



# THE NAVAL ARCHITECT

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Denmark / Heavy lift /  
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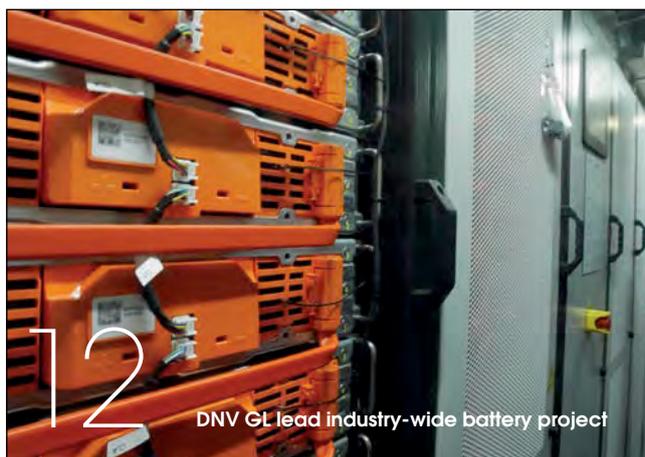
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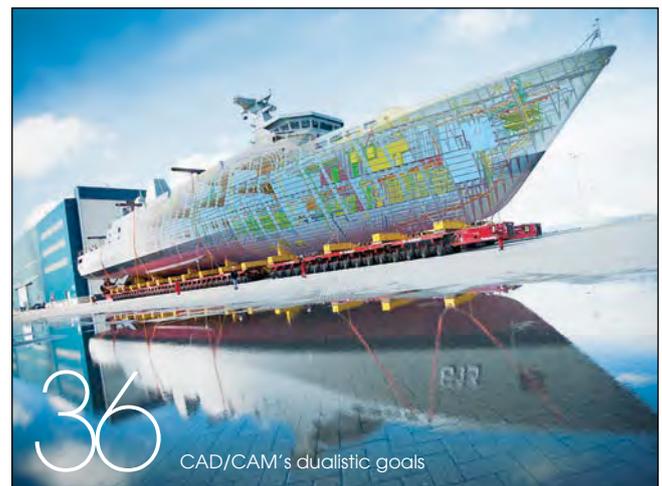
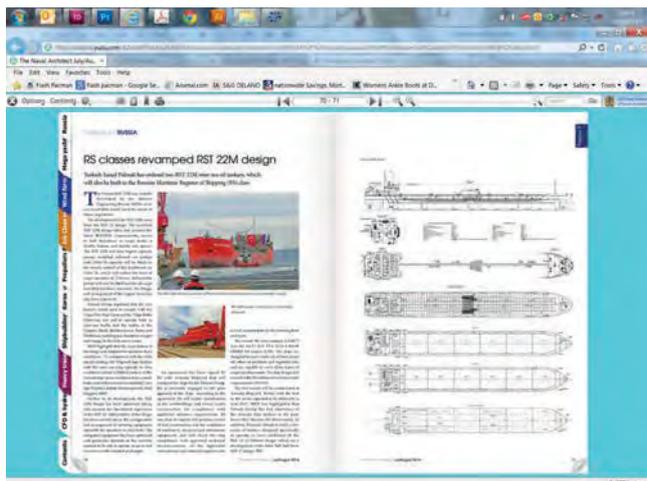
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## The dynamics of Danish innovation

Innovation network Green Ship of the Future has been involved with a number of projects, including the RegionalECOfeeder

Spend any period time with people connected to maritime and you'll hear a full spectrum of opinions as to whether or not it is truly committed to progress and innovation. One of the 'highlights' of a press trip I attended in Copenhagen at the end of February was sitting in a pub, at the end of a crammed schedule that day, and listening to the lengthy harangue of another journalist about how half-heartedly and ineffectually the industry embraces change.

Denmark though is well ahead of the pace when it comes to taking positive steps, with numerous initiatives both with regard to marine technology, environmentalism and maintaining a commercial advantage, many with some degree of state sponsorship (see p.16-18). In many respects its pragmatic maritime philosophy seems to reflect its geographical location, falling between the disciplined business focus of the powerhouse Germany on its southern border and the green idealism of Norway to its north.

One of the drivers behind maritime research in the country is the Technical University of Denmark (DTU). Twenty-one years ago, DTU established a business school for the purpose of educating engineers with the managerial skills they would need to succeed in a corporate environment. Some years ago, mindful of maritime's conservative reputation, it began exploring the dynamics of innovation within the industry to try and understand the underlying reasons for this.

It broke down the process of technological evolution into what have been termed as 'generations of innovation'. Starting with the Industrial Revolution, and taking in such factors as the post-war rise of consumerism, innovation has gone through a

series of distinct phases that have led us to today's 'networks' (or fifth generation), whereby companies and organisations with common interests openly collaborate towards common goals.

As Zoran Perunovic, Associate Professor at DTU Business explains it: "You know the best people do not work for you, so you need to seek knowledge outside the boundaries of your organisation. By doing that you decrease time and cost."

“(Denmark’s) pragmatic maritime philosophy seems to reflect its geographical location”

Focusing in particular on tankers, Perunovic and his fellow researchers found that, as a particularly capital intensive industry, new technologies tend to be driven by customer demand. Moreover, it was strongly impacted upon by environmental disasters and the regulatory changes subsequently mandated (e.g. *Exxon Valdez* and double hulls). Yet they concluded that the transition towards less prescriptive, more goal-based, policies had facilitated a more collaborative environment where different stakeholders worked towards common ends.

Despite the perception of it being slow-paced, the DTU team found that Danish maritime was actually very effective at this. In a report published in 2015, *Unleashing the Potential of Maritime Innovation Networks*, it identified six

different types of networks ranging from large centralised organisations which actively consulted with customers and suppliers, to informal arrangements based on personal relationships.

Its analysis concluded that these networks had escalated in the wake of increased technological and market uncertainties, although did raise concerns that sometimes they bred prevarication and that publicly funded networks in particular had a tendency towards unrealistic expectations in terms of the maturity of new technologies.

We've given quite a bit of coverage to some of these networks, such as Blue INNOship and Green Ship of the Future in previous issues of *The Naval Architect* (indeed you may have read about the latter's 3D printing project in last month's *Innovation in Shipbuilding* supplement). One of the advantages appears to be that, drawing upon the expertise of different stakeholders, they are an effective means of filtering out the hype from what's currently possible. The drawback is that there's a tendency to think small and companies become reluctant to invest substantially when their less-endowed partners may not be able to match them.

Perunovic says that DTU Business's research is now turning towards the implications of the sixth generation of innovation, the so-called 'Fourth Industrial Revolution', a fusion of the physical, digital and biological worlds with technologies such as nanotechnology, quantum computing and the Internet of Things. But here the line between anticipating the future and metaphysical speculation becomes rather blurred. What can be said with more confidence is that Denmark's wealth of expertise should ensure it has a prominent role in what lies ahead. *NA*

## Classification

## BV releases new cyber security notations

In recognition of the increasing importance of sound cyber security at sea, Bureau Veritas have announced the release of a series of notations and guidelines, designed to safeguard crews and vessels from attack as well as ensuring they are compliant with cyber security regulations.

The first new notation, SW-Registry, is concerned with the tracking of installations of new software versions on ship systems. Achieving this notation requires the establishment of a certified register of software, which details new installations and creates a record that stakeholders can refer to. The notation is compulsory for new ships with digital systems, and allows them to comply with IACS UR E22, which has been applicable since 1st July last year.

The second new notation, SYS-COM, has been specifically created to inhibit cyber-attacks by certifying the exchange of data between ship and shore. Although only voluntary, the notation covers an area that is generally considered a key weak point in ship data cyber security. In developing this unique notation, Bureau Veritas has worked with a number of shipowners and technology companies, including Bourbon and Kongsberg.

In December, Bureau Veritas released NI 641 – Guidelines for Autonomous Shipping, which advises on the risk assessment of ships and their autonomous systems, and provides recommendations for a minimum level of functionality of these systems and ways to improve their reliability.

To support these notations and guidelines, Bureau Veritas offers testing services for cyber safety, such as software code analysis and simulations using a ship mathematical model to test code in hazardous situations. Software penetration tests can also be performed to ascertain security risks.

Later this year, the class society plan to release a certification scheme covering all onboard systems and a

further notation covering monitoring of the state of these systems plus logging of security events.

## Disaster

## Fire aboard *Maersk Honam* results in fatalities

A Maersk Line container ship, *Maersk Honam*, suffered a fire on the 6 March en-route from Singapore to Suez which has claimed the lives of four crew members and left another missing.

The fire began in one of the forward cargo holds as *Maersk Honam* was in the Arabian Sea, 1,000 miles southeast of Oman. The crew sent out a distress signal after they were unable to extinguish the blaze. A nearby vessel, *ASL Ceres*, responded allowing 23 of the crew to evacuate, leaving four unaccounted for. One of the evacuated crew members died the following day.

By the 9 March, the fire had been tamed by *ICGS Shoor*, *CSC Nelson* and *Maersk Involver*, allowing Maersk to confirm that the remains of three of the missing crewmembers had been found. One crew member is still missing.

The 15,225 TEU H-class vessel, which is 340.5m long, was only delivered in August 2017.

A second incident occurred 10 days later as a container caught fire in a cargo hold aboard 2007-built, 6188 TEU *Maersk Kensington*. In this event, no crew members were harmed.

## South Korea

## South Korean shipbuilding to get government boost

The increasingly beleaguered South Korean shipbuilding industry, which has suffered latterly from a decline in orders, rising steel prices, and competition from China, is set to receive a boost from the South Korean government – using taxpayers' money.

The government is reportedly planning to order Kwon5.5 trillion (US\$5.1 billion) worth of newbuildings, equating to around 40 vessels, which will largely be military and patrol ships. A handful of LNG vessels will also be ordered each year going forwards, complementing a swell of 16 private LNG carrier orders this year by the likes of Flex LNG and BW Gas. A further Kwon8 trillion will be invested to secure the signing of 200 orders by private Korean shipping companies.

The government also intends to support the hiring of 3,000 workers, in an attempt to quell growing discontent in South Korea's industrial cities such as Busan and Ulsan. As part of a recovery plan concluding in 2022, greater development of design and production approaches for smaller shipyards, as well as autonomous

Classification societies look set to take the lead on cyber security



and green ships, will be encouraged. A council promoting cooperation between shipbuilding and the financial and shipping sectors is also set to be established.

Notably, an official announcement on 5 April raised the prospect of a sale of South Korea's largest yard, Daewoo Shipbuilding & Marine Engineering (DSME), following the conclusion of a rescue program being conducted by Korea Development Bank. However, the government has been criticised for 'lacking urgency' when it comes to the sale, given that Kwon20 trillion of taxpayers' money has already been poured into the state-owned yard.

The government's cash injection comes alongside ongoing efforts to restructure South Korean shipbuilding, which have focused on the poorly-performing mid-sized yards STX Offshore & Shipbuilding and Sungdong Shipbuilding and Marine Engineering, demanding lay-offs and the closure of failing divisions. The two largest shipyards besides DSME – Hyundai Heavy Industries and Samsung Heavy Industries – remain in the midst of self-rescue programs implemented in 2016.

#### Digital twin

## Digital twin platform launched in Ålesund

Following a memorandum of understanding signed in July last year by Rolls-Royce Marine, NTNU, SINTEF Ocean and DNV GL, the Open Simulation Platform has now been launched in Ålesund at the Norwegian Maritime Competence Centre.

The open source digital platform creates a virtual environment in which 'digital twins' can be created and simulations can be performed. Digital twins are copies of real ships which enable optimisation of the latter's design, maintenance, production and sustainability.

Since the launch of the platform, Hyundai Heavy Industries, Kongsberg Digital, Vard and the Offshore Simulator Centre have joined as partners. The invitation remains open, with the founders emphasising the possibilities of digital twins to prospective partners.

According to DNV GL Maritime North Europe SVP, Jon Rysst: "OSP is a joint industry project where the goal is to establish a maritime industry standard for models and system simulation, a standard that will allow companies to reuse simulation models and construct digital twins of existing and future vessels in a safe and more cost-efficient way."

A prototype of the OSP has already been running, comprising a simulated vessel and DP system. Using the cloud, different teams can use this prototype to verify correct handling of failures within the control system of the vessel's automated positioning systems, verify the impact of system changes before they are applied to the actual vessel, and optimise vessel performance.

Rolls-Royce Marine will be leading one of first projects to utilise the OSP, in which a digital twin will be created to verify a real vessel's power and propulsion system modules.

#### Finite element analysis

## LR to licence ShipRight FastTrack to MARIC

Lloyd's Register has announced the signing of a licence agreement with Marine Design & Research Institute of China (MARIC) which permits the China State Shipbuilding Corporation group (CSSC) subsidiary to use LR's ShipRight FastTrack software.

MARIC will be able to use ShipRight FastTrack to meet the increased requirements demanded in Finite Element Analysis (FEA) by the latest IACS and Classification rules. The software allows for significant time and cost savings by generating qualified FE mesh models from 2D/3D plans. According to LR, "the post process is enhanced, the result plot is displayed swiftly and an improved reporting function enables FE analysis [...] to be carried out efficiently."

MARIC's decision to purchase the license stems from a current project to design an 180K bulk carrier, which requires significant finite element analysis due to applicable classification rules and procedures, and the ship type. They state that the software will "enable us to complete this design on time and avoid a delay in the shipbuilding schedule." *NA*



Digital twins are set to become the industry standard for design optimisation and performance monitoring

# Shared vision leads to Wärtsilä acquiring Transas

The surprise acquisition of one of maritime's foremost technology companies may allow Wärtsilä's 'Smart Marine Ecosystem' to become a reality, writes Malcolm Latache

Even before it sold off its final share in the WinGD two-stroke engine business to its long-time partner CSSC in 2016, Wärtsilä was clearly positioning itself for a wider and more innovative role in maritime equipment and services. Nevertheless, the acquisition last month of Transas came as a surprise to most industry observers.

After its departure from shipbuilding in the 1980s Wärtsilä was seen primarily as an engine builder and propulsion specialist. However, its more recent acquisitions of Hamworthy, L3 (which included SAM Electronics), Eniram and now Transas gives it a much wider scope of specialist applications.

