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CONTAINER CHAOS SHOULDN'T LEAD TO PANIC

By **Richard Halfhide**

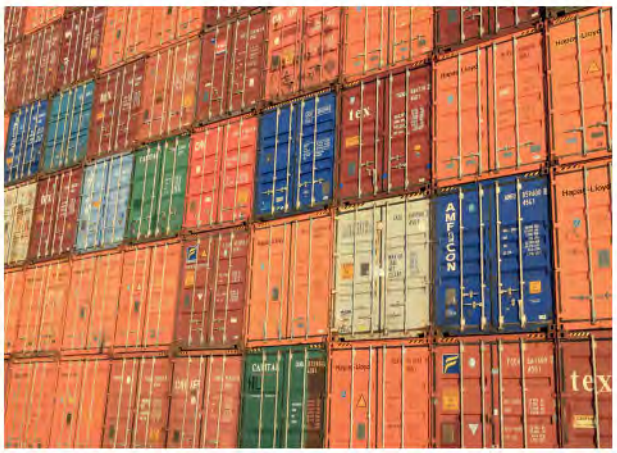
At the time of writing, it's just been announced that the Suez Canal Authority has reached a US$500 million settlement with Japanese shipowner Shoei Kisen Kaisha for the six-day blockage caused when the *Ever Given* became grounded in March. Elsewhere, Sri Lanka continues to report unprecedented environmental damage caused by the chemical products spilled when the *X-Press Pearl* caught fire and sank in early June. Meanwhile, boxship rates have skyrocketed by around 50% against the backdrop of Covid-19 disruption and limited capacity. Wherever you look right now there's no escaping that container shipping is experiencing some challenges at the moment.

The question is whether it's a temporary blip or the consequence of years of underinvestment? Such a suggestion would have seemed extraordinary as little as five years ago when, according to data published by Drewry, it was possible to transport a metric tonne of goods from Shanghai to Rotterdam for as little as US$10 (a tenth of current levels). And doesn't this publication regularly report on the record-breaking capacity of the latest newbuildings?

Part of the problem at the moment is that empty containers have been stockpiled in parts of the world from which there's limited demand for goods to be exported, namely Europe and North America, while there's a shortage in Asia. Maintaining schedules in difficult circumstances over the past year has meant that time which might have been spent returning empty boxes back to China was felt to be better spent sending the vessel back on its way that much sooner.

Then there's the position of the world's largest shipping operator. A.P. Møller – Mærsk has been exceptionally cautious when it comes to investing in new tonnage over the last few years and, coupled with the rise of slow steaming that began after the 2008 financial crisis, its fleet is being worked close to capacity. Data published by analysts Alphaliner earlier this year suggests the gap between Maersk Line and arch-rivals MSC is closing rapidly, spurred by the Swiss-Italian company's orders for large container ships with a combined capacity close to 700,000TEU, as well as MSC's heavy investment in second-hand tonnage.

But the evidence suggests the Danish company is willing to absorb a short-term hit to its status in the interests of the bigger picture. For one, there's the rapid ascendancy of the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping, the non-profit independent entity created to lead cross-party research into alternative fuels, which was launched with a 'start-up donation' of DKK400 million (USD$60 million) from the A.P. Møller Foundation (see the *Green Shipping* supplement, published in January).



SOURCE: PEXELS

Another pointer was the announcement at the start of July that Maersk has signed a contract with Hyundai Mipo dockyard for the construction of a 'carbon neutral' methanol-fuelled boxship. The 2,100TEU feeder ship, which will be 172m long, would be capable of running either on methanol or VLSFO, is scheduled for delivery in 2023 and will operate in the Baltic as part of the fleet of Maersk's Sealand Europe subsidiary. MAN Energy Solutions and Hyundai Engine and Machinery will collaborate in development of the methanol propulsion configuration, while ABS will serve as the classification society.

It seems improbable that Maersk, which has been conspicuously averse to considering LNG as a fuel solution, regards methanol as a panacea. For one thing there's no explanation in the press release how the methanol will be carbon neutral (given that most is still sourced from hydrocarbons) and while sourcing 'green' methanol for a single ship is quite feasible, it might equally mean some kind of carbon capture or offset strategy. There are also questions about methanol's lower energy density and the increased fuel capacity that would be required for deep-sea boxships.

Nonetheless, while the knock-on impact of higher freight rates may not be appreciated by consumers, now might actually be as good a time as any for container shipping to hit reset and address many longstanding concerns, such as safety (see last month's article on RINA's container safety workshop) and improved standards for the containers themselves. Research into new fuels and propulsion solutions will, in all probability, take up the rest of this decade and the dangers of investing in tonnage that quickly becomes obsolete is self-evident. Whether the segment can resist the temptation to splash out on new orders is, of course, something else (see News Analysis p.10). ■

NEWS

AUTONOMOUS SHIPS

NEW WHITEPAPER SETS THE STAGE FOR AN AUTONOMOUS MARITIME ECOSYSTEM

One Sea, an industry alliance aiming to develop and introduce autonomous ship technologies, recently published its white paper 'Autonomous Ships and Safety at Sea', which showcases the contribution that autonomous technology can provide for improving maritime safety.

It addresses topics of today's safety framework, cyber security, owner/operator views, the role of the human in decision-making, insurance implications, classification, highlights the need for a revised regulatory framework and offers a proposal for the next steps for autonomous shipping.

The alliance's primary aim is to drive the industry towards an operating autonomous maritime ecosystem by 2025 and following the publication, Päivi Haikkola, senior ecosystem lead at One Sea, remains confident that this is possible. "I believe we can create the operating autonomous maritime ecosystem by 2025. The main thing of course is to have the vessels to operate it, and if we are to have a newbuilding, then time really isn't on our side," she tells *The Naval Architect*.

"Fortunately, there are many companies around the world who already have invested in these technologies. Many of our members already have vessels that operate with the help of autonomous technologies. Also, many of these technologies are quite applicable for adaptation on existing vessels," Haikkola adds.

She also comments that, for these technologies to be adapted in wider use, there are still several things that must be achieved: "One important issue is international regulation, and that is something that One Sea is very much working on. We participate intensely in the current IMO work. Another thing that we feel would be helpful is the agreement on joint system architecture and the possibility of data exchange between the systems by different suppliers. One Sea is well equipped to lead this work, as all the major suppliers of these systems are members of One Sea."

CLASSIFICATION SOCIETIES

NEW CHAIR LEADS IACS INTO DECARBONISED FUTURE

IACS COUNCIL CHAIRMAN NICK BROWN

The International Association of Classification Societies (IACS) announced its plans for future digitalisation and decarbonisation work at its 83rd IACS Council session (C38), with Lloyd's Register CEO Nick Brown in attendance, who begins his tenure as IACS Council Chairman.

Work plans include establishing an expert group on the safety of new technologies and zero or very low-carbon fuels, developing relevant high-level positions and submissions to IMO, and a commitment to ensure that IMO's recently proposed short-term measures for GHG reduction can be implemented consistently on a global level.

These actions and more are part of IACS' decision to accelerate its existing work programme in order to be prepared to lead, influence and inform industry decision-making going forward on pressing topics related to digitalisation and decarbonisation, both at regulatory level with IMO and on an individual shipowner/operator basis.

This standpoint was reflected in chairman Nick Brown's address to the C38, as he highlighted: "The need for an even louder voice from IACS during this decade of rapid change as new technologies and new fuels need to be thoroughly understood and risks of adoption mitigated against ... There is lots for IACS to do and collaboration with all industry stakeholders will be key to our mutual success."

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WIND PROPULSION

SWEDISH WIND JOINT VENTURE LAUNCHED

Alfa Laval and Wallenius have announced plans for a 50/50 joint venture, known as AlfaWall Oceanbird, which will develop technology for fully wind-powered ship propulsion.

Originally designed by Wallenius, the Oceanbird technology consists of rigid telescopic wing sails, up to 80m tall and built from steel and composite materials, which rotate at 360° to make optimal use of wind conditions and generate a forward movement.

"Besides adjusting to catch the wind, they can be lowered to pass under bridges, to handle harsh weather conditions or for maintenance. Because they will interact with the hull in a sophisticated way, they will also require intelligent control," adds Peter Nielsen, business unit president, Alfa Laval Marine Division, who highlights that wind has a key role to play in decarbonising the marine industry.

The AlfaWall Oceanbird technology itself could reduce emissions by 90% on the largest oceangoing vessels, and Per Tunell, COO Wallenius Marine and future managing director of AlfaWall Oceanbird, comments that Alfa Laval are the ideal partner in its pursuit of sustainable shipping.

"We must create realistic alternatives, including the infrastructure for delivering and supporting them.

OCEANBIRD, A WIND-POWERED PROPULSION DESIGN

Wallenius is committed to wind propulsion, and we know from the experience with PureBallast that Alfa Laval can help us make it a global reality," Tunell explains.

Suitable onboard any ship type, the first implementation of AlfaWall Oceanbird technology is planned for a car carrier capable of carrying 7,000 cars. The 200m-long vessel will cross the Atlantic at an average speed of 10knots over 12 days.

PORT STATE CONTROL

PARIS MOU HIGHLIGHTS COVID-19 REPERCUSSIONS

The Paris MoU published its annual report in July, citing the effect of the Covid-19 pandemic on its yearly activities and statistics.

Despite the MoU's efforts to develop guidance for its member authorities tackling the restrictions caused by Covid-19, its activities were scaled back and brought about a decreased number of inspections, access order refusals, detentions and deficiencies.

Detention percentage fell from 2.96% to 2.81% in 2020 and detainable deficiencies lowered from 2,964 in 2019 to 1,942 in 2020. For inspections, only 13,148 were carried out in 2020, which is a significant decrease compared to the 17,913 that took place in 2019.

Changes are seen in the MoU's White, Grey and Black lists, with 41 flags on the White List dropping down to 39 flags in 2020, 22 on the Grey List (compared to 16 in 2019) and nine Black List flags (previously 13). The MoU also notes 545 inspections and 41 detentions for ships flying Black List flags, a detention rate of 9.36% compared to 12% in 2019.

Following the report, the Republic of the Marshall Islands (RMI) is named in the top three rankings on the Paris MoU White List and the flag state highlights that of the three largest registries, only RMI ranks within the top 10 in Paris and Tokyo MoUs, AMSA, and holds USCG QUALSHIP 21 status.

Chris van Tiel, fleet operations manager at International Registries Inc (IRI) Roosendaal, which supports the RMI in its activities within the Paris MoU area, comments that the true extent of the continuing effects of Covid-19 is still unknown: "Because our team is spread globally, we have been able to board vessels when superintendents cannot, and RMI-flagged vessel crews view our inspectors as the proactive arm of the inspection, identifying and resolving high risk issues before they become deficiencies. As we gain more and more physical access to vessels, we will get a full understanding of the impact Covid-19 has had on vessel operations."

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NEWS ANALYSIS

ARE FUTURE EFFICIENCY RULES DRIVING BOXSHIP BUILDING BOOM?

By **Malcolm Latarche**, Correspondent

Shipbuilding in the 21st century began with a boom period that lasted initially up to 2008/9 when the economic crash suddenly curtailed new ship orders except for the offshore and cruise sectors. In the run up to the crash, several newbuilding orders were already well advanced, resulting in a two-year gap in output figures and a peak in 2011 for delivered tonnage.

The offshore sector suffered its own downturn after 2014 when oil process collapsed. It has not really recovered from that although the related offshore wind sector is driving demand for some new vessels. Only cruising seems to have been unaffected despite a hiatus in operations caused by Covid-19. Some new deliveries have been delayed and a few veteran ships have either changed hands or been sent for scrapping but overall, confidence is strong.

In June, BIMCO carried an article on its website that began by saying global shipyards are under pressure and 2021 is turning out to bring the third lowest level of newbuilding orders in 12 years, despite new orders for container ships currently at a 14-year high. The BIMCO article was linked to its fleet forecast for the upcoming BIMCO ICS Seafarer Workforce Report 2021.

The opening statement about 2021 being at a low point for shipbuilding may have been a little premature. It mentioned container ship ordering at a high point and further along it also said that demand for LNG carriers and cruise ships was also strong. BIMCO forecast the trading world merchant fleet had a capacity of 74,505 ships across 11 main segments covered by the BIMCO ICS Seafarer Workforce Report 2021, at the start of 2021. In the baseline scenario, the total fleet is projected to reach 79,282 by the end of 2025.

A week after that BIMCO article, a piece in the *Korea Times* related to the KSOE takeover of DSME said that domestic shipbuilders reached over 70% of their sales goals for the 2021 year in the first two quarters alone.

It is certainly true that this year has seen an increase in orders for container ships and LNG carriers. Some might say that the increase in boxship orders is linked to the current high freight rates and demand for space on ships but that is too simplistic given that leading container ports, such as Rotterdam and Singapore, saw falls in throughput in 2020. Demand may have increased in 2021 but the period between late 2020 and early 2021 would hardly have been sufficient time for hard-headed liner operators to engage in a spending spree.

SOURCE: HMM

Despite the talk about decarbonisation, many new boxship orders are being built to run only on oil fuels and scrubbers are specified on some of these ships as well, suggesting that owners are quite happy to continue running on high sulphur fuels which would give them an advantage with bunker costs on a definite upward trend.

BIMCO's point that demand for LNG carriers is also strong is surprising since the need for energy has been reduced during the pandemic and all political talk is of a future reliant on renewable energy. Furthermore, considering the negative press that LNG has been given by the World Bank and others in 2021, it might be thought that demand for LNG would soon be on a downward trend.

Conceivably, the surge in orders for both container ships, LNG carriers and cruise ships has its roots in earlier events – not least the decision at MEPC 74 to advance the implementation of the EEDI Phase 3 dates for those vessel types from 2025 to 2022. As well as bringing the implementation date forward three years, the EEDI rules for containers ships above 40,000dwt were also made more stringent with the required reduction increasing in line with vessel size.

The new EEDI implementation date is for new ships with effect from 1 January 2022. Of course, many of the ships now being ordered will have delivery dates well beyond that, stretching through to 2024 and potentially even later. However, the definition of a new ship for EEDI purposes is not the delivery date but the contract date or, in the absence of a contract, the keel laying date. Therefore, the ships ordered so far this year and through to 31 December will not be subject to the more stringent EEDI requirements at all. The owners are of course allowed to better the required EEDI rating if they so wish and many of them will, but they will not be compelled to do so. ■

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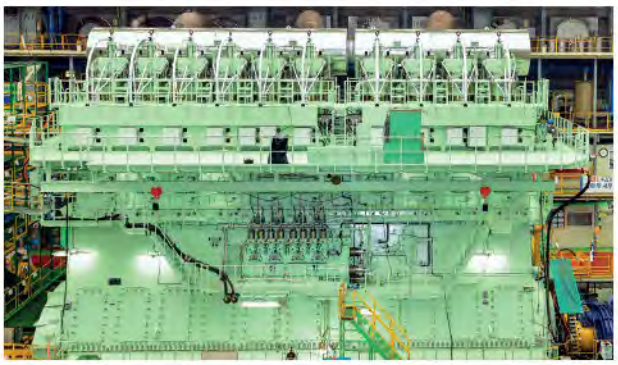
NEWS EQUIPMENT

ENGINES

ORDERS FOR LARGEST WINGD ENGINES SOAR



WINGD'S FIRST X92-B BUILT BY HYUNDAI HEAVY INDUSTRIES

Leading engine specialist WinGD has received over 80 orders of its largest engine, the 920mm bore X92-B, following increasing industry investment in large container ships.

As Volkmar Galke, WinGD global sales director, comments: "It has shaped up to be a competitive year in the container ship segment as owners race to secure spots at shipyards. The popularity of our large bore X92 engines is recognition from shipowners that this technology is providing the reliability, energy efficiency and low emission profile they require. More importantly, their investment in our technology offers the future fuel flexibility they need to be confident in the longevity of the vessel."

Configurable as 6- to 12-cylinder design, the X92-B from WinGD is its largest, most powerful two-stroke engine, with power ranges from 24,420-77,400kW. Its design also contributes to the base technology of WinGD's X92DF engine. The X-DF series – a Diesel and Otto cycle technology capable of using liquid and gas fuel and the most powerful dual-fuel Otto-cycle engine ever built – has also received continued orders in 2021.

