THE
NAVAL ARCHITECT

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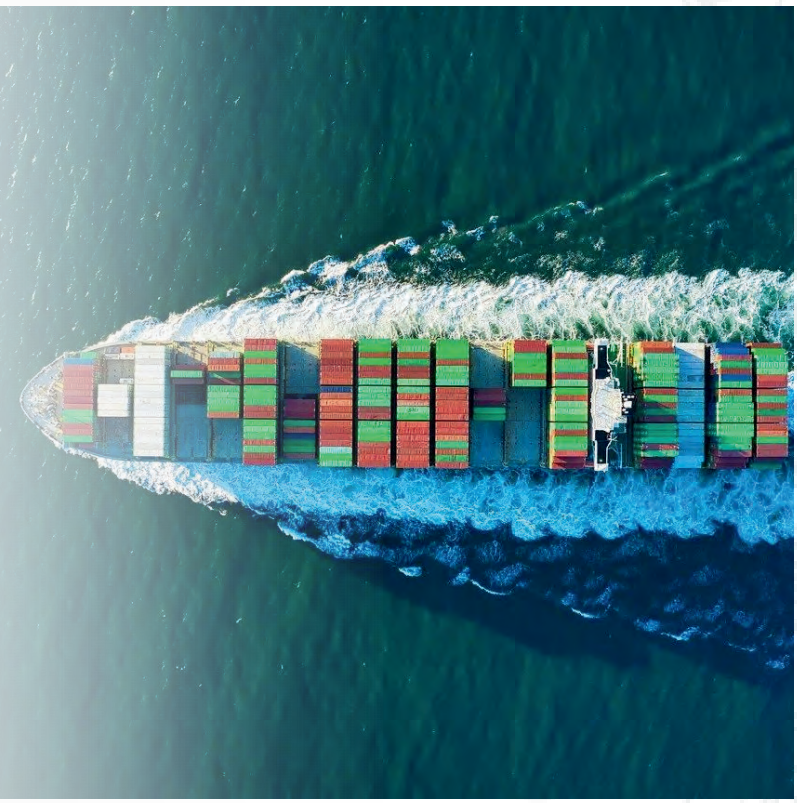
OCT 2024

CII 2025

TECHNICAL CONFERENCE: MANAGING CII AND ASSOCIATED CHALLENGES 2025

In January 2024, the Royal Institution of Naval Architects (RINA) hosted the first Technical Conference on Managing CII and Associated Challenges at the IMO Headquarters in London. The conference resulted in bringing together 90+ industry stakeholders who exchanged feedback and insight on CII's first year. The 2024 conference, supported by SPNL and the Nautical Institute, allowed the delegates an opportunity to hear from two keynote speakers – Mr. Tianbing Huang, Deputy Director, Sub- Division of Protective Measures, Marine Environment Division, IMO and Julien Boulland, Global market leader for sustainable shipping within Bureau Veritas Marine & Offshore, head-office commercial team, among many other presentations including from companies such as Ardmore Shipping; d'amico società di navigazione spa; MSC Cruise Management (UK) Ltd; DNV; Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping; International Chamber of Shipping; Royal Caribbean Group; and many more. The IMO must conduct a review of the CII before 1 January 2026, and following initial feedback, changes are expected to CII, though it is not yet clear on what the final outcome will be. The Royal Institution of Naval Architects is proposing a follow up conference in January 2025, and is inviting companies to share how they manage performance as a system, and to explain how continuous improvement in energy efficiency may be achieved.



Carbon Intensity Indicator (CII) – What is it?

The Carbon Intensity Indicator (CII) is a mandatory rating measure for ships, developed by the International Maritime Organization (IMO), that came into effect on 1st January 2023. As part of its commitment to addressing climate change, the IMO has been working on the development of a Carbon Intensity Indicator (CII) for international shipping. The CII is intended to measure the carbon efficiency of ships and assess their relative carbon emissions performance. The concept of the CII was introduced in the IMO's Initial Strategy on Reduction of GHG Emissions from Ships, adopted in 2018. The strategy sets out a vision to reduce total annual greenhouse gas emissions from international shipping. The CII is intended to be a key tool to assess and monitor the carbon intensity of ships, providing a standardized and transparent measure for evaluating their energy efficiency and emissions performance. It is expected to be a dynamic indicator that can be updated periodically to reflect technological advancements and best practices. However many sectors of the maritime industry have expressed concerns regarding the unintended consequences of implementation of CII.