Over the last year or so, it would seem that the visions of both Wärtsilä and Transas were on a converging course. Under the leadership of ex-Inmarsat President Frank Coles, Transas embarked on its THESIS (Transas Harmonised Eco System of Integrated Solutions) project, while last November, Wärtsilä announced its intention to 'lead the industry's transformation towards a Smart Marine Ecosystem'.

Wärtsilä describes its Smart Marine Ecosystem as 'a vision, whereby smart vessels connect with smart ports and beyond to deliver three fundamental industry benefits: maximising the use of resources and operational efficiency, minimising environmental impact and risk, and achieving the highest levels of safety and security. Through data integration, greater connectivity and cloud-based technology, Wärtsilä aims to resolve inefficiencies in the shipping sector resulting from overcapacity, sub-optimal fuel consumption, and waiting times at ports and other high-traffic areas.'

On the commercial side of the deal, Wärtsilä has paid out €210m for Transas which has current net annual sales in the region of €140m. However, since Transas' main commercial product is ECDIS where it has around 25% of the market, and the mandatory roll out reaches its final phase this year, income from future sales may well drop. Transas' other offerings are simulators where again they are market leaders claiming 45% of the market and VTS systems with a customer base of ports and coastal authorities. There is almost no doubt that under Wärtsilä ownership, Transas will continue to take a lead role in ECDIS development; it could be that the other two product lines fit better with the concept of managed ecosystems in ports and at sea.

At a press conference announcing the acquisition, Roger Holm, President, Wärtsilä Marine Solutions, said: "Combining Transas with Wärtsilä will bring the Smart Marine Ecosystem many steps forward. We can now connect Wärtsilä's product portfolio, the biggest in the marine industry, with ship traffic control, simulators, navigation solutions and fleet operation solutions from Transas. The combined package will further improve the way a vessel can sail in the most cost efficient and environmental friendly way for our customers."

For his part, Coles said: "We share a common vision; one of a safer, more efficient, and more environmentally friendly maritime industry. The Transas team has significant competencies in technology, along with a globally recognised leadership position in navigation, simulation and traffic control systems."

On a practical level, both companies can claim to have already taken some steps towards realising their shared vision. Wärtsilä was a founding member along with ABB, Cargotec, Meyer Turku and Rolls-Royce of the One Sea project funded by Finland aimed at developing autonomous shipping. Last August, it successfully demonstrated remote operation of a vessel when Gulfmark's offshore vessel *Highland Chieftain* was put through a series of manoeuvres in the North Sea controlled by DP and joystick operation from San Diego in California.

Transas has participated in a number of exercises where multiple simulators have been linked in mass rescue scenarios with qualified navigators operating the 'ships' under direction from shore-based co-ordination centres. Clearly simulators are not real ships, but the technology involved could be adapted to take data and visual feeds from ships to recreate the actual conditions being experienced at sea in front of a shoreside operator.

In a statement, Wärtsilä said the acquisition will speed delivery on the company's promise to disrupt the industry by establishing an ecosystem that is digitally connected across the entire supply chain, through applications that are secure, smart and cloud-based.

The acid test for the idea of a smart or managed ecosystem will however depend upon the willing participation of actual stakeholders. That is something that cannot be taken for granted and unless those involved see tangible financial benefits the drivers can only come from regulation by authorities. [NA](#)

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## Batteries

## DNV GL launches marine batteries JDP

Classification society DNV GL has launched a Joint Development Project (JDP) aimed at developing industry understanding of lithium-ion batteries and their use in shipping. They will be joined by over a dozen partners who will aid the project, with suppliers, flag states, universities, ship owners, operators, and yards chipping in. Partners include Rolls Royce Marine AS, Damen, Scandines, ABB, Stena, and the Norwegian and Danish Maritime Authorities, plus others.

The hope is that such a wide range of organisations, from across the industry and at all levels, will create a pool of expertise and experience fed by multiple perspectives. Ultimately, this will work to demystify the challenges and steps needed to grow the use of batteries in shipping. The supply chain will also be strengthened, as manufacturers will learn how to optimise their products, and DNV GL their procedures and approval processes.

The major tasks of the JDP are defined by DNV GL as: safety model development and assessment based on prior knowledge; concerted lithium-ion battery risk assessment; a battery safety testing program; battery safety simulation and analysis tool development and refinement; project management, dissemination, and finally input to requirements and rules.

Geir Dugstad, director of ship classification and technical director of DNV GL Maritime, stated: "Including batteries in ships, whether as a hybrid or fully electric system, offers the industry the opportunity to improve fuel economy, reliability and operational costs. For this technology to fully take hold, however, knowledge and requirements must be in place to ensure that we have products and a safety regime that address the concerns of all stakeholders while also creating the conditions for this technology to take off in the market."

Commenting on the setup of the JDP, project partner ABB's VP global product manager, energy storage and fuel cells, Jostein Bogen, said: "We believe this type of project arrangement will be extremely beneficial, to raise the level of understanding of all parties involved to a very high degree, while also providing guidance that the entire industry can benefit from."

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

## Azipods

## ABB marks 100th cruise Azipod order

Technology company ABB has announced its 100th Azipod sale to a cruise ship, after receiving an order for two Azipod VI propulsion units for a Ponant

luxury polar expedition cruise ship to be delivered in 2021.

ABB launched their Azipod technology in 1990, promising efficiency gains of 10-15% above shaftline systems and a lower environmental impact due to the technology's gearless construction. In 1995, the company received their first order for the Carnival Cruise Lines Fantasy-class vessels *Paradise* and *Elation*, followed in 1997 by a significant three-Azipod order by Royal Caribbean Cruises for *Voyager of the Seas*, the largest at the time.

The technology has been a popular choice since, particularly for ice class vessels; according to ABB, Azipods are installed on more than 80 vessels that sail in icy waters. The two units to be installed on Ponant's polar expedition cruise ship will feature 6-metre propellers and offer a combined power of 34MW, helping the vessel to optimise manoeuvrability and efficiency in difficult conditions. Azipods are also well-suited to the luxury standard of the ship as they create minimal noise and vibration, ensuring guests aren't disturbed.

Since its launch, ABB's Azipod range has grown, with options spanning 1.5 to 22MW. ABB have also introduced their Ability Collaborative Operation Center, which allows technicians to monitor the operational parameters of the Azipods installed on cruise ships and perform remote diagnostics, equipment analysis, and offer predictive maintenance.

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



Azipods offer greater manoeuvrability and efficiency than shaftline propellers

## Correction

In the March issue of *The Naval Architect*, the article "Economy and manoeuvrability prompt Viking Line's Azipod choice" reported that the twin Azipod XO 2100-type units supplied by ABB to *Viking Grace* have a combined power of 6,000kW. In fact, each unit outputs 11,200kW, meaning a combined power of 22,400kW. We would like to apologise to ABB for any confusion this may have caused.

## Coatings

### I-Tech AB receives major Selektope order from Japanese company

Japanese paint manufacturer Chugoku Marine Paints has reportedly made the largest-ever volume order for I-Tech AB's bio-repellent antifouling ingredient, Selektope. The deal is the latest step in a long-term supply agreement, which has seen Chugoku increase their range of antifouling coatings which utilise Selektope, including Seaflo Neo CF Premium, Seaflo Neo-S Premium and the new Sea Grandprix 880HS Plus, which Chugoku guarantee for up to 45 days of static performance.

Commenting on the deal, Chugoku's director Hideyuki Tanaka said: "Securing CMP's commercial relationship with I-Tech to support the strong demand received for Selektope-containing products offered by CMP is of great importance. We look forward to working with I-Tech going into the future."

In a further boost for I-Tech AB, the company has announced that it is soon to close on a deal with US-headquartered Cambrex Corporation which will render I-Tech the owner of the manufacturing process technology and IP for the production of medetomidine, the active substance trademarked as Selektope.

The deal has been made possible by I-Tech AB issuing new shares, making Cambrex a major shareholder in the company and giving them a position on the board of directors. I-Tech AB's motivation for the deal is to strengthen the supply chain, and to "ensure commercially competitive prices for its customers and deliver high volume demands for Selektope," according to a recent announcement by the Swedish company.

<https://selektope.com>

## Test-engines

### MAN and Hyundai to build test-engine facility

MAN Diesel & Turbo and its two-stroke licensee, HHI-EMD (Hyundai Heavy Industries' machinery division) have announced that they are to build a test-engine facility in order to grow MAN's R&D and support the development of its dual-fuel gas engines.

The facility will be built in Ulsan, South Korea, at HHI-EMD's works and will be ready for use in early 2019. The test-engine will be the first to feature online remote control, and will also be connected to MAN's Copenhagen research centre, allowing research engineers to monitor the testing in real time.

Notable about the set-up is the inclusion of MAN's ME-GI Pump Vaporizer Unit, an LNG supply unit which pressurises and vaporises LNG to the precise temperature and pressure needed by ME-GI engines. Full redundancy is enabled via separate control of each pump head. The unit's control system is also highly integrated within the ME-GI engine's control system.

The head of MAN Diesel & Turbo's Diesel Research Centre in Copenhagen, Lars Juliussen, said: "This new test set-up will enable us to further advance our pursuit of high reliable and environmentally-friendly technology with a strong focus on cost-competitive gas engines and related equipment."

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



MAN B&W 2S5ME-C-GI test engine

# To tackle the cyber threat, shipping must change its culture

After last year's attack on Maersk, cybercrime finally appeared on shipping's radar. However, the lack of information sharing amongst shippers must be addressed if the industry is to reap the benefits of cyber security

**T**hough Maersk was not the specific target of the 2017 NotPetya ransomware attack, which hit a wide range of companies using the Ukrainian accounting software MeDoc via a malicious update, it didn't much matter. The vast majority of the shipping giant's systems crashed, compromising operations at ports and on vessels around the world over 10 days as the company scrambled to re-install their network. Maersk have since reported attack-related losses totalling a huge US\$300m.

Such a shocking incident has compelled the shipping industry to confront the neglected issue of cybercrime, and consider its readiness to prevent future attacks. Lagging behind the likes of aerospace and finance when it comes to cyber security preparedness, the industry recognised that it is something of a soft target. NotPetya may not have discriminated, but it still caused a huge amount of damage. What, then, would be the cost of a more targeted cyberattack?

This is especially pertinent given that shipping has now entered the digital age, with so-called 'smart' vessels becoming increasingly connected, both in terms of on board systems and their links to shore-based service stations and third-parties offering remote performance monitoring and navigational assistance. Whilst cyber security technology has undoubtedly improved over recent years, the number of systems aboard a vessel that might be vulnerable to attack has proliferated, presenting hackers with far more opportunity to do damage. This will be further compounded by introduction of autonomous vessels in the coming years.

DNV GL's principal consultant of shipping advisory, Jan Hinnerk Haul, echoed this idea at an Immediasea cyber security round-table last month, suggesting that modern vessels are basically a "floating data center," reliant on an array of both standard IT (information technology) systems and OT (operational technology)



Be Cyber Aware At Sea highlights the wide range of cyber security threats facing shipping

systems, such as navigational platforms and remotely-controlled valves and pumps. While a data breach in IT might risk a company's finances and reputation, Haul noted that an attack on OT, which might mean overriding the ship's navigational systems, or causing equipment to malfunction, poses far greater risks to life, property, and the environment.

## The human element

The quick-fix of updating cyber security software is only half the battle, as systems are compromised most often by the actions of untrained crew and seafarers who can introduce malware themselves through an act as simple as plugging their phone charger into a bridge USB port, or carelessly opening a phishing email. This can then play havoc with the interconnected systems on board the vessel. Ports and shore-based offices are also at risk from human cyber security negligence, and are arguably the more lucrative target.

The significant cyber risk posed by the human element is the focus of industry-wide initiatives such as Be Cyber Aware At Sea, which offers training and guidance to seafarers and attempts to raise awareness about cyber security best practice. It takes a prevention rather than cure approach, seeking to limit opportunities for criminals by instilling the concept of 'cyber seaworthiness'. As JWC International founder Jordan Wylie, who led the Be Cyber Aware at Sea campaign, suggests: "Training and awareness for me is still the biggest vulnerability, the human factor as we often call it in the maritime sector." A firm advocate of the need for training from the bottom up, from seafarers to executives, Wylie warns that "cyber-attacks are not a case of if but when. Fortune favours the prepared."

However, whilst training equips seafarers against cyberattacks, attempts to quantify the scale of the problem are hampered by shipowners' tendency towards opacity



A screenshot of a computer infected with Petya ransomware

when it comes to cybercrime. A scan of the news brings up few examples besides major stories such as Maersk and the Clarksons data breach in December. This can be attributed less to shipping's immunity from cybercrime, though, and more to the tendency amongst shipping executives to keep news of cyberattacks out of the public sphere in order to protect their reputation and, by extension, profits. As an industry that relies on trust – to deliver goods safely, and on time – a breach of cyber security is potentially catastrophic for business, even if it is averted. It could also result in legal action by cargo owners and the need to complete extensive paperwork for law enforcement, creating further disincentives to reporting attacks.

### Security through community

Attempting to circumvent this secrecy culture is the CSO Alliance, a network of company security officers (and related professionals such as CTOs and PSCOs) that facilitates the sharing of information about physical and cybercrimes in the shipping industry, to achieve 'security through community'.

Speaking at the Immediasea round-table, director Mark Sutcliffe noted that the state of disorganisation amongst CSOs, prompted by disincentives to report crime put upon CSOs by their employers, is a panacea for criminals. To combat this, the CSO Alliance have created an anonymous crime reporting platform in collaboration with Airbus, which allows CSOs to report incidents without compromising their own or their companies' identities, and spread awareness about threats in real time. It is hoped that the platform will play a role in affecting a much-overdue culture change, in which shippers, having benefitted

from information sharing, will choose to collaborate with other shippers, flag states, ports, industry bodies and P&I companies to tackle cybercrime as a united front. In Sutcliffe's words: "It's all about teamwork if we are really serious about looking out for our industry."