According to WinGD, the demand for LNG-fuelled, large-bore engines is increasing as shipowners seek to reduce air pollution, greenhouse gas emissions and fuel costs. "Shipowners today must promise to not only deliver their goods on time but also in the most sustainable way possible. The efficiencies of these large-bore engines provide significant benefits which make them the clear choice as the way forward," Galke adds.

CLASSIFICATION

BV PLATFORM AIDS EEXI/CII COMPLIANCE

For shipowners navigating IMO's new EEXI and CII measures for existing ships, classification society BV has launched its VeriSTAR Green online platform, which assists users in vessel and fleet compliance.

While IMO's carbon intensity index (CII) is an operational measure stipulating a year-on-year reduction in carbon emissions, the energy efficiency existing ship index (EEXI) is a one-time technical measure whereby a vessel's attained EEXI value – a calculation of CO_2 emissions per cargo tonne and mile, which is based on a ship's design particulars – must meet a required EEXI value.

VeriSTAR Green allows shipowners to check a ship's required EEXI, compare this value to an existing EEDI/EEXI value and directly request verification or technical advisory support from BV or its technical branch, Bureau Veritas Solutions M&O (BVS). BV intends to expand VeriSTAR Green's capabilities in line with MEPC 76 decisions. By September 2021, users will be able to utilise a tool to calculate the attained EEXI for each vessel, and similar functionalities to calculate CII and its associated rating between A-E are expected be in place by the end of the year.

The online platform aims to prepare the industry for the fast approaching EEXI and CII measures, which will enter into force in 2023. "Until then, shipowners will need to pre-assess their compliance to get ready for the 2023 deadline. As a world-leading classification society, Bureau Veritas has an important role to play to support shipowners as they navigate these new regulations. I am proud that Bureau Veritas Marine & Offshore and Bureau Veritas Solutions M&O have joined forces to open this dedicated online platform to help the industry tackle the EEXI & CII challenges in time to reach compliance," comments Laurent Leblanc, senior vice president of technical and operations for Bureau Veritas Marine & Offshore.

Additionally, BV clients under contract for Data Collection System (DCS) or Monitoring, Reporting and Verification (MRV) are able to use VeriSTAR Green to report fuel consumption data and request verification.

Tiphanie Jeanperrin, digital and excellence director, BV Marine & Offshore, explains: "This platform aims to support any shipowner, with or without a contract with Bureau Veritas, through their EEXI and CII compliance journey. In VeriSTAR Green, you will have access to a list of our key contacts within our global network whom you can contact should you need any assistance regarding EEXI, CII, but also DSC and MRV."

BALLAST WATER TREATMENT

BIO-UV LAUNCHES COMPACT BWTS DESIGN

BIO-UV'S M-SERIES BALLAST WATER TREATMENT SYSTEM

A new design from BIO-UV, the M-Series ballast water treatment system (BWTS), repurposes the ballast water specialist's existing technology in a manifold-free, compact design that can reduce system footprint and integration costs by at least 25%.

The new M-Series is based on the technology used in previous iterations of the BIO-SEA system, but the key design difference is its M reactor. Previously, a BIO-SEA BWTS required two UV reactors to tackle a 300m^3/h flow rate, but the M-Series uses just one UV reactor with two lamps inside, with roughly the same filter, power cabinet and controls, and without additional manifolds.

Xavier Deval, business director at BIO-SEA BIO-UV Group, explains the advantages of the design: "In terms of savings, we have divided the height by two or more, the ground footprint has been reduced by at least 25% compared to the previous version and integration has been optimised, also reducing by at least 25%."

Bio-UV has designed a range of M reactors suitable for different capacity requirements, ranging from 190m^3/h up to 2,100m^3/h flow rates, and with additional reactors the system could theoretically achieve a maximum flow capacity of 4,000m^3/h.

Deval adds that the reduced number of UV reactors and lamps required to create a high-capacity BWTS is not the only way M-Series' design differs to its competitors.

"The design we have selected is chosen because we want to have less lamps but be more efficient and powerful. The flow is longitudinal, parallel to our lamp; the design that some others have made is multiple lamps with perpendicular flow to the lamps. As the design is not the same, they need and must have many more lamps in order to have the same performance," he concludes.

Available as either a skid system, used mainly in newbuildings, or modular, used for retrofitting due to its flexible installation, the M-Series has a lower risk of corrosion with its reduced number of components.

Type approved by IMO and USCG, the BWTS is available with a short lead time and a number of units are ready for immediate delivery.

CLASSIFICATION

PROSTEP ENTERS OCX CONSORTIUM

The Open Class 3D Model Exchange (OCX) consortium, a data exchange format for model-based class approval, announces PLM integration solution provider Prostep as its founding member.

Shipbuilding class approval is a drawing-based process, where class societies and shipyards exchange large format drawings with annotations, but in the last year there has been a gradual shift towards digital drawing files. According to Prostep, embracing OCX will help change the class approval landscape: "The distributed use of OCX will provide an exchange format that would contain all information needed for the class approval process as a topological and parametric 3D model, thereby eliminating the need for drawings."

Prostep began as APPROVED, a project led by classification society DNV (see *TNA* May 2019, p18) and supported by product lifecycle management (PLM) software vendors over the past few years. Its integrated platform for shipbuilding, OpenPDM SHIP, supports OCX-based scenarios. It allows connected computer-aided design (CAD), product data management (PDM), and enterprise resource planning (ERP) systems to utilise OCX-based processes, ensuring that these become part of a company's digitalisation architecture and product creation.

The ability to connect with PLM system environments and shipbuilding specific solutions such as Aveva, Cadmatic, Napa and SSI, makes Prostep a unique platform capable of model-based bi-directional exchange between classification societies and ship designers. It ensures secure information flow, tracking of 3D model data delivery, direct processing of class annotation by the shipyard and creating workflow in a company's PLM environment, as well as built-in 3D PDF support to allow digital signatures and protected data package exchange between maritime parties.

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The function of the Marine Survey Office is to ensure the implementation of national and international legislation relating to safety of life at sea, security, living and working conditions and prevention of pollution of the marine environment from ship related sources. Vacancies now exist in the following roles:

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OPINION

RECENT EVENTS HAVE HIGHLIGHTED MARITIME'S PR FAILINGS

By **Ben Pinnington**, managing director, Polaris Media

Two torpedoes have slammed into the reputational hull of the maritime industry recently: the *Ever Given* Suez Canal crisis and the Black Trail TV documentary (see the News pages of June's *TNA*). Both exposed the PR weaknesses that are well known in the sector – organisations that are not comfortable with the media often do not understand or value PR and prefer a low profile. This approach is increasingly untenable in a media saturated world where social media has given everyone a voice.

When the nearly 400m-long *Ever Given* blocked the Suez in March it thrust maritime onto the front pages worldwide. It was a golden opportunity to champion the industry and grow understanding. But the aftermath saw a stinging editorial in *Lloyd's List*, which said the response saw 'faceless' shipping executives 'hide in the shadows.' Lloyd's observed that few executives gave media interviews and hid behind 'limp updates'. While this was evidently a complex crisis for the PR teams to deal with, with different organisations and cultures involved, all the latest media training teaches you – you need to front up in a crisis.

Can you imagine a major global media crisis involving a Virgin plane and not seeing Richard Branson on the media? It is unthinkable. Executives need to be visible in a crisis as it is in these moments that you find out what a company and its leaders really stand for. A crisis well-handled should see an organisation's reputation enhanced with an empathetic spokesman sensitive to the human implications of the incident giving informed updates and answering difficult questions. So often where organisations go wrong is when they seem detached, cold or insensitive to the impact of a crisis. Maritime organisations need to be aware how the low-profile approach can backfire.

The Black Trail documentary meanwhile is the mother of all wake up calls. Billed as 'how shipping pollutes the planet, avoid taxes and dodges regulations' it falls into the 'viewing from behind the couch' category for maritime executives of a sensitive disposition. While it clearly had an agenda, the programme raised valid points which required serious answers but the candid unguarded interviews with some Greek shipping executives were painful to watch. It goes without saying that no executive should give an interview without media training and pre prepared messages.

Maritime simply cannot go on in this way. Public and mainstream media scrutiny of maritime is only likely to increase as it becomes better known how the industry is responsible for carbon emissions equivalent to Germany. Organisations need to undertake crisis horizon scanning understanding that the decarbonisation agenda is taking maritime out of its bubble blinking into the blinding sunlight of the climate change emergency debate. This means shipping lines, ports, shipyards, logistics companies and OEMs have to be in touch with public opinion on environmental matters. It is now expected that organisations demonstrate they are going green with hard evidence.

The definition of PR is: PR is about reputation, what you do, what you say and what others say about you. By far the most important element of this statement is what you do. As PRs we are aware that the environmental

MAKING WAVES IS AVAILABLE NOW

agenda places massive pressure and responsibility on maritime businesses to listen and shape their operations accordingly, not green washing or purpose washing. This is not the soft world of CSR where companies did good things, which were not always fundamental to operations, and expected recognition. The advent of Environmental Social and Corporate Governance (ESG) in place of CSR is a tougher game altogether. We see ESG in action particularly in maritime finance where the Poseidon Principles have been signed by lending institutions responsible for US$158 billion, roughly half of global ship finance. The signatories demand that shipowners meet the IMO targets for their fleets otherwise ships risk not being mortgaged.

Public relations is also changing. The era of PR being seen as a tactical tool, communications gloss or an add on to marketing is over. Astute organisations now use PR to shape their strategic direction. PR today is as much about listening as it is about broadcasting a message. If we expect stakeholders to believe in, and be influenced by, our messages, we have to show we are prepared to listen and become an advocate of their message. Listening is the starting point of building trust and deepening relationships – the ultimate goal of PR. This is why organisations are making PR part of their C-suite to ensure they are in tune with their stakeholders, as well as public opinion on issues that affect them, giving them a considerable advantage over those who are not.

BEN PINNINGTON

The world is a very noisy place. It is harder than ever to pierce through that wall of sound. Maritime organisations need to find their voice on the issues that matter most like climate change as well as the human stories of triumph and adversity overcome. This is not the time to be quietly hiding, tapping on the door of Government and the media with a sponge. We need champions so the immensity of Maritime's role in the world is heard, appreciated and acted upon.

Ben Pinnington's new book *Making Waves: 'PR strategies to transform your maritime business'* is published by Rethink Press and available through Amazon.

POWER & PROPULSION

FUEL CHOICE DRIVING ENGINE DEVELOPMENT

Years of refining engine performance to extract a few more percentage points in efficiency appears to have given way to development of engines to accept new fuels – notably, methanol, ammonia and hydrogen

By **Malcolm Latarche**, Correspondent

HAPAG LLOYD'S *BRUSSELS EXPRESS* RECENTLY BECAME THE FIRST 'LNG READY' VESSEL TO BE RETROFITTED FOR GAS PROPULSION. SOURCE: HAPAG LLOYD

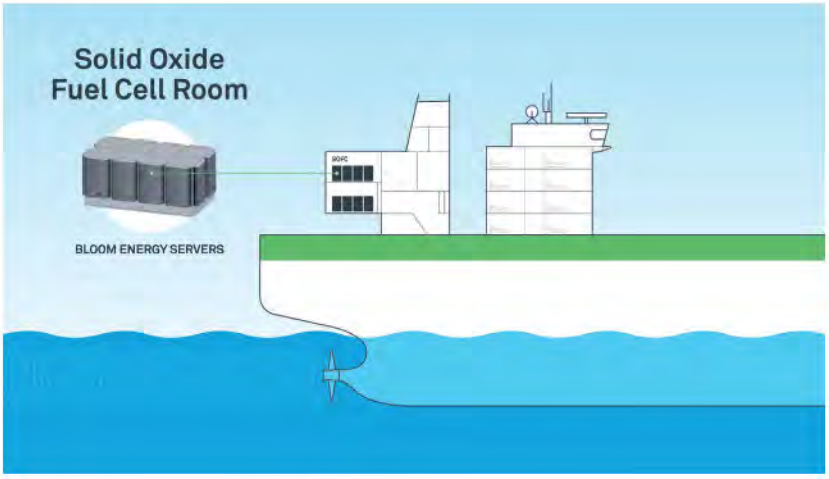
In the drive to decarbonise shipping, few new technologies have emerged as viable alternatives to the marine diesel (or Otto) engine to propel existing ships and those under construction or on order. For short use such as in ferries or tugs, batteries are an option although their environmental benefit will depend on how the electricity used to charge their batteries is produced.

On an oceangoing vessel, battery systems alone cannot provide the motive power for vessels to complete typical voyages but they can help to reduce emissions in port areas, either as providing propulsive power in the final approaches or by reducing or eliminating generator use while berthed.

Fuel cells have been promised as being on the horizon for over a decade and after a period of quiet there does appear to be some movement again. When fuel cells were the 'in thing' a decade ago, most of the research was being driven by the fuel cell developers themselves but today shipbuilders and operators are also involved. As an example, Samsung Heavy Industries is working with US-based Bloom Energy to develop tankers and LNG carriers powered by fuel cells with a commercial project powered by a 30MW fuel cell or bank of cells planned for 2022. DNV gave AiP as long ago as 2019 for the tanker and the LNG carrier was announced last year.

In Europe, Germany-based fuel cell maker Freudenberg is involved in several projects. One involves Carnival Corporation's *Aida Nova* in a project first announced in 2019. At the time, it was said it was thought AIDA Cruises will be the world's first cruise company to test the use of fuel cells on a large passenger ship. The project is said to be still in progress despite cruising being the sector worst hit by the Covid-19 pandemic. Initially the fuel cell was set to be installed in 2021 as part of the Pa-X-ell 2 research project.

Last December, Freudenberg stated that it was also working with shipyards Lürssen and Meyer Werft, along with DNV, to develop methanol-fuelled fuel cells for



SHI AND BLOOM ENERGY ARE WORKING OF A FUEL CELL SOLUTION FOR TANKERS, WITH A TEST PROJECT DUE NEXT YEAR. SOURCE: BLOOM ENERGY

container ships. The fuel cells will be pre-manufactured and housed in containers for easy installation. Each individual container has a rated output of up to 500kW and can be scaled with other units to achieve total outputs in the double-digit megawatt range for heavy oceangoing vessels.

In June this year, working again with Lürssen, Freudenberg announced a new ambition to develop fuel cell systems for megayachts. The fuel cells are to completely replace the conventional generators on the ship at times during the first joint ship installation. This will enable the yacht to anchor for 15 days or cruise 1,000miles with zero emissions.

Other projects announced recently involve Ballard Power Systems, which has an established facility in Denmark and could be providing systems to power a ferry for Scottish operator CMAL. The company is also involved in a project with Australia-based Global Energy Ventures (GEV) and Wärtsilä to develop a fuel cell and battery propulsion system for GEV's proposed prototype 430tonne capacity liquid hydrogen carrier known as C-H2.

As with battery systems, wind assistance can help reduce main engine power requirements under some conditions but a return to wind power alone for long voyages is not considered a viable option by commercial operators. Another alternative to diesel engines is nuclear power, which seems to be gaining some traction as covered elsewhere in this issue.

GERMAN MANUFACTURER FREUDENBERG IS DEVELOPING METHANOL FUEL CELLS. SOURCE: FREUDENBERG

The demise of the diesel engine is seen by most industry observers as not something that will happen in the immediate or mid-term future and most see their use assured even in the long term. A big advantage of the diesel engine is that it was always intended to be able to run on different types of fuel with oil not initially being the envisaged choice.

Given that conventional fuel oil (including VLSFO) and LNG have both been accepted fuels for some time, synthetic or bio varieties of each will become drop-in replacements for their fossil equivalents with few caveats. The problems with fatty acid methyl ester (FAME) biodiesel produced from waste fats, oils, and greases are well known and understood if not yet fully accounted for in ISO standards.

Biofuels are being used by numerous ship operators, allowing them to reach deals with major customers for carbon offsetting. However, IMO EEDI rules make no allowance for so-called renewables as things stand.

LNG use has accelerated as a means of meeting the 2020 SOx with dual-fuel engines now installed in every ship type from cruise vessels to ULCVs. In early June this year, Hapag Lloyd's *Brussels Express* (ex *Sajir*) became the first LNG-ready vessel (a ship built with a dual-fuel engine but no LNG fuel system) to enter service after being fitted with an LNG fuel tank at Huarun Dadong Dockyard in Shanghai. "We have broken new ground with the conversion, and we will now be testing it very precisely in real-world operation," said Richard von Berlepsch, managing director fleet management at Hapag-Lloyd. "Fossil LNG is currently the most promising fuel on the path towards zero emissions. The medium-term goal is to have CO_2-neutral shipping operations using synthetic natural gas".

