilding scrubbers

While Asian and American scrubber manufactures are up to their necks trying keeping up with demand, the more popular, predominantly European manufacturers are already booked up to 2020, leaving no room to accommodate even their best customers before then. Lead times and delivery schedules have



Ramniwas Mourya

already gone up by 20-25% and continue to rise. Yards are filling up and dry docks are dealing with scheduling nightmares.

As retrofits have their own challenges, the newbuilds can circumvent some of these providing that they are considered in time. With the right design, solid engineering and precise installations ship owners will see quicker return on investment. Scrubbers types vary across closed loop (CL), open loop (OL), hybrid (HY) and dry types. Each have suitability for specific vessels and specific areas. However, among newbuilds the largest number of inquiries is for HY's.

At Buoyancy Consultants, we found that newbuilds have a unique advantage in being able to substitute silencers with scrubbers. Scrubbers not only have a smaller footprint but also minimise the impact on engine efficiency. With the right scrubber choice, energy efficiency numbers can be less than 1.5-2 % of the engine power required with the additional benefit of low cost maintenance. Furthermore, these space savings should have little to no negative impact on the cargo holds, passenger stateroom and other such areas. NCL cruise ship *Pride of America*, for instance, was able to use one small scrubber for each engine instead of

a large multi inlet scrubber. Maintenance and repair spaces should be provisioned for early during design.

Newbuild and retrofit projects alike have considerations for pipework, load and power calculations. Another important consideration is ensuring the scrubbers are made from suitable materials. Higher grade material will be needed to deal with heat corrosive agents and oxidization, making it critical to have the right suppliers.

Electrical power will also need to be factored and assessed for the increased load from the run sea water and process pumps. In addition there are exhaust fans, monitoring equipment consoles and dosing units. Viability under actual conditions will have to be carried out.

Some units may also have to deal with back pressure. This increase will bring down engine efficiency as the engine will have to work harder to cope. Functional design of the scrubber exhaust will have to be skilfully conducted. This includes ascertaining the right size of the exhaust piping, minimising bends, optimising the exhaust size length and orienting the scrubbers for maximum efficiency. While the majority of original equipment manufacturers (OEMs) are sensitive to this, conditions on the vessels may call for further analysis.

But the most important part of the scrubber installation is safety and training. Crew and staff should be guided each step of the way by the OEM to ensure the highest level of safety. From installation to operation, an OEM's network of trained agents will help avoid unfavourable situations in the future.

## Why scrubbers make sense

While shipowners understand that the capex is higher over the medium and long term, they see their return on investment

(ROI) for scrubbers might be anywhere between 13 months for a 20,000 dwt container vessel to two years and four months for a 22,000 dwt general cargo vessel. LNG, on the other hand, takes between two years and seven months to five years and 11 months. Capex wise, it is undoubtedly the lowest cost option.

Additional calculations for costs with alternate fuel (read LNG) is the storage tank space requirement onboard, whereas the HFO and scrubber option has a far more compact footprint. On a container ship, the LNG storage tank would typically occupy around 3% that would otherwise be used for the container slots. Training of crew on the safety of the entire cycle of LNG, its handling, burning system, availability and installation costs all add up to the longer ROI period, not to mention maintenance.

Experienced design engineering houses and the services supply are operating at

near full capacity. Delays with decision making will adversely affect newbuilds. As the technology isn't widespread yet, be prepared to look for alternatives to your regular design engineering firm.

Furthermore, the lack of clarity on the availability of not just LNG as a fuel but also distillates and low-sulphur fuel oil (LSFO) raises the element of risk. Supply of the fuel itself is just one part of the equation, it's the lack of bankability and clarity on the availability at desired locations that makes these options less desirable.

Of course, that doesn't mean we've written off the alternatives completely, but after carrying out extensive analysis the options get skewed in favour of scrubbers. That being said, other options may be more suitable subject to the range of travel, cargo capacity and area of operation. Case in point, solar and battery operated passenger ferries plying across Canada and

Europe are exemplary working models of what alternate fuels can achieve. Moreover, scrubbers for vessels older than 20 years are less suitable as the owner isn't likely to realise the full cost benefits and saving during the ship's lifecycle.

September marks the final month that owners will have to decide if they want to set sail after the 2020 deadline. To scrub or not to scrub, that is no longer a question.

### About the author

Ramniwas Mourya's experience in ship design, production and marine engineering spans 18 years. His practical know-how was honed onsite in projects across Europe and Asia. Prior to co-founding India-based design and engineering consultancy Buoyancy Consultants in 2013, he led a team of production engineers at a Singaporean shipyard. *NA*

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# Britain's new polar research ship in the virtual wind tunnel

The Hamburg Ship Model Basin (HSVA) investigated the aerodynamic performance of the RRS *Sir David Attenborough* in a 'virtual wind tunnel'. Lars-Uve Schrader from HSVA presents a selection of results

Earth's polar regions play a crucial role in the global climate. There is therefore a need to conduct environmental science activities in Antarctica and the Arctic – and of modern ice-breaking ships to enable this. To secure the UK's leading position in the field, the Natural Environment Research Council (NERC) commissioned a new research vessel – the RRS *Sir David Attenborough*, a design by Rolls-Royce Marine AS (Figure 1). Currently under construction at the Cammell Laird dockyard, the ship will be operated by the British Antarctic Survey (BAS) from 2019 [1]. In order to assess the aerodynamic characteristics of the vessel, Rolls-Royce engaged the Hamburg Ship Model Basin (HSVA) in performing a simulation-based analysis of the wind field around the ship.

Wind-tunnel tests at model scale are the traditional means of specifying the aerodynamics of a ship. In recent years, the use of Computational Fluid Dynamics (CFD) has developed into an attractive alternative thanks to major advancements in turbulence modelling and computer performance. Traditional unsteady Reynolds-averaged Navier-Stokes (URANS) simulations are increasingly being replaced by high-fidelity methods which are able to capture turbulent flow events on small-to-medium spatial and temporal scales. While Large-Eddy Simulation (LES) is mostly infeasible in industrial aerodynamics owing to the high computational cost, hybrid URANS-LES approaches represent an attractive compromise between accuracy and efficiency. Detached-Eddy Simulation (DES) considered here is a popular variety of such hybrid methods [2].

## Virtual wind tunnel

The CFD-based 'virtual wind tunnel' offers the possibility of testing the ship in

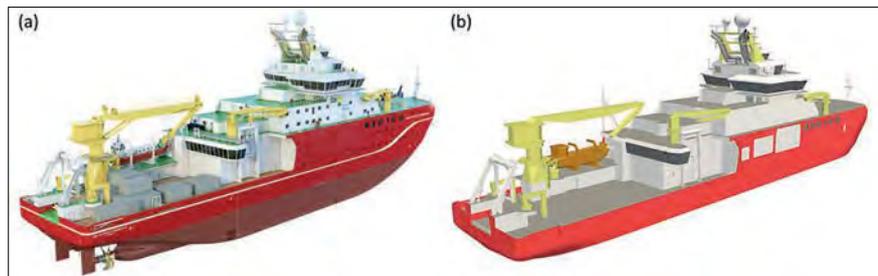


Figure 1: Polar research ship RRS *Sir David Attenborough*. (a) Detailed design model by Rolls-Royce Marine AS

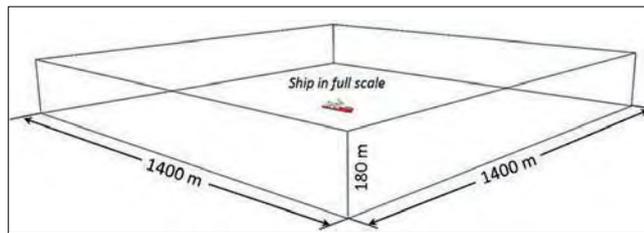


Figure 2: Test section of the 'virtual wind tunnel'

full scale, using a very large computational domain ('virtual test section') with minimal blockage effects. Here, the horizontal dimensions are roughly ten times the vessel length while the height is more than four times the air draft of the ship (Figure 2). The treatment of the flow field at the domain boundaries allows for a straightforward adjustment of different

wind speeds and headings (see Figure 3 for a definition of the wind parameters). The wind over the ocean is modelled by a standard atmospheric boundary-layer profile with a power-law distribution in the vertical coordinate  $z$ . The nominal true wind speed  $TWS_0$  is given for a reference height of  $z_0 = 10$  m above the sea level.

The simulations have been carried out using HSVA's in-house flow solver FreSCO+ developed in collaboration with the Hamburg University of Technology (TUHH) [3]. Key to a successful DES computation is a meaningful division of the computational domain into small cells (CFD mesh, cf. Figure 4). The present mesh comprises some 15 million hexahedral cells with fine resolution in regions of turbulent vortex generation

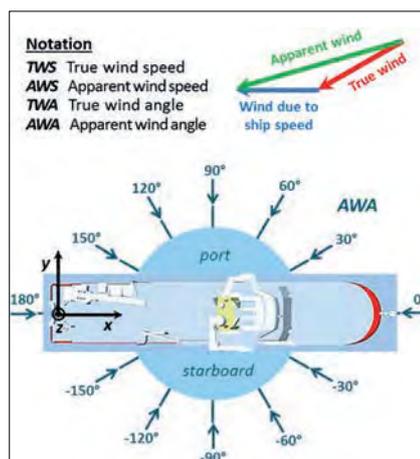


Figure 3: Coordinate system used and definition of wind parameters

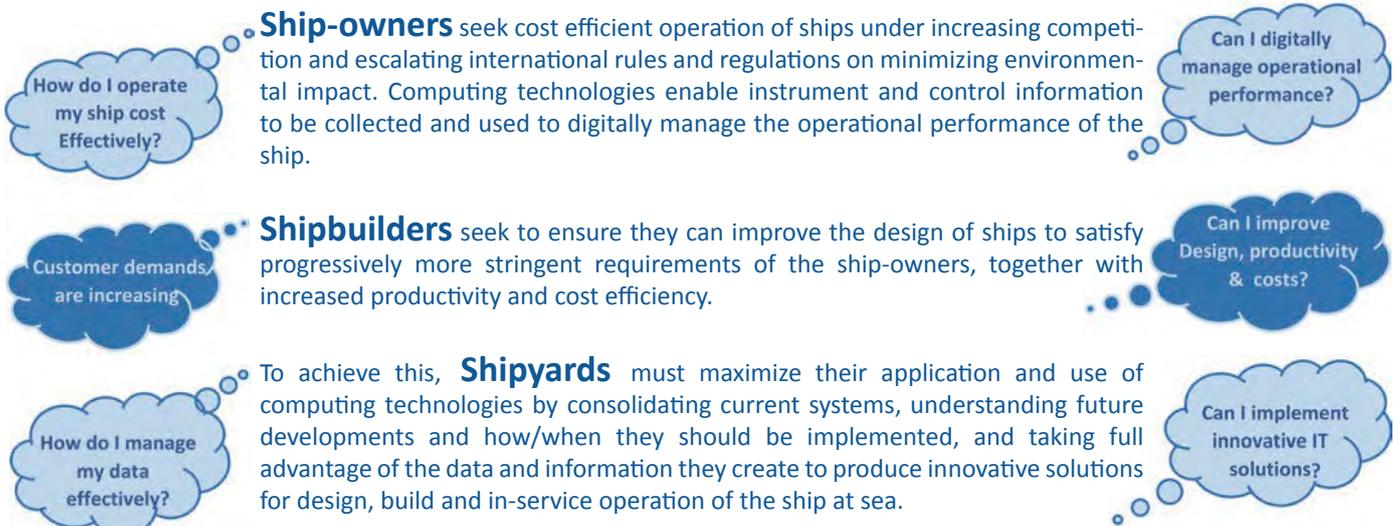
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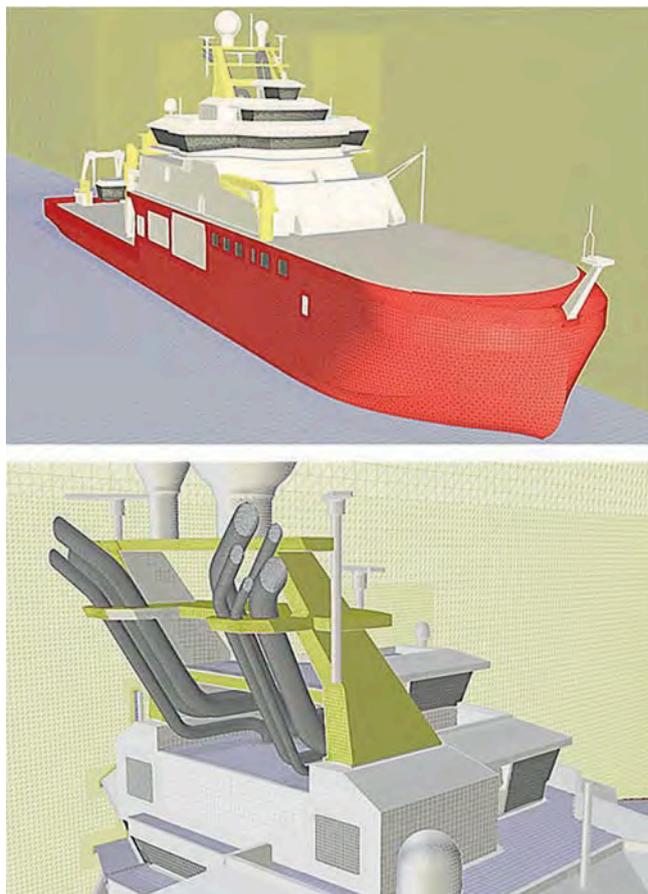


Figure 4: CFD mesh for DES

conditions as these can be compensated by established correction methods. The simulations reveal that this error level is achieved only when observing a sufficient distance to the mast platform (example in Figure 5).