Cyber security advocates are keen to point out the strong commercial basis for taking a more transparent approach to cyber security in shipping, which is ultimately the strongest driver of behavioural change in the industry. Firstly, as awareness about maritime cybercrime grows, companies that openly demonstrate the efficacy of their cyber security arrangements are likely to appear more trustworthy to cargo-owners, who will worry less about disruptions to their supply chain. As Haul pointed out at the round-table, quoting Møller-Maersk CEO Jim Hagemann Snaab's words at the World Economic Forum, Maersk decided post-attack to "make cyber security a competitive advantage. Being good at [cyber security] is good for making money."

Secondly, as the EU's GDPR (General Data Protection Regulation) is set to come into force in May this year, and the IMO has announced that all shipowners will be required to incorporate cyber security risk management into their vessels' safety management as part of the ISM Code (audited by flag states), cyber security compliance has become essential in order to avoid harsh financial penalties and even vessel detainment.

Thirdly, transparency around cyber security will allow classification societies to develop more relevant and effective cyber notations, which are likely to positively impact P&I insurance premiums by lowering the risk of certified Club

members' vessels. At present, P&I Clubs do not exclude liabilities to carriers and shipowners caused by cybercrime, but if the number of attacks rises as expected and shipowners cannot demonstrate some kind of compliance, the increased risk may force the Clubs to do so.

### Looking forward

As with many issues in shipping that require owners and operators to adjust their behaviour and commit funds, such as ballast water management, the sulphur cap, and the Hong Kong Convention, there will be those who delay action on cyber security, as well as plenty of doubters about the cyber threat. The newness of cybercrime and its complexity also mean many shippers find it difficult to understand.

The IMO released MSC-FAL.1/Circ.3 Guidelines on maritime cyber risk management in July last year, marking the first significant global attempt to address the issue, but has not yet set out any regulations, which are likely to be goal-based if/when it does.

The suggestion at the roundtable was that the class societies will take the lead on cyber security, with Bureau Veritas, Lloyd's Register and the American Bureau of Shipping having released basic notations and China Classification Society a set of guidelines so far. DNV GL is also working on a set of class notations. These will give shipowners something concrete to work towards, and begin to generate a competitive advantage for those who achieve the notations.

The growing commercial and institutional support given to initiatives such as the CSO Alliance and Be Cyber Aware at Sea that are trying to open up the conversation and, more importantly, are providing concrete training and reporting solutions, further suggests that shipping is finally starting to treat the cyber threat with the seriousness that it deserves. It may take another Maersk to truly convince the industry, but as the stakes get higher, the winners will be those who see cyber security as an investment rather than a tax – and take decisive action now instead of remedial action later. **NA**

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# 'More than just Maersk': Denmark stakes its claim as maritime superpower

In January, the Danish government published its Maritime Denmark report, setting out its vision towards 2025. The head of the Danish shipowners association explains how the country aims to lead from the front

**F**or a country with a long, proud maritime heritage, it seems a little absurd that for many it has become synonymous with just one company, Maersk, even if it is the world's largest container and supply vessel operator. But as the world's sixth largest nation in terms of operated tonnage, and thirteenth largest when measured by vessels registered to operate under its flag, Denmark continues to attract shipowners and operators keen to avail themselves of Danish expertise.

Anne H. Steffensen, Director General and CEO of Danish Shipping, the national trade association which represents more than 40 shipowners, says it's important to remember that shipping is one of the business sectors in the Danish economy. "Two thirds of all our activities are outside the EU. Our biggest markets are China and the US but also other areas such as Africa, where more than 10% of our activities are related, including container services, tankers and bulk. We are also the biggest export sector in Denmark, accounting for 20% of goods and services."

This year has seen the launch of two reports intended to further advance the prospects of the Danish maritime industry. Firstly, Danish Shipping published its own four-year strategy – entitled 'Ahead of the Curve' – which outlines a series of targets to be achieved by the end of 2021. These include:

- Achieving 10% growth in both the total number of Danish-flagged vessels and the overall gross tonnage.
- Retaining the number of Danish employees at sea. The present total stands at 7,640 Danish seafarers.
- Increase to 7,000 shipping-related jobs ashore from its last calculation of 6,237.
- Develop a 'toolbox' of means to ensure effective enforcement of global sulphur cap regulation from 2020.
- Collaborate with stakeholders in implementing new IMO regulatory requirements.



Anne H. Steffensen,  
Director General  
and CEO of Danish  
Shipping

Coinciding with this, Denmark's Ministry of Industry, Business and Financial Affairs published its own Maritime Denmark report, an all-encompassing vision of how Danish Shipping needed to make the country a maritime 'power hub' between now and 2025, placing the Danish-flagged fleet into the wider context of its expertise in maritime products and services.

## Framework conditions

The Maritime Denmark report notes that Denmark is part of a growing number of emerging economies which view the shipping industry as a major growth driver, and that Danish companies must therefore be given a framework that allows them to compete on equal terms.

Danish shipping has long benefited from strong political and environmental backing, not to mention the country's political stability. But the changing international economic landscape, with declining growth and the rise in protectionism signified by Brexit and the Trump presidency, are introducing new pressures.

The report notes that: "Denmark's position as a global flag state is crucial to the weight and influence [it] carries in the forums where

international agreements and regulations are negotiated," and needs to be safeguarded in maintaining its clout in determining the maritime agenda. In certain respects though this stance is nothing new; Denmark first introduced an incentivising tonnage tax scheme (whereby tax is determined by the net tonnage of a company's entire operational fleet) in 2002, and the latest strategy builds upon earlier growth plans in 2006 and 2012.

Significantly though, the new plan marks the Danish Maritime Authority's abolition of the registration and mortgage fees for operating under the Danish flag (one thousandth of the value of the ship or its mortgage) and the eliminating of some technical requirements, such as the curious and cost-prohibitive obligation that vessels joining the Danish registry from another flag must be equipped with an onboard swimming pool.

Many of the ideas are designed to ensure Danish companies are not caught out in a changing marketplace. Among the options to be explored, Danish Government says that it will seek to initiate a dialogue with the European Commission about a 'maritime engineer scheme', which might see tax exemptions extended to service engineers

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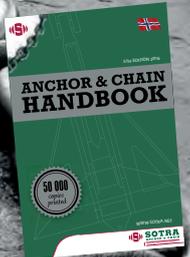
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# DANISH MARITIME FAIR

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# DANISH MARITIME FAIR 2018

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performing services while a vessel is in operation and falls within the remit of the EU's rules on state subsidies.

### Digitisation

Denmark was one of the first countries to embrace electronic certification in 2016 and Steffensen says that digitalisation and the exploration of new technologies are also components of the growth plan.

The Maritime Denmark report notes the new opportunities being created by companies such as Amazon and Alibaba expanding their business into transport and logistics, and that ships are in the process of transforming from being 'analogue units to digitised transport platforms'. In the context of marine engineering what this really means of course is increased ship-to-shore connectivity and more automated functions onboard the ships of the future. The report makes specific reference to autonomous technology and the need for Denmark to be at the forefront of its development, no doubt conscious of the significant progress its neighbours in Norway and Finland have already made with their own test centres. However, Steffensen stresses the focus will be on the use of autonomous technology within new business models, rather than for its own sake.

"I don't think 'autonomous vessels' is entirely about looking into a future of completely unmanned vessels. I think there will be less people onboard but more conducting onshore operations vis-a-vis the vessel. We asked CEOs how much of a reduction they expect in seafarers in 10 years' time and they estimated between 10-20%. They think autonomous ships may have better safety and lower emissions, and that ships can be maintained by robots. So the

main point is not reducing the crewing costs but a lot of other reasons"

This year also marked the launch of the 'Disruptors Academy', a four-day course that aims to keep Danish shipowners at the forefront of digital development and the latest technological trends, with seminars including Artificial Intelligence, robotics, 3D printing and the use of blockchain technology in maritime. Steffensen explains that one of the intentions behind it is about making sure smaller shipowners understand the new trends and technologies and how to bring them back into their companies as well as using them as a hook for attracting younger talent into the sector.

### Knowledge hub

The Maritime Denmark report includes a vow to pledge DKK237m (approx. US\$40 million) into new technology. Among the initiatives highlighted are 'ShippingLab - Driving Future Maritime Innovation', a non-profit innovation and project collaboration platform, which builds upon the community partnerships established by the earlier Blue INNOShip scheme (see previous issues of *The Naval Architect*).

The platform has been initiated by Danish Maritime (the association for Danish maritime equipment and ship manufacturers), Danish Shipping, consultancy group Force Technology, the Technical University of Denmark (DTU), the Danish Metalworkers Union and The Danish Maritime Association; a number of workshops have already been held and project ideas are being received during the first half of 2018, ahead of a formal application to the Danish Innovation Fund in August and projects commencing in January 2019.

DTU, in addition to spearheading the Green Ship of the Future network, is also part of a group consisting of the Copenhagen Business School, University of Southern Denmark, Aalborg University, Copenhagen University and others collectively known as the Maritime Research Alliance that will form a 'critical mass' of maritime educational research.

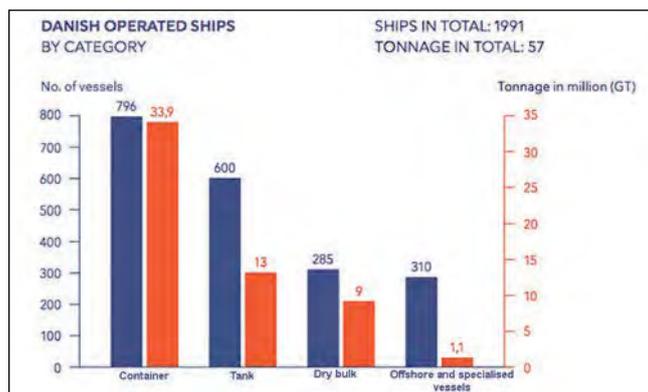
### Sustainability

Like Norway, environmental responsibility is front and centre of Denmark's shipping strategy. Danish Shipping's strategy calls for concrete initiatives by which IMO can achieve CO<sub>2</sub> reduction and Steffensen is adamant that this month's meeting of the MEPC must yield meaningful results: "Shipping has to accept its responsibilities concerning the Paris Agreement otherwise there must be legitimate demands from the public and politicians. So it's really important that in April we get a preliminary strategy on how the industry is going to reduce emissions.

"We had a study made that if we peak in 2025 it will be possible to achieve a reduction of 50% by 2050... One of the big short-term measures being discussed is speed reductions but we think it would create market distortion. It's not going to reward efficient ships and would create big problems for the ro-ro and ro-pax sectors."

Ship recycling is another significant concern. Despite Denmark being one of the few nations to have signed up for Hong Kong Convention it has still not entered into force, with many still waiting on the EU's Ship Recycling Regulations to publish an expanded list of approved recycling facilities. Steffensen warns there is mounting concern given that the current facilities, which do not extend beyond Europe, only have capacity to recycle 12% of the vessels likely to be scrapped in the coming years, and that figure shrinks further when larger ships, which few scrapyards in Europe are capable of handling, are factored in.

It's clear though that Denmark is determined to keep punching above its weight and prepared to push the agenda where other nations, perhaps less reliant on the maritime industry per se, seem more content to wait and see. [NA](#)



Container ships and tankers dominate the Danish operated fleet, although it is well represented in other sectors

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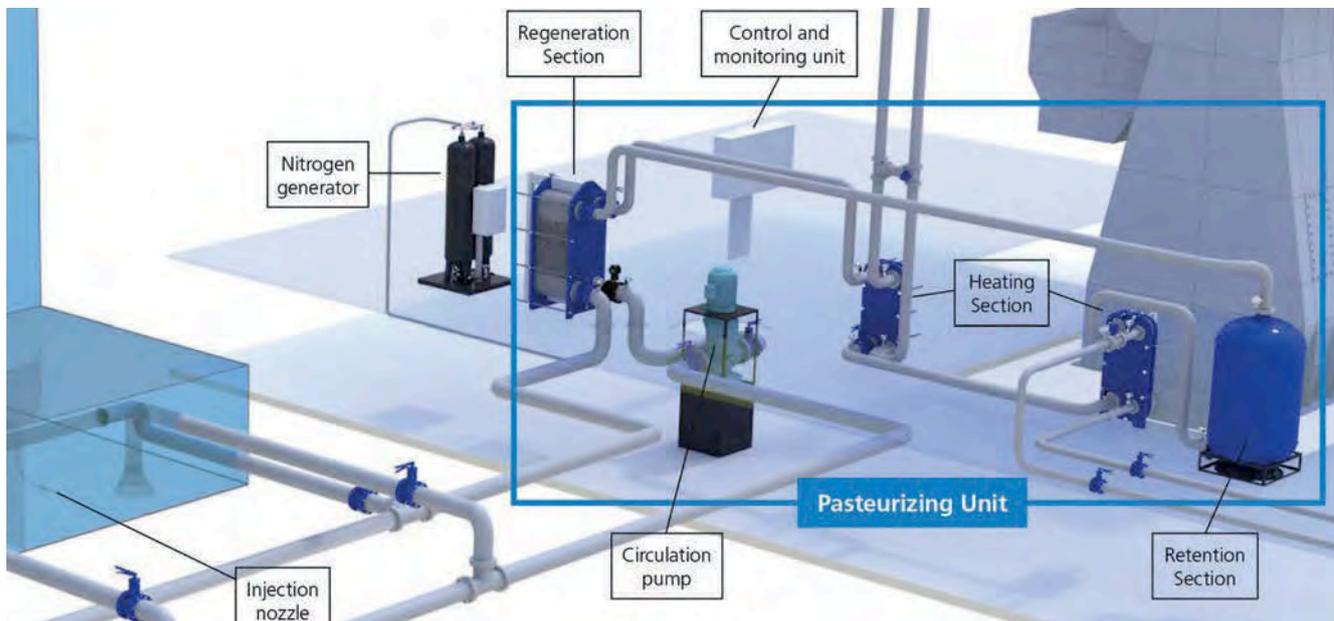


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# Danish ballast treatment firm gets into hot water

A Danish company has developed a solution to ballast water treatment that's so simple it raises the question why nobody thought of it sooner



Bawat's system utilises standard pipes, pumps and heat exchangers to exploit waste heat

Since IMO's Ballast Water Management (BWM) Convention entered into force in September 2017 competition between the manufacturers of different systems has been underway in earnest, with all keen to demonstrate the efficacy of their particular treatment technologies both to generate business from shipowners and to secure the all-important type approval from IMO and the US Coastguard.