Von Berlepsch's view is shared by UK-based shiprepair and retrofitting group Newport Shipping, which has developed a deck mounted LNG fuel system suited to tankers, bulk carriers and other ship types with engines either designed as dual-fuel or with engines that are capable of being converted.

The race now is to develop and refine the diesel engines capable of burning the four other most favoured

STENA GERMANICA RECENTLY COMPLETED ITS FIRST 'BLUE METHANOL' BUNKERING

alternatives – LPG, methanol, ammonia and hydrogen. In all cases there will be some engine modifications needed to run efficiently on these fuels compared to oil fuels and, depending upon the ship's type, fuel systems for more than one type of fuel including fuel oil.

To some degree both LPG and methanol are already commercial propositions with both retrofit/conversion and newbuilding references. Methanol has a longer history as a marine fuel beginning in 2015 with the conversion of *Stena Germanica*. In June this year, Stena claimed another first when it bunkered the vessel with recycled methanol fuel.

Stena Germanica has so far been unique among the methanol-fuelled ships as being the only one with a four-stroke engine. The other 20 or so vessels in service or under construction have so far been methanol tankers with fuel drawn from the cargo. These ships are all fitted with MAN B&W ME-LGIM dual-fuel engines.

However, further ship types are in the pipeline. This year has seen Port of Antwerp announce a methanol-fuelled tug – which will feature an engine from local maker ABC – to be ready for service in 2022, and Maersk has ordered a series of 3,500TEU feeder container ships from KSOE for delivery in 2023. In February 2021, Maersk declared a policy for all future newbuilds to have dual-fuel technology installed, enabling either carbon neutral operations or operation on standard VLSFO. The Danish owner has said that LNG will not feature in its plans, suggesting either green methanol or ammonia as its choice.

MAN has also cornered the market for engines of LPG-fuelled ships with 76 of its ME-LGIP model sold. Again, these have so far been for use on LPG carriers but as there is already a global trade in LPG, a bunker infrastructure and availability could very likely see it being used as a fuel for other ship types.

Of the remaining two fuel types – ammonia and hydrogen – the latter is the most environmentally friendly from a combustion chemistry viewpoint but has more technical obstacles to overcome as regards storage and engine development. Its energy density except at extremely low temperatures is poor and its ability to diffuse through most materials and embrittle metals are problematical. Nevertheless, Belgian engine maker ABC has established a subsidiary under the name BeHydro to develop and sell hydrogen-fuelled diesel engines and a hydrogen-powered tug is planned also for Antwerp Port. The *Hydrotug* would be the first vessel with output in the 4,000kW class to be powered by hydrogen-diesel dual-fuel engine.

Ammonia has captured the attention of the shipping industry as the likeliest future fuel. Its attractions are that it is completely carbon free at point of use and has a high hydrogen content. When combusted the only exhaust gases will be water vapour, oxygen and some potentially large measure of NOx. If a pilot fuel system is used, then when there will also be a very small amount of CO_2 emitted.

But there are hurdles to overcome. Ammonia has a high ignition temperature of 650°C well above that of fuel oils (250°C) and is corrosive to many of the materials used in conventional fuel supply and injection systems. These are the areas that MAN Energy systems and Wärtsilä are focusing on as they push towards bringing engines to commercialisation within the next three to four years.

Some have questioned the safety of ammonia as a marine fuel because of its toxicity. While it is dangerous in high concentrations, causing damages to eyes, lungs and potentially being fatal, it is already carried on many ships as cargo and is widely used in other industries and industrial processes.

Storage onboard vessels should not be a problem as ammonia can be stored as a liquid at 8bar at ambient temperature or refrigerated to -33°C. LNG fuel storage systems could easily be modified to carry ammonia. It is less energy dense than oil but careful planning of bunkering facilities should not prevent it from being adopted. Production capacity could be an issue in the short term as unlike HFO, ammonia is not considered a low value product with no other uses.

If production cannot be scaled as rapidly as some would like, ammonia could also be used in a combination with fuel oil or LNG to reduce the carbon emissions of vessels. With regard to engine development, MAN is following the two-stroke engine route it has for its methanol, LPG and LNG engines while most other engine makers will obviously be modifying their four-stroke offerings. Used as a mixed fuel, some of the issues with ammonia's combustion may be more easily overcome but will not of course eliminate shipping's CO_2 output. ■

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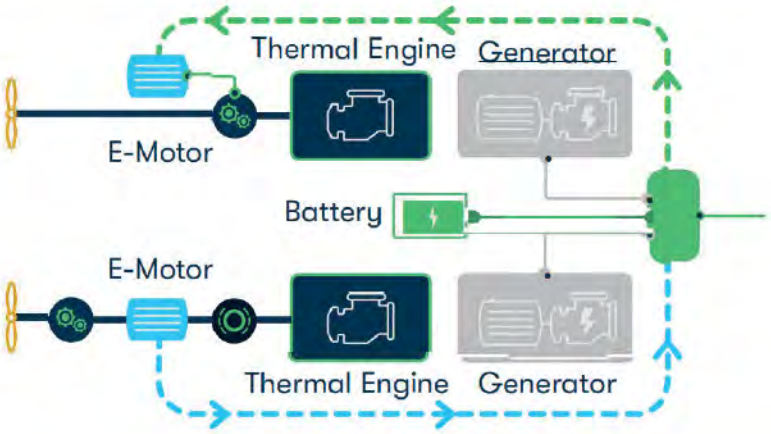

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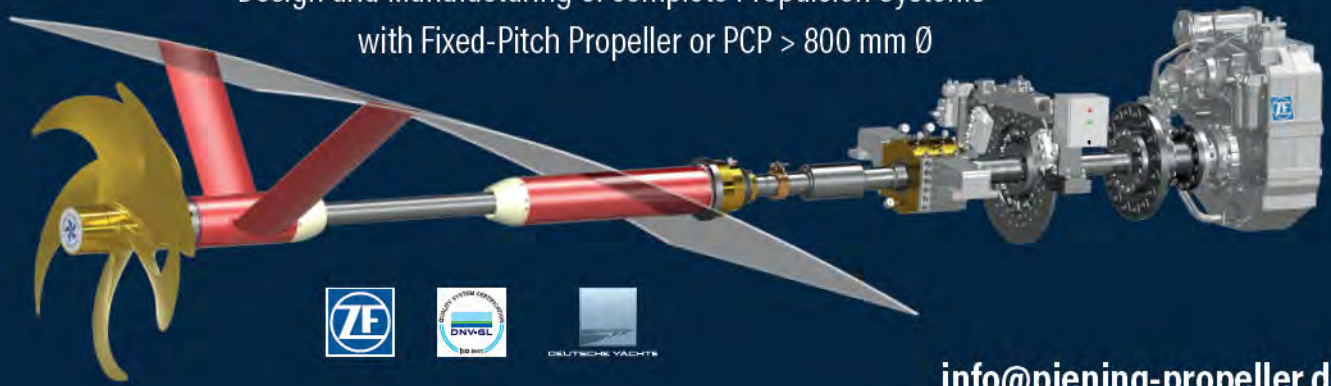

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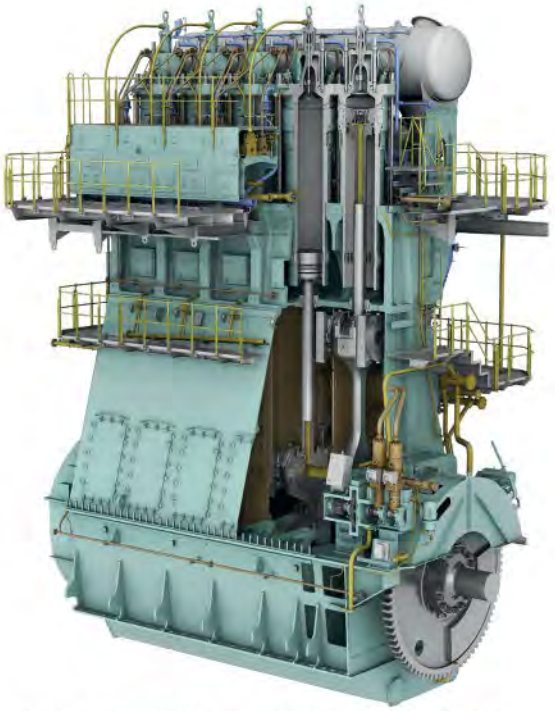
ZERO-CARBON VESSELS LEAD TO SHIP ENGINE PANIC

By **Ship Economy & Trade**

With the development of low carbon technology at home and abroad, the call to action for zero-carbon and the coming wave of green energy, the shipping industry faces uncertainty for the future.

Recently, at an industry forum, Fan Jianxin, former deputy chief engineer of the 711th Research Institute of China State Shipbuilding Corporation (CSSC) discussed the topic with Chinese Academy of Engineering academic Yan Xinping. "Right now, there is a phenomenon going on where we, as engineers engaged in ship power, generally feel that there is no good pathway out of building diesel engines. With the rapid development of low-carbon energy, the European automobile industry is already no longer developing diesel and gasoline engines. At what point do you think hydrogen fuel cells will become the mainstream ship engine for the world's shipping industry?" Jianxin asked.

"In my opinion, the internal combustion engine, a classic and reliable power machine, is still a very important piece of power equipment for vehicles and ships, as it has been for quite a long period of history," Xinping responded. So, when can new low-carbon and zero-carbon energy resources be applied to oceangoing ship engineering? Xinping believes that although there are high expectations for hydrogen fuel cells, in reality there are still a lot of problems to be solved.



ON 2 APRIL, 2021, CHINA'S FIRST INDEPENDENT RESEARCH AND DEVELOPMENT OF THE WORLD'S SMALLEST BORE LOW-SPEED, DUAL-FUEL ENGINE CX40DF WAS OFFICIALLY DELIVERED TO CHINA SHIPBUILDING POWER GROUP, A SUBSIDIARY OF CHINA STATE SHIPBUILDING GROUP (CSSC)

Achieving the green transformation

From the perspective of the integrated development of transportation equipment and energy supply, unlike 'grey hydrogen' which is reliant on fossil fuel energy production, 'green hydrogen' produced by renewable energy such as solar or wind is the only way that the green vision can be carried out. However, it is also a fact that renewable energy cannot provide a large-scale supply of hydrogen. Not only does the production cost remain high, but also storage, transportation and refuelling of the hydrogen itself are difficult problems to crack.

"We look forward to the development and application of hydrogen storage, especially solid-state hydrogen," says Xinping, who believes it is very likely that low-carbon and zero-carbon technologies will develop quickly, just like Moore's law in the IT industry. Although Xinping did not predict when traditional internal combustion engines will be replaced with hydrogen fuel cells, it is not difficult to see that he has high hopes for new energy. But how does Jianxin, as a senior expert of ship power in China, having experienced the anxiety felt by ship crews, view the subversion of ship power technology? He estimates that, in the next 30 years, hydrogen will still be incapable of becoming the mainstream energy source for ship power.

"Technically, it's not difficult at all," says Jianxin. As early as 2003, Chinese technical teams jointly developed China's first fuel cell hybrid car with independent intellectual property rights. After nearly 20 years of technological change, the hydrogen fuel cell, which made its fortune in the automobile industry, has had little technical controversy. For the shipping industry, hydrogen is widely regarded as the ultimate answer to zero-carbon shipping, and Jianxin is no exception to this. However, he stresses that there are still two fatal problems for the large-scale engineering application of hydrogen: economy and safety.

Key problem areas

Economically, the current cost of hydrogen production is high. Nowadays, hydrogen energy is mainly chemical by-product hydrogen and its yield is not enough to support the large-scale use of transportation equipment in the future. As for wind power, solar power, or these kinds of renewable energy sources that use electrolytic water to produce hydrogen, at present the power consumption is

greater than that of the hydrogen production. At the same time, Chinese regions rich in renewable energy often have scarce water resources and the investment, operation, and maintenance and transportation costs of constructing hydrogen production plants are high. Of course, this is not an unsolvable problem, but it will take time to resolve.

In Jianxin's view, the use of nuclear energy in coastal areas to produce hydrogen from seawater is a good option that takes into account energy, cost and transportation. "The most important thing to solve is the problem of where the hydrogen will come from," says Jianxin, adding that he believes that if the whole industrial chain is not straightened out, the popularisation and application of hydrogen energy is empty talk.

As far as safety is concerned, the flammability limit of hydrogen is 4.0% ~ 75.6%. This means that both liquid and gaseous hydrogen are far more dangerous than diesel and natural gas; a traditional marine engine leak will easily catch fire, but a hydrogen leak will cause an explosion. In order to use hydrogen safely, liquefaction and storage technologies need to develop and mature, and the standardisation, design, construction and management of the shipbuilding industry needs to keep pace with these developments. "Disruptive technology is definitely needed, but when technology is not yet mature enough speculation can easily affect the backbone of the industry and many people lose their enthusiasm for research and development," Jianxin comments.

Future predictions

Jianxin does not deny his realistic, conservative standpoint, but he also believes that hydrogen power is likely to be the next disruptive technology to change the shipping industry. Judging by the Chinese government's emission reduction schedule, which strives to reach carbon peak before 2030 and carbon neutrality before 2060, Jianxin predicts that the next decade will be the key development period of carbon reduction and zero-carbon technology, and China will begin to operate large hydrogen powered ships in succession by 2050.

At the same time, he pointed out that industry subversion comes from outside the industry itself: "The technology of the automobile industry is generally 10 years ahead of that of the shipbuilding industry. I think it is likely that automobile enterprises in China are the ones that will drive this next round of leveraging the global shipping industry to realise its green transformation."

** A version of this article was originally published in the Chinese publication 'Ship Economy & Trade'*

ABB TURBOCHARGING READY TO MEET THE NEEDS OF FUTURE FUELS

By **Richard Halfhide**

ABB Turbocharging is better equipped than many to understand the challenges associated with decarbonised power generation, whether that's onshore or at sea. But while there's little certainty about what fuels and technologies will come to dominate, or even how successful they will prove in abating emissions, the Swiss company is confident that the internal combustion engine (ICE), and with that turbochargers, will continue to play a central role.

"There is no doubt that the ICE is here to stay, it has proven many times over the decades that it can burn all kinds of fuels and meet new requirements, and it will do so in the future," declared Christoph Rofka, SVP for ABB Turbocharging, during a recent webinar.

The company believes there are three potential pathways for all industries: renewables, biomass and fossil fuels. Of these the cleanest and most efficient is renewable electricity, but it's not an option for deep-sea shipping, where the energy equivalent of one litre of fuel currently requires 40kg of batteries. Likewise biomass, while being CO_2 neutral, has limitations given the low volumes that can be produced and is more likely to serve as a transitional fuel.

Unsurprisingly, the company anticipates hydrogen will be at the heart of all future power generation. Realistically, like electrification, it is only viable for short-sea transportation. For fuelling larger vessels, where hydrogen's low energy density makes it impractical, that will entail processing into ammonia, methanol or synthetic LNG.

ABB's calculations suggest that enabling the fuel infrastructure for a 20,000TEU container, so that it could run on ammonia, would add an extra €100million to its construction cost for the onboard plant needed for the Haber-Bosch process. However, this figure is dwarfed by the €600 million that would be needed to build a 350MW onshore hydrogen power plant to generate the requisite 45,000tonnes of fuel that the vessel would require annually.

TABLE 1: COMBUSTION PROPERTIES FOR DIFFERENT FUELS

Fuel	L_{min} [kg_{air} / kg_{fuel}]	LHV [MJ / kg]	L_{min} [kg_{air} / MJ]
Diesel	14.5	42.7	0.34
LNG	17.2	50.0	0.34
LNG (Propane)	15.6	46.3	0.34
Methanol	6.4	21.1	0.31
Ammonia	6.1	18.6	0.33
Hydrogen	34.3	120.0	0.29

"I would say it will take decades to build sufficient renewable electricity to feed both the power generation and the shipping industry," says Rofka. But he believes there is significant potential in adopting so-called 'blue hydrogen', where the gas is derived from fossil fuels but deploys additional carbon capture and storage technology, to develop those pathways before renewable sources are available. "Or even cleaner 'turquoise' hydrogen using pyrolysis, where carbon is captured in a solid state, making it easier to store than steam reforming. The solid carbon could even be used in the fertiliser industry," he adds.