Vertical profiles of wind speed above the foremast have been evaluated so as to establish a suitable position for the anemometer installation (cf. Figure 5). A closer look at two levels,  $z = 19.1$  m and  $z = 25$  m above the water line, reveals that the accuracy requirement by BAS in upwind conditions is largely fulfilled when installing the wind gauge in a height of  $z \geq 25$  m (Figure 6). For wind from the stern, in contrast, the deckhouse shades the foremast, preventing meaningful wind measurements.

### Exhaust dispersion

Simulations of exhaust-gas transport in the airstream have been carried out to identify potential risks of pollution at the air intakes towards the engine rooms. Two design variants of the exhaust system have been considered, differing in the length and diameter of the exhaust pipes and the arrangement of the radoms and radars next to the pipes. For  $AWA = 30^\circ$  – the most critical wind angle studied – the exhaust plumes generated by design 1 are more dispersed than those of design 2 (shown in Figure 7). As a result, design 1 violates the odour criterion based on a limit of 300 ppm at the windward air inlet (Figure 8a) while design 2 – the final choice – marginally complies with this criterion (Figure 8b).

### Helideck safety

The UK Civil Aviation Authority (CAA) provides two safety limits for helidecks [5]: (i) the standard deviation of the vertical turbulent fluctuations should stay below 1.75 m/s; (ii) the 3-second average temperature rise above the ambient temperature due to the exhaust plumes of the ship should not exceed  $2^\circ\text{C}$ . In 25-knot upwind conditions, both criteria are largely fulfilled within the helideck aiming circle. If  $AWA = 30^\circ$ , for instance, the wind is fairly uniform and steady in the forward part of the helideck whereas an unsteady low-speed zone is created near the deckhouse (Figure 9a). This is

(“source”, e.g. deckhouse) and of particular interest (“target”, e.g. helideck). In these regions, the hybrid DES model operates in the scale-resolving LES mode while the URANS mode is active in the boundary layers forming along the surfaces of the

hull and the superstructure. Finally, the DES turbulence treatment is combined with a volume-of-fluid approach for the simulation of exhaust-gas dispersion in the airflow.

### Wind measurement

Like many other research ships, the RRS *Sir David Attenborough* features a foremast carrying the meteorologic instruments. The helideck at the bow calls for a foldable construction, setting a limit to the mast length; at the same time, the foremast should be tall enough to reduce negative effects on the anemometer accuracy owing to the airflow distortion by the deckhouse [4]. According to the meteorologists from BAS and their scientific collaborators, errors in wind speed of  $\pm 5\%$  are acceptable in upwind

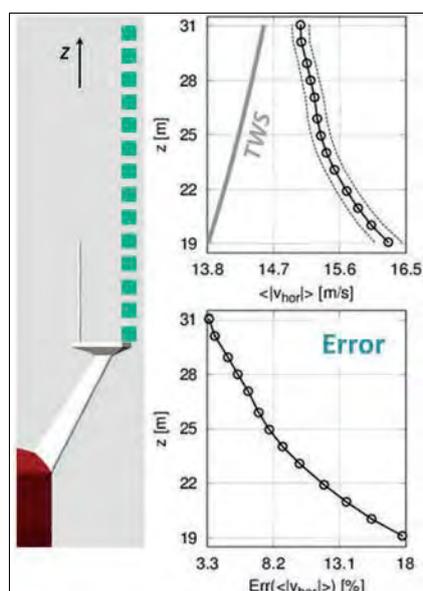


Figure 5: Wind profile above the foremast (black line with symbols) compared to target (grey line) for  $TWS0 = 25$  kn and  $AWA = 60^\circ$

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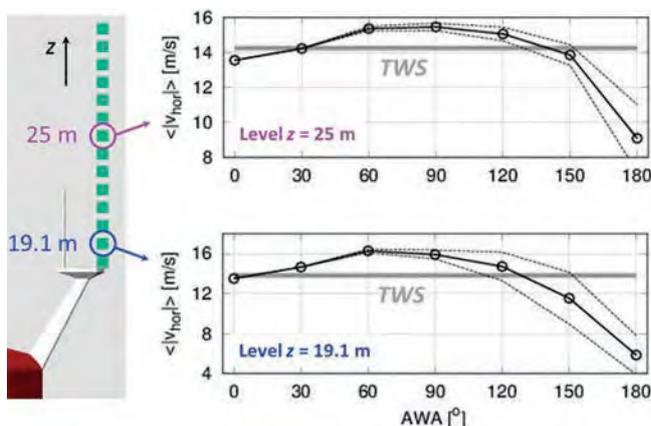


Figure 6: Mean wind speed (black line with symbols) versus AWA in two heights: 1.91m and 25m above sea level. Comparison with target TWS (grey line)

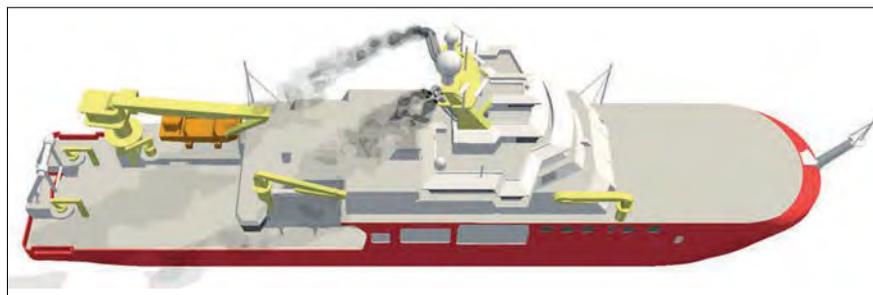


Figure 7: Smoke dispersion for design 2 of the exhaust system (see text). Wind conditions: TWS0 = 25kn, AWA = 30°

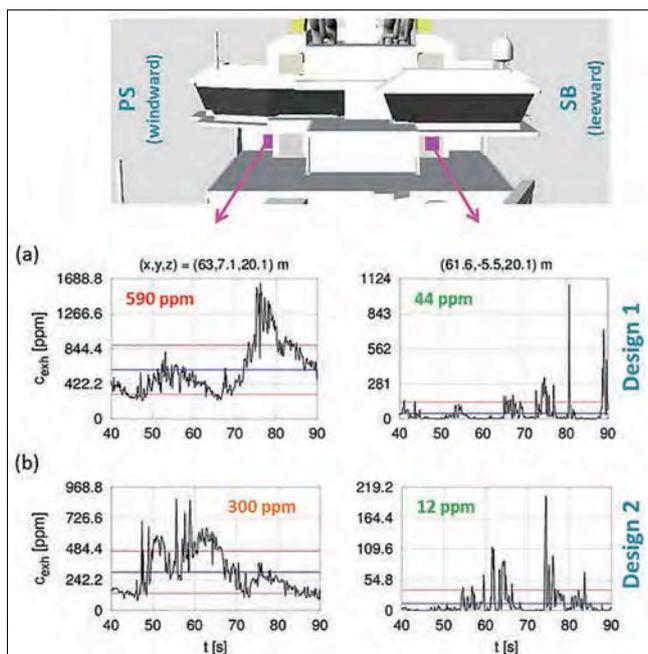
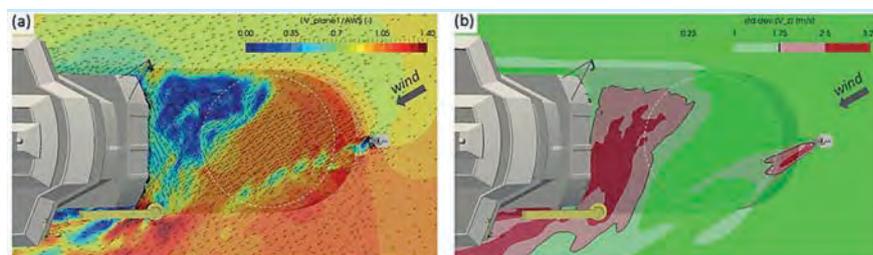


Figure 8: Smoke concentration at the intakes to the engine room for two variants of the exhaust system: (a) design 1 and (b) design 2 (see text). Comparison of time averages with odour limit of 300 ppm (green/orange/red font: odour criterion fulfilled/marginally fulfilled/violated)



reflected in the distribution of “safe” and “unsafe” areas across the helideck as per the CAA guidelines (Figure 9b). In the simulations, the foremast has been in the upright position for simplicity whereas it will be folded down in practical operation, which further improves the helideck safety in terms of the CAA criteria.

### Summary

The purpose of the project described was to demonstrate the capabilities of modern unsteady scale-resolving simulations such as DES. Compared to traditional URANS computations, these simulations represent substantial progress in terms of accuracy and confidence level. Here, HSVA has applied DES in a fruitful collaboration with Rolls-Royce and BAS to verify and improve the aerodynamic performance of the RRS *Sir David Attenborough* during the design stage of the ship.

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Figure 9: Turbulence above the helideck. (a) Snapshot of normalised wind speed (colours) and direction (arrows) in a plane located 2m above the helideck. (b) Evaluation of the CAA safety limit on the level of turbulent fluctuations in the vertical direction (green/red: criterion fulfilled/violated). Wind conditions: TWS0 = 25kn, AWA = 30°

# HOLISHIP: from birth to adolescence

Apostolos Papanikolaou and Jochen Marzi of Hamburg Ship Model Basin (HSVA) explain how the HOLISHIP project is utilising CAESES in developing a holistic, life-cycle approach to ship design



Joint HOLISHIP-SHIPLYS-LINCOLN project workshop on Holistic Ship Design in Brussels on May 31st, 2018 on the occasion of the project's Midterm-Assessment by the European Commission

**F**unded with an €11.3 million (US\$12.45 million) grant by the Horizon 2020 Transport Research Programme of the European Union, the HOLISHIP project (HOListic optimisation of SHIP design and operation for life cycle) is developing the next generation of ship design software systems for the needs of the European maritime industry. Commencing in September 2016 (see that month's *The Naval Architect*) the four-year project is now at the midterm stage and several notable achievements have been already reached.

The design of ships and of maritime assets in general is a complex endeavour requiring the successful coordination of many disciplines, of both a technical and non-technical nature, and of individual experts to arrive at valuable design solutions; this includes the multi-disciplinary nature of a ship's operation over her entire life-cycle. The HOLISHIP approach brings together all relevant main disciplines of maritime product design and operation under the umbrella of user-friendly design software platforms, in which advanced simulation and parametric design modelling tools are integrated. This enables the parametric, multi-objective optimisation of the product ship or of marine assets in general. Market analysis and operational data, hullform, stability, hydrodynamics and structural design, adaptation of prime movers, propulsors and main outfitting, economy,

efficiency and environmental considerations form the mission requirements and enable the formulation of a rational foresight analysis for the viability of the product model over its life cycle. To achieve its goals, HOLISHIP is integrating techno-economic databases, naval architectural, design, hydrodynamic, structural and safety simulation algorithms, modern GUI and information exchange systems allowing the exploration and optimisation of the design space to a much larger extent than in today's practice.

## Current design

Based on CAESES by Friendship Systems, a state-of-the-art process integration and design optimisation environment, HOLISHIP's design platform integrates first-principles analysis software from various disciplines relevant to ship design and combines them with advanced multi-disciplinary and multi-objective optimisation methods. The HOLISHIP design platform is intended to support ship design through different stages of development, namely from concept through contract design and operational analysis, while dedicated cost models allow for the control of capital and operational expenditures. Compared with traditional approaches the interplay/interaction of all design components/software tools in the form of a design

synthesis model/integrated software platform allows exploring a much wider design space and, finally, helps generating superior designs (and competitive design alternatives) in substantially less time than in practice today. Tools and system data from all disciplines are integrated by design synthesis in the HOLISHIP platform(s), which enables a concurrent analysis and optimisation of systems and components, contrasting the sequential approach associated with the idealised view of the classical design spiral.

Since quite a few simulation tools require substantial computer resources (e.g. a viscous flow analysis may need several hours of computational time on a small cluster) and special environments (e.g. with regard to the operating system, license allocation and user access), which may not all be available at the same time and to the same people, CAESES provides methods to pre-compute data for later usage. The basic idea is that a design-of-experiment (DoE) is undertaken for a chosen set of free variables, which form a task-specific sub-set of the total design space of interest, from which a surrogate model (response surface) is built. To this end Dakota, an open-source optimisation kit by Sandia National Laboratories ([dakota.sandia.gov](http://dakota.sandia.gov)), is embedded in CAESES. A simulation tool can then be run from CAESES separately and upfront

Number of passengers	$\geq 2,080$
Number of passenger cabins	$>300$
Lane length	$\geq 1,950\text{m}$
Payload	$\geq 3,500\text{t}$
Number of crew	120

Length between perpendiculars $L_{pp}$	162.85m
Beam	27.6m
Subdivision draught	7.10m
Height of bulkhead deck	9.80m
Gross tonnage (GT)	$\approx 36,000$
Deadweight (DWT)	5,000 dwt
Block coefficient $C_B$	0.5677
Midship coefficient $C_M$	0.9760
Longitudinal centre of buoyancy $X_{CB}$	0.4545

Table. I: Most important owner's requirements and baseline design characteristics

Free variable	Lower bound	Baseline	Upper bound
Length $L_{pp}$	155.0m	162.0m	170.0m
Beam	27.6m	27.6m	30.6m
Design draught	6.5m	7.1m	7.1m

Table. II Free variables and range for the optimisation

to be subsequently replaced by a suitable response surface. A range of models are made available, for instance, Artificial Neural Networks (ANN), polynomial regression and Kriging.