The BWM requires that a system either kill or render inviable the overwhelming majority of organisms present in the ballast water and vast majority of those technologies fall into two broad classes: those using UV radiation or those using a chemically based treatment such as electrochlorination.

But there's a third option that's not only more environmentally friendly but doesn't even require filtration of the ballast water before treatment: pasteurisation. Heating the water to a range of 64°C to 72°C all will not only kill all organisms present but this can be achieved using waste heat generated by the vessel during its regular operations.

A Danish company is now seeking to persuade shipowners the benefits of its pasteurised ballast water treatment system (BWTS). Copenhagen-based Bawat Water Management was established in 2011 with the purpose of developing, attaining type approval and bringing to market optimal technologies for ballast water management, with stakeholders including the Danish Maritime Fund.

## Pasteurisation process

Unlike UV or electrochlorination-based ballast technologies, which require treatment of the ballast water both before and after it enters the storage tanks, the Bawat Ballast Water Management System Bawat BWMS) is unique in that it pasteurises the water in transit. A circulation is established that draws water from the top of the ballast tanks, pasteurises, then injects nitrogen to facilitate the deoxygenation process. The water is then reintroduced at the bottom of the tank for a thorough mixing.

Testing to IMO's D2 standards has found that levels of phytoplankton and bacteria fall

within the permitted range and the system received type approval in January 2015. It has also been certified as an Alternate Management System by the USCG, with full approval testing ongoing and likely to be issued in 2019.

One of the advantages of in-transit treatment is that time spent in de-ballasting in port can be eliminated which, given that mechanical failures of treatment systems continue to be a common occurrence, can prove enormously costly in terms of delays to cargo operations.

"What we do is take it to shore so that the vessel is prepared for the next port arrival, either with treated water or trimmed in such a way that it's ready for loading" explains Kim Diederichsen, CEO of Bawat. "All the other systems have to treat the water coming in and going out but we only have to do it once."

## System configuration

Depending upon the vessel type and its particular trading pattern different operational treatment options are available, in effect making the Bawat BWMS a

configured solution that factors in the voyage time, ship type and number and design of ballast tanks. Although the most commonly used source of energy is harvested from jacket water via the main engine's plate heat exchangers, any waste heat source which can bring the ballast water temperature to pasteurisation temperature can be used. In the event that there is insufficient heat, for example if the vessel has been dormant for a time, then as a contingency, heat for pasteurisation can be supplied via additional pipework to the boiler.

While such heat scavenging is particularly suited towards retrofitting onboard less energy efficient older vessels, there are few ships that cannot be adapted to use the Bawat BWMS. Ships are usually designed to operate at full speed in a sea temperature (i.e. water that might potentially be taken aboard for ballast) of up to 32°C and as low as 3°C but Bawat's solution is calibrated to work within whatever circumstances it encounters.

"If we have less heat then our hardware configuration will be adjusted accordingly. We use off-the-shelf heat exchangers but with less energy available we install more plate heat exchangers to increase the efficiency, although of course that has an impact in terms of money," he says.

"Put it this way, we have low hanging fruits and more challenging ones. It's well suited to container vessels, all kinds of cargo ships, ro-ro's, LPGs and various types of tankers. At the upper end with very large vessels there are probably other technologies at least as good as ours. We have our limitations with some bulk and ore carriers that are slow steaming and the engines are relatively small compared to the ballast water volume where the system is challenged."

Bawat's system is unique in that it uses standard piping and components (i.e. heat exchangers and pumps) which can be sourced from anywhere, meaning that the company's business model is not dependent on hardware (the installation costs range from US\$140,000 for a smaller vessel to US\$350,000 for a larger ship).

Instead, Bawat's intellectual property lies in the technology behind its control process and the automatic flow adjustment systems it supplies to the vessel. So far it has registered eight separate patents (of which six are pending), including in China, where most its initial projects have taken place so far. It has

also established partnerships in more than 25 countries for third-party installations.

### Teething problems

Diederichsen says that future for Bawat is promising and, unsurprisingly, is confident that the company is on the right track, but admits that one of the challenges remains convincing shipowners that it's an effective treatment. Maersk, which was one of the initial investors during Bawat's startup, have conducted pre-studies but have yet to be persuaded of the technology's maturity.

Another challenge is that shipyards, not owners, often have the advantage when it comes to the selection of which treatment system to install and opt for a preferred partner unless the owner expressly stipulates otherwise.

Nonetheless, while it may arrive at the party a little too late to reap the dividends of the retrofit boom, ballast water treatment is here to stay and in the long-term there appear to be few impediments to Bawat's system establishing itself as a credible option. **NA**

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# Changing partners as heavy lift looks for a better year ahead

Heavy lift has had a tough time of late, but increased activity in the sector may herald a partial recovery, writes Malcolm Latache

Just as for most other sectors in shipping, the heavy lift and project segment has suffered over the past few years as confidence in world trade demands fell after the crash in oil prices.

To highlight the problem faced by conventional heavy lift shipowners, of the almost 840 or so ships in service or on order with lifting capacity in excess of 150 tonnes, a little more than half – 443 vessels – are of types considered as being purpose built offshore ships. With little work available in offshore construction many of the multipurpose type have returned to their traditional role but have found specialist cargoes hard to come by.

There has been a high level of scrappage of older vessels in recent years but there are more than 40 newbuildings spread across several owners. Whether or not all of the ships will be built remains to be seen. Ten of the vessels on the orderbook of Chinese builder Taizhou Sanfu are a series of 12,325dwt vessels with 250-tonne cranes. These were ordered as long ago as 2014 with deliveries planned from 2015 onwards, but last year after several delays Zeaborn reportedly terminated the contract. The vessels are still recorded as being on order but with no details of potential owners having been made public.

Around the same time as Zeaborn was placing its order at Taizhou Sanfu, Danish operator Nordana was also ordering eight similar vessels at the same yard. These vessels were also delayed and before they could be delivered the consolidations that were taking place in the sector saw Nordana acquired by Rickmers Linie in June 2016. The venture was short lived with Rickmers Linie itself being acquired by Zeaborn in February last year.

Four of the vessels that Nordana had ordered have been built and two are now in service but they were purchased before completion by newly formed Netherlands-based Cargow with the assistance of Japanese finance. The first of the vessels,



Multipurpose heavy lift vessels have fared better than purpose-built offshore ships

*Frigg W* was delivered in October last year and the second named *Freya W* in January this year. The second pair are due for delivery in May 2018. Of the other four vessels, three have been commenced but their future is somewhat unclear at this moment.

The vessel size and types mentioned above are typical of most ships in the heavy lift sector although slightly smaller than most of the other vessels in the orderbook which come in at between 13,300 and 14,000dwt. In terms of ship numbers, Leer-based BBC Chartering have the most with three 12,500dwt vessels with 250-tonne cranes and four 14,400dwt vessels with 400-tonne cranes all being built at Jiangxi Jiangzhou Union in China. The largest ships on order are six 18,000dwt R-class vessels for Spliethoff of Amsterdam and a 19,000dwt vessel for Spliethoff's Biglift subsidiary.

The new R-class ships are a departure in design from the typical multi-purpose vessel and have a forward wheelhouse and accommodation, a hold length above 100m and are designed to meet Polar Code requirements. They will also be built with scrubbers fitted.

As well as the various consolidations and new ventures mentioned above, the last twelve months have seen other changes in co-operation agreements. In July last year, Japan's K Line agreed to sell its German

subsidiary SAL to Harren and Partners which also owns the semi-submersible operator Combi Lift. The SAL ships have all since been reflagged to Germany and in February it was announced that as of 1 April, SAL would team up with RollDock to form the world's first pool for dock vessels. The pool will consist of the combined fleet of six vessels and will be managed by RollDock with SAL providing specialised heavy break bulk cargo support.

Last October, the four-and-a-half year marriage of Biglift and RollDock – as BigRoll – was announced as ending in January this year. The four-ship fleet was split between the two partners. In the same month, another Dutch operator, Jumbo, announced a co-operation agreement with BBC Chartering under the title Global Project Alliance. Whilst both partners have agreed to an exclusive co-operation they will continue to operate as separate entities.

Most recently in February, AAL and Hyundai Merchant Marine (HMM) launched a global cooperation that will create a joint Far East – Middle East MPV liner service, served by five MPV vessels and a scheduled bi-monthly rotation. The fleet comprises four 30,100dwt 640-Class vessels from HMM and one 31,000dwt A-Class vessels from AAL. [NA](#)

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# Da Ji's designers do the heavy lifting

Prioritising loading flexibility and efficiency, SDARI-designed *Da Ji* is an assured contribution to a sector in recovery

The widely-reported slowdown in the project cargo and heavy lift sectors over the last few years has resulted in consolidation, cost-cutting, and a decline in the number of heavy-lift vessel newbuildings. As well as a merger between United Heavy Lift and Thorco Shipping in 2016 to form Thorco Projects, 2017 saw German ship management company Harren & Partner acquire SAL Heavy Lift from K Line, which only purchased the project cargo specialist in 2011.

Nevertheless, a handful of newbuildings are proceeding in the heavy lift sector to satiate the demand for more economically and environmentally efficient project cargo vessels, given that the average age of vessel in the current fleet sits at 15 years. As in the containership and bulk sectors, vessels are growing in size to maximise efficiency, but are also becoming increasingly flexible in order to allow for diversified and therefore more profitable operation.

## Flexible operation

*Da Ji*, the first of a series of four general cargo / heavy lift vessels designed by the Shanghai Merchant Ship Design & Research Institute (SDARI) and delivered in January 2017 to COSCO Shipping Ltd., is an example of these current trends in heavy lift ship design. At 179.67m long and 28m wide, and with a (design) deadweight tonnage of 23,772dwt, *Da Ji* is at the larger end of multipurpose cargo vessels, allowing it to accommodate for both very large, singular cargoes and smaller, more standard cargoes.

It is this flexibility which defines *Da Ji*, rendering it a general cargo ship with specialist heavy lift capabilities. The diverse cargoes it has already transported include a new Panama canal lock and part of a nuclear power station. Overlength and heavy cargoes that can't be conveniently or safely loaded onto the exposed deck can be accommodated in the 54m-long no.2 cargo hold, as was the case for eight sets of RTG container cranes.



*Da Ji's* innovative hull form and bulwarks can be seen here

*Da Ji* also has a container capacity of 1,035 TEU, allowing the vessel to fulfil the role of a conventional cargo ship in-between one-off projects and maximise revenue for COSCO. The total cargo capacity of the vessel is 35,684m<sup>3</sup>.

## Lift capacity

Perhaps the most important equipment on board a heavy lift vessel are its cranes, which enable the safe but efficient loading and discharging of complex project cargoes. *Da Ji* possesses three TTS NMF cranes on the port side, the front two of which are identical, and a smaller third crane towards the stern. The larger cranes each possess a SWL (safe working load) lifting capacity of up to 350t, enabling tandem lifting of up to 700t, whilst the smaller crane can manage 100t.

Essential to compensate for the weight of the cranes and the imbalances created during lifting is an effective ballast system. *Da Ji* is fitted with an automated anti-heeling system, which can adjust the corresponding water ballast required to guarantee stability. COSCO's own BWMS is utilised aboard to ensure ballast water

is compliant, with a capacity across two pumps of 500m<sup>3</sup>/h.

## Hull and propulsion

Whilst SDARI needed to ensure that *Da Ji* could be flexible in its operation, an equally important consideration was fuel efficiency, achieved largely by designing an optimal hull form.

SDARI performed comprehensive model testing at the China Ship Scientific Research Center, and combined this with their empirical method to develop a hull form that would achieve maximum energy efficiency over the vessel's broad anticipated range of speeds and draughts. The hull also includes an innovative bow to reduce speed loss in rough seas; *Da Ji* is noted to be a particularly fast vessel in the heavy lift sector, achieving 15.50kn at design draught.

In terms of propulsion, *Da Ji* is fitted with a Wärtsilä 6RT-Flex50D, running on HFO, MDO and MGO and achieving an output of 7000kW x 95rpm. The designers say that low-sulphur versions of these fuels will be used once the 2020 sulphur cap comes into place. At present, however, the vessel's

EEDI value still satisfies Phase III, aided by inclusions such as a water-lubricated shaft bearing system to avoid oil leakage. Further efficiency measures include Hub Vortex Absorbed Fins (HVAFs) fitted to the fixed-pitch propeller to counteract swirls and break the vortex, reducing losses of energy in the propeller.

### Out at sea

*Da Ji* is also outfitted with a range of anti-piracy features to reassure project cargo owners and improve crew safety. The side-rails that would conventionally be installed have been replaced by thick bulwarks capable to shielding against bullets and knife stabs, further acting as a deterrent to boarding. In such an event, however, crew can retire to the citadel in the forward-located wheelhouse, which features specially-made doors and hatches, plus steam nozzles.

#### TECHNICAL PARTICULARS

##### *Da Ji*

Length, oa.....	179.67m
Breadth.....	28.00m
Depth, to main deck.....	14.80m
Deadweight, design.....	23,772dwt
Cargo capacity.....	35,684m <sup>3</sup>
Cranes.....	3
Performance.....	SWL 350/200/40t x 20/33/36m SWL 100/40t x 18/36m

*Da Ji* and its sister ships have been cited as a component of China's 'Belt and Road' development strategy, with the vessel currently deployed on the Europe/Mediterranean route. Notably, only one month after its deployment,

the vessel was involved in a rescue in the Mediterranean Sea, responding to a distress call from cargo ship *Anna. Da Ji* managed to save all 10 crew members, after their stricken ship sank.