So what could the choice of fuel mean for turbocharging technology? As part of an extensive research programme, ABB Turbocharging began by looking at the respective properties of the various clean fuel options. For controlled combustion two parameters are key: stoichiometric air mass describes how much air is required to achieve complete combustion of a quantity of fuel, while lower heating value (LHV) is the thermal energy released by burning a quantity of fuel.

This varies widely between different fuels (see Table 1), but the critical factor for determining turbocharger requirements is the air demand needed to release a specific amount of energy from a fuel, represented by dividing stoichiometric air mass by the LHV. As shown in the fourth column of Table 1, when this is introduced the difference between the fuel options is greatly reduced. However, the combustion properties mean that very different engine concepts are needed, with various temperatures and pressures, necessitating different injection systems and aftertreatment for emissions.

For a fuel such as ammonia, there are two options for turbocharger optimisation. The lower temperature of exhaust gas creates potential to use less heat-resistant materials for the turbines. At the same time, ammonia's high ignition temperature might be achieved by adjusting the compression of the cylinder and valve timings for more efficient combustion, something ABB has been exploring in simulations.

With hydrogen, at the opposite end of the combustion spectrum, the favoured concept is a lean-burn high-speed engine with spark ignition, rather than fuel injected at high pressure into compressed air as found in diesel engines. The twin challenges are to provide a comparable power outlet to diesel engines without dramatically altering the engine map, while also finding a turbocharger arrangement that allows for variable load. ABB says it has found an atypical solutions (for high-speed engines) in the sequential operations of two-stage turbocharging systems.

In conclusion, the company is confident it's possible to satisfy even more challenging applications of hydrogen with known turbocharger technologies and configurations. ■

GAS ENGINE SALES SOARING

By **Malcolm Latarche**, Correspondent

With engine development almost entirely switched to evolving engines to suit new fuel types, new product offerings have been few and far between recently. In March this year, MAN Energy Solutions demonstrated its first ME-GA dual-fuel Otto cycle engine in Copenhagen. After concentrating on Diesel cycle two-strokes for decades, the decision to develop an Otto version was clearly a response to increasing sales of X-DF engines by rival WinGD. The company said that it plans to start testing the first, commercial ME-GA design by the end of this year, with the first engine delivery following in early 2022.

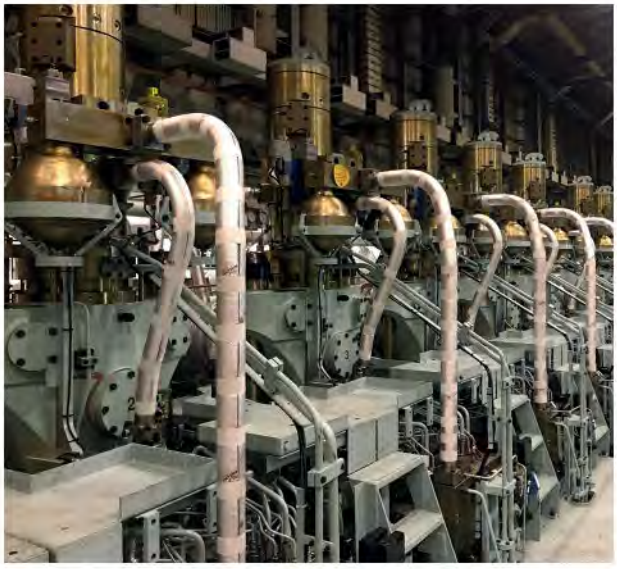
While the ME-GA engine opens another sales avenue for two-stroke dual-fuel engines for MAN, it is also notching up successes with its Diesel cycle variant, the ME-GI, breaking into new market segments and accelerating sales. Last October, Singapore-based Eastern Pacific Shipping ordered five 6G70ME-GI Mk 10.5 dual-fuel engines in connection with the construction of five 210,000dwt Newcastlemax bulk carriers. In May this year, the same owner came back with a new order for three more 6G70ME-GI engines for a trio of similar vessels.

In March, MAN entered the VLCC segment with an order for 10 dual-fuel 7G80ME-GI Mk9.5 engines from DSME to power 300,000dwt VLCCs for three different owners. Within weeks, a second significant order was announced when Samsung Heavy Industries confirmed an order for 10 of the 8G95ME-GI10.5 engines for a series of 15,000TEU container ships for Seaspan Corporation. The vessels are scheduled for delivery in the first half of 2023 and will go on 12-year charters for ZIM Lines. These engines will feature a newly introduced PVU (Pump Vaporiser Unit), which ensures an optimal integration between the engine and LNG-supply system.

In July, MAN announced that a six-unit order for MAN B&W 11G95ME-GI Mk10.5 engines for 23,500TEU ships for Hapag-Lloyd placed in December 2020 was to be doubled as the German shipowner had exercised options for a further six vessels.

MAN's first dual-fuel foray into the container sector was back in 2015 when it supplied the engines for the first ever dual-fuel boxship TOTE's Marlin class *Isla Bella* although the order had been made two years earlier. Despite its successes in this sector, it has not been unchallenged. WinGD claimed the contracts for the first ULCVs to be dual-fuelled when it won the order for the nine-ship CMA CGM 22,000TEU series back in 2017.

The last of those vessels, *CMA CGM Sorbonne*, was handed over at the end of June. The French ships were fitted with the X92DF, WinGD's largest dual-fuel engine, but it also produces smaller vessions and in February this year expanded its popular X72DF with four new variants (see *TNA*, March 2021).



HAPAG-LLOYD RECENTLY DOUBLED ITS ORDER FOR SIX MAN B&W 11G95ME-GI MK10.5 ENGINES. SOURCE: MAN

New variants of old favourites

Although engine development has been mainly directed into new fuel types rather than new engines, some evolution of long-established engines has also been evident. In April this year, Rolls-Royce delivered the first ever 16-cylinder versions of the successful MTU Series 8000. The two 16V 8000 M71L engines capable of producing 72,800kW were destined for patrol vessels for the Taiwanese Coast Guard. Rolls-Royce has also already sold further engines of the new type to a second customer. The 16V engine thus continues the success story of the MTU Series 8000: with an output of up to 10,000kW, its big brother 20V 8000 has been the best-selling engine in its power class since its introduction around 20 years ago.

Another evolved engine is MAN Energy Solutions' Mk3 6L23/30H. The base engine of the 23/30 series debuted in 1965 and more than 12,000 have been sold since then. The new Mk3 variant is a cost-effective genset that complies with 2020 SOx regulations and has a power range of 500-1,800kW. Compared with its Mk2 predecessor, among other characteristics, it features increased power output per cylinder, reduced fuel consumption, a two-part piston design for quicker maintenance and an improved conrod design.

The first references were gained this year when STX Engine signed a contract with Daehan shipbuilding for three gensets each for a one vessel and an option. The engines will achieve Tier III emission levels with the aid of SCR. They are provisionally scheduled for delivery in August 2021. ■

NUCLEAR-POWERED SHIPS – ARE THEY WORTH THEIR SALT?

By **Malcolm Latarche**, Correspondent

Nuclear-powered ships aren't entirely uncommon and over the years their number has probably exceeded that of all the LNG-fuelled ships ever built. However, with few exceptions all of the vessels have been military ships and in the main submarines.

In the commercial sector – if the Russian-owned nuclear icebreakers are excluded from the count – only four nuclear merchant ships have been built. They were not exactly successful and Russian-owned *Sevmorput* is the only one still in service. That ship's survival is an interesting story as it was planned to be scrapped on more than one occasion and was also expected to be turned into a drill ship for Arctic oil exploration, before being recommissioned in 2016 to carry mainly military cargoes on the Northern Sea Route (which, coincidentally, is the meaning of its Russian name).

Today, nuclear ships are once again being talked about as a possibility but now the driving factor is decarbonisation. The subject of nuclear merchant ships resurfaced late last year in a project involving UK-based Core Power and US company Terrapower to develop a molten salt reactor (MSR) suitable for shipboard power production. The attention it drew was due in a great part to Terrapower being linked with former Microsoft head Bill Gates.

But it's not the first occasion that the idea has received publicity. In 2010, Lloyd's Register began formulating new rules for nuclear powered ships, saying it had received some approaches for development of nuclear vessels from various interested parties. If nuclear ships

CORE-POWER'S MOLTEN SALT REACTORS

are to become reality, the MSR looks to be the best choice for a power source. It has many advantages and is considered safer and compact enough to power most vessels using a single reactor. Larger and faster ships and those with a great power demand, such as cruise ships and ULCVs, would need multiple units.

Ultimately, all nuclear reactors are nothing more than a source of heat, which is used to produce steam by means of heat exchangers to drive a turbine that in turn produces electricity. MSRs – of which there are numerous variations – were first developed in the 1950s and intended as the propulsion system of a nuclear-powered bomber. They employ nuclear fission but under conditions that are very different from the types of pressurised reactors that have caused disasters such as Chernobyl or Fukushima.

VESSEL TYPE	Max power installed (MWe)	Ave demand MWh/year	Installed m-MSRs	Fuel Cycle / Years
VLCC	30.0	179,361	2	20-25
SUEZMAX	16.0	95,659	1	20-25
AFRAMAX / LR2	12.0	73,058	1	25-30
LR1 / MR	10.0	63,072	1	30-35
VLOC / CAPE	30.0	179,361	2	20-25
POST / PANAMAX	15.0	89,681	1	25-30
ULTRA / SUPRA	7.0	43,384	1	30-35
ULCV / N. PANAMAX	75.0	573,233	4	20-25
POST PANAMAX	50.0	366,825	3	20-25
PANAMAX	20.0	140,598	1	25-30
FEEDER	10.0	64,167	1	30-35
LARGE CRUISE	100.0	554,946	5	20-25
MED CRUISE	50.0	277,473	3	20-25

TABLE 1: THE NUMBER OF MSRS REQUIRED FOR DIFFERENT SHIP TYPES AND THE LIKELY SERVICE LIFE. SOURCE: CORE-POWER

According to an 1999 academic paper authored by Furukawa *et al* titled 'Thorium fuel utilization: Options and trends. Proceedings of three IAEA meetings held in Vienna in 1997, 1998 and 1999', the safety of MSRs is due to many factors; they operate at pressures lower than 5 Bar (reducing risk of failure), the fuel and coolant salts are chemically inert, and the boiling point of fuel salt is about 1,670K or more, much higher than the operation temperature 973K. Therefore, the pressure of primary system cannot increase.

As well as the Terrapower/Core Power project, other research is under way for ship power. South Korean shipbuilder Samsung Heavy Industries (SHI) has partnered with Korea Atomic Energy Research Institute (KAERI) with an aim to develop MSR nuclear-powered vessels and DNV is exploring nuclear fusion as a source of power. It is anticipated that the first prototype MSR will be trialled in around four years' time.

Core Power foresees that its MSRs will change ship designs and methods of operating ships. Assuming opposition to their use can be overcome, a nuclear-powered ship has several operational attractions. Unlike the previous generations of nuclear merchant and naval vessels, with an MSR there will be no need to refuel. The ship will be delivered with sufficient fuel to allow for a lifetime of normal service (see Table 1).

Thus, the ship will be immune to fluctuations in fuel costs – a factor that has caused great pain for ship operators over the years. Furthermore, there will be no requirement to slow steam beyond shortage of cargoes and indeed ships could be built to travel at much faster speeds than is common. This could mean that less ships and crew will be needed to match the carrying capacity of today's world fleet.

Building nuclear-powered ships would mean that in some cases new ships designs will be developed free of some of the limitations that exist today as regards bunker capacity and location and with less need for energy saving devices and pollution abatement equipment. There would be no need to plan voyages and cargo intake based on bunkering prices and opportunities. Ships' ranges would be increased and limited only by the need for provisions and fresh water for crew use.

In times of low demand, laying up ships could be avoided as the vessel could sail aimlessly in circles without wasting fuel. This would ensure that fouling does not accumulate and prevent transfer of species. Of course, all of the above could be accomplished with zero emission of CO_2, SOx, NOx or particulate matter. The risk of pollution from bunker spills would also be eliminated. ■

CONTAINER SHIPS

AKER ARCTIC DEVELOPS ICEBREAKING CONTAINER SHIP

By **Richard Halfhide**

AN ADDITIONAL COVERED WHEELHOUSE AT THE STERN OF THE VESSEL HAS BEEN INCLUDED FOR WHEN THE VESSEL NEEDS TO PROCEED BACKWARDS. IT IS ACCESSED VIA A COVERED PASSAGEWAY UNDER THE DECK. SOURCE: AKER ARCTIC

Although the global warming that facilitated it is a clear cause for concern, the opening up of the Northern Sea Route (NSR), heralded when Sovcomflot's LNG carrier *Christophe de Margerie* became the first vessel to navigate the waters without the support of a dedicated icebreaker in August 2017, was a watershed moment for commercial shipping.

Designed by Finnish naval architects Aker Arctic, the Arc7 LNG carriers are now a 15-strong fleet dedicated to transporting gas from the Yamal Peninsula. In October 2021, Aker Arctic and Korean shipyard DSME jointly announced plans for six second-generation Arc7 carriers, this time for Novatek's Arctic LNG 2 project, which may be powerful enough to navigate the more challenging eastern sector of the NSR even during the winter months.

But might similar solutions be applied to other ship types and what would be the economic argument for utilising the NSR? Aker Arctic recently set itself the challenge of developing an icebreaking container ship which could use the NSR on a year-round basis. The result is the Arctic container ship, a design for an 8,000TEU vessel that could potentially expedite the transit of goods between Asia and Europe. In addition to features such as an ice-strengthened hull and icebreaking bow, the design incorporates a number of innovations, including Aker's Double Acting Ship propulsion technology.

While the company had previously designed a 648TEU capacity general cargo ship some years ago, Reko-Antti Suojanen, managing director for Aker Arctic Technology, tells *TNA* that it's ostensibly a completely new concept, albeit one that draws heavily from the experiences of the Arc7 carriers. However, there are some key differences. He explains: "The technical and environmental challenges are the same but with transporting containers through the Arctic seas, principally without stopping at the local ports, the logistics are very different to exporting liquid cargoes."

Shallow draft

Like the Arc7 carriers, the proposed container ship has a 300m LOA and, crucially, a shallow draft of 13m that factors in the limited depth on the Arctic routes. Luigi Portunato, who led the research, says that this has meant some adaptations compared to a standard vessel of equivalent size that might operate along a more conventional Asia-Europe route via the Suez, but in many respects the differences are negligible. "With the icebreaking hullform you get some displacement in the bow compared to those vessels, which affects the amount of containers you can bring in.... The [slightly wider] beam is optimised for the ice but that's even better for the containers than an open water vessel."

Despite that this also means increased resistance, Suojanen stresses that one of the ideas behind developing an NSR optimised ship is to arrive at a solution for the overall distance the ship would be travelling. "That was why we made certain changes for the second generation of LNG carriers, because the main transport route is different from the first generation. The first generation are sailing from Sabetta to European ports, but the next ones are from Sabetta to Asian ports. So the balance between the ice navigation and the open water seas is different."

One advantage of having a slower open water speed is that the additional installed power required for

icebreaking is only around 12%. Portunato estimates an average speed of 14-15knots should be possible across the entire voyage during winter conditions, with much faster speeds during the summer months. In that respect container ships have an advantage over the gas carriers, given that their schedules can be adjusted to account for any delays, whereas gas and oil production requires a constant routine.

Power and steering

Double acting ship technology, which allows a ship to turn around and proceed astern in heavy ice conditions, has been a common feature of icebreaking ships for many years. Aker's own Double Acting Ship (DAS) solution dates back to the early 2000s and comprises a single shaftline with two azipod units on the sides.

Alternatively, shipowners interested in the Arctic container ship can choose a design with two conventional shaftlines and rudders, although such vessels require the assistance of an additional icebreaker during heavier ice conditions, given their lower icebreaking capabilities. Suojanen comments that despite the advantages of the DAS configuration, which allows for a larger propeller (and therefore wake field), with the azipods also helping to stabilise speed in open water, many shipowners still appear to be reluctant about what they perceive as a more complicated propulsion arrangement.

Typically, double acting ships have the deckhouse located at the stern of the ship, making it possible to navigate backwards. However, the Arctic container ship has its deckhouse located midship, so to negotiate this problem the design incorporates a special aft wheelhouse at the stern. Portunato says: "The idea is to have a second steering position with the same equipment as the main one, also with cameras and things like that, in the covered mooring deck under the containers."