### Design example

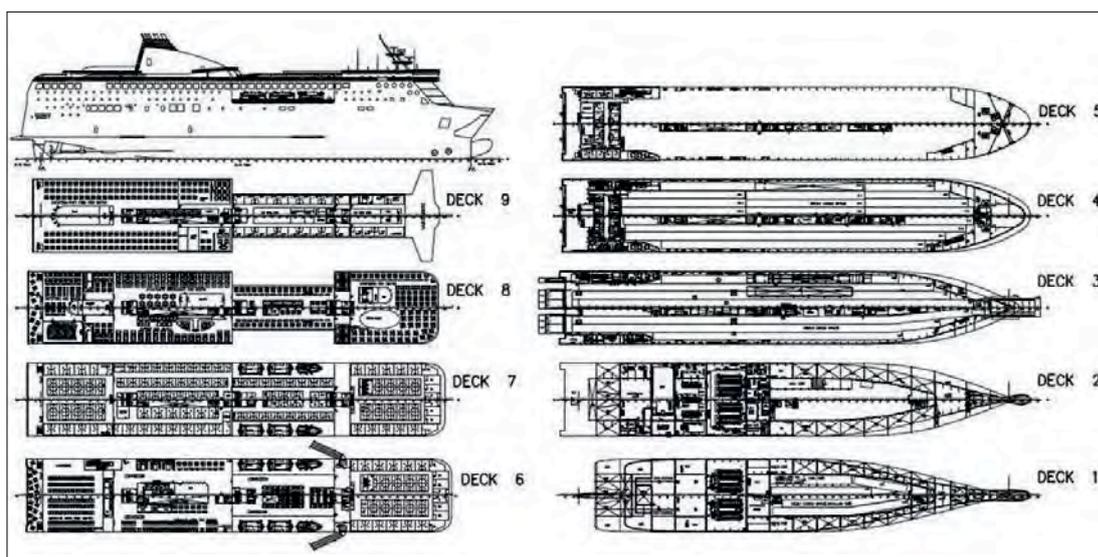
For an illustration of the above HOLISHIP developments, a realistic design example was chosen at the start of the project, namely a medium size ro-pax vessel. This example served as both a testbed and a

showcase of the project. Meaningful owner's requirements and a representative operational profile were defined, namely a ferry service between Piraeus and Heraklion (on the island of Crete), in which a daytime trip would take about 6.5 hours at 27kn while a return trip during the night would require around 8.3 hours at 21kn. Taking into account port time for manoeuvring, bunkering, and loading the round trip could be completed within 24 hours. Table I states the most important

owner's requirements with regard to transport capacity and a baseline design's main characteristics, originally developed by Fincantieri for the needs of the EU funded project GOALDS (2010-2013).

A series of optimisation studies was undertaken to identify optimal ro-pax vessels fulfilling the owner's requirements through exploration of a huge design space, involving several hundreds of parametrically generated, alternative designs. It should be noted that the original Fincantieri baseline design was at that time designed according to the older SOLAS 2009 regulations. However, considerably more stringent damage stability requirements were introduced by the IMO Resolution MSC.421(98) in 2017 and are nowadays in force for all ro-pax newbuildings. It was therefore anticipated that, although sharing the same topology and arrangements with the baseline, the outcome of the optimisation would be

Fig. 1 General arrangement of the optimised ro-pax ferry





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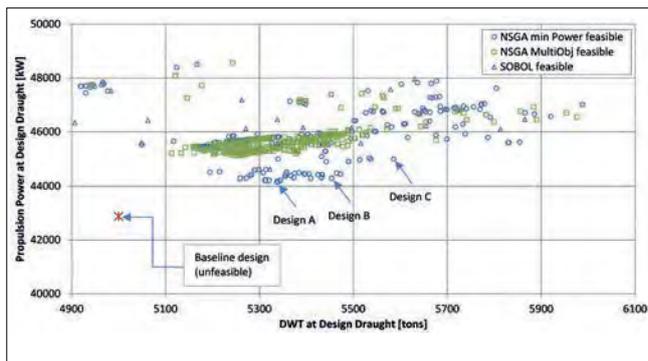


Fig. 2 Propulsion power at design draught and 27 kn vs. DWT

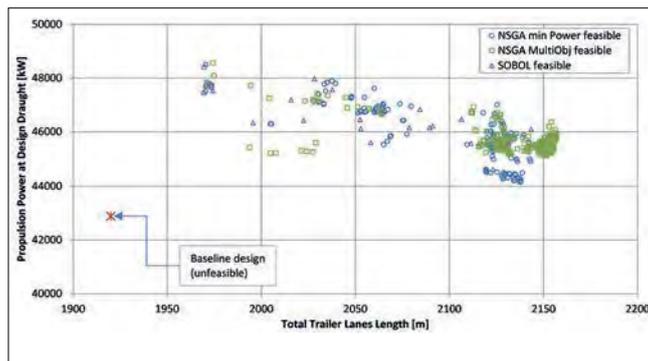


Fig.3 Propulsion power at design draught and 27 kn vs. total lane length

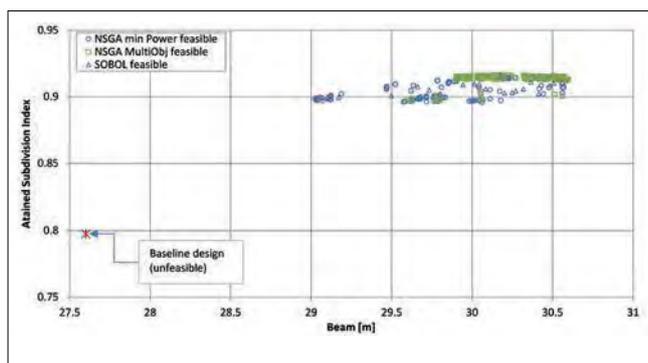


Fig.4 Attained subdivision index (A-Index) vs. beam

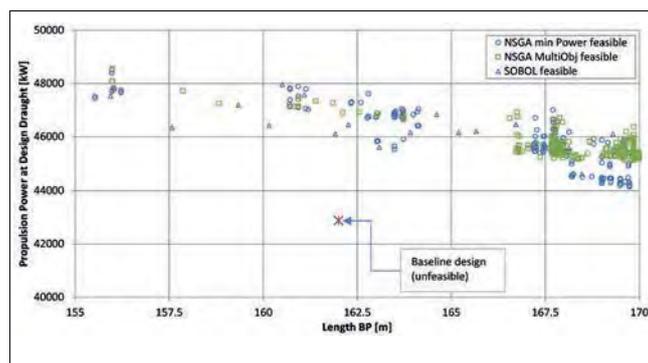


Fig.5 Propulsion power at design draught and 27 kn vs. length between perpendiculars

a significantly different design. In other words, the baseline, although being a valid ro-pax ferry design when it was developed several years ago, would today have to be considered an infeasible design and, consequently, the design space was extended towards vessels of wider beam as can be seen from Table II.

From a large series of results, only a few are presented in the below scatter diagrams (see Figs. 2 to 5). For more clarity, only feasible designs are shown. Note again that the baseline design is infeasible since it fails to comply with the newly revised R-Index of ship damage stability. However, it is included in the diagrams for the sake of comparison.

Fig. 2 presents a scatter diagram of propulsion power at 27knots versus the ship's dwt at design draught, while Fig. 3 depicts propulsion power versus the ship's total lane length, both dwt and lane length being part of transport capacity as an objective. As may be observed, a number of designs were produced with significantly increased transport capacity (up to 6,000t dwt and 2,160m lane length), featuring a required propulsion power at design draught and 27 kn between 44,150 kW and 47,000 kW. As can further be seen, the single-objective optimisation resulted in a series of designs with dwt values ranging between 5,300t and 5,500t, total lane length between 2,130m and 2,140m and propulsion power between 44,150 kW and 44,400 kW. Fig. 4 shows that all feasible designs feature significantly wider beams, above 29.1m, than the baseline's of 27.6m. This is due to the new damage stability requirement (which the older baseline did not have to observe). The required propulsion power as a function of length between perpendiculars is depicted in Fig.5. All feasible designs with a length LPP comparable to that of the baseline have a considerably larger power requirement.

Table. III Main characteristics and validation of selected designs (estimates are from surrogate models)

	Design A	Design B	Design C
Length bef. perpendiculars	169.74m	169.74m	169.72m
Beam	29.03m	29.06m	29.52m
Design draught	6.66m	6.70m	6.70m
DWT at design draught	5,337t	5,454t	5,586t
Number of passengers	2,209	2,211	2,234
Lane length	2,138m	2,137m	2,142m
Payload	4,095.6t	4,095.3t	4,101.8t
Propulsion power (estimated)	44,153kW	44,280kW	44,983kW
Propulsion power (re-calculated)	44,640kW	44,862kW	45,850kW
Estimation error	-1.09%	-1.30%	-1.89%
R-Index	0.86648	0.86651	0.86686
A-Index (estimated)	0.89874	0.89896	0.90948
A-Index (re-calculated)	0.89597	0.89626	0.90424
Estimation error	+0.309%	+0.301%	+0.579%

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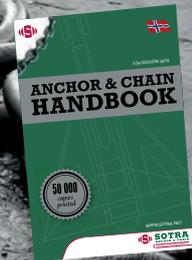
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## RINA - Lloyd's Register Maritime Safety Award

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The Maritime Safety Award is presented annually to an individual, company or organisation that in the opinion of the Institution and Lloyd's Register, is judged to have made an outstanding contribution to the improvement of maritime safety or the protection of the maritime environment. Such contribution may have been made by a specific activity or over a period of time. Individuals may not nominate themselves. Nominations are now invited for the 2018 Maritime Safety Award.

Nominations of up to **750 words** should describe the nominee's contribution to:

- safety of life or protection of the marine environment, through novel or improved design, construction or operational procedures of ships or maritime structures
- the advancement of maritime safety through management, regulation, legislation or development of standards, codes of practice or guidance
- research, learned papers or publications in the field of maritime safety
- education, teaching or training in maritime safety issues



The closing date for nominations is **31st December 2018**.

The Award will be announced at the Institution's 2019 Annual Dinner.

**Nominations** may be made by any member of the global maritime community and should be forwarded online at: [www.rina.org.uk/maritivesafetyaward](http://www.rina.org.uk/maritivesafetyaward)

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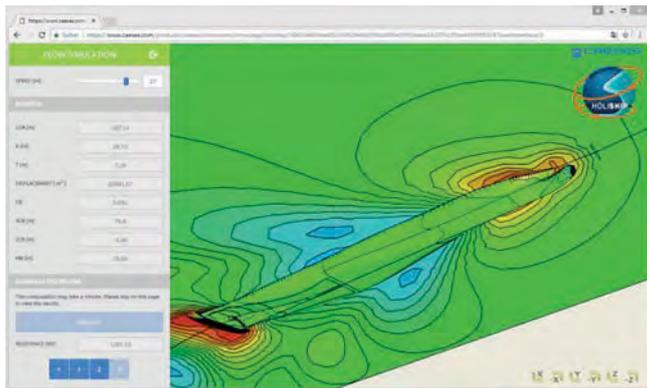


Fig. 6 WebApp for v=Shallo of HSVA on the basis of CAESES® of Friendship Systems

This increase of power is attributed to wider beam and larger displacement. It should be noted here that the EEDI has yet to be included in the analyses, particularly since it is known that ro-pax designs often are susceptible to the EEDI as an important constraint. This subject will be duly addressed in follow-up work within HOLISHIP.

In Fig. 2 three designs are highlighted. They were selected from the Pareto front for further investigation, for instance to study how close the estimations from the response surfaces match the results from direct simulation. The main particulars of these designs, marked A, B and C, are listed in Table III. In comparison to the baseline, their transport capacity is increased by 7% to 12% in terms of design DWT and by 11% in terms of lane length while the propulsion power is increased by merely 3% to 5%. It should be appreciated that the new designs are in compliance with the new damage stability requirements even though the optimisation was set out from an infeasible baseline.

### Project potential

It was shown that HOLISHIP can lead to new insights and promising new design alternatives within a very short lead time. Even more, depending on the degree of fidelity of the employed/integrated geometry models and the software tools, it inherently offers the option of generating virtual prototypes/digital mock-ups of the product. Within HOLISHIP, virtual prototyping is understood as digital mock-ups of varying complexity, namely for concept development, design exploration and optimisation, design prototyping and optimisation at the

stage of contract design, modelling and optimisation of ship operation, including refined modelling of main systems and components, dynamic modelling and assessment of the ship-prime mover/propulsor-environment interaction ('Virtual Vessel Demonstrator' VVD). In HOLISHIP, this will be enabled by the interaction of CAESES of Friendship Systems with the CPACS platform, which is supported by DLR (Deutsches Zentrum für Luft und Raumfahrt). This collaborative approach will be reported in a future issue of *The Naval Architect*.

Last but not least: HOLISHIP does not promote a 'monolithic' design software system, but rather flexible software platforms in which technical simulation tools (Apps) are being made accessible and may be used in different ways, depending on user's background and the study objectives. In this respect, when using, e.g., CAESES, some Apps can be as simple as generating a hull form for a set of parameters, using a web-browser as a reduced graphical user interface (GUI). Other Apps may be offered as components to be included (as dominos) in larger projects, so-called meta-projects. These components become self-contained CAESES projects which can be addressed from other CAESES projects, making available functionality at a higher-level of abstraction and allowing the streamlining of processes in meta-projects. An example web-based App (WebApp) is shown in Figure 6. The WebApp computes total resistance at a given speed and a chosen draft for a twin-screw Ro-pax with bulbous bow and skeg (see <http://www.holiship.eu/approach/>).