The success of *Da Ji* is exemplified by the delivery of two sister ships: *Da Xiang* in July 2017 and *Da Gui* in November 2017. A fourth sister ship is expected for delivery this year. In its flexibility, the vessel represents a move away from intense specialisation, which is to be expected as profit margins become thinner and diversification more important, particularly in sectors such as heavy lift. However, as long as large-scale infrastructure projects continue to take place – which there can be some confidence about, given the ongoing growth of the developing nations – there looks to be a more hopeful future for heavy lift and project cargo yet. **NA**

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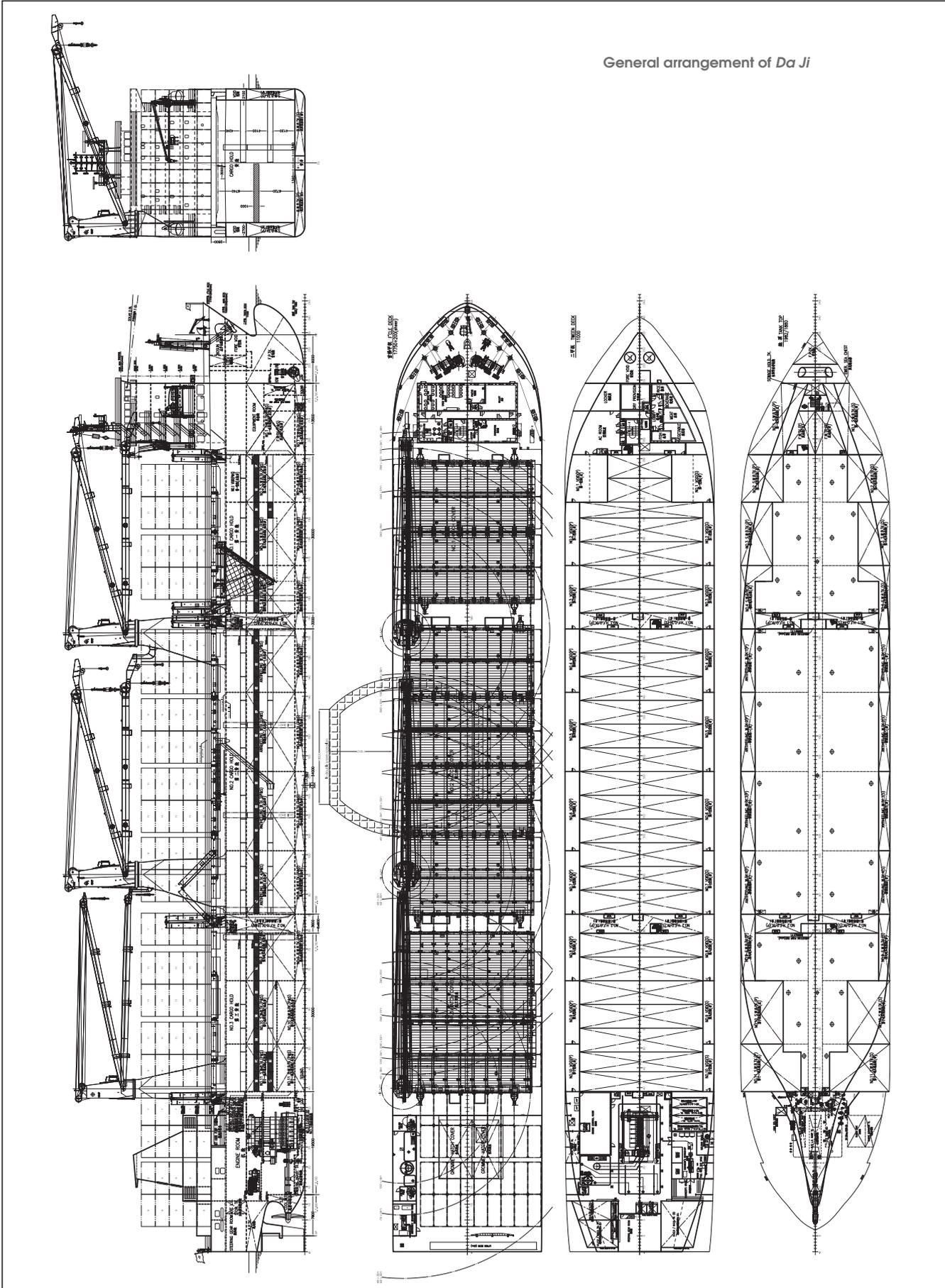
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# RPG Stuttgart is a vote of confidence for inland LNG operation

A state-of-the-art, dual-fuel inland tanker/barge that runs on up to 98% LNG, *RPG Stuttgart* is an example of eco-friendly design optimised for its operating environment



Shallow waters require a design with a correspondingly shallow draught and minimal resistance

**B**uilt by Dutch shipbuilder VeKa Group, owned by Shell Trading Rotterdam BV, and operated by Plouvier Transport NV under a time-charter agreement, *RPG Stuttgart* is the first in a series of 15 dual-fuel inland barges to be delivered following an agreement penned in 2015.

*RPG Stuttgart* and the later vessels in the series are intended to support Shell's refined oil product business, transporting goods in the Amsterdam-Rotterdam-Antwerp (ARA) region, in the Netherlands and Belgium, and along the Rhinetrack, in Germany and Switzerland. As such, the vessel's design has been optimised for inland operation along the European rivers and canals, with a focus on energy efficiency and sustainability thanks to the choice of LNG dual-fuel propulsion.

## Riverine design

With a length (oa) of 110m and a breadth (moulded) of 11.4m, *RPG Stuttgart* has a long and thin shape primarily dictated by

the locks and bridges that the vessel must traverse whilst in operation. The designers also had to factor in optimal cargo carrying capacity, without increasing the resistance too much or hampering the vessel's ability to sail well on the shallow waters found along its routes. These contradictory demands were solved with a hull form designed to allow for the highest displacement – 3,563m<sup>3</sup> – without increasing resistance, plus a shallow draught of 3.3m. Crucial to this was keeping the lightweight down, thus allowing for a fairly high deadweight of 2,672dwt.

Eight stainless steel cargo tanks are installed from stem to stern, ranging in size from 371.2m<sup>3</sup> to 379.8m<sup>3</sup>, enabling a total capacity of 3,028m<sup>3</sup>. Eight Marflex MDPD-80 cargo pumps will facilitate the loading and discharging of refined oils, each commanding a capacity of 100m<sup>3</sup>/h @ 6 bar.

Despite the challenge of designing a vessel so restricted by its environment, VeKa Group note that they did not have to consider issues pertinent to ocean-going

vessels: "There are some items that are simpler. For example, the longitudinal strength needed for sea conditions is not applicable because of the very low waves in inland waters."

*RPG Stuttgart* was classed by Lloyd's Register, which was involved from the design stage because of the vessel's LNG usage. The classification society performed a HAZID (hazard identification) study before providing approval and certification.

## Dual-fuel propulsion

Perhaps the most notable feature of *RPG Stuttgart* is that its main engines will run on dual-fuel, with up to 98% LNG usage. The remaining percentage will be diesel used for ignition. *RPG Stuttgart's* LNG tank is located fore and is a type C, the most common choice for smaller LNG-powered inland vessels, which despite being less space efficient than tank types A and B can handle much greater pressure build-ups and as such does not require boil-off gas handling. It has a volume of 58m<sup>3</sup>, which

VeKa Group suggest is large enough to enable the vessel to make a round trip from and ARA region to Switzerland and back.

The choice of LNG is a significant vote of confidence for LNG bunkering infrastructure in the ARA and Rhinetrack regions, particularly given the order for a total of 15 vessels, which will eventually require significant bunkering volumes. At present, *RPG Stuttgart* bunkers from trucks at several places along the Rhine, but in the future there will be, say VeKa Group, “some fixed bunker stations or small bunker ships.”

The dual-fuel main engine is a 6-cylinder Wärtsilä 6L20DF, which runs at a speed of 1200rpm and commands an output of 1,110kW. The unit is noted for its small size and light weight, as well as what Wärtsilä call “fuel flexibility,” as switching between fuels can be achieved without speed or power loss. The engine is also a green choice, being compliant

with IMO Tier II emissions regulations and able to operate efficiently using LNG, despite its low sulphur content. Wärtsilä are also providing their LNGPac fuel gas handling system and a fixed-pitch 273rpm propeller and HR nozzle.

### Safe operation

Another focus for the vessel is high safety performance. Although the complement of the vessel is five crew, the bridge is fitted for one-man operation. It also features a Werkina DBS digital operating system that allows for the measurement of the main engine rpm, pressure, and cooling water temperature, plus fuel, ballast and lubrication oil tanks. The tank measuring system is also linked to the vessel’s damage stability computer, which calculates the damage stability and longitudinal strength. The choice of a type C LNG tank also contributes to the overall safety of the vessel.

*RPG Stuttgart* represents an uncomplicated yet effective design that looks set to encourage wider LNG adoption in the inland sector, as operators recognise the environmental and efficiency benefits that the fuel choice offers, particularly as LNG infrastructure continues to develop in Europe. Following the delivery of *RPG Stuttgart*, the delivery of the further 14 vessels will be staggered, with a deadline of mid-2019. **NA**

#### TECHNICAL PARTICULARS

##### *RPG Stuttgart*

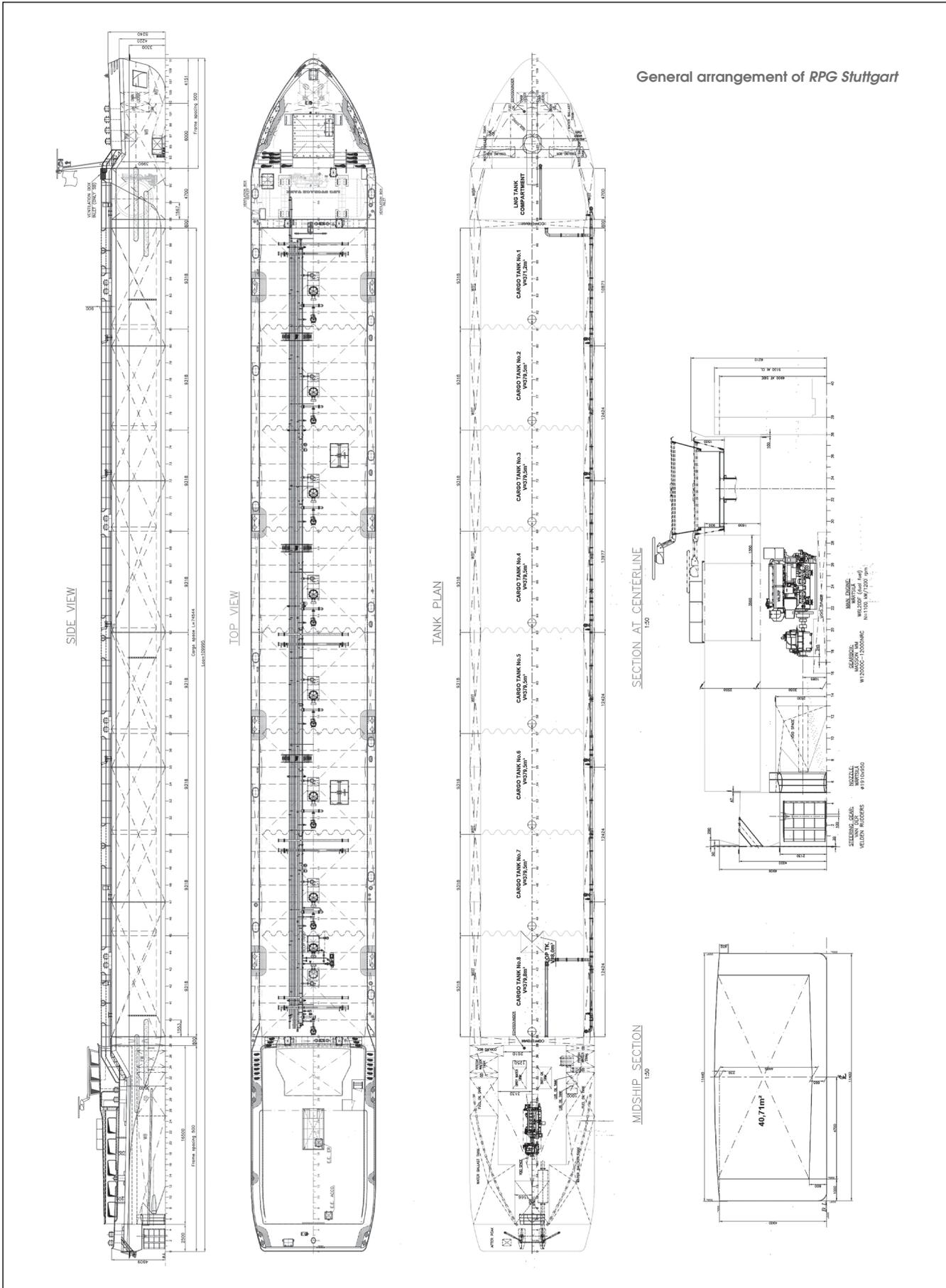
Length, oa.....	110m
Breadth.....	11.4m
Depth, to main deck.....	4.9m
Deadweight, design.....	2,672dwt
Cargo capacity.....	3,028m <sup>3</sup>
Cargo tanks.....	8

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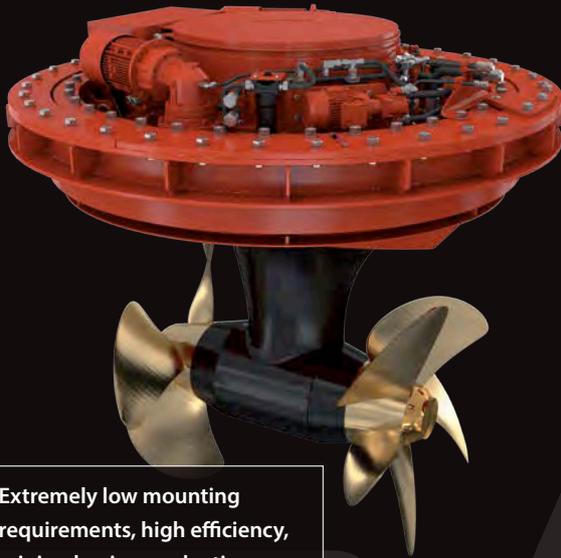
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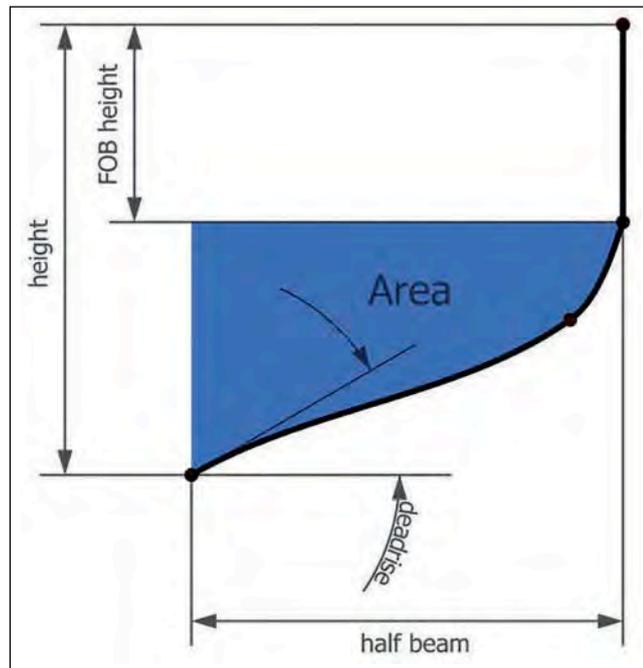
# Application of CAESES and NavCad for optimisation of ship hulls

HydroComp and Friendship Systems have recently presented a hull design workflow that includes their respective tools, NavCad and CAESES

The advantage of pairing NavCad and CAESES in a design workflow lies in the ability to rapidly optimise the geometrical properties of the vessel in question, based on the performance feedback provided by NavCad, especially in early stages of the overall design process.