Economic feasibility

As part of Aker Arctic's research, a comprehensive study was undertaken into the economics of operating a container ship along the NSR comparing three different scenarios: a normal open water vessel using the Suez, the Arctic container vessel shipping goods between Asian and European ports via the NSR, and a third option of using the Arctic container ship only on the iciest stretch of the NSR with dedicated reloading hubs at either end (where non ice-classed ships could collect the containers).

Unsurprisingly, it found that an economy of scale applied in terms of TEU capacity, and that in certain situations the two NSR options might become more profitable, but factors such as fuel pricing and the filling ratio of the container ship made it impossible to state with any certainty. However, Portunato points out that running the vessels on LNG (readily available in the region), as well as removing the need for icebreaker assistance would both contribute to driving the cost down.

Arctic development

Aker is not the only company exploring the possibilities for Arctic container shipping. In 2019, Russia's state-owned Rusatom Group announced it planned to invest US$7 billion in developing a container line service along the NSR, including the construction of up to 55 ice-class container ships and the upgrading of port infrastructure in the region, with the ambition of competing as an alternative to the Suez. Unsurprisingly, the plans are enormously controversial given the environmental sensitivity of the area.

Suojanen understands the concerns but stresses Aker takes these environmental issues very seriously. "For example, long before double sided fuel tanks became obligatory we designed ships with such solutions, so that in case of ice damage there would not be leakage. That was done voluntarily decades ago. The same goes for our designs for the arctic ships; we often design beyond the regulations, because we know the loads and conditions, and that the rules are too simple to answer all the questions."

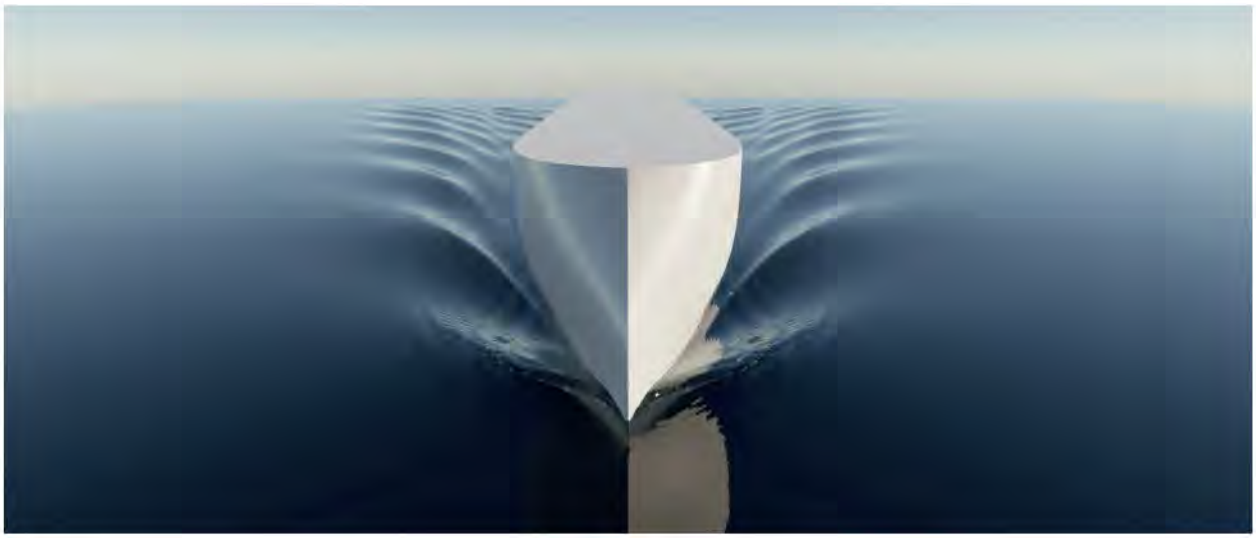
There has been some initial interest in the Arctic container ship concept, but Suojanen believes that developing it further really depends on finding operators with very specialised transportation needs rather than the big players.

"Cargo is king, it doesn't come from the shipowners. Somebody needs to start setting up this logistic arrangement and the products to be transported, then the ship can be ordered and designed. We wanted more to illustrate that it's technically possible and probably also brings some economic benefits, if certain conditions are met. The volumes on the southern route are huge and there's no chance of replacing that. But this definitely has possibilities with container cargoes which can be transported directly from Europe to Asia without any stopping in between." ■

TECHNICAL DETAILS	
Container capacity	8,000TEU
Length overall:	300m
Breadth:	46m
Draught:	13m
Installed propulsion power	
A version:	56MW (1 x 22MW shaftline, 2 x 17MW thrusters)
B version:	44MW (2 x 22MW shaftlines)
Icebreaking capability:	Level ice performance ahead (3knots)
A version:	2.3m
B version:	1.9m
Ice class:	RMRS Arc7

X-BOW DESIGN COULD GIVE AN EDGE TO GREEN CONTAINER SHIPPING

By **Richard Halfhide**



EDGE NAVIGATION AND ULSTEIN HAVE BEEN DISCUSSING COLLABORATION FOR SEVERAL YEARS

Since Ulstein first unveiled its X-Bow in the early 2000s, the inverted bow concept has been successfully incorporated for more than 100 vessels, principally offshore and in more recent years expedition cruise vessels. The notion that it might be a beneficial hullform for container ships has been raised periodically for much of that time but struggled to gain traction, mainly for cost related reasons. But that could be set to change with the announcement in June that Norwegian startup EDGE Navigation has partnered with Ulstein Design & Solutions AS on an X-Bow container ship design suitable for non-fossil fuelled propulsion, with the aim of having such a vessel in operation by 2025.

Describing itself as "a team of shipping professionals focused on developing commercial ships with non-fossil propulsion moving towards achieving zero-emission maritime transport", Jakob Tolstrup-Møller, EDGE Navigation's managing director, tells *The Naval Architect* that the company wants to offer stakeholders impartial, unencumbered participation in the energy transition.

He explains that he first held discussions with Ulstein more than a decade ago. "At the time, technology and infra-structure for alternative vessel designs with non-fossil propulsion were not really available. With significant investments now going into infrastructure for non-fossil maritime fuel and evolving technology becoming readily available, new energy efficient designs like Ulstein´s X-BOW have become a key component today for making the energy transition happen."

Currently the project is still in its early stages and Tolstrup-Møller says the companies are still in the process of analysing trade routes to determine the potential size of the proposed X-Bow container ships, but that given the availability of renewable energy sources worldwide there are "a number of trades where such ships can be deployed". The plan is for an initial series of vessels to be built in Europe, however Ulstein's design expertise would allow for them to be built anywhere. He adds: "We envision also to be building future vessel series with Asian yards."

In July, Ulstein and EDGE announced they were also in the process of evaluating a modular hydrogen fuel cell solution that will utilise zero-emission Proton Exchange Membrane (PEM) technology.

"Hydrogen is emerging as the energy carrier of choice across industries so we are happy to collaborate with ABB and Ballard Power Systems for developing a hydrogen fuel cell modular solution to the designs," says Tolstrup-Møller. Further announcements are expected to follow in the coming months. ■

CFD ILLUSTRATION OF THE X-BOW CONTAINER VESSEL. SOURCE: ULSTEIN

THE ROYAL INSTITUTION OF NAVAL ARCHITECTS

In association with

QINETIQ

2021

rina.org.uk

MARITIME INNOVATION AWARD

To enable the sustainable growth of maritime industries, innovation is paramount.

RINA in association with QinetiQ are launching the **2021 Maritime Innovation Award.**

The award will distinguish an individual, company, or organisation, whose research has pushed forward the boundaries of design, construction, or operation of vessels, particularly in the areas of:

Hydrodynamics, propulsion, structures, or materials.

HOW TO PARTICIPATE?

Nominations may be made by any member of the global maritime community. Individuals may not nominate themselves, although employees may nominate their company/ organisation.

Nominations should include a 750 word summary, describing the research and its potential contribution to improving the design, construction and operation of maritime vessels and structures.

Nominations are open until the 31st January 2022.
Online at: www.rina.org.uk/maritimeinnovationaward
Or, by email: maritimeinnovationaward@rina.org.uk

A panel of members of RINA and QinetiQ will deliberate and the winner will be announced at RINA's Annual Dinner.

For Queries about the Award contact the Chief Executive at:
hq@rina.org.uk

THE ROYAL INSTITUTION OF NAVAL ARCHITECTS

In association with

Lloyd's Register

2021

rina.org.uk

MARITIME SAFETY AWARD

Safety at sea is a crucial collective responsibility of the maritime industry. Naval architects and other engineers involved in the design, construction, and operation of maritime vessels; have a significant role in maritime safety.

To raise awareness and promote further improvements in this important field, RINA in association with Lloyd's Register are launching the **2021 Maritime Safety Award.**

The award will distinguish an individual, company, or organisation, who has made a **significant technological contribution to improve maritime safety.**

HOW TO PARTICIPATE?

Nominations may be made by any member of the global maritime community. Individuals may not nominate themselves, although employees may nominate their company/ organisation.

Nominations should include a 750 word summary, describing the technological contribution made towards the advancement of maritime safety.

Nominations are open until the 31st January 2022.
Online at: www.rina.org.uk/maritimesafetyaward
Or, by email: maritimesafetyaward@rina.org.uk

A panel of members of RINA and Lloyd's Register will deliberate and the winner will be announced at RINA's Annual Dinner.

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INTEGRATION IMDG AND LOADING AND STABILITY SOFTWARE

By **Herbert Koelman**, SARC BV

Container ship loading software has traditionally included a number of notable safety-related features, such as stability, damage stability, longitudinal strength and line of sight. In 2004, this set was extended by incorporating provisions for the carriage of dangerous goods in packaged form, as mandated by the International Maritime Dangerous Goods (IMDG) Code.

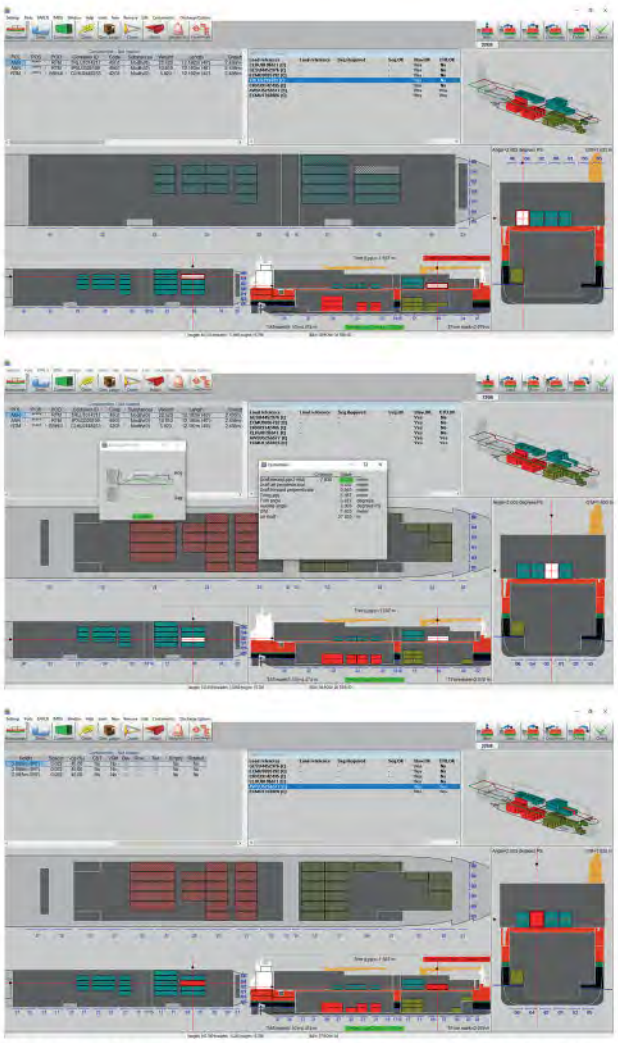
The verification of a loading condition with containers carrying dangerous substances against this Code usually requires the application of separate tools, such as stand-alone software or paper-based procedures. But recently, two manufacturers of dedicated software packages have worked together to create an integrated tool which covers all the mentioned aspects.

One partner is Exis Technologies, of Darlington, UK, a leading global supplier of systems for the management of dangerous goods in sea transport. One of Exis's key products is its Hazcheck system, which includes the full IMDG database with all requirements concerning packaging, separation, heat sources, ventilation, etc. Such an externally supplied database offers the advantage of being filled and scrutinised by professionals, with a strong commitment to keeping the database up to date. This is demonstrated by the fact that the most recent IMDG 40-20 amendment, which becomes mandatory in June 2022, is now already available at Exis. A nice feature of Hazcheck is its ability to act as a background server, which enables seamless integration with onboard loading and stability software.

LOCOPIAS is a state-of-the-art loading computer, manufactured by SARC, Bussum, The Netherlands. Since its conception in the mid-90s, it has been installed on more than 1,500 ships of various types, such as container, ro-ro, naval, dry cargo, tanker, inland waterway, pipe laying, and offshore construction and crane vessels. LOCOPIAS has always been equipped with a dedicated container graphical user interface with support for a wide range of standard container types.

However, corresponding container slot positions needed to be pre-defined for all container types, which has long been a demanding task to perform. Recently, a completely redesigned and rewritten container module was released, equipped with enhanced logic for the positioning of containers of varying sizes. This new module requires only a minimal amount of predefined data, while still supporting all ISO container types, even those not foreseen in the design stage of the ship.

The redesign of this LOCOPIAS module also offered the opportunity to extend the vessel's geometric data set with IMDG-related items, such as the locations of living quarters and ventilation inlets. In collaboration with the Hazcheck database this allows for an automated verification of a container load against the IMDG code, including checks on individual container placement and separations between multiple containers.



LOCOPIAS'S CONTAINER MODULE HAS BEEN COMPLETELY REDESIGNED

LOCOPIAS can be installed as a shipborne software program, where relevant connected to the tank gauging system. In addition, LOCOPIAS copies are allowed to be used in shore offices as well, with the ability to transfer loading conditions, including IMDG particulars, to and from the ship. Data exchange with other computer systems is supported by the BAPLIE importer and exporter.

Exis and SARC are confident that this fusion of their products will allow them to continue to support their customers with productive and user-friendly software solutions. ■

CLASSIFICATION AND REGULATION

DETANGLING DECARBONISATION: WHAT IT MEANS FROM 2023

By **Song Kanghyun**, senior vice president, Korean Register's Decarbonisation Ship R&D Center

The anticipated adoption of amendments to MARPOL Annex VI came to pass on 17 June during the virtual 76th session of the International Maritime Organization's (IMO) Marine Environment Protection Committee (MEPC 76). The amendments are the next step in the IMO's carbon reduction goals, which aim to reduce carbon intensity by 40% by 2030, 70% by 2050, and to reduce shipping's total annual greenhouse gas emissions by at least 50% by 2050, compared to 2008 emissions.

Both the Energy Efficiency Existing Ship Index (EEXI) as a technical approach, and Carbon Intensity Indicator (CII) as an operational approach were adopted at the June meeting to achieve the short-term measures to cut carbon emissions from ships. The EEXI targets all ships of 400gt or above that fall under MARPOL Annex VI, and for the CII, all ships of 5,000gt or above. Included are those vessels built from 2013 onwards and which are required to comply with the Energy Efficiency Design Index (EEDI). Based on the same methodology developed for the EEDI, EEXI details CO_2 emissions from a ship's engine power, transport capacity and ship speed.

The new measures will be applied from 1 January 2023, creating a significant challenge for the maritime industry. Korean Register (KR) has been examining the impact of the new regulations on its shipowner and operator clients and has developed resources to help them and the wider industry navigate the actions they will be required to take.

How it works

There are two sets of criteria that shipowners and operators must meet. Firstly, a vessel's EEXI value must be obtained, and KR's customers can do this easily by using KR's web-based smart software. If a ship meets a specific EEXI, the classification society, on behalf of the flag state, will issue an International Energy Efficiency (IEE) Certificate which must henceforth be carried on the vessel. However, the shipping company must implement other measures if the EEXI regulations are not satisfied. Options include the installation of a shaft/engine power limitation (SHaPoLi/EPL) system or Energy Saving Devices (ESD) to improve the vessel's energy efficiency.