The material presented in this article describes only a 'snapshot' of a series of

completed and on-going developments within the HOLISHIP project, referring herein to a sub-set of the disciplines covering important aspects of ship safety (intact and damage ship stability) and hydrodynamic performance in calm water and in a seaway (Harries et al, 2017). Together they largely determine two fundamental criteria of ship design already, namely high safety and excellent efficiency. The material presented highlights the integration concept which is being also extended to other design disciplines (e.g. structural design, economy and environmental impact), which are currently being elaborated in HOLISHIP. The status achieved during the first two years of the project and the successful implementation of a holistic approach to the design of a ro-pax ferry allows us to look into very promising future developments of the project. **NA**

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# China feels the pressure – but refuses to crack

With a consequential re-merger looming, Chinese shipbuilding is in the midst of a wider restructuring to remain competitive despite a stubborn market

There are two ways of looking at the expected and now state-approved merger of CSIC and CSSC, the twin behemoths of Chinese shipbuilding that separated in 1999 to represent the territories north and south of the Yangtze River.

On the one hand, it could be argued that the creation of the world's largest-ever shipbuilding enterprise – casting even the likes of the Korean Big Three into its shade – will cement the dominance of Chinese shipbuilding. After all, the nation has enjoyed the world's largest orderbook for some time; despite South Korea making a surprising return by securing more orders in the first half of the year at 4.96M cgt (compensated gross tonnage) to China's 4.39M, the latter has a much greater backlog formed by its years of pre-eminence, at 28.25M cgt to Korea's 17.38M (figures provided by Clarkson Research Services). The feted mega-corporation could extend China's lead even further by exploiting increasingly advantageous economies of scale.

Conversely, the merger might be said to reflect desperation rather than dominance. In April this year, the Shanghai Stock Exchange restricted and issued a delisting risk warning on CSSC shares after the company announced a profit warning in January. CSSC suffered net losses in both 2016 and 2017 of RMB2.6 billion (US\$389 million) and RMB2.3 billion (US\$344 million) respectively. Despite the scanty improvement year-on-year, Chinese listing rules penalise companies that experience losses for two consecutive years by imposing a daily trading limit of 5%; a third year of losses will see complete delisting from the stock exchange.

In an effort to return to profit once again, CSSC and its subsidiaries have reportedly sold off a number of assets, including Waigaoqiao Shipbuilding's share in the struggling CSSC Cruise Technology, and CSSC's stake in CSSC Shengui Equipment. By merging with CSIC, which posted a net income of RMB838 million (US\$125



Large vessels such as the 400m *COSCO Shipping Universe* are an increasingly common fixture in Chinese yards

million) at the year-end of 2017, CSSC would be thrown a far more effective lifeline to return to the black.

Whatever the ultimate meaning of the re-unification of CSSC and CSIC, it almost certainly represents the growing pressure on the nation's shipbuilding industry caused by increasingly difficult trading conditions. These include rising steel tariffs and material costs, expectations of higher wages across an increasingly affluent workforce, low newbuilding prices, and the yuan's growth against the dollar.

To combat this gloomy prospect, Chinese shipbuilding has been forced to adapt. Early indications appear to be positive, with a palpable sense of renewed optimism that has been buoyed by a surge in newbuilding orders, with CANSI reporting a year-on-year increase of 99.6% (in deadweight tons) compared to January-May last year. Moreover, the number of yards that have delivered vessels in 2018 sits at 143, a considerable increase from the 107 in 2017 (although far off the 239 that managed this in 2010). There are a number of factors that have contributed to this turnaround.

Firstly, there has been a noticeable shift across the industry towards the construction of increasingly large vessels, such as VLCCs (very large crude carriers) and 20,000 TEU+ ULCSs (ultra-large container ships), with China taking the lead from Korea in this segment as the latter continues to suffer

from a prolonged slump. Construction of very large vessels means that, whilst actual numbers of vessel orders may be falling, the total dwt of orders is on the up, with more complex and longer builds providing a welcome source of revenue.

One example of such a vessel is *COSCO Shipping Universe*, a 198,000 dwt, 21,237 TEU ULCS delivered on the 12 June by Jiangnan Shipyard. By deadweight, it is the heaviest container vessel of all time. Although a record-breaker, *COSCO Shipping Universe* is only a small part of COSCO's orderbook, which is the largest in the industry with 27 vessels to be delivered by the end of next year. 10 of these will be ULCS (over 14,000 TEU), which were deferred from their original 2018 delivery.

Such heavy ordering by the state-owned COSCO is likely to benefit the Chinese shipping industry, particularly as the liner company is set to take over Hong Kong-based OOCL in a massive USD\$6.3 billion deal, rendering it the world's third-largest liner behind Maersk Line and Mediterranean Shipping Company.

International companies, too, have chosen Chinese yards to construct ULCS amidst other vessels, as suggested by CANSI figures claiming export ship orders between January and May are up 108% year-on-year. Yangzijiang Shipbuilding, for instance, completed the 25th 10,000 TEU vessel for Canadian containership

firm Seaspan in May, which will charter a number of the vessels to French major CMA CGM (as reported in July/August's *The Naval Architect*). The latter themselves ordered nine 22,000 TEU containerships in 2017, to be built both at Hudong-Zhonghua Shipbuilding and Shanghai Waigaoqiao Shipbuilding, with delivery expected by the end of 2020. Notably, all will be powered by LNG.

As well as LNG, Chinese shipbuilding is attempting to diversify into a number of new segments beyond its staples of containerships and bulk carriers (although the latter still proves lucrative, with orders this year from Alpha Bulk and Mitsui for a quartet and quintet of kansarmaxes, respectively). This is somewhat due to China being undercut by nations such as the Philippines competing for these low-margin vessels, with China's response being rebranding itself as a high-tech shipbuilder able to compete with the likes of Europe. For example, an

undisclosed Chinese yard is currently in the process of building a 104m, Ulstein-designed polar expedition vessel, complete with electric propulsion, putting the country in direct competition with European yards.

The nation is also close to completing *Snow Dragon 2 (Xuelong 2)*, a scientific research icebreaker that was started in 2016 and was docked at Jiangnan Shipyard this March for equipment installation. It is the country's second such vessel, and the first to be completely constructed locally, with predecessor *Snow Dragon* built in 1993 in Ukraine and transferred to Jiangnan Shipbuilding to be converted into a research vessel. Notable is the fact that Finnish company Aker Arctic Technology provided *Snow Dragon 2's* basic design. Although demonstrating the continuing primacy of European technical expertise, it does show willingness within China for greater international co-operation (see May 2018's *The Naval Architect*).

Outside of shipbuilding, a further attempt to modernise China's shipping industry is the construction this year of the Wanshan Marine Test Field, a coastal facility spanning 2,252nm for the testing of autonomous and unmanned ships. Led by industry, academic and government partners, it is the first of its kind in Asia, and is larger than Kongsberg/NTNU's Trondheimsfjorden site in Norway and the DIMECC Jaakonmeri Test Area in Finland, establishing China as a major player in the race to develop commercially viable autonomous vessels.

It is apparent that Chinese shipbuilding has the unique opportunity to offer both low-cost mass production and highly specialised vessels, gaining further ground over its rival Korea as the country's shipbuilding industry continues to fall into the doldrums.

However, despite national goals and intentions, it is only a continuing trend of orders that will prove a resurgence of Chinese shipbuilding. **NA**

## RINA-QINETIQ

# Maritime Innovation Award

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# Shandong shipbuilding industry empowers intelligent manufacturing

Liu Zhiliang reports on a range of projects and initiatives to promote 'intelligentisation' in the province's shipbuilding industry

**T**oday, with the rapid evolution of artificial intelligence, a variety of intelligent development methods have been applied across many industries and the shipbuilding industry is no exception. It has become a noticeable trend in Chinese shipbuilding to make use of 'intelligentisation' to improve production efficiency and the quality of shipbuilding enterprise.

As a major shipbuilding province, Shandong attaches great importance to intelligent manufacturing. An official from the Office of Scientific and Technological Industry of National Defence in Shandong Province (SDOSTIND) said that Shandong province encourages key shipbuilding enterprises to establish intelligent manufacturing and green manufacturing facilities, as well as related management systems. By inciting the intelligentisation of shipbuilding in Shandong, a solid foundation can be built for the establishment of modern shipbuilding models, initiating the transformation from old to new.

## Intelligentisation projects

In the face of a persistently sluggish ship market, China's shipbuilding enterprises have been actively seeking a breakthrough. The integration of information technology into industrial processes and intelligent manufacturing are regarded as the main routes to achieving this.

Starting with digital lean design, a number of R&D projects relating to intelligent production lines are being undertaken, alongside those relating to integrated systems. These will improve the quality and efficiency of shipbuilding as well as reducing cost and the consumption of resources and energy.

For instance, in June last year Qingdao Beihai Shipbuilding Heavy Industry Co. (BSIC), taking the lead on a project with Shanghai Jiaotong University, the 716 Research Institute of the China Shipbuilding



Qingdao Beihai Shipbuilding Heavy Industry is leading a project to develop advanced coating technology

Industry Corporation (CSIC) and Chongqing Changjiang Coating Equipment Co., jointly signed a co-operation agreement regarding a scientific research project to establish intelligent coatings. This research will be conducted in co-operation to take full advantage of the integration of shipbuilding, education and academic institutions.

In a separate project to increase overall production efficiency, Penglai Zhongbai Jinglu Ship Industry Co. and the 11th Research Institute of CSSC signed an agreement to develop an enterprise resource planning (ERP) system. Based on the extensive introduction and successful use of information management systems elsewhere – such as the Korean ERP system – and the ever-closer integration of virtual and physical entities, the ERP is to be adopted to realise intelligentisation in all aspects of the production process, leading to higher-quality products, refined management and efficient services.

One of the most successful companies in the region, Yantai CIMC Raffles Offshore Ltd. has also put forward its 'CIMC marine engineering 2025' programme to accelerate

the pace of intelligent manufacturing. CIMC Raffles hope to use databases to aid design and construction, exploring the potential of Big Data. In particular, the company hopes to develop more intelligent offshore platforms.

## Embracing co-operation

In order to overcome roadblocks to intelligent manufacturing and reduce the gap between shipbuilding and other sectors at home and abroad, shipbuilding enterprises in Shandong province are strengthening co-operation with external experts. In addition, the leadership of Shandong province has introduced a variety of policies to promote intelligentisation.

According to a strategic cooperation agreement signed by the Office of Scientific and Technological Industry of National Defence in Shandong Province and the 11th Research Institute of CSSC, the Institute will provide the key shipbuilding enterprises in Shandong province with consultation services and technical support in the fields of intelligent and



Yantai CIMC Raffles Offshore aims to develop a platform to make offshore platforms

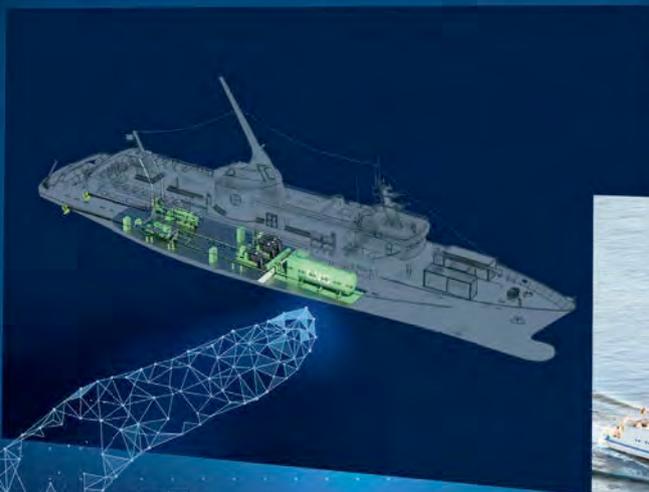
in the province. Under the plans, shipbuilding enterprises on the state 'white list' should fully establish a lean manufacturing system, and levels of automation, digitalisation and intelligentisation should be greatly improved with the introduction of intelligent workshops, warehouses and production lines.

At the same time, Shandong provincial government is also capitalising upon the important role that key specialised projects have played in promoting intelligent manufacturing. With the implementation of 11 major projects, such as the 7th generation ultra-deep-water drilling platform, deep-sea space station, and offshore structure installation and de-commissioning ship, Shandong province will further enhance its profile. Moreover, universities both inside and outside the province, research institutes and shipbuilders and their clients, are encouraged to apply for and to undertake national high-tech ship and offshore equipment research and development projects. **NA**

green manufacturing. Priority will be given to how these innovations can be demonstrated and applied to enterprises in Shandong province. In addition, Jinglu Ship Industry, part of the Shandog Huiyang Group, and a Weihai-based marine science

and technology company have each signed strategic cooperation agreements with the 11th Research Institute.

In 2017, the Shandong provincial government published a document on the transformation and upgrade of shipbuilding



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# Cradle of comfort

Rolls-Royce has developed an innovative alternative to traditional davit systems that could instil greater safety in boat launch and recovery

Whether it's smaller offshore workboats or lifeboats, launch and recovery of daughter craft is one of the more hazardous operations to take place on board a vessel. Around two years ago, Rolls-Royce Marine was challenged by an operator to see if it could find an alternative solution.

The result was the Boat Transfer System (BTS). Martijn de Jongh, chief designer, Rolls-Royce Ship Design and Systems, explains: "It's basically a cradle-based system with the cradle being continuously attached to the vessel, meaning there's no free-swinging boat. We have been targeting it towards windfarm support, but it's suitable for any maritime operation where you are launching or recovering larger boats (of 9-20 metres), such as naval vessels and also standby rescue ships. Recovery of lifeboats is one area where we see big potential."