Within this performance-driven design process, CAESES fulfils two roles: generating geometry variants based on selected parameter combinations, and providing the necessary functionality for process automation. The former includes different strategies for the efficient and, most importantly, robust variation of complex, free-formed geometries as they are encountered in ship hulls. The latter comprises systematic variation and optimisation algorithms, coupling to and execution of external tools, as well as management and assessment of the large amount of data that is typically generated in such an automated design study. In cases where the time for setting up the study is limited, morphing techniques can be applied to an existing, imported hull shape. While this approach is very fast, it allows for somewhat less direct control over the hull's properties and constraints.

The alternative approach is to set up a fully parameterised model of the hull from scratch in CAESES. CAESES' powerful surface parameterisation technology – where a parameterised cross-section, e.g., a frame or waterline, is swept in a specified direction either longitudinally or vertically, and function curves control how the cross-section parameters, such as waterline beam, deadrise angle or sectional area, change during the sweep – allows for a highly flexible, yet very efficient, parametric description of the hull lines. The number of free variables is kept low, especially in comparison to control point based modelling approaches, which is advantageous for a speedy optimisation. Obviously, in comparison to the previous, this approach requires more time, but brings along the advantage that properties of the hull form can be addressed in a very direct and precise



Example of parametric variation

way, and that constraints, such as hydrostatic properties or internal arrangements, are easy to fulfil by the generated hull variants.

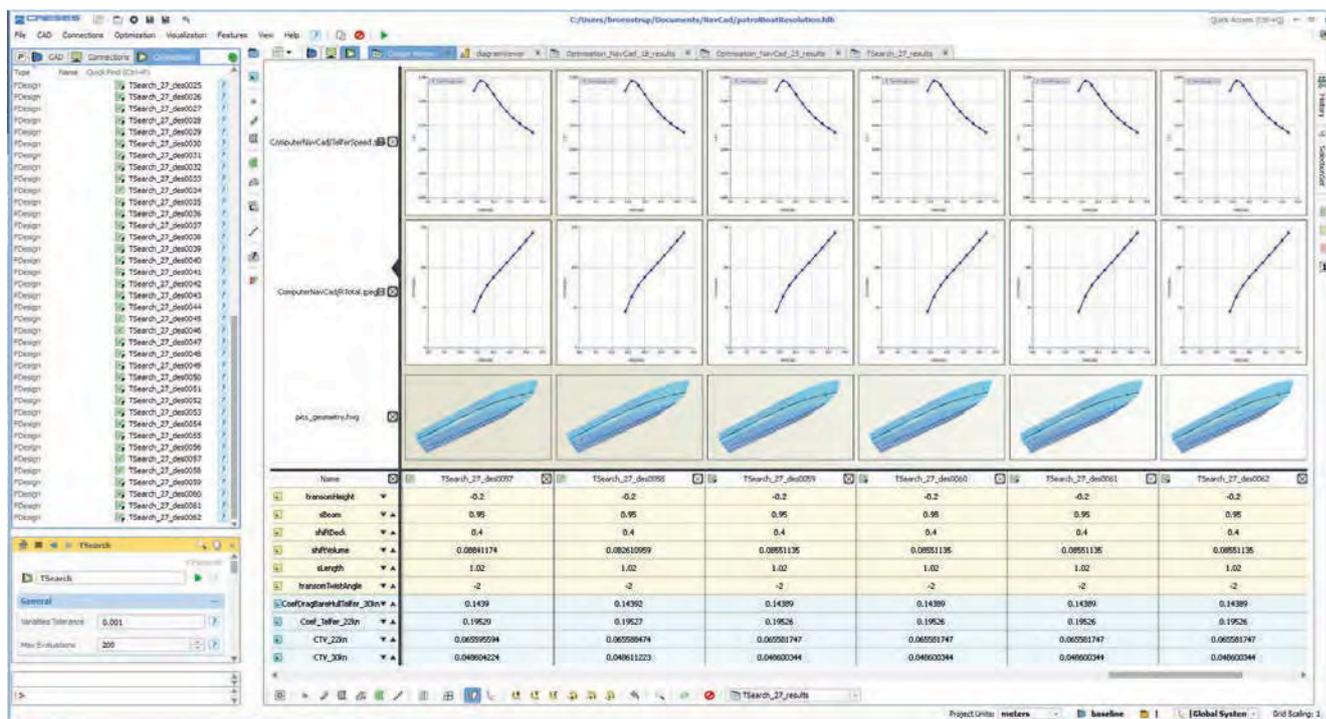
NavCad's role in the design process is to provide a performance feedback for each CAESES design iteration, by performing an operational hydrodynamic and propulsion system simulation. A physics-based framework for the Hull-Propulsor-Drive-Engine system is the foundation of the simulation. NavCad offers a variety of 1D and 2D component prediction models that connect to the system for a broad range of hulls and propulsors. It is the 2D ADVN hull resistance method in NavCad Premium that is employed for this study, which will be coupled to a waterjet propulsor model for a complete system simulation.

## Workflow in practice

This workflow shall be demonstrated here on the example of a waterjet-driven patrol boat, which had failed to reach the target speed of 26knots promised in the tender (an initial speed prediction by the designer

indicated barely 23knots.) The vessel has a round-bilge hull with an immersed transom stern. Length overall is 29m and beam overall 6.8m. The design targets that were set going into the process were to find the best hull form with regard to resistance, find the best hull-waterjet-engine configuration and, finally, reach the target speed of 26knots.

Since a parent hull form already existed, a morphing approach on the imported hull form was used. Several different morphings or transformations were set up to allow changing of the length, beam, transom immersion, transom deadrise, deck and waterline shape, as well as the volume distribution in a longitudinal direction. While the geometry for each variant can be exported in several generic formats (like IGES, STEP, or STL), a special input script is used for NavCad that contains the computation settings and the geometric particulars of the vessel. Apart from the main dimensions, this comprises values for waterline beam, sectional area, and sectional area centroid at a certain amount of longitudinal positions.



Example of CAESES workspace for evaluation of optimised variants

To seamlessly transfer this input to NavCad, a custom export was written in CAESES that automatically extracts all necessary values from a given geometry and generates the script file. Finally, NavCad is tightly-coupled in the automated process workflow through the interface available in CAESES for the connection of external tools. This interface allows a user to specify and prepare all the necessary input for the external tool, as well as the results that are loaded into CAESES after the computation for the evaluation of the variant.

Prior to initiating the optimisation session, it is typically necessary to setup a NavCad project to define static data (such as appendages or environmental data), as well as analysis and prediction settings. This was prepared within the NavCad Premium GUI using its recommended standard settings, but could include user-defined custom options. Data for the parent hull from the study was entered into NavCad to allow its “Method Expert” utility to evaluate the suitability of the selected component models for the proposed speed and principal hull characteristics.

### The optimisation process

The six aforementioned design variables with suitable bounds defined the design space for the optimisation process. The objectives were

the resistance values at 22 and 30knots and constraints were put on the displacement and the center of buoyancy, allowing only small changes for these properties. Various approaches can be taken within CAESES to drive formal optimisation processes. For the patrol boat a combination of Design-of-Experiments (DoE) and a deterministic search strategy was selected. Firstly, a DoE with 500 designs was undertaken to explore the design space and to identify favorable parameter combinations. Secondly, several local optimisations using a deterministic pattern search were run to fine-tune the hull form further.

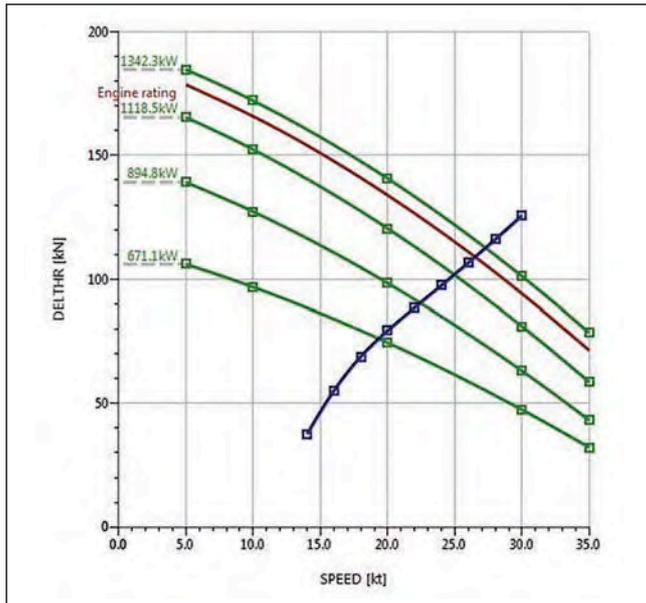
The results of the preliminary design space exploration helped to recognise the sensitivity of the objectives to the individual design parameters. While some of them showed a strong influence on the resistance, like the transom immersion and deadrise, some only had a negligible influence, such as the shape of the deck and design waterline. The final optimisation results recommended a new hull geometry with a slightly more slender hull, LCB shifted aft, greater immersed transom area, and a narrower entrance angle. Evaluation of the resistance over the complete speed range showed a tangible reduction throughout and a first indication that the

modified hull shape would be able to meet the speed objective.

Following this step, a study was run in NavCad to select a suitable waterjet for the vessel. The waterjet component model in NavCad has the ability to accept manufacturer product-model performance data, and to utilize this in novel ways. It integrates the nozzle-inlet Speed-Thrust-Power data with impeller Power-RPM data to predict proper speed-power-RPM relationships for engine load, as well as to expose propulsor efficiency from the data. This is particularly important for successful product selection, as a waterjet’s propulsor efficiency across the speed range is generally embedded in the data and not expressly published.

### Significant savings

The CAESES-NavCad optimised hull form with a proper waterjet increased the operational speed from approximately 23.0knots to 26.5knots – meeting the design objectives without installation of a larger engine. The original parent hull with its specified high-speed waterjet would have needed an engine of some 10% to 15% more power to meet the design speed. Of course, this translates into a comparable increase in fuel consumption – without further



NavCad's presentation of equilibrium-thrust waterjet component performance

of \$100,000, can be scaled proportionally to a cost of approximately \$120,000. So, for the pair of engines needed the client receives a saving of capital expenses of at least \$40,000. Operational expenses are even larger. The fuel consumption predicted in the NavCad analyses for a mean cruising speed of 20knots is 252 l/h per engine for the parent hull and 185 for the proposed hull. Given a representative operating demand of 500 hours-per-year for a patrol craft at an average cost of marine diesel fuel of ~\$1.05 per litre, an estimate of the savings of operating cost with the proposed hull and waterjet will be \$72,000 per year.

Ultimately, this study demonstrates how a highly automated and tightly-coupled pairing of CAESES and NavCad can provide a very cost-effective and time-efficient solution for any naval architectural office. This pairing is a powerful instrument for finding improvements in hull form and propulsion components at any stage in a design. [NA](#)

considering the heavier displacement due to a larger engine. Naturally, the initial capital expense would also be greater with a

larger engine. The original expectation by the client was to install an engine some 20% larger, which, assuming an initial engine cost

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### Call for papers

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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# Software interoperability makes ever-more complex analysis possible

Bentley Systems' MOSES Connect Edition 10.12 promises greater functionality and integrated solutions in meshing and pre-processing actions. Concurrently, new interoperability options in SACS Connect Edition 11.2 promise smoother modelling for offshore operations

Naval architects and marine engineers have access to a range of high fidelity solutions aligned with their project needs, with functions for hydrostatic, hydrodynamic, mooring, multi-body interaction, transportation, launching and structural analyses in the time or frequency domain. Among them, industry specific software like MOSES and SACS apply best practices to predict motion and structural response.

MOSES is an advanced hydrostatic and hydrodynamic software that provides for the accurate calculation and simulation of marine and offshore floating systems with more than 30 years of focus on these specialised requirements. SACS is an integrate finite element structural analysis package of applications that uniquely provides for the design of offshore structures, including wind farms, and has been used for nearly 40 years.

The latest developments in MOSES Hull Modeler 10.12, part of Connect Edition 10.12, have focused on implementing further manipulation commands for Trimesh surfaces. Naval architects can now move, resize, flip, rotate, align and offset Trimesh surfaces interactively and save pre-processing time in their analyses. These automation tools mitigate modelling risk from misaligned surfaces likely to result when importing CAD geometries and allow the designer to explore alternatives efficiently while maintaining mesh properties throughout. Possible CAD geometries to import cover popular formats like Microstation (.dgn), IGES Type 128 (.iges) and Rhino (.3dm) among many other. Figure 1 illustrates the alignment command where the two bow nodes of a yacht are aligned on each of the Trimesh surfaces.