When the shaft/engine output limiting system is applied without ESD or retrofitted, the shipping company should expect a reduction of ship speed from 0.9knots to 6.5knots (tanker average 1.7knots, bulk average 2.4knots, container average 4.1knots), which is a rapid deceleration.

SONG KANGHYUN

For the CII, following calculations, ships will get a rating of their energy efficiency between A-E, with A being the highest score. The IMO is encouraging ports, administrations and other stakeholders to offer incentives for the highest performing ships, whilst vessels with a score of D for three consecutive years will be required to submit a corrective action plan to their classification society to show how a C rating or above can be achieved. The same is true if an E is scored only once.

A shipowner can improve their CII score in a number of ways; from thorough maintenance of the hull, propeller and engine, to optimising operations via trim/route optimisation and speed reduction, or even retrofits and the use of low-carbon bunkers such as ammonia and biofuels.

Current industry conditions

KR has conducted a preliminary analysis to ascertain the industry's readiness for the IMO's new regulations and the results show that most ships do not meet the EEXI regulations and the ships that do are small in size.

A 2019 survey of how well the vessels would perform against the CII revealed that 21% of ships would receive

an A or B rating, 31% a C rating, and 48% a D or E rating. KR also ran EEXI calculations on tankers and bulk carriers. Most vessels were pre-EEDI and a significant percentage – 90% of tankers and 100% of bulkers – did not satisfy the EEXI requirements. Further, of the vessels that require an EEDI – those built from 2013 onwards – 7% of tankers did not meet requirements and neither did 34% of bulkers.

These figures suggest that a significant proportion of vessels will be required to consider their choices come 2023. The most appropriate option will be vessel-specific and dependent on a variety of factors including CAPEX, OPEX, remaining service life, chartering speed, CII over the lifetime of the vessel, retrofits, or timings of engineering, installation and verification.

Whatever the scenario, ultimately the owner or operator will have to choose from four possible options: fitting an EPL, fitting an EPL with ESD, opting for a LNG/dual-fuel retrofit, or finally to scrap the vessel and order a newbuild.

Meeting the criteria

The key decisions from the 76th MEPC meeting regarding the EEXI/CII guidelines are as follows:

- Where an engine power limitation (EPL) is installed, the engine power in the EEXI calculation (PME) should be 83% of the maximum limited power (MCRlim) or 75% of maximum power (MCR), whichever is lower.
- The CII reduction rate will be applied equally to all ships regardless of ship type, and the method of applying the reduction rate in stages was adopted. Phase 1 (2020 to 2022) 1% per year, Phase 2 (2023 to 2026) 2% per year, Phase 3 (2027 to 2030) undecided (to be reviewed in 2026)
- Numerical analysis (CFD) was accepted as a substitute for the model test.
- Ship Energy Efficiency Management Plan (SEEMP) guidelines were not finalised but have been sent to a Correspondence Group for further work.

KR is providing customised technical services to allow its clients to adopt the most beneficial countermeasures for their individual vessels, such as determining exactly how much engine power limitation and reduction in ship speed is required. A web-based smart software has also been launched by KR to provide the EEXI calculations as well as CII, offering an easy and simple way to check whether a vessel meets EEXI requirements or not.

In addition, KR's decarbonisation taskforce has been developed to help shipping companies to stay compliant with the relevant regulations of today, as well as exploring technology for carbon neutral, alternative marine fuels such as hydrogen, methanol and ammonia, and providing industry stakeholders with key timely information for their fleet operations.

KR has also published presentations on its YouTube channel, offering comprehensive guidance on EEXI/CII compliance. Free to view, the videos offer details of KR's preliminary analysis and introduces energy saving devices which will help shipping companies to make the necessary changes to manage their decarbonisation progress. Manuals are in development, and KR will be offering training seminars to support this important and rapid industry transition.

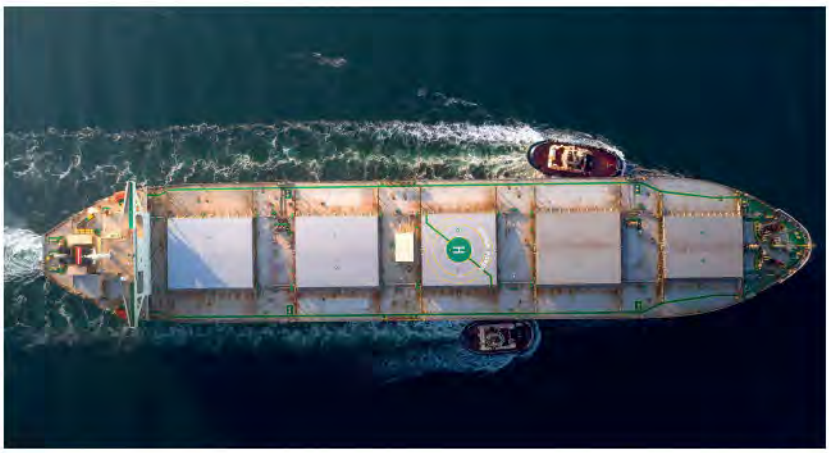
Decarbonisation is a top priority for KR, and as IMO regulations become more and more demanding further technical expertise will be made available. The new regulations are short-term measures laid out by IMO to reduce out industry's carbon intensity. As technology advances, the industry should brace itself for more regulations that will ultimately help it reach the IMO's overarching GHG goals.

KR, as a technical expert group, is committed to using all of its expertise and capabilities to help the shipping industry to address the challenges and find optimal solutions for a sustainable future. ■

Further information

If you are interested in our comprehensive visual presentation on EEXI/CII, please refer to Korean Register's official YouTube Channel. There are altogether six videos uploaded and the titles are as below:

1. How to respond to EEXI and CII
2. EEXI Calculation Results
3. Power Limitation Concept in EEXI
4. Energy Saving Devices for EEXI improvements
5. Considerations for Compliance with CII Rating
6. KR's Decarbonization Services



KR OBSERVES THAT A HIGH PERCENTAGE OF BULK CARRIERS DO NOT SATISFY EEXI REQUIREMENTS. SOURCE MUDASSIR

GLOBAL FLEET SQUARES UP TO THE CHALLENGE OF DECARBONISATION

By **Georgios Plevrakis**, global sustainability manager, ABS

The advent of the Energy Efficiency Existing Ship Index (EEXI) and Carbon Intensity Indicator (CII) regulations has created a challenging landscape for shipowners, operators and charterers across different segments of the global fleet. Both of these short-term measures will apply to all vessels in service regardless of age.

Therefore, it is important to understand the status of the global fleet in order to analyse the effect of the short-term measures on its evolution. This article considers the Energy Efficiency Design Index (EEDI) and expected EEXI compliance levels of five key vessel segments: tankers, bulk carriers, gas carriers, LNG carriers and container ships, and how each segment has performed to date.

GEORGIOS PLEVRAKIS

Tankers

Based on the EEDI and EEXI results, it seems that design-based efficiency over a range of tanker deadweights has improved slowly since 2013. Compliance with EEDI Phase III – and in some cases even Phase II – remains a challenge.

The challenge will be greater for older hulls that are now being asked to comply with the IMO EEXI requirements. Pre-EEDI ships have higher installed main engine maximum continuous rating (MCR) and have not necessarily been optimised for fuel efficiency, as is commonly the case for their EEDI-verified counterparts.

A small number of VLCCs (dwt > 300k) have achieved EEDI Phase II criteria, but no vessel in this category has achieved a 30% reduction compared to the baseline yet. Smaller dwt segments such as Aframax tankers (80,000–120,000dwt) appear to meet Phase II criteria more comfortably when compared to larger ships. However, these better performers have marginal compliance with Phase III by only a small number of vessels.

The slow progress made in improving the design-based efficiency of tankers can be attributed to the relative lack of innovative technology adoption. The main technology adopted for tankers and particularly VLCCs is waste heat recovery for electric power generation onboard.

Bulk carriers

As with the tanker fleet, bulk carrier compliance with EEDI Phase III — and in some cases even Phase II — is a challenge. For large Capesize bulk carriers (200,000–300,000dwt), the number of delivered hulls meeting EEDI Phase II appears to be increasing between years 2016 to 2019 with vessels showing improved average achieved efficiency. However, no ship in this category has achieved 30% reduction compared to the baseline yet.

Smaller dwt segments such as Panamax bulk carriers (60,000–80,000dwt) appear to meet Phase II criteria more comfortably when compared to larger vessels. However, these better performers have marginal compliance with Phase III by only a few ships.

In a similar manner to what was observed for tankers, the limited advances made towards improving the design-based efficiency of bulkers points to slow adoption of the insights gained from the experimental case studies reviewed at MEPC 72 and later also apply to bulk carriers.

The adoption of practical energy saving devices, such as pre/post-swirl devices, contra-rotating propellers, low friction coatings, WHR and solar power, can help the global tanker fleet to increase its design-based efficiency. In addition, the transiton to low- and zero-carbon fuels can offer further significant reductions to EEDI/EEXI as well as the CII by directly reducing the actual tank-to-wake carbon emissions.

Gas carriers

In the early implementation stages of EEDI regulations, gas carriers were grouped together with LNG carriers to evaluate and benchmark their energy efficiency levels. To account for the high ratio of cargo volumetric capacity to dwt for LNG carriers, the EEDI calculation guidelines allowed for the use of a correction factor.

However, in 2014 the IMO effectively split gas carriers from LNG carriers for all ships delivered after 1 September 2019. EEXI Regulations will follow this separation scheme and benchmark all LNG carriers separately using the LNG carrier EEDI baseline.

SLOW ADOPTION OF INNOVATIVE TECHNOLOGIES IS LIKELY TO HINDER EXISTING BULKERS AND TANKERS. SOURCE: ABS

Gas carriers — particularly those of higher dwt capacity — have proven capable to meet the EEXI reduction (30%) expected by the IMO GHG Strategy. Even though older hulls were not designed to consume gas cargo as fuel, this trend has recently changed.

As gas fuels generally have higher calorific value and lower carbon content compared to liquid fuels, their inclusion to the EEXI calculation provides a significant benefit. For example, a gas-fuelled gas carrier may not need to slow down to achieve EEXI compliance and therefore in-service speed obligations would not necessarily be affected.

LNG carriers

The LNG carrier fleet verified for EEDI includes vessels with conventional or non-conventional propulsion that have been contracted on or after 1 September 2015 and/or delivered on or after 1 September 2019.

Following the adoption of the EEXI requirements at MEPC 75, steam turbine LNG carriers will need to comply with a 30% reduction rate applicable to the EEDI reference line of this ship category. All of these LNG carriers were built before the enforcement of EEDI regulations and thus demonstrate lower efficiency levels compared to their conventional propelled or diesel-electric counterparts.

The Specific Gas Consumption (SGC) of a steam turbine propelled LNG carrier is optimised to the ship's design operation point and directly tied to the nominal boil-off rate (NBOR). It has been observed that, in many cases, steam turbine LNG carriers marginally meet EEDI Phase 0.

If a shaft limitation is applied to the output of the steam turbine plant, the resulting SGC increases at a rapid rate at the low load range. This may lead to an approximate 50-70% shaft power limitation requirement in order for steam turbine LNG carriers to become compliant with EEXI regulations, which has multiple negative implications.

Another group of LNG carriers that will need careful evaluation within the EEXI framework are the conventionally propelled vessels burning liquid fuel. Apart from the high installed main engine power to support service speed needs and the use of high carbon content liquid fuel in the EEXI calculation, these vessels are also fitted with reliquefication units that require high electric power for operation. In this respect, dual-fuel or tri-fuel diesel electric LNG carriers that consume boil-off gas for propulsion do not show any significant issues in meeting EEXI requirements.

Container ships

Of the 856 container ships that have attained EEDI values, based on the reduction factors approved by MEPC 75, 649 of these vessels are expected to comply, while 207 are not. These 649 container ships correspond to 13.8% of the global fleet considered.

The global container ship fleet has shown good performance and efficiency, surpassing the EEDI Phase III compliance for the majority of ships above 80,000dwt. However, the smaller dwt segments do not perform as well, with less than 100% compliance with Phase II and even Phase I. Based on analysis of the global fleet data, the IMO has adjusted the required reduction rates for the lower 20-foot equivalent unit (TEU) capacities accordingly.

It should be noted that common energy saving measures adopted by container ships are waste hear recovery systems and shaft generators. Lately, hybrid options and fully battery-electric propulsion for small scale applications have been explored. ■

MASTERING THE WINDS TOGETHER

By **Aude Leblanc**, technology leader, Bureau Veritas Marine & Offshore

CREDIT: BERNARD BIGER/CHANTIERS DE L'ATLANTIQUE

The use of wind to propel ships is not new. For centuries, it was the main force moving vessels and cargoes on the world's oceans. Bureau Veritas' (BV) expertise on wind propulsion also goes back to the 19th century; while our first NR206 rules were published in 1987, the first classification of a tanker with wind propulsion by BV took place in 1886.

After being left aside – and for many perhaps, consigned to the history books – wind propulsion is once again back in vogue, as a combination of fluctuating oil prices and more stringent regulations on greenhouse gas (GHG) emissions have led shipowners to examine alternatives to fossil fuels. In this context, a new generation of wind propulsion solutions for shipping are emerging at an impressive pace. These are developed with a vast variety of new shapes, principles and materials, which brings about a fresh set of challenges.

There is no doubt that wind propulsion systems (WPS) have enormous potential to help decarbonise shipping, but we must ensure that those technologies can be developed, installed, operated and maintained, safely and efficiently. This is where BV is a key ally for the industry, and where our role as a class society goes far beyond just assessing compliance. By developing common sets of standards that are recognised across the sector, we provide guidance that supports the developers of wind propulsion technologies, while giving shipowners confidence in these innovative solutions.

New notations for wind propulsion

Developing notations while keeping pace with the fast-evolving technological and regulatory landscape can only be achieved through close collaboration between classification societies, technology developers and shipowners.

Shipowners and developers of various WPS technologies were closely involved in the creation of two notations providing the class requirements for modern wind-powered ships, which we issued earlier this year: WPS 1 for standing rigging and WPS 2 for standing and running rigging. Both notations provide load cases and coefficients for all types of wind propulsion technologies, including free-standing rigs, wing sails, kite sails and wind turbines.

Wind propulsion technologies may take different shapes, but they share a number of fundamental principles which form the foundation of these new BV rules. Combining our long-standing expertise in wind propulsion with industry experience, we have developed a common set of requirements addressing the risks of WPS, the management of operations in various environmental conditions and the broader impact of a wind propulsion system on the ship.

The unique challenges of wind propulsion

These rules and notations will help shipowners and technology developers understand, assess and address the challenges which are inherent to wind propulsion – thereby helping them to make smart choices now to realise the benefits that this clean technology solution can deliver.

The first and perhaps most obvious of these challenges comes from the very nature of the power source: wind is not constant, nor can it be controlled. This can be mitigated through technical means, such as the installation of release systems that automatically compensate or disable WPS if manoeuvrability is compromised. Our rules also provide for different configurations of the WPS when it is in operation. Moreover, one of our main requirements to ensure the global safety of the system is a rule on "extreme conditions", when winds are too strong and wind propulsion systems cannot be used. Another key point is the careful planning of the ships' route to account for weather and wind conditions.

Other challenges relate to design. Wind propulsion systems can be installed on any type of ship, but some technologies are more suitable for specific sizes, configurations and operational contexts. For example, container ships require a free deck to handle containers, so we must ensure that WPS are not an obstacle. It is also essential that any wind propulsion system placed in front of the ship doesn't restrict visibility, to ensure compliance with current regulations. While this problem is easier to tackle for new designs, for example by placing the bridge at the front of the ship, this doesn't mean that retrofitting is not possible – simply that a number of factors must be taken into account.

The work continues

The collaborative development of norms and standards for wind propulsion systems is still a work in

progress. We are currently seeing the beginning of the commercial phase, with the first prototypes and the first installations entering service. The tests which will take place in the coming years will gather precious data and experience that will help us review and refine notations accordingly – and we are committed to continuing our partnership with shipowners and developers every step of the way.

Most of the shipowners we are working with on WPS technologies are focusing on wind-assisted solutions, particularly those that can be retrofitted on their vessels to enable them to meet the new regulations on emissions reductions. But some are already pushing the boundaries to make wind their main propulsion system, especially for smaller ships.