One of the biggest challenges with traditional davit systems is that they are reliant on a single lifting point. In difficult conditions this can lead to what is known as the 'pendulum effect', when the boat swings due to the long wire length. Another common hazard in boat recovery occurs when the boat is being attached to the painter line at the bow, for positioning purposes, leaving the boat crew responsible at risk of being struck by the free-swinging recovery hook.

Larger boats not only demand bigger hooks, but in the case of dual point lifting systems the risk from swinging hooks is effectively doubled. Moreover, it is not uncommon for one of the hooks to become detached and need re-securing during lifting. A further problem can arise if the vessel is unevenly loaded, which can upset the balance of the davit system.

By contrast, the BTS dispenses with the need for hooks altogether. The cradle is secured to rails and lifting wires which lower the boat out of the water, while the boat is essentially nestled within the cradle and held in place with friction by dampers



Rolls-Royce has a patented pending on its cradle technology

at the bottom. A further advantage over conventional davit systems is that there is effectively an 'unlimited' safe vertical travelling distance, allowing the boat's crew to step off at deck level. The rails end before the waterline of the hull so wouldn't affect resistance.

De Jongh says: "We were a bit surprised that nobody had done it before. There is a patent pending on it as there are no similar systems."

Because testing of the system required realistic wave conditions working at model scale wasn't a practical option, so instead Rolls-Royce worked with the Offshore Simulation Centre in Ålesund to develop a full 3D simulation. Rolls-Royce identified the burgeoning requirements for windfarm support and maintenance – where technicians need to be transported from the main ship to be deployed at the turbines for service and maintenance work



The Boat Transfer System in its stored position

– as a prime target market. Consequently, the sea state for the simulated tests focused on a wave height of 2m, based on typical wind farm conditions.

But de Jongh also notes the potential application of the technology onboard expedition cruise ships where, for example, parties of passengers may need to be transported to shore for excursions and then returned safely to the deck of the mother ship afterwards. It is also envisaged as a solution for lifeboat and life raft recovery, where it may be necessary to retrieve elderly passengers with limited mobility.

However, de Jongh concedes the BTS does have some drawbacks which may rule against widespread application on commercial vessels. The cradle and rails occupy more space than a traditional davit system and are also significantly heavier, which he explains is partly due to safety factors.

Rolls-Royce has developed two versions of the system. The ‘heavy duty’ version has a work load limit (WLL) of 20tonnes, a safe working load (SWL) of 40tonnes, 4.9m beam width and can accommodate a boat of 20m. The ‘light’ version has a WLL of 10tonnes, SWL of 20tonnes, 3.8m beam width and is suitable for a boat up to 13m in length.

Both versions are adaptive to the boat’s shape and can be fitted with either a knuckle boom or overhead crane handling unit, depending on the application and arrangement of the vessel. De Jongh adds that additional sizes are also available and that in terms of cost it will be comparable with a high-end davit system.

Rolls-Royce is currently seeking partners to allow them to build and test the system in real life, probably initially as a retrofit. **NA**

The boat can be lifted and lowered smoothly into the water from the mother ship



The cradle removes dangers of a lifting hook and wires



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# The pull of electric winches

Over the last decade, electric winches have started to challenge their hydraulic counterparts, promising greater simplicity and green credentials. ABB hopes to lead the transition

**W**inches are used on vessels across all sizes and segments to perform a wide range of operations, including anchoring, cargo lifting, towing and most frequently, mooring. Depending on the parameters of these operations – for instance the weight of cargoes to be lifted, or the size and displacement of the vessel to be moored – different winches are chosen, ranging in rated load, size, and most importantly type. While smaller vessels like yachts tend to employ manual winches, the majority of commercial vessels select either electric or hydraulic winches.

The latter has historically been, and remains, the most popular choice, installed on approximately 70% of marine vessels worldwide. Hydraulic winches are a tried-and-tested technology and are well-established within the industry, with a wide network of suppliers and servicing providers. Their durability, ability to operate continuously while the engine is running and capacity to pull heavy loads has made them the dominant technology when it comes to cargo vessels.

In common with other hydraulic machinery, hydraulic winches work using pressurised oil. The fluid – which is pressurised by a pump powered by gensets – passes through a control valve before driving the motor that rotates the winch, then passing back through a filter and into the tank to restart the process.

## Electric efficiency

Given that hydraulic winches require electricity to power the pump, their power conversion is less energy efficient than electric winches, which are driven directly from the gensets. Moreover, electric

VSD functionality allows for smoother operation and greater efficiency in winching operations

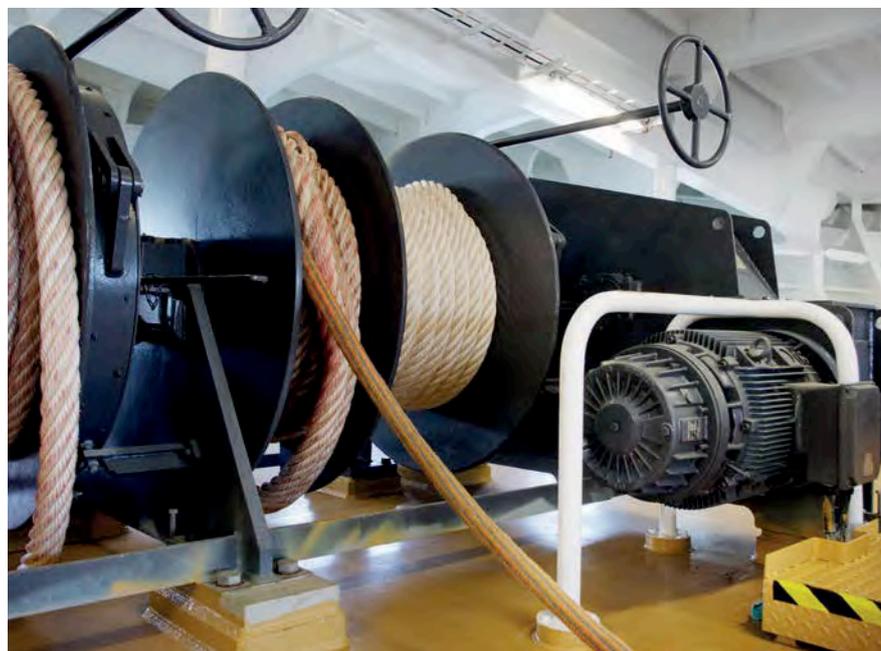


Streamlined drives, such as ABB's ACS880, have vastly improved electric winches

Yet electric winches initially failed to make much of a dent within commercial shipping. This might partly be attributed to shipping's oft-remarked upon tendency for slow uptake of new or alternative technologies; having been around for longer, hydraulic systems are simply better understood and trusted by ship operators who are reluctant to switch over to a new system, particularly one so crucial for vessel safety and used on a daily basis.

A few more specific reasons might be preferred for the faltering uptake of electric winches. One is the relative complexity of early/first-generation electric winch systems, with VSD winches requiring a programmable logic controller (PLC), encoders, and load sensors. Another is the substantial

winches avoid the danger of oil spillage and offer VSD (variable speed drive) functionality, enabling flexible operation and a high degree of control.



starting current required to operate the winches, and the potential for overheating, causing delays until the system cools down. Cost too has been a factor, particularly in the case of retrofits to replace existing hydraulic systems.

However, recent advances in the technology are now leading to more streamlined solutions. A major player in electric winch development is multinational technology group ABB, already well-known across shipping for their electrical expertise. Recognising the value of this expertise in the case of winches, ABB has been working closely with “almost all of the large deck machinery OEMs,” according to segment communications manager Otto Laitinen, to integrate their drives and motors.

### Driving innovation

ABB released the first winch control program based on their well-known ACS800 VSD drive in 2007, but have since developed what they refer to as their “second generation” drive, the ACS880, which the company believes offers real potential for electric winches due to its simplicity. Because ACS880 drives utilise DTC (direct torque control) motor control, the shaft encoders of earlier electric winches are not needed. Moreover, built-in control software in the drive means that PLCs and additional winch controllers are also discarded, while signal delays are cut to a minimum, contributing to smoother and safer operation. Load cell sensors are also no longer required when automooring due to newly developed autotension capabilities.

Considerable simplification has been achieved via the removal or relocation of external devices and components into the drive. This has the benefit of reducing maintenance needs as there are components, as well as reducing the total cost of ownership. Operationally, improvements have also been made with regard to noise reduction, winch movement (with full torque available even at low speeds, preventing jerking) and braking, with the winch drives including an integrated brake chopper. Ultimately, utilising the ACS880 drive allows for “faster and more accurate operation,” says Laitinen, “reducing turnaround time in harbour.”

With the improvement of electric winches spearheaded by ABB’s drives, Laitinen suggests that ABB “can clearly see a market trend going from hydraulic to electric winches. And considering the clear advantages that VSD-based all-electric solutions bring to the equation, this is a quite natural direction.” Next steps, according to ABB, include inbuilt intelligence taking in regenerative variants that enable energy to be brought back into the vessel’s network when lowering anchors. A further possibility is the use of synchronous reluctance motors in winches, following a successful trial of a pairing of ABB’s SynRM motors and the ACS880 VSD drive on board Viking Line’s *Gabriella*. The main advantage of using SynRM motors is the improved response time; they do not suffer from the lag often experienced with induction motors which must be magnetised for the brake to be released. By contrast, the SynRM motor acts instantaneously once the brake is released, with the speed controller rotating the winch. A second improvement noted by the crew is more efficient power consumption, with previous peak current issues resolved. [NA](#)



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# SUBSEA FACILITIES FOR TRANSPORTATION, INSTALLATION AND MAINTENANCE OF VARIOUS APPLICATION SUBSEA EQUIPMENT



*Rubin develops breakthrough technologies for subsea transportation*

In the nearest future Arctic water areas will play important role in hydrocarbon fields development. Heavy ice conditions including ice ridges, low temperatures, strong winds make difficult or impossible hydrocarbon fields development, namely conducting transportation, installation/dismantling and maintenance of various application subsea equipment in surface condition using existing technological means.

To perform the works towards hydrocarbon fields development in the Arctic water areas it is required to use vessels of high ice classes. These vessels should be equipped with DP systems for installation/dismantling and maintenance with continuous vessel positioning and should be supported by ice-breaking fleet.

CDB ME "Rubin" has developed promising advanced technology for subsea transportation, installation/

dismantling and maintenance of various application subsea equipment for year-round development of hydrocarbon fields in Arctic seas with heavy ice conditions irrespective to weather and ice cover conditions.

Key feature of this promising technology is special Subsea Transportation & Installation and Service Facility (ST&ISF) which can ensure year-round performance of works towards hydrocarbon fields' develop-

ment in Arctic.

The ST&ISF concept was developed taking in consideration operating conditions and the specific features of the above tasks.

ST&ISF is subsea self-propelled catamaran-type vessel which comprises two hulls connected with cross-arms and passages.

Main parameters of ST&ISF:

- Full submerged water displacement 17670 m<sup>3</sup>;
- Principal dimensions (LxWxH), 100x35x17 m;
- Basic draft in surface position, 8 m;
- The maximum speed is about 7 knots;
- Endurance is up to 90 days.

Sea depth in the region of transportation, installation/dismantling and maintenance works is from 100 to 4500 m.

ST&ISF transportation zone is between the hulls and between forward and aft passages.

Handling equipment is located in the superstructures of both outer hulls from the transportation zone side. Two rudder propeller units installed at the ST&ISF are its main propulsion system.

Depth and course control of the ST&ISF is provided by forward planes and rudder propeller units which comprise aft planes.

For positioning and stop-trim during operations the ST&ISF uses retractable free tiltable rudder propellers and vertical thrusters.

Procedure for installation of various application subsea equipment on the seabed with the help of ST&ISF is as follows:

1. ST&ISF comes to the area of subsea equipment installation and positions above the point of unloading (operation). Positioning systems keep ST&ISF above the worksite for the whole duration of equipment installations works.

2. The place of equipment installation is examined with the help of remotely operated unmanned underwater vehicles located on board ST&ISF. After examination the remotely operated unmanned underwater vehicles support the operation of installation of the subsea equipment to the operation site.

3. Securing devices release the subsea equipment to be descended. ST&ISF with the help of handling

equipment and with support of remotely operated unmanned underwater vehicles lowers and installs the subsea equipment on the seabed.

4. Once the subsea equipment is installed on seabed the remotely operated unmanned underwater vehicles give signal to disconnect the handling devices from the equipment, examine the equipment with further putting it to operation.

This Subsea Transportation & Installation and Service Facility provides the possibility to take on board various application subsea equipment, deliver it subsea to the particular region avoiding navigation obstacles and install it on the seabed. ST&ISF also provides possibility for maintenance of various application subsea equipment installed on seabed, namely to perform adjustment, repair, mounting or dismounting of failed devices and if required taking them to the onshore base.