Another new mesh operation is the ability to offset a Trimesh surface concentrically

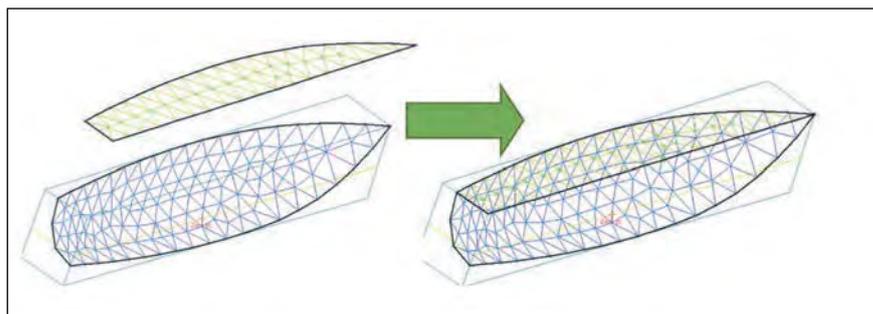


Figure 1 Node alignment between hull and deck Trimesh surfaces

or longitudinally. This feature can be useful when modelling double hull and internal stiffening arrangements as shown in Figure 2. Similar operations can be carried out when modelling repetitive elements like double bottom stiffeners and stringers throughout the ship length.

## SACS-MOSES interoperability

Traditionally, engineers have used both MOSES and SACS separately in their own environments, but recent developments by Bentley Systems have introduced a combined modelling environment where MOSES and SACS interact, providing the comprehensive capabilities required for today's projects.

Users can now select a new analysis type under "Marine Applications" in SACS Connect Edition 11.2 where they can find MOSES Launch. Interoperability between

SACS and MOSES allows for automatic data exchange, creating a smooth analysis workflow. This cooperation enables engineers to study the structural integrity, for instance, of a barge during launch by making sure that shear forces and bending moments remain within permissible limits. This technology implements MOSES' technology for transportation and launch within the SACS interface for the first time. Post-processing in this synergy takes place within SACS without changing environments.

Today's specialised marine operations demand a functional and integrated environment in which to perform truly effective analyses. Although both MOSES and SACS will continue to provide cutting edge solutions on their own platforms, the best of both worlds can be achieved through their interoperability. *NA*

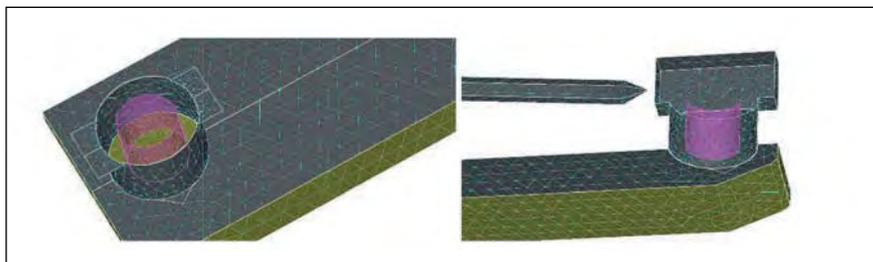


Figure 2 Concentric Trimesh surface offset in a crane column

# The dualistic goals of CAD/CAM software in shipbuilding

CAD/CAM software has come a long way in nearly 40 years ago, with ever-more advanced functionalities. However, its dual remit to support innovative designs and facilitate production remains unchanged, says Cadmatic



Modern CAD software allows for creative vessel designs whilst also guaranteeing production

In the early 1980s, CAD/CAM software was an emerging innovation. Bottlenecks restricting development included underdeveloped hardware, the ingrained practice of using 2D drawings for designs, and a lack of tools in 3D software packages.

Andries Staal of Cadmatic recalls the era: “Back then, it was difficult to convince shipyards and design offices to invest in CAD/CAM systems – they were used to producing 2D drawings, and it was their main means of communication with production. Spending money on hardware, software and time to create a 3D model just for the sake of producing the same 2D drawings did not make much sense to anybody, even taking into consideration the increased level of accuracy and the ability for simultaneous work by all disciplines in the same 3D model. The future focus was on automated output and direct connections with CNC machines.”

Nowadays, of course, 3D CAD/CAM software packages are the main tools in any shipyard or design office in the marine industry. Shipbuilders, in particular, need tools that can handle complex engineering projects, produce error-free and customisable outputs for production automatically, gain access to design resources that are distributed around the globe on their design projects, and make everyday work easier.

CAD software is tasked with the facilitation of both design and production: while the tool must be capable of generating complex and often artistic designs, it also has to ensure production is possible and aid designers to do various checks. Unleashing the imagination of ship designers requires a software program that allows designers to both create 3D designs and evaluate the designs in different ways before production.

We are a long way from the 80s; it is now possible to extract all data from a ship's digital twin and virtually walk around a vessel and

visualise 3D and all other production data, including work building sequence animations, augmented reality 3D models or visualisations of spools on the assembly table.

Shipbuilding-specific software packages, such as Cadmatic, also include numerous tools for speeding up simple and repetitive design tasks, and leave room for designers to create new design solutions and think out of the box. Specification-driven 3D design rules and production checks ensure that no production errors are made. These checks include, for example, bending machine parameters for piping, coloured elongation lists for shell plate production, collision checks, and even specific rules applied to piping materials and components based on the space they are located in, such as pipes that penetrate ballast tanks.

The constant challenge to add more functionality to 3D design remains a Cadmatic focus. The modern need for smooth and accurate production that is as



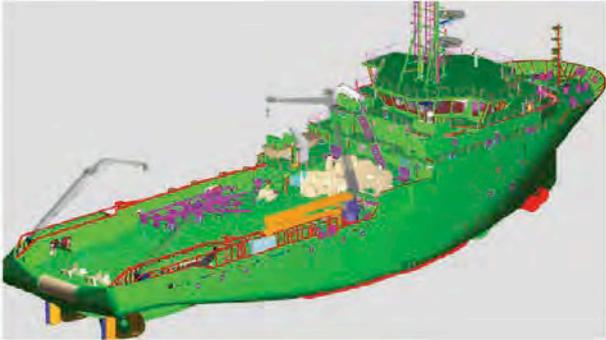
Software that aids specification-driven design for plant such as piping frees up designers to develop more innovative vessel designs

and links with PLM/PDM solutions. In several cases, Cadmatic has cooperated with shipyards to come up with new ways of accommodating the developed technology, with customers such as Flensburger yard in Germany, Tanjong Kling (Jurong) yard in Singapore, Meyer Turku yard in Finland and Tsuneishi yard in Japan.

In the future, there will be even more possibilities for production automation, including 3D printing, automation of non-repeatable processes, robot welding, and the use of new materials. All these trends are already visible and attempts at using the new technologies are ongoing. It is only a matter of time before they break through the resistance of outdated practices and high implementation costs, just as CAD/CAM software did in the 1980s. New generations of shipbuilders require CAD to be a reliable facilitation tool to achieve their goals; Cadmatic aims to assist them to meet their high expectations. *NA*

automated as possible challenges shipyards to update their ways of working and to consider investing in new production lines to boost performance. Usually, the first automation efforts are targeted at bulk operations. Routine and time-consuming tasks, such as steel cutting and shell plate production, as

well as profile and pipe cutting and bending, are automated first. Advanced shipyards are increasingly investing in workshop automation, production lines, and new machinery. Cadmatic participates in such projects and develops interfaces to the latest CNC machines, postprocessor interfaces,



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# Marlink reaps the dividends of increased connectivity demand

A diverse maritime portfolio has allowed the satellite communications provider to weather the peaks and troughs of different sectors as it continues to consolidate its position

It hardly needs saying that for today's commercial ships connectivity has advanced from being important to absolutely essential. Modern vessels are engaged in a constant electronic dialogue with shore-based services and operational support, ranging from fuel-optimising routing, condition-based maintenance, emissions reporting, e-certificates being relayed to Port State Control and of course seafarers wanting to stay in touch with home. There is something like one million seafarers traversing the world's oceans at any given point, plus tens of millions of containers carrying goods which operators are keen to monitor.

"We are living in very exciting, transformational times in the maritime and satcomms industries," says Erik Ceuppens, CEO of the Marlink Group. The former commercial satellite communication division of Airbus Defence and Space, which was rebranded following its acquisition by Norwegian satellite communications provider Vizada in 2015, has established itself as the world's largest provider of maritime communications services.

Marlink's position has been consolidated by a string of its own strategic acquisitions and partnerships over the past 18 months. First came Telemar, which had developed a particular niche as a provider of support services for integrated bridge and communications systems. Next, in February 2017, it acquired its long-term vessel management partner Palantir, allowing it to include onboard IT services. Also notable was the announcement of a partnership with Radio Holland, which saw Marlink acquire the Dutch firm's connectivity business, while Radio Holland focuses on bridge electronics, ICT and field engineering.

Marlink began this year with the acquisition of two specialists in superyacht communications services: Livewire Connections and OmniAccess. "We believe



Marlink acquired Radio Holland's connectivity services in late 2017

superyacht sector will bring us further growth. Superyachts are like the Formula One of maritime and a showcase for what future technology will bring and in the next couple of years will become mainstream," says Ceuppens.

## Sustainable growth

The spread of Marlink's portfolio of services, across different sectors, has added its own resilience to the company's business model. Ceuppens notes that some of the competitors have seen declining profits due to putting too many eggs in one basket. "If you look at companies that are purely specialised in one segment, they become very unstable. Inmarsat, for example, are predominantly in merchant marine. Marlink has been able to continue sustainable growth because we are diversified and there tend to be counter cycles in that. Commercial is currently down but cruise is going like a rocket. Merchant marine is really up on the connectivity side but we know the underlying profitability is still poor."

While some satellite communications providers and hardware manufacturers do sell their services directly to shipowners, it's more common for third-party providers to offer a wider and more flexible portfolio of connectivity services tailored to the owner's particular needs, and it's in this field Marlink has become the market leader. It now has a consolidated total of around 5,000 vessels subscribed to its VSAT systems and the company boasts it has the 'best in class' Ku-Band network in terms of coverage, capacity and built-in redundancy.

Among its high-profile clients are tanker operators Carisbrooke Shipping, which recently signed a new contract for Telemar (which continues as a brand within Marlink) to provide bridge system repair and maintenance services across its fleet, in addition to the VSAT services they were receiving under their previous arrangement with Marlink. Tore Morten Olsen, President Maritime, Marlink, explains: "Everything is digitised onshore

and onboard. They use it measure onboard productivity, which some crew members don't like, but from the company perspective it's good, to see if there are relative differences across the fleet. The important thing here is not only that we supply the bridge and the connectivity, but a complete support contract, where we provide 24/7 remote support for anything, whether it's a bridge problem, an electronics problem, or something on the connectivity side.

"We have a dedicated service coordinator for them, so they have one go-to person when they need to arrange work during port calls. We have a network of more than a thousand field engineers, including the bridge electronics people, so that was a driver for them. They don't want to deal with many different players if they can avoid it, because their core business is transporting goods from A to B."

Bridge systems are increasingly large consumers, with software updates for navigational charts (ECDIS systems), voyage data recorders and voyage optimisation (Marlink says in one case it helped an owner make 25% efficiency gains). But the data consumption is still miniscule compared to a large cruise ship. At the launch of the *MSC Seaside* in December 2017 a record-breaking throughput of 580Mbps was achieved with Marlink's Sealink VSAT service, utilising Intelsat's EpicNG High Throughput Satellite (HTS) network. Olsen wryly notes that the main driver for the passengers using the internet onboard is so they can

brag about the places they're in and upload videos to social media, in effect providing the cruise operator with free advertising.

### New services

With satellite operators constantly innovating and seeking new ways to differentiate their offerings, the technology continues to advance at a prodigious pace. In February, Marlink was announced as a launch partner for Iridium's Certus, a new pole-to-pole L-band network using Iridium's NEXT constellation, operating in a Low-Earth Orbit (LEO). Certus will initially offer speeds of initially around 350 kbps, uniquely using a small 'solid state' VSAT antenna without moving parts. While its speeds are not comparable with the higher throughputs that Ku-band or Ka-band can offer, it could represent a cost-effective solution to today's smaller connected ship that might be operating in the northern sea routes.

A host of further LEO and Near Earth Orbit (NEO) satellite solutions are already in the pipeline, with maritime likely to become a client. In the spring of last year SpaceX founder Elon Musk filed documents outlining plans to launch 4,425 super-fast LEO internet satellites by 2019. It will be rivalled by the OneWeb satellite constellation, consisting of nearly 900 LEO satellites operating on the Ku-Band, due to launch and become operational by 2019-2020.

"I'm not sure Certus is going to be fantastic for next decade, but it's going to be a good choice for certain purposes

over the next two to three years before other services come into play," reflects Olsen. "Who knows what Musk or Wyler are thinking? All we know is these guys are moving the needle and making more bandwidth available.

"At Marlink we spend a lot of time with the satellite operators discussing how their systems can best serve the maritime market. Maybe one day a ship will have five or ten different means of connectivity and we will choose the best for whatever application. For example, for voice calls latency is important, whereas for streaming latency doesn't matter."

### Further ahead

Cybersecurity is increasingly essential and there are plans for greater monitoring of data traffic patterns for potential anomalies, using either detection services or a remote monitoring centre. "We already have a lot of cyber detection, filtering and firewalls but we want to bring it one level beyond. Our task is to deliver a secure, fully digitalised and fully managed service, what we define as 'smart connectivity'."

As thoughts turn increasingly towards unmanned vessels, either remotely operated or autonomous, Marlink is confident that the technology and connectivity are already more than capable of fulfilling increased demand. "The technology is there, if not the regulatory framework, but that will come," says Ceuppens. "For us from a connectivity perspective it drives requirements for more reliable, resilient systems. We have the bandwidth so it's more about level of redundancy. With our network, we typically don't cover the ocean with just one satellite or beam; in traffic dense routes there are at least two, typically four, different positions that cover that area. Even if you have a blockage there or interference, there are multiple paths, and the more satellites are the more resilient the service will be.