Of course, one of the big questions for owners is the performance gains that WPS can be expected to deliver. Put bluntly, how will it reduce my fuel consumption and emissions? Identifying ways to assess the performance of these systems with precision will be a key challenge in the years to come. Different technologies are likely to have varying levels of efficiency, and any given system may give different results depending on the ship and operating conditions. Again, the results and data that will be gathered in the next few years will give a clearer picture of whether wind propulsion systems can deliver on the promises made by their manufacturers.

CREDIT: AYRO

More work also needs to be done to adapt IMO and national regulations on emissions to properly cater for wind propulsion systems, and to correctly calculate and recognise the performance of WPS in rules such as the Energy Efficiency Existing Ship Index (EEXI) and the operational carbon intensity indicator (CII). BV is also involved on that front, sharing our expertise with flag states and national authorities. Making sure the legislation keeps pace with technological developments will provide a key incentive for the wider adoption of WPS, which will shape the face of shipping for decades to come. ■

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COMMUNICATION SYSTEMS

A COMMUNICATION COUNTERMEASURE FOR GROUNDING RISKS

By **Sophie Collingwood**

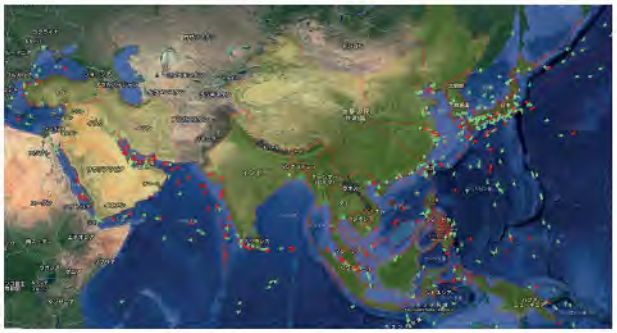
Seemingly the entire world weighed in as container ship *Ever Given* remained grounded in the Suez Canal for six days in March, holding up 10-12% of global trade (see *TNA* May, p20). Dredging work commissioned by the Suez Canal Authority is underway to widen and deepen the southern section of the canal, close to the site of the accident, but could the key to preventing such incidents lie in specialised navigation systems?

"Digitalisation of vessels should be number one priority," Elias J. Makris, director of EU business development at Japanese weather technology specialist Weathernews (WNI), tells *The Naval Architect*. "Navigation assistance services for high-risk areas (in terms of grounding, collision, severe weather, off-track, Navareas) for sure will decrease, if not eliminate, any similar incidents mainly caused by human error."

A world first for grounding risk support services was commercially launched by WNI in May 2021. Its Navigation Assessment and Routeing (NAR) service – an intelligent, navigation risk management program accessed via a user interface – automatically detects ships at risk of grounding, sending out alert notifications to the vessel itself, shipowners and shoreside operators. To achieve this, the NAR service analyses a ship's passage plan, weather and oceanographic data of ocean current conditions, and ship position data in real-time via automatic identification system (AIS) monitoring, which is updated at standard two-minute intervals.

Bringing these elements together, the service can assess whether a vessel is intending to approach an area of high grounding risk, caused by shallow water or dense fishing fleets, as well as when a ship unexpectedly navigates towards these zones due to weather and wave conditions. Makris adds: "NAR weather forecast is updated every six hours, so at any time the master as well as the office operators will have a clear view about the weather on a vessel's track. In case of any severe and unexpected explosive low-formation (weather), WNI will contact all the vessels that will sail close and we will provide all the necessary support to the masters."

Communicating risk to shoreside operations was a driving force behind the product's inception. Weathernews identified that navigational decision making is often delegated to onboard crew already burdened with an increased workload, leading to human error and accidents, but until now no system existed for staff ashore to identify ships at risk of grounding. Makris comments: "The real-time alerting both to vessel and shoreside through email in combination with the AIS monitoring ensures that vessels will always have an extra pair of eyes watching, taking care and alerting if something seems like it may go wrong."



GROUNDING RISK SUPPORT SERVICE DISPLAY IMAGE

Makris also stresses that NAR's analysis is designed so as not to inadvertently overwhelm shore or onboard staff: "In terms of grounding and safety and in order to avoid a flood of alerts, we initially check the passage plan against any risks prior to vessel's departure. When a vessel is enroute, we have set a standard time of two hours notification in advance of any potential risk based on vessels actual position, heading and expected position."

But NAR functions as so much more than a navigational tool for detecting grounding risks, Makris explains: "It is commonly accepted that WNI provides extremely accurate and high-resolution weather globally, but that was not enough for us. What makes NAR so unique is that combines the weather resolution display along with potential risks such as grounding, unexpected off-track steaming, collision, Navarea crossing and so many more that are under development."

Considering the place of navigation risk systems as a vital service for the future of safety and environmental risk management, Makris reflects that nowadays a passage plan created and verified by a master in an Electronic Chart Display and Information System (ECDIS) is, by definition, safe in terms of grounding and safety. However, as vessels are sailing in a dynamic and sometimes volatile environments, combined with human factors, accidents are happening, and WNI sets out to support both ship and shoreside parties facing these challenges.

"Our point of view is that navigation risk systems are not meant to replace the master. On the contrary, our goal is to provide to both master and shoreside high-quality, easy to understand information and risk alerts for the master to be prepared for any upcoming situation. All in all, our vision with NAR is to eliminate any accidents that could be avoided," Makris concludes. ■

SCANREACH CRACKS THE CODE FOR ONBOARD WIRELESS CONNECTIVITY

By **Steve Marshall**, Contributor

An onboard Internet of Things (IoT) system that integrates all critical equipment in an interlinked network steered from the control room and connected via the cloud to shore is still seen by most shipowners as the stuff of fantasy.

While there have been major advances in IoT technologies for onshore industries, the shipping sector has largely baulked at the prohibitively high cost and complexity of retrofitting vessels and installing extensive cabling for ship-wide digital networks. In addition, the time required for such work and need for recertification due to structural changes have hitherto prevented the industry from harnessing and utilising data that can optimise a vessel's performance.

"The main barrier to date for full digital connectivity of ship systems has been the thick internal steel structures of bulkheads and decks that have prevented transmission of wireless signals," says Jacob Grieg Eide, head of business development at Norwegian digital technology developer Scanreach.

"Therefore, cables have been seen as the only solution for data transfer – that is, until now."

Penetrating the steel barrier

Scanreach has developed remote sensors for a suite of pioneering digital solutions that enable wireless connectivity of onboard systems for the first time, even in large and complex steel environments.

The Norwegian company, founded in 2015 on a strategic vision to develop life-saving technologies for both ships and offshore rigs, initially developed the ConnectPOB solution, which gives the control room an immediate overview of the location of personnel onboard using connected wearables.

This saves critical time in an emergency such as a fire onboard by being able to locate crew members accurately and carry out targeted search-and-rescue operations, replacing time-consuming manual headcounts and paperwork that can cost lives due to delayed response.

Scanreach has since expanded application of the ground-breaking technology beyond safety to real-time wireless monitoring of fuel consumption using flow sensors with ConnectFuel, which Eide estimates can result in fuel efficiency savings of between 5% and 10% annually – a significant figure given fuel costs account for about 70% of a ship's operating expenses.

New sensor solutions

Scanreach is set to roll out new sensor solutions in the near future, including vibration and temperature sensors to monitor the condition of equipment for preventive maintenance, cargo monitoring to detect load movements and temperatures, and environmental monitoring of oxygen and gas levels in confined spaces, all connected through a wireless node mesh.

The expanding subscription-based suite of onboard wireless connectivity (OWC) applications, which can be easily installed at minimal cost by a crew and have plug-and-play functionality, are interconnected via the cloud to ConnectFleet, facilitating data aggregation, visualisation and distribution for online fleet management from shore.

Eide believes this digital technology has revolutionary potential to drastically improve the cost-efficiency of fleet performance and will also be needed to meet green regulatory reporting requirements in the future by enabling real-time data-sharing with third parties, such as ports and class societies.

It could also have an impact at the financial level, not least by allowing real-time, rather than historical, insurance assessments of cargo, hull and machinery

REAL-TIME DATA TRANSMITTED BY WIRELESS SENSORS INSTALLED ON SHIP SYSTEMS CAN BE ACCESSED VIA THE CLOUD BY FLEET MANAGERS ONSHORE TO GIVE A VISUAL PICTURE OF VESSEL PERFORMANCE. CREDIT: SCANREACH

to reduce premiums and delivering the required environmental performance data to secure green finance from banks.

'Kodak moment'

But he says: "many shipowners are locked in a mindset that they have reached the limit of fleet optimisation and have closed their eyes to the possibilities of new wireless technology".

Another big barrier to adoption is reluctance from equipment suppliers that fear their business models could be undermined by digital technology, he claims.

Eide warns the shipping industry is facing a "Kodak moment" – referring to the failure of the photography giant to embrace the digital realm that led to its downfall – as "wireless technology is set to change the competitive maritime landscape as it has done on land where business is data-driven".

Scanreach has so far achieved more than 35 installations of its system onboard ships for several players, including Olympic Shipping and Dess Aqua, that have installed Scanreach's solutions on close to all their vessels globally. ■

OPTIMARIN APPLIES BIG DATA TO BALLAST WATER MANAGEMENT

By **Steve Marshall**, Contributor

Optimarin has taken ballast water treatment to the next level with the recent launch of its innovative OptiLink digital cloud solution, which captures the potential of big data to greatly enhance fleet efficiency and aid regulatory compliance.

All ships are required to have ballast water treatment systems (BWTS) installed by a September 2024 deadline to comply with the IMO's convention on ballast water discharges. But this will still not address the challenge of variable water quality at ports in different parts of the world that can hit vessel compliance, causing costly delays to commercial operations.

The Norwegian specialist has therefore developed OptiLink, which comprises a control panel to monitor the BWTS and transmit real-time data on water quality and system performance to a cloud-based database accessible both in the ship's control room and onshore. The ethernet-linked panel uses either 4G connectivity or the vessel's internet to connect to an IoT gateway that allows this operational data to be securely transferred via a deck-mounted antenna to shore for analysis by the ship operator.

Data transparency

The company claims this is the first digital solution of its kind to provide data transparency and predictability in this area to enable proactive ballast water management in support of reduced downtime and fuel consumption.

Its head of technology, Kim Stian Haugland, who developed OptiLink with his team, says analysis of big data means a ship operator can assess water quality in specific ports through "heat-mapping" to determine the duration of ballasting operations, which makes for better fleet planning.

OPTILINK PROVIDES ACCESS TO BALLAST WATER TREATMENT SYSTEM PERFORMANCE DATA VIA THE CLOUD BOTH ONBOARD SHIP AND ONSHORE. CREDIT: OPTIMARIN

Access to key performance indicators for the BWTS also facilitates diagnostics for preventive maintenance that can boost uptime efficiency, he explains. Furthermore, OptiLink makes possible remote troubleshooting 24/7 from shore with over-the-air software updates, reducing the need for physical intervention for maintenance to save time.

Another major benefit is that compliance data from the BWTS can be transmitted directly to statutory authorities for compliance certification, avoiding lab testing and inspections at ports. Haugland says the main technical challenge for this solution was unstable connectivity onboard, which means data on ballasting operations needs to be buffered and then safely unbuffered when a stable connection is re-established.

"The main barrier we are up against is conservatism in the shipping business. Shipowners need to see that being able to share and analyse data with greater transparency can actually benefit their bottom line," Haugland says. ■

COMMUNICATION IS THE KEY TO CONTROL

By **Alan Johnstone**, Contributor

"We all know what it's like to lose control," states NAVTOR's Arild Risholm Sæther, adding: "Just consider what we're doing now.

"If we could choose, if we had real agency, we'd probably be having this conversation face-to-face. However, we can't because of coronavirus – a situation we can't change. But we can still see one another and talk. We can still share knowledge, discuss innovations and seek solutions.

"And that's the power of digital communication and seamless data exchange. It connects us when we can't physically be somewhere. It enables effective decision making and restores a much-needed sense of control.

"Now, that's important to us as individuals and, given current challenges, essential to owners and operators wishing to safeguard assets, drive efficiencies and enhance business performance – today, tomorrow and for the long-term."

But, and this needs to be stressed now, Sæther is not suggesting the industry needs more Teams calls. Far from it...we probably have enough of them already.

Instead, he's espousing a new type of digital communication solution that connects ships, shore-based teams and entire business organisations. An ecosystem.

Making the connection

Sæther's firm, NAVTOR, is known primarily for e-Navigation. Formed 10 years ago, the Norwegian headquartered business has grown quickly, thanks to innovative digital solutions that simplify navigation and make life safer, more predictable and profitable for global customers. NAVTOR is now the largest provider of ENC-based e-Navigation products and services, serving a worldwide base of over 7,000 vessels.

However, the firm has evolved. Rather than dealing with e-Navigation alone, it's now focused on enabling smarter shipping through a "joined up" approach to data, as Sæther explains.

"Don't get me wrong, e-Navigation is still our heart and soul," he says. "But we came to realise it could be a platform for so much more – for really connecting ship and shore and empowering teams to work together as one. That's where the ecosystem comes in."

Real-time benefits

NAVTOR's solutions are pieces of a puzzle. They fit together – connected by something called the NavBox, a DNV certified cyber secure gateway that shares business critical data between ship and shore – to deliver full picture awareness for customers.

ARILD RISHOLM SÆTHER. SOURCE: NAVTOR

For example, when a vessel navigator creates a passage plan in the NavStation digital chart table (a simplified process with a high level of automation) he/she activates it and it immediately becomes accessible on shore, through the fleet management solution NavFleet.

This means onshore teams can see where vessels are in real-time and how they are performing in relation to plans, schedules, etc – a crucial benefit when it comes to fulfilling charter agreements. What's more, they can also receive notifications if a vessel strays from within its safe corridor (defined by XTD – cross track distance – calculations), or if there's increased risk posed by, for example, approaching weather fronts. All this gives the onshore teams the ability to contact and work with those onboard to maintain safe, optimal and predictable operations. Or, in other words, control.

Furthermore, real-time performance can be monitored across individual vessels and entire fleets, allowing not just benchmarking, but also vessel trouble shooting and identifying potential issues, such as system failures or excessive biofouling and poor hull performance.

"There's so many sensors and systems on today's ships, producing so much data, but unless you know how to collect, analyse and really utilise it you will never extract true value," remarks Sæther.

"Our ecosystem essentially enables the communication and integration of that wealth of data so teams can access it, act upon it and work as one. That's never been more important than it is now."

Simplifying complexity

Here the NAVTOR executive points to fuel consumption and emissions.

The commercial benefits of remote and continual performance monitoring and optimisation speak for

themselves, both in terms of financial reward, reputation and meeting stakeholder expectations.

But the benefits in terms of compliance should not be overlooked either, comments Sæther.

"The regulatory landscape is becoming more stringent, and more complex," he states. "As an illustration, the recent MEPC 76 saw the adoption of new technical and operational measures to reduce the carbon intensity of international shipping, taking effect from 2023. These include the Energy Efficiency Existing Ship Index (EEXI), the enhanced Ship Energy Efficiency Management Plan (SEEMP) and the Carbon Intensity Indicator (CII) rating scheme.

"When you add that to the patchwork of local, regional and international measures, it's simple to feel overwhelmed – again, like you're losing control. So, what we need are systems that share data to enable easy compliance, automated reporting (e.g. of EU MRV requirements) and awareness of what applies, when and where, to make sure vessels sail safely within that framework.

"The seamless flow of data, and automatic updating of relevant charts and systems, can take away that headache for owners and operators.

"In short, we can make the complex simple with an enhanced, fully integrated communication ecosystem."

Shared success

Summing up, Sæther notes that data, communication and the solutions that utilise them are tools for creating uniform understanding – for bringing remote teams and assets together, so everyone works towards shared goals, with shared knowledge and awareness.

"That's really the key to unlocking smart, sustainable shipping for every owner and operator," he says. "We can't transform the way we work, as we must do, if every component of our business and operations stands in isolation. We have to join the dots to navigate the future, and working through a connected ecosystem, for example, delivers the ability to achieve that.

"We can take back control," he concludes with a smile, "and that, I think we can all agree, is a good feeling to have right now."

www.navtor.com

DIGITALISATION IN SHIPPING REQUIRES A TWO-FRONT TRANSFORMATION

By **Jens Ewerling**, product manager, VSAT at Cobham SATCOM

The digital transformation of the shipping industry relies on not one singular component but the simultaneous strategic deployment of many technologies. A united approach is key to unlocking greater operational efficiencies, environmental benefits and higher safety standards. Although the shipping industry's digital transformation has seen tremendous progress in recent years, the reality is that the sector is a long way from achieving the super slick integration enjoyed by many on land.