Advertorial is based on article by E.E. Toropov A.N. Pavlovsky

For more information you are welcome to visit [www.ckb-rubin.ru](http://www.ckb-rubin.ru)



Rubin proposed idea of developing the Prirazlomnaya offshore Arctic platform



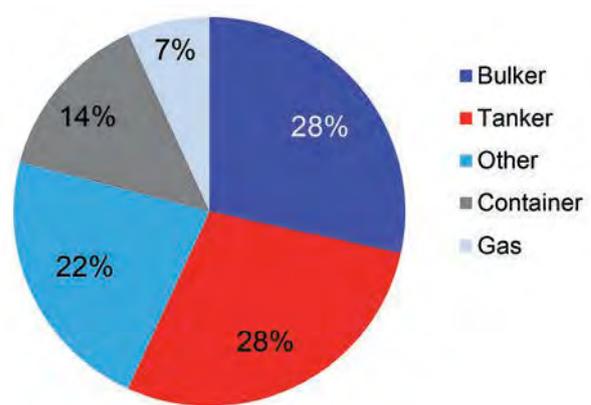
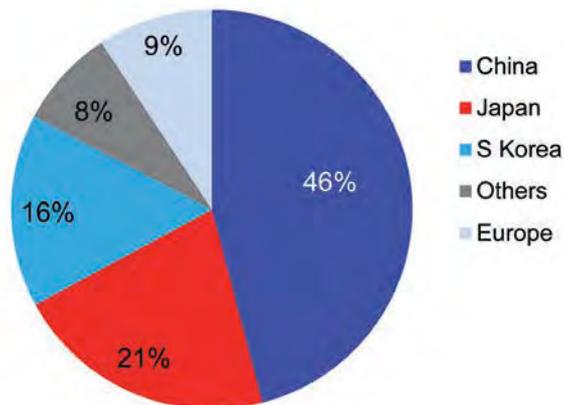
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Data extract from World Fleet Register available at [www.clarksons.net/wfr](http://www.clarksons.net/wfr)

Vessel Type	2007		2008		2009		2010		2011		2012		2013	
	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half
VLCC >= 200,000	15	14	18	23	32	20	30	24	35	27	27	22	21	9
Suezmax 125-200,000	15	11	8	5	23	22	26	11	26	18	30	15	23	4
Aframax 85-125,000	29	27	26	42	63	33	39	31	28	31	30	15	14	6
Panamax Tankers 55-85,000	28	15	17	26	26	12	15	16	19	10	9	6	7	5
Products 25-55,000	72	70	73	92	92	67	66	46	45	27	27	30	49	29
Products 10-25,000	10	9	8	5	5	5	7	6	8	6	13	5	9	4
Chem & Spec. 10-55,000	59	62	83	103	106	70	75	60	53	41	39	9	8	13
Tankers < 10,000	32	47	61	92	71	70	65	50	53	51	69	34	37	28
Capesize > 100,000	31	26	21	24	33	77	101	112	128	122	149	65	63	40
Panamax 80-100,000	22	16	15	17	27	21	60	61	81	97	140	94	101	68
Panamax 65-80,000	22	22	23	20	18	15	18	33	36	44	53	39	34	42
Handymax 40-65,000	49	50	66	61	84	100	168	166	199	198	228	146	147	119
Handysize 10-40,000	49	63	75	75	117	156	162	169	172	172	220	116	115	80
Combos > 10,000	0	0	0	0	0	0	3	2	3	0	0	0	0	0
LNG Carriers	16	16	25	26	22	17	15	12	5	10	1	2	4	13
LPG Carriers	16	20	27	33	25	18	18	18	16	14	13	8	22	16
Containers > 8,000 teu	21	17	25	26	21	14	29	33	48	30	51	28	51	33
Containers 3-8,000 teu	58	73	69	62	59	59	77	41	31	21	39	19	46	29
Containers < 3,000 teu	107	124	137	109	68	53	54	26	33	30	33	38	29	17
Offshore	3	17	15	16	12	19	22	25	28	21	32	10	12	19
Cruise Vessels	7	3	6	3	3	6	9	4	4	2	6	1	6	0
Ro-Ro Ferries	12	10	21	6	11	8	10	13	10	9	8	8	6	6
Other	141	135	155	156	152	162	171	179	182	181	99	99	97	79
<b>TOTAL</b>	<b>812</b>	<b>847</b>	<b>974</b>	<b>1,022</b>	<b>1,070</b>	<b>1,024</b>	<b>1,240</b>	<b>1,138</b>	<b>1,243</b>	<b>1,162</b>	<b>1,140</b>	<b>809</b>	<b>901</b>	<b>659</b>

Orderbook by builder region (number of vessels)

Orderbook by sector (number of vessels)





Data includes all vessels with LOA estimated at >100m

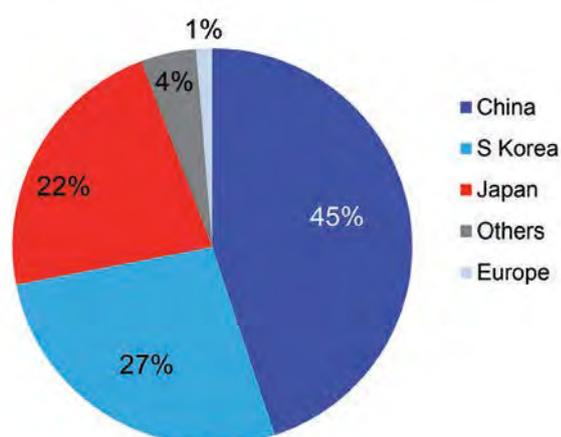
Where scheduled month of delivery is unknown an arbitrary month of build has been applied for orderbook data

The orderbook by year of delivery on this page is based on reported orders and scheduled delivery dates and do not necessarily represent the expected pattern of future deliveries

All data taken as of 1st July 2018

2014		2015		2016		2017		2018	Scheduled Orderbook		
1st Half	2nd Half	1st Half	2018	2019	2020						
14	10	9	11	23	24	29	21	21	25	56	25
4	4	7	3	8	19	35	22	25	19	19	11
4	13	22	10	31	22	36	28	24	38	52	19
3	1	2	1	7	13	10	11	7	10	14	13
49	49	60	57	60	42	39	25	26	41	88	25
1	8	4	0	3	2	6	4	7	10	12	6
12	11	36	29	43	36	38	31	39	45	55	21
25	22	12	14	25	15	23	27	33	45	30	6
56	38	46	42	65	39	55	20	30	27	74	66
62	35	57	41	71	40	75	27	38	37	104	50
42	20	19	4	1	2	6	1	1	0	1	6
98	101	144	121	124	94	124	54	56	52	73	44
96	67	100	83	84	45	67	27	41	60	50	23
0	0	0	0	0	0	0	0	0	2	2	0
14	19	16	16	15	18	20	12	31	33	36	29
14	14	25	40	49	33	45	17	23	12	33	17
59	42	58	62	37	26	34	36	47	22	51	43
26	25	18	6	2	0	2	5	7	12	6	0
22	27	27	35	39	25	35	38	43	64	106	32
32	30	25	14	25	21	18	24	25	38	32	18
3	2	5	1	8	2	7	3	8	8	21	21
12	7	13	7	6	16	21	10	8	32	26	14
72	62	66	48	50	58	44	55	42	114	131	36
<b>720</b>	<b>607</b>	<b>771</b>	<b>645</b>	<b>776</b>	<b>592</b>	<b>769</b>	<b>498</b>	<b>582</b>	<b>746</b>	<b>1,072</b>	<b>525</b>

Orderbook (DWT) by builder region



Source: Clarkson Research Services

# Switching on to the Internet of Things

As smart shipping becomes a reality, Inmarsat has been surveying the maritime sector's preparedness for technological transformation

Until relatively recently, a ship's internet connectivity was primarily seen as a means for seafarers to keep in touch with friends and family ashore, or for relaying important operational information to the captain and bridge officers via email. That began to change when equipment manufacturers and service providers, such as engine manufacturers, began requesting access to in-service data for analytical purposes. With the rise of 'smart ships', remote servicing and monitoring and now remote and autonomous shipping, equipment-based internet requirements are fast overtaking 'human based' purposes.

But how prepared is the maritime industry for the Internet of Things (IoT) and the different requirements and responsibilities that will come with it? Inmarsat, the global satellite network owner and operator, is now in the second year of a research programme focused on understanding the way the IoT is affecting the global supply chain. As part of this research the company commissioned a survey about IoT attitudes across the different sectors in which it is involved - Agriculture, Energy, Mining, Transport, Maritime and Others - and recently published the results.

Speaking at the company's recently opened Norwegian Maritime Competence Centre (NMCC) in Ålesund, Norway, Christer Baltzersen, sales director, certified applications programme explains: "Inmarsat has a lot of engineers that can make any sort of product and service if you ask them to. But also we need to ensure we make something that people want to use and need. That's why we're looking into all these different areas, like adoption of services, security, what kind of connectivity are they using today, what kind of data are they sending and what kind of skills they have to meet the wave of digitalisation that is coming."

With this in mind a total of 125 ship owners and operating companies were surveyed across the various maritime subsectors, including container ships, bulkers, tankers, offshore and fishing with

Vessels	Total	Shipping	Fishing
1-10	40%	25%	79%
11-20	28%	33%	15%
21-30	16%	20%	6%
31-50	11%	15%	0%
51-100	6%	8%	0%
Average fleet size	19	23	8
Base	125	92	33

Fig.1 Respondents to Inmarsat's survey by fleet size

a range of different fleet sizes (see Fig. 1). It also broke the respondents down into different geographical areas.

### Adoption

It is something of a cliché to note that shipping is more conservative than other industries, so it is something of a surprise to note that shipping has a surprising number of 'leaders' when it comes to IoT adoption (Fig. 2). However, Baltzersen notes that there can be enormous disparity between shipping companies; larger companies are likely to have dedicated IT departments while smaller ships may still be relying predominantly on fax machines.

More than 70% of respondents said that insurance was one of their drivers for adoption. Baltzersen says that Inmarsat intends to investigate this further but that insurance

companies themselves are becoming increasingly exacting in their IT demands for ships they underwrite: "They want to read into the future as much as possible and see big opportunities in getting more data, not only specific vessels but also fleets in order to predict better what will happen."

### Skills

When it came to the question of whether the maritime sector had the skills it needs for IoT, a far greater number of respondents fell into the 'laggard' category (see Fig. 3) and Inmarsat's report highlights a lack of skills as one of the barriers to adoption. Baltzersen reflects: "A lot of companies are scratching their heads at the moment and trying to come up with a digitalisation policy because everyone else is doing it.

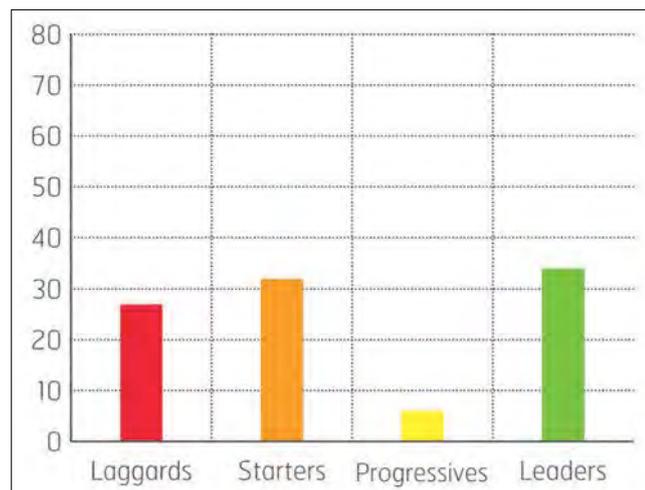


Fig.2 How mature is the maritime sector in relation to IoT adoption? (%)

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With ever more complex systems and technology, greater improvements in safety can be achieved through a better understanding of human/system dynamics. A greater awareness of the role played by management structures, culture, procedures and regulation in safe and effective operation is also important to the effective running of the vessel and wellbeing of the crew.

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## The Royal Institution of Naval Architects

### CONTRACT MANAGEMENT FOR SHIP CONSTRUCTION, REPAIR & DESIGN

17 - 19th October 2018  
Dr Kenneth W Fisher, FRINA

This programme is a lessons-learned one, not some theoretical course on contract management. It bears a lot of "scar tissue" from marine contractual disasters. It is designed for; (a) project management who handle day-to-day relations with the other party, (b) persons who form contracts, and (c) senior managers who monitor contract-related resources/cash flow.

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- Contract performance documentation
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When we go and talk to them it's still in the planning stage, but this is natural because it's still early for them."

**Security**

With regard to security (Fig. 4), none of the companies surveyed claimed to be leaders, and the 2017 Maersk cyberattack appears to have served as a wake-up call for the industry. Inmarsat emphasises that its own products and services, which are also used by governments and militaries around the world, come embedded with high-grade security to provide a basic defence in this regard.

However, when asked about the biggest security challenges associated with IoT-based solutions within their organisations, it was internal threats which concerned the respondents more; 50% mentioned poor network security, 44% mishandling/misuse of data by employees and 55% concerned by insecure storage of data. Baltzersen says: "The highest risk comes from insecure storage of data and that's something we have to analyse further. It probably has something to do with the fact we're using more cloud-based services now."

**Data usage**

In terms of the level of advancement of maritime's approach to IoT data, the overwhelming majority of companies conceded they were really only just starting. Many companies are keen to exploit the possibilities for real-time monitoring of data, with health and safety scoring highest (43% - see Fig 5) in terms of how they anticipate using the collected data. However, the maritime sector was particularly concerned by lack of timeliness, with 51% noting the lag that exists between collection of data and its availability for use.

Inmarsat says that it is working hard on ways to facilitate this faster delivery of data, which it anticipates would boost appetite for IoT-based solutions.

**Connectivity**

Interestingly, only 20% of maritime respondents felt connectivity to be a barrier to IoT adoption, a lower figure than any other sector. Inmarsat found that 69% of those surveyed rely on satellite connectivity to support their IoT solutions. Satellite has become the preferred platform for IoT

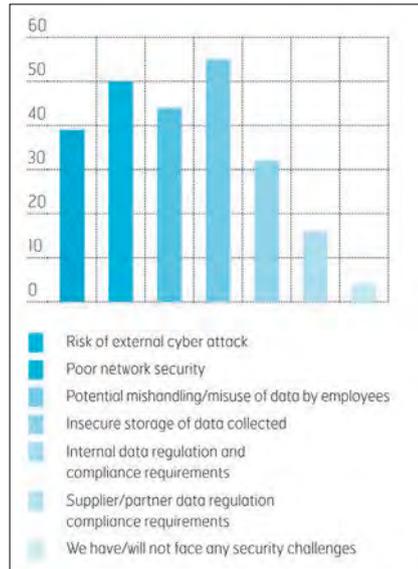


Fig.4 What are the biggest security challenges associated with IoT in your organisation?

fact that the respondents expect to spend more of their IT budgets on it than other digital technologies. Inmarsat has noted significant variation in expenditure, however, with some planning investment of up to US\$3 million over the next three years and others as little as US\$100,000 over the same period.