"More bandwidth will enable more functions than you had in the past, which is one of the drivers which pushes up volume. For crew perhaps it's not so nice but I think the role of the sailor 15 years from now is likely to be very different than in the past. Of course, there will still be mechanics onboard, but their main concern will not be navigating the ship from A to B." **NA**



An impressive 580Mbps throughput was achieved onboard the *MSC Seaside*

# A view from the bridge

A participatory design project in Canada using affordable VR is aiming to give naval architecture students a new perspective on vessel working spaces

In February's issue of *The Naval Architect* ('A design for working') we looked at recent efforts to develop a shared platform by which ship's crew could share their insight about engine room layout and design, with a view to improving the ergonomics. While there remains some scepticism among naval architects, who often feel it is something of a luxury compared to more important structural imperatives, there is growing interest about the potential of participatory design approaches.

Virtual Reality (VR) technology is one possible means of accomplishing this, according to a paper presented at last year's International Conference on Computer Applications in Shipbuilding (ICCAS) by Winston Pynn, a naval architecture instructor at the Marine Institute (MI) of Memorial University of Newfoundland, Canada. Drawing upon an earlier survey of professional mariners, the MUN project utilises the relatively inexpensive VR hardware and software now becoming available to create virtual mock-ups of key vessel

areas for input and evaluation of the design by end users, in particular those working on the bridge.

Pynn's paper notes naval architects and marine engineers spend years learning the language of engineering, and how to communicate their ideas to other design professionals, but that these terms and vernacular can be rather opaque to non-designers. Moreover, while owners may have some involvement in design decisions the insight of those who might serve on a given vessel, or have served on similar vessels in the past usually doesn't become part of the design process.

Perhaps the one exception to this, Pynn tells *The Naval Architect*, is the custom yacht market, the reason "perhaps being the same that you or I might be involved in the design and build of our own homes... they are the ones who have to live with the design and construction decisions. I'm not sure that's true in commercial construction".

Participatory design is not without its doubters – Steve Jobs famously remarked that "a lot of times people don't know what

they want until you show it to them" – but Pynn notes that other industries such as automotive put enormous faith in their consumer research departments and have incorporated VR into their processes.

"I think there is an opportunity here for professional mariners to become consultants to naval architects, particularly with the advent of affordable VR, so merchant ship designers can have that immediate feedback from professional mariners at various stages throughout the design process."

## Professional mariner survey

In order to ascertain how much of a knowledge gap problem actually existed, two surveys were conducted of professional mariners at MI, as well local chapters of the Master Mariners of Canada and the Canadian Institute of Marine Engineers. The first was focused on bridge crew and bridge design, while the second addressed marine engineers and engine spaces. By Pynn's own admission the response rate was 'dismal', with just 19 respondents from more than 100 it was sent to.



The HTC Vive headset and components retail for around US\$800

The responses that were received were a little more positive than had been anticipated. Asked whether the layout of the bridge aided proficient bridge operations, a weighted average score of 4.09 was achieved (on the Likert Scale, with 1 being Strongly Disagree and 5 Strongly Agree). For another question of whether designs were adequate in terms of bridge size, window placement and door placement a score of 3.73 was recorded.

However, when asked what design features made the bridge least functional, factors such as limited access to open air bridge wings, poorly located equipment and a range of visibility issues were mentioned. Many were also in favour of greater involvement in the design process, with one respondent noting: “To me effective design is backward design. In other words, include the stakeholders to determine the exact specific requirement and outcome. This process would be thorough and involve all stakeholders.”

### VR technology

Pynn notes that in order to evaluate the efficacy of a workspace it's a long-established practice to build a physical mock-up of the environment. Again, this method is more commonly found in high-volume recreational craft and yachts where it's clearly preferable to make easy changes early on than have a less-than-ideal space potentially replicated hundreds of times. However, these physical mock-ups are increasingly being supplanted by their VR equivalent. Notwithstanding the savings in physical space and waste, design variations to a digital model can be tested within minutes or with as much detail as required.

Typically, 3D models are created from the 2D general arrangement drawings, and these form the basis for the virtual mock-up. Although some platforms, such as Mindesk, are now exploring the possibility for of using VR for the initial design, most VR modelling software is able to work with the most commonly used CAD file types.

Having considered a range of options, in November 2016, MI acquired the HTC Vive VR hardware and upgraded the Institute's computers for the specific purpose of investigating how VR could be incorporated into the design workflow. The Vive hardware, which costs



Evaluation of the digital bridge mock-up

around US\$800, consists of a headset, scanners to track the headset and two controllers, along with cables to connect it to the workstation. Pynn says the total investment in equipment was less than Can\$5,000 (US\$3,800), the cost of a decent engineering workstation not so long ago, and because of that comparatively low sum it was possible to begin the project within a month of the initial idea.

Pynn says: “I will admit I knew very little about the technology as I was planning the project and also during the execution. When I attended ICCAS in September I learned a great deal more about commercial applications... My argument for these [VR] producers was that there are many more small and medium sized design offices or shipyards who can't afford the big solutions they are selling and in order to achieve the widespread adoption they are hoping for, the price needs to come way down, and it finally has.

“To use this tech as an everyday design tool it needs to be cheap enough that the office will let even a junior designer have it on his desk and leave it unattended at lunchtime.”

He explains it is part of MI's long-term vision: “In my view there is no better

place to be introduced to and experiment with a new technology than at university. That way we have a cohort that goes into the workforce each year extolling (hopefully) the virtues of this new technology. Contrast this with a busy engineering office, which must account for nearly every billable hour and doesn't have the time or funds to experiment unless directed by a client.

“I also don't mind blowing the horn of some of the other departments here at MI such as the Centre for Marine Simulation, who have been doing full mission bridge simulation and other types for years and are well recognised as being one of the leaders.”

### Student project

The resulting project saw a dozen of the senior naval architecture students volunteer to model their bridge designs for use in VR mock-ups, which were then evaluated by professional mariners who were instructors at MI. The students had created their 2D general arrangements using AutoCAD and hull models on Maxsurf, both of which could be easily imported into Rhinoceros 3D for the 3D modelling.

On average, this process took the students around 40 hours and in some



The full-size virtual ship

cases it was possible to save some time by importing some pre-built furnished object models from vendors that MI held in its library (e.g. electronics, helm seats). The models were then imported to the Lumion 6.5 platform for creation of the panorama, where ‘snapshots’ are taken of different positions to tell the software that a 360° panorama is required at a given viewpoint. Depending on the number of viewpoints and quality settings it can then take anything from a few minutes to several hours to render this into a VR environment.

As well as the high(er) end Vive hardware the project also looked at the feasibility of cheaper smartphone VR headsets, which while more limited had the potential to both further democratise the use of VR and make it accessible from anywhere in the world. The panoramas created with Lumion can also be imported into a smartphone-friendly format using software developed by IrisVR, which makes it possible to view them using the company’s Scope app.

IrisVR also provides the viewing package for experiencing the model in VR with the Vive headsets, a package known as Prospect, which allows Rhinoceros 3D files to be imported via a plugin. After conversion, the Prospect software opens to reveal a model of the ship on a virtual table, much like a physical architectural model. Using the Vive controllers and wearing the headset, this model can then be enlarged and rotated. By directing the controller’s laser pointer to a horizontal ‘walkable’ surface on that model, a human-shaped graphic appears. If the user then pulls the controller’s trigger they are then taken to that point in the model in the full scale.

Pynn says that many users find the experience of using the Vive/Prospect combination for the first time “awe inspiring”. On a more practical level evaluating a student model quickly brings up issues that were missed while simply viewing on a 2D screen. For example, a space outside the bridge designed for walking was actually too narrow. Prospect, which was originally conceived as a platform for land-based architecture, allows the user to annotate problem areas, or taking screenshots for subsequent review outside the VR environment.



Viewing the table top model

The feedback from students and professional mariners alike has been overwhelmingly positive, according to Pynn. “My feeling is that to see your design in 3D on the screen and to experience it in

“In my view there is no better place to be introduced to and experiment with a new technology than at university”

an immersive way makes those 40 hours worthwhile, particularly if you’re a new designer and this is your first design. The students add a tremendous amount of detail, probably more than would be added in a working prototype in the industry, but you can hardly fault their enthusiasm.

### Next steps

One of the problems, Pynn readily concedes, is that affordable VR remains a relatively crude tool, but he points out that new iterations of VR platforms and better tools are becoming available almost weekly. Moreover, he believes as a design review and discussion tool it is already highly beneficial. “I think that once we get additional features such as haptic feedback when a user bumps into an object or bulkhead in the virtual prototype the tool will be particularly useful.”

He suggests the transition from CAD to designing in a virtual environment will be similar to the change in mindset an

experienced Photoshop user needs when accustoming themselves to Google’s ‘Tilt Brush’ 3D painting application, or indeed the adaptation that old designers had to make when swapping their drafting boards for CAD.

Looking ahead, Pynn says that as well as developing further virtual bridge prototypes, this year the project will look into machinery spaces and the sort of insight marine engineers can provide. He adds there is also some consideration being given at MI into how to apply the technology to other specific engineering challenges.

“One naval architecture instructor had his students create structural models for VR so the students could get a feel for how their structural design decisions and scantling calculations affected the vessel’s arrangement. He also wanted them to understand the challenges involved in the build process and the importance of build strategy. One of the highlights was having the designers virtually access some of the tight spaces they had designed and sort out how a human was actually to fit into and access those spaces. It was quite enlightening for the students (and the instructor).

“Additionally we are building up a library of parts to make the process go faster in the future as well. Ultimately we would like to see if design in VR is possible. As not many envision what 2D CAD will evolve into, it is difficult to see what tools, processes and strategies might become evident once designers start to work ‘in there.” NA

### Further reading

Pynn, W.; Minimising the Designer/End User Knowledge Gap Using Virtual Reality, presented at ICCAS 2017, Singapore.

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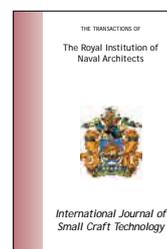
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[www.rina.org.uk/Contract\\_Management\\_Course\\_May\\_2018](http://www.rina.org.uk/Contract_Management_Course_May_2018)

**May 16-17, 2018****European Environmental Ports Conference 2018**

International conference,  
 Antwerp, Belgium  
[www.wplgroup.com/aci/event/environmental-ports-conference/](http://www.wplgroup.com/aci/event/environmental-ports-conference/)

**May 16-17, 2018****Damaged Ship IV**

International conference, London, UK  
[www.rina.org.uk/Damaged\\_Ship\\_IV](http://www.rina.org.uk/Damaged_Ship_IV)

**May 16-17, 2018****NaviGate**

International exposition,  
 Turku, Finland  
[www.turunmessukeskus.fi/en/eventnavigate](http://www.turunmessukeskus.fi/en/eventnavigate)

**May 22-24, 2018****Navalia International Shipbuilding Exhibition**

International exhibition, Vigo, Spain  
[www.navalia.es/en](http://www.navalia.es/en)

**June 4-8, 2018****Posidonia 2018**

International exhibition,  
 Athens, Greece  
[www.posidonia-events.com](http://www.posidonia-events.com)

**June 5-8, 2018****Basic Dry Dock Training Course**

Training course, London, UK  
[www.rina.org.uk/Basic\\_Drydock\\_Course\\_June\\_2018.html](http://www.rina.org.uk/Basic_Drydock_Course_June_2018.html)

**June 18-19, 2018****Advanced Design of Ship Structures (Includes Common Structural Rules)**

Training course, Glasgow, UK  
<https://asranet.co.uk/Courses/AdvDesignofShipStructuresCSRS>

**June 19, 2018****Maritime 2020**

International conference,  
 Copenhagen, Denmark  
<https://www.maritime2020.com/>

**June 20-21, 2018****Warship 2018: Future Surface Vessels**

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

**June 20-22, 2018****NAV 19th International Conference on Ships and Maritime Research**

International conference, Trieste, Italy  
[www.atenanazionale.org/nav/nav2018/](http://www.atenanazionale.org/nav/nav2018/)

**August 20-25, 2018****Corrosion, Fatigue and Fracture**

Training course, Glasgow, UK  
<https://asranet.co.uk/Courses/Corrosion-FatigueFracture>

**September 3-5, 2018****Basic Naval Architecture**

Training course, Glasgow, UK  
<https://asranet.co.uk/Courses/BasicNaval>

**September 4-7, 2018****SMM 2018**

International exhibition, Hamburg  
[www.smm-hamburg.com](http://www.smm-hamburg.com)

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

International conference, Singapore  
<https://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 24-25, 2018****Full Scale Performance**

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

**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)

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

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

**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/events\\_programme](http://www.rina.org.uk/events_programme)

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

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

The Royal Institution of Naval Architects

International Conference:  
WARSHIP 2018: Procurement of Future Surface Vessels

11-12 September 2018, London, UK



### Call for Papers



Modern navies are increasingly having to manage the trade-off between capability and cost. Versatility, flexibility, and affordability are key criteria which designers need to balance as warships become an exportable commodity, where market value may be just as important as the strategic value of any newly built vessel. Many nations are designing vessels with exportability in mind, this can mean that the Navy needs to accept some compromises to achieve this. On the other hand other nations are looking to build up their sovereign capability or to create jobs in country for national prosperity. In this scenario the nation must select a partner who can provide some degree of technology transfer and the key driver may not necessarily be the ships capability.

All of this is against the backdrop of rapidly advancing technologies including unmanned and autonomous systems, a changing threat environment and an insecure world; these factors require ever more adaptable ships that can fulfil a number of different roles and save money through life. Modularity may be one way to address this adaptability, however this approach has its compromises and there are other design considerations that must be in place to make a platform truly adaptable.

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26-27 September 2018, London, UK



### Call for Papers



The work of naval architects and marine engineers directly influence the operability and safety of the vessel and the seafarer. Decisions made at the design stage can influence human behaviour and health. And an improved understanding of ergonomics by engineers can 'design out' hazards and prevent incidents, both to the individual and the vessel.



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. Please submit an abstract before 28<sup>th</sup> May 2018.

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