The challenges preventing change include logistical factors, like the impact of the global pandemic preventing technicians from maritime VSAT service providers going onboard ships to install new technologies. This is in addition to ongoing issues, such as a more traditional mindset in relation to the level of connectivity required at sea and a fragmented market, which makes it hard for owners and operators to define and enact a decisive approach.

Similarly, digitalising existing vessels with older systems can be a highly complex process and tailored to each vessel's unique requirements. In most cases, digital interfaces (such as client computers and proxy servers) must be installed into analogue systems to make them ready to exchange data. The physical act of installing separate systems is necessary to start collecting and amalgamating data and must happen before a vessel can take advantage of advanced satellite networks to unlock greater benefits. All different areas of a ship must have their own data collection platforms and from there you can start exporting and interfacing to others to deliver data.

While a growing number of shipowners have digital interfaces already, and are adding others, the expectations of the industry, external bodies and its workforce are evolving. Driven by the impact of the pandemic and growing calls for owners to increase the environmental performance of their vessels, these two prominent trends are triggering a greater need for connectivity at sea and the integration of software to measure and optimise voyage performance.

Connectivity as a human right

More specifically, the ongoing crew change crisis resulting from the global pandemic has led to an increase in calls from seafarers to be able to access reliable connectivity, and often on multiple devices. With the relationship between connectivity at sea and mental wellbeing accentuated by the pandemic, many shipowners and operators have decided that now is the time to upgrade their systems or broadband subscriptions. This trend was confirmed in the recent Mission to Seafarers annual Seafarer Happiness Index report, which found that Covid-19 has spurred an increase in connectivity investment.

JENS EWERLING

However, the situation is far from resolved, with the IMO's recent 'International Day of the Seafarer' highlighting a sombre situation and a need for ongoing action to support thousands of seafarers still stranded out at sea. In line with this, the Mission to Seafarer's report also found there to be scope for improvement, with the results reflecting a notable inconsistency in the connectivity access provided by shipowners and operators. To put it simply, the industry needs to do better now.

Voyage and vessel optimisation

In addition to the humanitarian element of connectivity access, decarbonising the shipping industry relies on a cohesive and united approach. Data driven voyage optimisation technologies are not a new concept in the industry. The benefits that can be reaped by enhancing voyage routing and elements such as just in time arrival are already well known. Indeed, the requirement to invest in such solutions is becoming increasingly pressing considering the IMO's new energy efficiency requirements.

The Energy Efficiency Existing Ship Index (EEXI) – which will be applied retroactively to all vessels in service in 2023 – and the Carbon Intensity Indicator (CII), will mandate year-to-year carbon intensity reduction and reporting for all vessels. Once implemented, access to real-time data to measure and improve voyage and vessel performance will be an increasing

priority for owners and operators that need to make improvements to ensure their assets remain compliant.

Every piece of the puzzle

For both trends, new digital technologies present solutions that have previously been considered impossible by many. However, for shipping to reap the benefits, every key player in the process must recognise these changing expectations and respond with an agile approach that meets rapidly evolving needs.

Satellite communications providers, for example, will see a consequent change in demand from owners and operators requiring different antennas to fulfil different needs. With new satellite networks that offer enhanced network capabilities set to come online, long gone are the days when a "one size fits all" very-small-aperture terminal (VSAT) antenna measures up. Instead, technology that can be configured to work with geostationary (GSO) or non-geostationary satellite (NGSO) networks with a high level of flexibility is set to become the norm.

At Cobham SATCOM, we are responding with agility to evolving owner-and-operator demands for access to higher levels connectivity. Our new generation antenna platform, SAILOR XTR, has been built with changing market demands and evolving satellite networks in mind. Software-controlled, prepared for the Internet of Things and new satellite constellations in LEO, MEO, GEO and HEO orbits, the SAILOR XTR will set a new industry standard for shipping.

Every SAILOR XTR antenna also includes an Ethernet port inside the SAILOR XTR above deck unit that facilitates new connectivity options and the new powerful XTR Antenna System Control Module (ASCM) which makes data exchange faster, enabling safer operations and more reliable connectivity.

In line with SAILOR XTR, the antennas installed today must have the capability to easily convert between satellite networks. With a smart IT system set-up, a ship may operate a network for seafarers to offer high-speed connectivity, including video streaming and calls, on up to three personal devices per seafarer. The ship may also operate a network to facilitate real-time monitoring of, for example, fuel, bridge and automation systems.

Staying one step ahead

The need for greater connectivity at sea will not diminish or cease to become vital. Connectivity will continue to become a more critical component to enabling the digital transformation of the shipping industry. To facilitate this requires a cohesive approach from all those involved. The simultaneous evolution of technology, coupled with uptake, is critical to unlocking greater seafarer wellbeing and environmental monitoring. Both are aspects within the industry that can no longer be ignored. ■

CONFERENCES

ANNOUNCING IMDC 2022

By **Prof. David Andrews**, chair, IMDC international committee
and **Prof. Chris McKeeson**, joint chair, 14th IMDC local organising committee

The 13th International Marine Design Conference (IMDC) took place in June 2018 at Aalto University, Espoo, Finland, as reported in an article in *The Naval Architect* in June 2018, the latest in the series of tri-annual conferences, which commenced in 1982 in London. During 2018's IMDC official dinner, Professor Jon Mikkelsen of the University of British Columbia (UBC) served delegates a mouth-watering glimpse of what the city of Vancouver had to offer as the proposed venue for the next IMDC, which was scheduled for June 2021. Needless to say, the Covid-19 pandemic prevented this. However, UBC has recently confirmed that the conference will go ahead from Sunday 26 June to Thursday 30 June 2022 on its magnificent campus in Vancouver.

SOURCE: PEXELS/JAMES WHEELER

Given the aim of these long-standing tri-annual conferences is to promote all aspects of marine design as an engineering discipline, the host for 2022 wishes to focus the conference on the design challenges and opportunities in current maritime technologies and markets, with special emphasis on:

- Design of new shipboard technologies and how they will modify the ship design process (this includes specifically work being done on Ship RF systems integrated into ship design)
- How societal developments have and will further modify the way in which 'ship design' is practiced
- How teaching marine design is changing
- How the impact of the no crew onboard driver is changing ship design
- How human-centric design modifies the ship design process

There are intended to be a series of keynote papers presented and the ongoing feature of IMDCs is presentation and discussion of State of Art Reports on key issues, such as Design Methodology and Design for X, in plenary sessions together with parallel streamed presentations of papers on the topics of current marine design issues and cutting-edge design related research.

The timetable for the run up to June 2022 is:

- Submission of abstracts – 15 September 2021
- Authors of abstracts informed of IMDC acceptance of abstract – 1 October 2021
- Announcement of IMDC with early bird booking open – January 2022
- Full paper submission 31 January 2022
- Authors of submissions informed of IMDC acceptance of paper – 1 March 2022
- Delivery of final paper by corresponding author (and end of early bird booking) - 30 April 2022
- Final announcement of IMDC May 2022
- Conference – Sunday evening 26-30 June 2022

Why Vancouver?

Vancouver is a thriving maritime city; home to the fourth biggest port in North America and one of the continent's largest shipyards. Students studying at UBC benefit from Canada's investment in local shipbuilding; Vancouver's many marine-related companies and firms; and the university's close relationship with key members of industry locally, nationally, and internationally.

In 2010, the Government of Canada announced the National Shipbuilding Procurement Strategy (NSPS), a C$38 billion investment to fund the production of 28 large vessels for the Royal Canadian Navy and the Canadian Coast guard, as well as more than 100 smaller vessels. Seaspan Shipyards in Vancouver was awarded the non-combat contracts, amounting to C$8 billion of the investment, and has recently undergone a C$170 million renovation and expansion project to prepare for the new work.

Seaspan ULC is Canada's largest marine transportation company and parent to three shipyards, all located in British Columbia: Vancouver Shipyards, Vancouver Drydock, and Victoria Shipyards. These shipyards engage in vessel new construction, maintenance and repair. In November 2014, Vancouver Shipyards completed a C$170 million modernisation project.

Canada is also a major world power in academic research and UBC is the home to the only degree-granting programme in naval architecture and marine engineering in western North America. It is hoped that the extra year in which we have all been forced to work online will have produced further developments in marine design and that the opportunity to present and debate these worldwide developments to fellow designers and researchers face-to-face once more, will produce yet another excellent IMDC. ■

COMPIT PREVIEW: POSITION AND HEADING OF THE MARITIME DIGITAL TRANSFORMATION

By **Volker Bertram**, DNV & COMPIT organiser

The digital transformation of our industry is a fluid process. The COMPIT conference is a traditional occasion to determine the current position and course of this transitional flow. Covid-19 has impacted our field as it has impacted many other industries, reducing levels of activities and putting some segments under considerable business stress. But in some other fields, such as digital training and digital collaboration in ship design, Covid-19 has accelerated the pace of progress.

Connecting data & people

Information Technology (IT) used to be just data processing – we have come a long way in creating ever more terms and acronyms, AI, VR, digital twin, etc. But at the heart, there is still data and what we do with it. Data has gotten bigger but is it really 'Big Data'? Big data is used more often than not as false labelling in maritime applications, trying to impress. My data is bigger than yours...

The challenges do not lie in handling TeraBytes of data, they lie in connecting them and turning them into insight and decision. "By collecting it, connecting it and ensuring it is no longer siloed, data can be the basis for true business agility within the marine industry", elaborates David Thomson, marine solutions manager at Aveva. But how do we collect and connect data? At first glance, the answer seems simple: modern ships are full of smart equipment, each with sensors, and of generation Industry 4.0, ready to share via local networks and the Internet of Things (IoT). But when we take a closer look, there is a multitude of native (= company internal) data formats. A modern container ship may have more than a 1,000 such data 'standards'. Nick Danese (founder and CEO of Syrrkle) compares it to getting access to a North Korean TV news show via the internet – you still don't understand what they are trying to tell you even if you get the electronic signal. Having something in a digital format does not mean automatically being able to process it digitally in your world, as Herbert Koelman (SARC) also points out.

Captain Kirk had his Universal Translator to overcome language barriers – whatever language assorted lifeforms in the galaxy spoke, this little device translated them into English. And we may have something similar evolving for our industry. The hope that the many vendors will agree on a common data standard, a digital lingua franca understood by all, is unrealistic. Neither will we see one dominating company imposing a de facto standard, akin to Microsoft in the IT world. This leaves having digital adaptors that are able to understand company data formats and translate the data into a common standard. Developments on this side look at least promising and may unlock some of the potential that the IoT promises.

It is easy to see that IoT technology may revolutionise shipping, especially in the context of autonomous or unmanned shipping. That is the bold vision at least, but like the illusionary giant in the children's book *Jim Button*, as we get closer the giant seems to get smaller, less intimidating, more down to earth. Think big, start small. Italian researchers around Marco Bibuli (CNR) demonstrate the collaboration of networking maritime drones with various sensors, allowing the extension of

THE 3D MODEL IS BECOMING AN INFORMATION-RICH 'TECHNOLOGY ISLAND' IN SHIPS. SOURCE: CADMATIC

IoT towards the marine environment. This data fusion for enhanced situation awareness is already working, albeit at the level of robotic boats rather than full-scale ships. Rome wasn't built in a day, and piece by piece research gets us closer to the vision of unmanned shipping.

3D everything

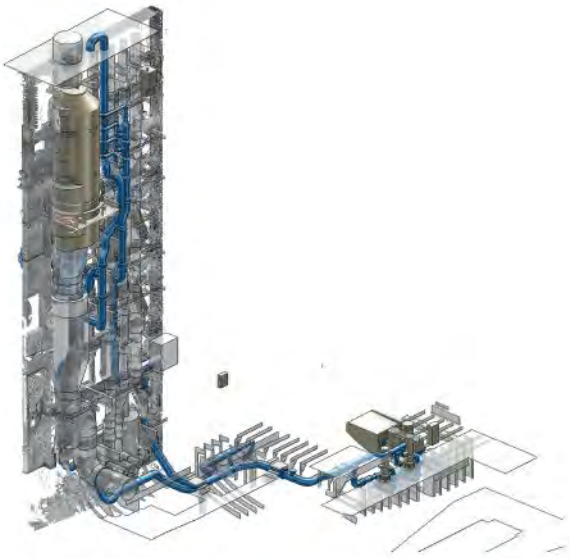
The data interfacing problem is as old as COMPIT, and so is the theme of '3D' CAD. Twenty years ago, there were already discussions on whether to model in 2D or 3D – but that question has been decided in favor of 3D a long time ago in our industry. Ships are 3D objects and it is advantageous to model them from the very beginning in 3D.

But now some of the visions of COMPIT 2000 are becoming reality – we move from 3D CAD to 3D everything: 3D scanning, 3D viewing, 3D printing, etc. For Ludmila Seppälä (Cadmatic), the "3D model has become the technology island in ship design, an information-rich digital twin of the [new ship design] project." And the central island of the 3D CAD model is linked to various technologies building on it and allowing it to be built more efficiently. Marius Blom (CEO of Blom Maritime) presents how 3D scans of ships can be directly integrated into CAD models, without having to fit surfaces or other CAD elements to the millions of points on the scan model. This has saved 25% of the time needed in conversion projects, such as scrubber retrofits in the wake of the 2020 global sulphur ban of IMO. Knud E. Hansen has employed virtual reality (3D viewing) to collaborate on ship designs under Covid-19 constraints, working across company borders and even across continents – Connect and conquer! Augmented reality is used in production, e.g. in complex commissioning tests, to accelerate processes, saving time and money, through smart connection of data and integrated 3D data worlds.

If I have to choose, I take both

New technologies aren't always that new. In many cases, we have a new label on an old tool that we just enhanced by one or two features. Machine learning used to be called numerical statistics, the digital twin is a reincarnation of simulation models. And the discussion whether we should use experience or first-principles, i.e. machine learning or digital twin in our brave new IT world, is also as old as the COMPIT conference. It may not come as a surprise that both approaches have their pros and cons, and that, in many cases, it is a clever idea to combine (or connect) them in order to conquer.

Machine learning is often denoted as a 'black box' model – the derived relation between input and output variables is rarely explicitly revealed. In contrast, first-principle based digital twins are denoted as "white box" models, where the claim is that everything is transparent and can be checked by third parties. In reality, we have 50 Shades of Grey: Artificial intelligence is much more efficient when human intelligence helps with insight, selecting key factors affecting the outcome, reducing data scatter by prescribing base functions, etc. And virtually all digital twin models resort to some empirical support, be it only in the form of coefficients for turbulence models in sophisticated CFD simulations. In between, there is a wide spectrum of applications, presented e.g. by Prostep (ship production), Austal (ship motions), Sener (detail design), or Sintef Ocean (collision avoidance).



NEW METHODS MAKE IT POSSIBLE TO DIRECTLY INTEGRATE 3D SCANS INTO CAD MODELS. SOURCE: BLOM

The vision or hope is that we will see a similar development as for 3D modelling, namely that current island solutions for machine learning and digital twin will get connected in passing on or integrating information.

Homo Digitalis

If the future holds an ever-closer symbiosis of man and machine – and resistance against the digital transformation seems to be futile – this will affect training which is mirroring the general trends, adapting to digital requirements and exploiting digital opportunities.

If we could start from scratch, how would we set up an undergraduate curriculum for future naval architects or maritime engineers? In a nutshell, this was the task of Herbert Koelman (NHL Stenden University of Applied Sciences) and Sietske Moussault (TU Delft). Their approach was refreshingly unconventional: Think bold and don't seek inspiration in the past or established curricula deeply rooted in tradition. Instead, reduce on classical mathematics and mechanics, and put much more IT on the agenda: optimisation, geometric modelling, CFD, big data and machine learning – and teach it with a combination of modern digital training methods and hands-on project work. Forget mathematical derivations and explore qualitative relationships in simulations.

Another next-generation approach to maritime training comes from the University of South-East Norway, where eye-tracking in immersive virtual reality training is used to track performance of the trainees. Combine a technique from marketing with a maritime application where awareness tracking is key – and you conquer at least our attention.

Once again, COMPIT brings together thought and technology leaders in advanced maritime IT applications, this year meeting in Mülheim/Germany, 9-10.8.2021. For the many who cannot join in person, there is the consolation that the proceedings will be again freely downloadable. ■

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