Inmarsat itself is continuing to develop new solutions to reflect new trends and requirements. No longer is it a question of an engine manufacturer 'borrowing' capacity from the vessel operator when it wants to access data from its systems, as it is now possible for them to enter into a separate third-party agreement with its own dedicated bandwidth. In addition, the company offers dynamic bandwidth packages, so that companies only requiring occasional access – such as telemedicine services which might want to connect from ship to shore in the event of a medical incident – can open a line for short periods billable at 15-minute increments.

It is also developing application hosting solutions, which Baltzersen says will become more important going forward with regard to the ability to store more data, noting: "You don't necessarily need to send all the data back to shore raw; you can do some of the processing onboard the vessel before sending what you need. If the system is working normally you just send ordinary amounts of data to let everyone know that it is working, but when you get an alarm, from an engine for instance, you can download more to analyse what is going wrong."

As smart shipping gathers momentum Inmarsat is increasingly becoming more closely involved in the construction and development stages of vessel. It is currently working with Samsung Heavy Industries in South Korea on a project that will allow the shipyard to monitor it from the point of delivery, rather than having to wait to assess its condition at the five-year dry docking point.

Change rarely comes easily in shipping, but Baltzersen concludes that, at least as far as the IoT is concerned: "It's not looking too bad for maritime." **NA**

support, with 51% of companies naming it as their preferred method against 22% for VSAT and 21% for radio. But the report notes this is also hindering uptake of emerging technologies from can support IoT, such as LoRaWAN and Bluetooth.

**Investment**

That maritime companies do appreciate the importance of IoT is reflected in the

Fig.5 How do you/will you use data from your company's IoT-based solutions?



# The 13th International Marine Design Conference

Chair of the International Marine Design Conference, Professor David Andrews, reviews the 13th IMDC, which saw a strong focus on design methodology, Ice Class design, and autonomous ships

The 13th International Marine Design Conference (IMDC), which took place from 10-14 June 2018 at Aalto University, Espoo, Finland, was the latest in a series of tri-annual conferences, which began in London in 1982. Some 173 formal participants (plus some 20 local students) presented 111 papers including four keynote papers and two State of Art (SoA) reports. Papers were presented from 18 countries in Europe, the Far East and the Americas, with the largest number coming from the host nation, Finland.

Given the aim of IMDC is to promote all aspects of marine design as an engineering discipline, Aalto University focused the conference on the design challenges and opportunities in current maritime technologies and markets:

- The challenge in merging ship design and marine applications of experience-based industrial design;
- Digitalisation as a technology enabler linking efficient design, operations and maintenance in the future;
- Emerging technologies and their impacts on future designs;

and, owing to the major two ship design and building sectors in which Finland is prominent:

- Cruise ship and icebreaker design, including fleet composition to meet new market demands.

The latter was reflected in a joint presentation that commenced the technical programme given by Jan Meyer, CEO of Meyer Turku Shipyard, and Kevin Douglas, Vice President for New Building & Innovation, Royal Caribbean Cruises. It dynamically set out the success factors behind the two companies' long term partnership at the cutting edge of the cruise ship sector. Having outlined both their recent highlights (Meyer Werft has seen



IMDC delegates at Aalto University, Espoo, Finland

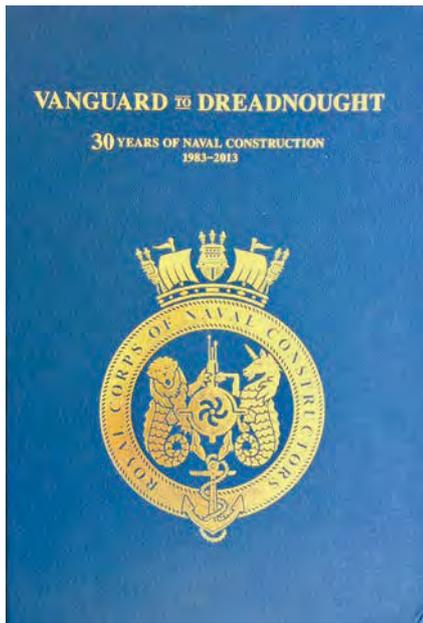
51% growth in the last decade, while RCCL boasts an annual revenue of US\$8.8 billion) and current innovative collaborations, such as the Diamond (stern) Window and the Quantum Class series of vessels for the Chinese market, they emphasised their partnership was characterised by “a solution-oriented spirit” in marked contrast to the traditional short term competitiveness found in much of the shipbuilding sector.

The keynote papers included ‘Disruptive market conditions require a new direction for vessel design practice and tools application’ in which Ulstein International’s Deputy MD Dr Per-Olaf Brett argued that to be resilient in such a disruptive market will require future naval architects to be able to develop both the business case and the ship design solution as one integrated delivery. Meanwhile, in his ‘Towards maritime data economy using digital maritime Architecture’, Tommi Arola of the Finnish Transport Safety Agency suggested that Big Data could potentially equate to big wins for the maritime sector. University College London’s (UCL) Prof. David Andrews posed more fundamental

questions with ‘Is a naval architect an atypical designer – or just a hull Engineer?’ Andrews concluded that the answer is decisively the former, since only a naval architect has the overall task of concept creation. The fourth keynote was ‘Design and construction of advanced Arctic ships in an international network’ by Markku Kajosaari, SVP of Arctech Helsinki Shipyard, which outlined the challenges in designing ice-breaking condensate tankers capable of operating efficiently and environmentally in Russian Arctic waters.

The plenary sessions of the third and fourth days began with two SoA Reports. In the first, on ‘Design methodology’, UCL’s Andrews and Dr Austin Kana of TU Delft reviewed recent publications covering both the broader philosophy behind design practice, and those specifically related to ship design research. This was supplemented by a contribution, by Prof. Jani Romanoff of Aalto University, on ‘Material and structural selection tools at the early design stages’. For the second SoA Report Patrik Rautaheimo, CEO of Elomatic Oy, addressed ‘Cruise vessel

## “VANGUARD TO DREADNOUGHT: 30 YEARS OF NAVAL CONSTRUCTION 1983-2013 Celebrating the 130th Anniversary of the Royal Corps of Naval Constructors”



The 130th Anniversary update to the history of the RCNC, following delays in obtaining security clearance and a committed publisher, has been published recently as an unclassified book by the Royal Institution of Naval Architects.

The book is A4 size in hard back at 190 pages, with a navy blue cover having the title and RCNC crest shown in gold. ISBN number is 978-1-909024-74-8.

The book, compiled and edited by Charles V Betts, Head of RCNC 1992-98, is similar in content to the PROTECT classified version published within the MOD in 2013 but with corrections and some additions together with a full Index and list of abbreviations.

The book is on sale via the RINA Bookshop at a price of £27.50 plus £3 P&P. The price for active and retired RCNC members is £22.50 plus £3 P&P thanks to a subsidy by the RCNC Mess.

The book is available via the link [www.rina.org.uk/rina\\_books](http://www.rina.org.uk/rina_books)

The Royal Institution of Naval Architects

### International Conference: Full Scale Performance

24-25 October 2018, London, UK



### Registration Open



In general there is a growing need in the maritime world for ship performance analysis on full scale. This has several reasons related to either cost saving, legislation and environmental concerns.

With the introduction of the IMO Energy Efficiency Design Index (EEDI) the need for ship full scale performance measurement and verifications has grown in importance. There are now new ISO standards for initial ship trials to verify the EEDI calculations. ISO 19030 standard consolidates the latest academic and industry knowledge regarding a standardised method to measure the performance of a vessel through the water. IMO and EU require vessels to monitor their efficiency in terms of fuel consumption and distance travelled (EU MRV starts 1st January and the IMO system 1st January 2019). It is expected that the data collected will help inform future EEDI regulations.



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design' and reviewed the sector using extensive data and illustrations of some of the latest vessels.

In the limited space here, it's only possible to give a flavour of the range and depth of topics presented in the remaining 105 papers. Themes included:

- State of art ship design principles – education, design methodology, structural design and hydrodynamic design;
- Cutting edge ship designs and operations – ship concept design, risk and safety, Arctic vessel design and autonomous ships;
- Energy efficiency and propulsion – design for energy efficiency, hull form design and propulsion equipment design;
- Wider marine design practice – naval vessels, offshore and wind farm installations and production considerations.

Highlights of the first Design Methodology session included Henrique Gaspar of NTNU in Norway presenting via internet 'Vessel.js: An open and collaborative ship design object-oriented library' using the Javascript based system with a 'fleet of ship representations' in a seaway. Anreitte Bekker, from Stellenbosch University, spoke on 'Exploring the blue skies potential of digital twin technology applied to a polar supply and research vessel', concluding that the challenges are the veracity of data used and the understanding of interdisciplinary insights to be obtained through this sort of facility. Morten Strøm, on behalf of a Norwegian team, addressed 'Combining design and strategy in offshore shipping' to consider how to design a robust offshore vessel to give value throughout its life cycle. He concluded Markov methods could be used to provide quantitative decision support in the design process.

In the Structural Design session Mark Smith of US company Navatek proposed an 'Improved ultimate strength prediction for plating under lateral loading', which not only expanded design space consideration to multihulls but also proposed moving away from the traditional Regression Analysis (Rules based Design) in early stage design to first principles in order to cover novel cases. Focusing on education, and

the outdated tools and techniques today's students are being taught with, Rachel Pawling of UCL presented 'HYDRA: Multipurpose ship designs in engineering and education'. Tools used at UCL for ship design courses include cost-capability trade-offs, SWOT risk approaches and "quick and dirty" sketching of layout typologies. The presentation led to a lively debate and a decision to explore the rapidly changing nature of ship design education more fully at the next IMDC.

The following day, Richard Birmingham of Newcastle University (and RINA's new President) gave a very unusual and fascinating paper on 'The role of aesthetics in engineering design—insights gained from cross-cultural research into traditional fishing vessels in Indonesia'. While considering the embedding of aesthetics in engineering design theory, he showed from an Indonesian fishing boat case study that ignoring local customs and aesthetic norms, when upgrading such fleets, can be counter-productive. Etienne Gernez of the Oslo School of Architecture reported on 20 years of studies at sea getting to know the people, context and culture in 'Human-centered, collaborative, field-driven design – a case study'. A comment was made in the discussion that few naval architects spend any significant time at sea sufficient to absorb the mariners' culture.

UCL's Pawling presented again on 'Designing ships inside out', and 'Seeing arrangements as connections: The use of networks in analysing existing and historical ship designs' which had analysed a wide range of naval-like ship general arrangements with different visualisations of the results to identify possible 'design style' characteristics and how this might assist future new designs. Ken Droste of TU Delft considered 'Process-based analysis of arrangement aspects for configuration-driven ships' where he stated their performance was driven by the internal arrangement of critical spaces, using an naval amphibious warfare vessel as an example.

In the first of two papers from NTNU Trondheim, Sigurd Pettersen addressed 'Design for resilience: Using latent capabilities to handle disruptions facing marine systems' on how to design offshore support ships to still be useful outside their

intended mode(s) of operation in an era of disruptiveness. The fact that he showed 10 different definitions of 'resilience' shows how these 'style' aspects of D for X need to be carefully addressed. An issue often overlooked in marine design, 'Design for Decommissioning (DfD) of offshore installations', was considered by Calum Campbell of Strathclyde University and proposed an approach focused on reducing risk by early consideration.

A session of papers on autonomous ships began with Osiris Banda of Aalto University and 'The need for systematic and systemic safety management for autonomous vessels' applied to two autonomous ferries being developed for Finnish operations. Eetu Heikkila of VTT Finland Limited asked "Do we know enough about the concept of unmanned ship?" and covered aspects such as seaworthiness and concluded there was a need for a new design philosophy. Martin Bergström of Aalto University outlined the measures 'Towards the unmanned ship code' proposing a pattern similar to the recently agreed Polar Code in meeting an equivalent level of safety with approval based on IMO guidelines.

One of the final papers, from Connor Goodrum of Michigan University, provoked lively discussion as it considered 'Understanding initial design spaces in set-based design using networks and information theory' and illustrated – with network analysis of design communications paths – the key role the naval architect plays in the ship design process.

Beyond the presentations, IMDC 2018 featured a lively social calendar with nightly events. A visit to Meyer Turku shipyard was also arranged for the final day.

IMDC 2018 was organised under the chairmanship of Professor Pentti Kujala, Vice Dean of the School of Engineering at Aalto University, and was sponsored by ABB Marine, Aker Arctic, Arctech Helsinki shipyard, Elomatic, Meyer Turku shipyard, and Royal Caribbean Cruise Ltd. **NA**

The Proceedings of the 13th International Marine Design Conference (IMDC2018) 10-14 June 2018 at Espoo, Finland are published by CRC Press an imprint of Taylor & Francis Group, London, UK. ISBN: 978-1-138-5487-0 <http://imdc2018.aalto.fi/>

# Three decades of naval construction

Reviewed by Paul Wrobel FRINA RCNC

**Vanguard to Dreadnought:  
30 years of Naval Construction  
1983-2013**

Compiled and edited by Charles Betts CB.  
Published by The Royal Institution of Naval Architects, 2018. 192pp, ISBN 978-1-909024-74-8



HMS Montrose, an example of the successful Type 23 frigate class

*Drawing upon first-hand accounts, material from the annual Royal Corps of Naval Constructors (RCNC) Journal as well as unclassified technical papers and official reports, 'Vanguard to Dreadnought: 30 years of Naval Construction 1983-2013' charts the design, procurement and support of warships and their systems over the last two decades of the 20th century and the first decade or so of the 21st. It places these developments in the context of how the Ministry of Defence (MoD) organisation and warship acquisition and support have changed and the effect of these changes on the RCNC itself.*

*This 130th anniversary volume was originally commissioned by the then Head of the Royal Corps, Tony Graham, for publication within the Ministry of Defence in 2013 as a companion to David Brown's 1998 history of the RCNC: 'A Century of Naval Construction'. After relatively minor changes the Ministry of Defence has now granted permission for open publication.*

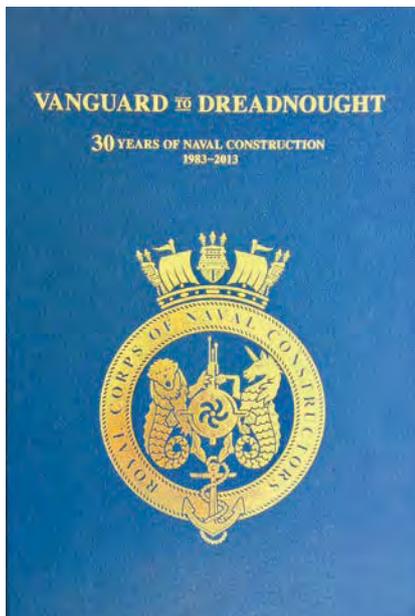
What a great story – or should that be stories? With career paths like those described, who wouldn't want to join the RCNC?

By necessity there are a lot of names from the recent past that can make the early part of the book as daunting as a Russian novel. In one context these names do matter since it is those people that have made this history, but these will soon be forgotten (I even found my own referenced). For a younger and wider readership, the stories behind the RN's ships and submarines are what provide real interest.

Charles Betts, who himself led the RCNC from 1992-98, has managed to cover a huge spread of activities that should both astound

and excite readers. Did all this really happen within the span of a single career? Even for insiders there is a myriad of stories that no one person will be familiar with.

One observation is that the greatest interest, responsibility (and fun) described in the book seems to correlate with the furthest distance away from bureaucracy. Sometimes this is geographic such as the recovery of HMS Nottingham from Lord Howe Island, others to do with organisational visibility such as covert boats for the Special Forces. Seniority certainly doesn't seem to equate with engineering added value.



The chosen period covers perhaps the Corps' greatest successes. HMS Vanguard was delivered to budget, performance and time (just 14 years from starting concept studies to Innovative Ship Design [ISD]). The Type 23 Frigates really did achieve more for less. Industry made a healthy return. Since then it appears that the system for major projects has become anaesthetised to over-runs of up to 100% and 5+ years to ISD, then followed by a performance 'get well' program incurring further cost and time. All this has contributed to a further reduction in fleet numbers and concerns about critical mass across the whole UK Naval Enterprise. What's going on – can it be reversed?

One irony of the period covered in the book is that we started and finished this 30-year span with whole propulsion system failures at sea in first-of-class vessels – HMS Upholder and HMS Daring. Furthermore, despite all the initiatives in procurement, the taxpayer footed the bill. What have we failed to learn? Should we expect the same again within the next 30-year story?

In the same 30 years the UK's naval enterprise has also undergone multiple policy and management changes – privatisations, industry mergers as well as "experiencing" a panoply of MoD organisational initiatives that put Jeremy Hunt and his predecessors in the shade for Health reform. It is a testament that the Corps survived at all during this period and perhaps that is the principal

reason that so much was achieved for the Royal Navy – “SNAFU”.

One of the most important developments in the 30 years has been the passing of front line warship design to industry. This has involved a tricky learning curve for all concerned, which has been assisted by the members of the RCNC who joined industry and who had the training, knowledge and background to do the job. It is to be hoped that industry will sponsor the training and wide understanding of naval requirements for its naval architects and marine engineers that the Corps has always considered necessary for designing and procuring a front-line Navy.

On reaching the end I will hear some readers say: “But surely things are a little different today?”; “This book draws the final curtain at the end of that age”; “The future for those wanting advancement in the MoD belongs to bureaucrats who are merely engineering magpies”; etc.

To these comments, I disagree. The defence needs of the nation and the Royal Navy are just as demanding, albeit different, and the budgetary constraints create an environment in which innovation is increasingly important. We don’t have the luxury of the decades it took to transition from sail to steam, steam to gas turbines etc. I do agree that the same careers won’t exist purely within the MoD – and certainly not in Abbey Wood. The next generation will need to manage their own careers and with greater mobility – across MoD and industry, UK and Overseas. The current generation is already doing this.

There are some interesting insights as to what really happened inside the MoD on key projects that might seem surprising even to those involved in the same project from the outside. What is equally interesting is that there were critical times at which the MoD appears to have been completely ignorant of how industry

reacted to, and sometimes anticipated, the MoD’s moves. Various attempts to outwit industry or pass off requirements and levels of risk that evidently didn’t match the budget could be likened to the Boy Scouts dealing with the Sopranos. When the MoD has gone off-piste then it usually has been the cause of trouble downstream.

Now let us hear the same story through the eyes of Industry. Then will we get a more complete picture of the reality. **NA**

### To order

*Vanguard to Dreadnought* is available from RINA at a discounted price for active and retired RCNC members of £22.50 plus £3 P&P thanks to a subsidy by the RCNC Mess. It is available to the general public via RINA at a price of £27.50 plus £3 P&P.

For more information visit: [www.rina.org.uk/RCNC\\_book.html](http://www.rina.org.uk/RCNC_book.html)

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The Royal Institution of Naval Architects



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RINA's Historic Ships conference returns for a fourth instalment that will not only focus on the restoration and preservation of historic vessels, but also the research and investigation into the engineering and efficiency of historic designs through modern naval architecture techniques.



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### LAMENTABLE INTELLIGENCE FROM THE ADMIRALITY

By Chris Thomas

HMS Vanguard sank in thick fog in Dublin Bay in September 1875 rammed by her sister ship. No lives were lost (except perhaps that of the Captain's dog) but this one event provides valuable insight into naval history of the late nineteenth century. Chris Thomas examines what happened, setting it in the context of naval life, the social and economic situation of officers and ratings. He describes the furore caused by the unjust verdict of the Court Martial, vividly illustrating the joys and trials of the seagoing life in the Victorian era, and the tragic effect on the life of Captain Richard Dawkins and his family.

Price: UK £9.00 EUR £10.00 OVS £12.00  
AMAZON PRICE: £12.74

### SHIPS AND SHIPBUILDERS: PIONEERS OF SHIP DESIGN AND CONSTRUCTION

By Fred Walker FRINA

Ships and Shipbuilders describes the lives and work of more than 120 great engineers, scientists, shipwrights and naval architects who shaped ship design and shipbuilding world wide. Told chronologically, such well-known names as Anthony Deane, Peter the Great, James Watt, and Isambard Kingdom Brunel share space with lesser known characters like the luckless Frederic Sauvage, a pioneer of screw propulsion who, unable to interest the French navy in his tests in the early 1830s, was bankrupted and landed in debtor's prison. With the inclusion of such names as Ben Lexcen, the Australian yacht designer who developed the controversial winged keel for the

1983 America's Cup, the story is brought right up to date.

Price UK £12.50 EUR £16 OVS £18  
AMAZON PRICE: £21.25

### THE ROYAL INSTITUTION OF NAVAL ARCHITECTS 1860-2010

Published to commemorate the 150th anniversary of the founding of the Institution, The Royal Institution of Naval Architects 1860-2010 provides a history of the Institution as reflected in the development of the naval architecture profession and the maritime industry over that time. In the book, members give their personal views on the development of their sector of the maritime industry and how it will develop in the future.

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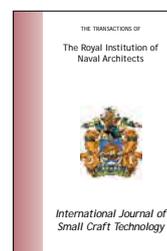
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[www.issc2018.org](http://www.issc2018.org)

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International conference, London, UK  
[www.rina.org.uk/Warship\\_2018](http://www.rina.org.uk/Warship_2018)

**September 16-21, 2018****International Maritime Conference on Design for Safety**

International conference, Kobe, Japan  
[dfs2018.naoe.eng.osaka-u.ac.jp](http://dfs2018.naoe.eng.osaka-u.ac.jp)

**September 25-26, 2018****Shipping2030 Asia**

International conference, Singapore  
[maritime.knect365.com/shipping2030-asia/](http://maritime.knect365.com/shipping2030-asia/)

**September 26-27, 2018****Human Factors**

International conference, London, UK  
[www.rina.org.uk/Human\\_Factors2018](http://www.rina.org.uk/Human_Factors2018)

**October 2, 2018****International Green Shipping Summit**

International conference,  
Amsterdam, The Netherlands  
[www.gssummit.org](http://www.gssummit.org)

**October 17-19, 2018****Contract Management for Ship Construction, Repair and Design Course**

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[www.rina.org.uk/Contract\\_Management\\_Course\\_Oct\\_2018](http://www.rina.org.uk/Contract_Management_Course_Oct_2018)

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International conference, London, UK  
[www.rina.org.uk/Full\\_Scale\\_Performance](http://www.rina.org.uk/Full_Scale_Performance)

**October 24-27, 2018****SNAME Maritime Convention**

International conference, Providence, RI  
[snameconvention.com](http://snameconvention.com)

**October 26-28, 2018****NAOME 2018**

International conference, Seoul, S. Korea  
<http://www.icnaome.org/>

**October 29-31, 2018****Seatrade Maritime Middle East**

International exhibition, Dubai, UAE  
[www.seatrademaritimeevents.com/stmme](http://www.seatrademaritimeevents.com/stmme)

**November 14-15, 2018****Education & Professional Development of Engineers in the Maritime Industry**

International conference, London, UK  
[www.rina.org.uk/EPD\\_2018](http://www.rina.org.uk/EPD_2018)

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International conference,  
Chennai, India  
[https://www.rina.org.uk/Computational\\_Experimental\\_Marine\\_Hydrodynamics](https://www.rina.org.uk/Computational_Experimental_Marine_Hydrodynamics)

**November 29, 2018****President's Invitation Lecture**

Lecture and dinner, London, UK  
[www.rina.org.uk/Presidents\\_Invitations\\_Lecture\\_Dinner\\_2018](http://www.rina.org.uk/Presidents_Invitations_Lecture_Dinner_2018)

**December 5, 2018****LNG/LPG Ships 2018**

International conference, Athens, Greece  
[www.rina.org.uk/LNG\\_LPG2018](http://www.rina.org.uk/LNG_LPG2018)

**December 5-6, 2018****Historic Ships**

International conference, London, UK  
[www.rina.org.uk/Historic\\_Ships\\_2018](http://www.rina.org.uk/Historic_Ships_2018)

**January 22-23, 2019****Power and Propulsion Alternatives for Ships**

International conference, London, UK  
[www.rina.org.uk/events\\_programme](http://www.rina.org.uk/events_programme)

**February 27-28, 2019****Design and Operation of Ice Class Vessels**

International conference, London, UK  
[www.rina.org.uk/Ice\\_Class\\_2019](http://www.rina.org.uk/Ice_Class_2019)

**March 27-28, 2019****Propellers – Research, Design, Construction & Application**

International conference, London, UK  
[www.rina.org.uk/Propellers\\_2019](http://www.rina.org.uk/Propellers_2019)

**April 30-May 1, 2019****Design and Operation of Passenger Ships 2019**

International conference, London, UK  
[www.rina.org.uk/Passenger\\_Ships\\_2019.html](http://www.rina.org.uk/Passenger_Ships_2019.html)

**June 04-07, 2019****Nor-Shipping 2019**

International exhibition,  
Oslo, Norway  
[nor-shipping.com](http://nor-shipping.com)

**June 10-14, 2019****CIMAC Congress**

International congress,  
Vancouver, Canada  
[www.cimac.com/events](http://www.cimac.com/events)

**June 17-20, 2019****Basic Dry Dock Training Course**

Training course, London, UK  
[www.rina.org.uk/events\\_programme](http://www.rina.org.uk/events_programme)

**September 10-12, 2019****Maritime Transport 2019**

International conference, Rome, Italy  
[www.wessex.ac.uk/conferences/2019/maritime-transport-2019](http://www.wessex.ac.uk/conferences/2019/maritime-transport-2019)

**September 24-26, 2019****International Conference on Computer Applications in Shipbuildings (ICCAS)**

International conference,  
Rotterdam, The Netherlands  
[www.rina.org.uk/ICCAS\\_2019](http://www.rina.org.uk/ICCAS_2019)

**October 3-5, 2019****INMEX SMM India**

International exhibition and conference,  
Mumbai, India  
[www.inmex-smm-india.com](http://www.inmex-smm-india.com)

**October 8-10, 2019****Pacific 2019**

International exhibition,  
Sydney, Australia  
[www.pacific2019.com.au/index.asp](http://www.pacific2019.com.au/index.asp)

**October 22-25, 2019****Kormarine**

International exhibition,  
Busan, South Korea  
[www.kormarine.net/](http://www.kormarine.net/)

**November 5-8, 2019****Europort 2019**

International exhibition, Rotterdam  
[www.europort.nl](http://www.europort.nl)

**December 3-6, 2019****Marintec China**

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

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