21ST - 22ND JANUARY 2025

LONDON, UK

Conference Topics:

- **Experience with managing and complying with CII**
- **Challenges with implementation of corrective actions**
- **Experience with effectiveness of corrective actions**
- **Lessons learnt**
- **Intersection with commercial and contractual issues**
- **Best practice energy efficiency management approaches**

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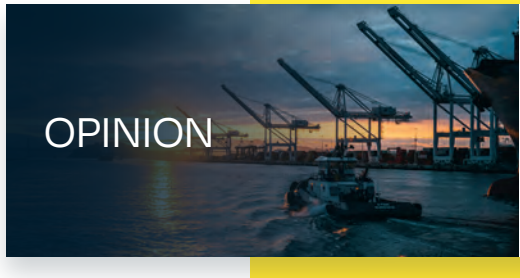

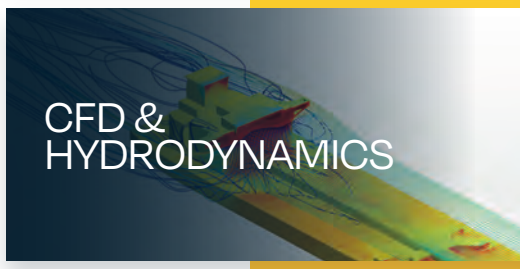

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CAN FIRE SAFETY EQUIPMENT BE RELIED UPON?

By **Daniel Johnson**

I wrote in the July/August issue of *The Naval Architect* that for a journalist the summer months can be very slow-moving in terms of newsworthy events. Discussing this recently with a colleague from Germany, I was delighted to discover the German language, in its poetic way, has a word that is used to uniquely capture this period: sommerloch ("summer hole"). Our conversation took place at last month's SMM trade fair in Hamburg, which was anything but short of maritime news.

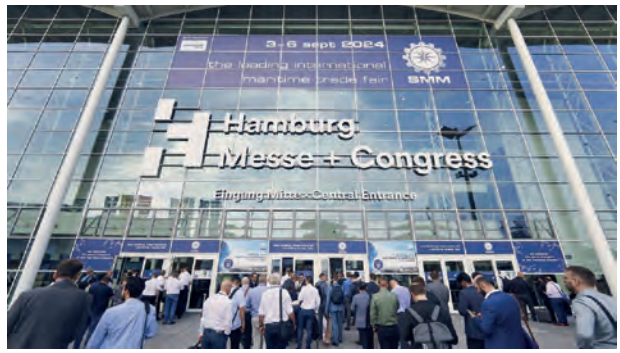
With more than 2,000 exhibitors and roughly 40,000 visitors from around the world, SMM continues to cement its position as the biggest and most important trade show in the maritime industry calendar, and once again proved a perfect platform to ascertain the course of developments in the sector. The focus for this year's event was firmly on decarbonisation and the digital transformation of the industry, topics that feature prominently on the pages of this month's issue of *TNA*.

As the industry transitions to new technologies and practices, the importance of safety cannot be overlooked. The occurrence of fire on board ships remains a daily reality and in a new white paper presented to *TNA* at SMM, survival technology solutions provider Survitec points out that fire continues to be a leading cause of major shipping incidents, accounting for over 20% of total losses, and the most expensive cause of marine insurance claims. The firm also notes that fire incidents are reported to be up 17% year-on-year.

So why the increase? In its *Safety and Shipping Review 2023*, insurance firm Allianz cites the use of new alternative fuels and a growth in the carriage of lithium-ion battery cargoes as two reasons. Industry analysts also point to an increase in the size of container ships and the resulting higher container accumulation and exposure, as well as a reported increase in misdeclared dangerous cargoes, especially hazardous cargoes.

According to Metkel Yohannes, Survitec's director of service and rental solutions and one of the authors of the company's white paper, these factors certainly create new fire risks and safety challenges, but there is also evidence to suggest that it's not the whole story. "While fire detection and protection measures on board ship have improved significantly over the years, there has also been a worrying hike in fire safety-related deficiencies on board ships, with an increase in reported safety breaches and subsequent detentions following Port State Control inspections," states Yohannes.

This unwelcome trend is reflected in figures from the Paris MoU. In 2022 it recorded the highest level of fire safety deficiencies in a decade. Similarly, the Tokyo MoU also reported an increase in detentions, with a staggering 15,562 deficiencies reported in 2023, often involving fire safety concerns.



AN END TO SOMMERLOCH: SMM 2024. SOURCE: HM+C

Yohannes believes that the economic downturn and the emphasis on cost reduction post-Covid have negatively impacted fire safety, with some shipowners and operators maintaining and inspecting safety equipment themselves in an attempt to save costs. "We're finding basic errors and oversights that do not become apparent until either the ship fails an inspection and is detained, or there is a fire," he says.

Among the examples given by Survitec in the white paper is call out to a vessel after an engine room fire. The crew had managed to extinguish the fire but suspected there was a fault with their high-expansion foam firefighting system. Survitec's technicians discovered the crew had installed a new foam pump and forgotten to remove one of the protective caps from the inlet.

The company also finds wrong parts being used or poorly fitted, or low-quality parts that deteriorate rapidly and fail. For example, in CO_2 firefighting systems, hydraulic hoses are often mistaken for high-pressure hoses but they are not designed for CO_2 applications and may burst under pressure.

"We see evidence of a slip in standards regarding basic safety practices but also a wide disparity in service quality between service providers. Approval stamps are being applied to fire systems and appliances that would or should not pass inspection," says Yohannes.

Survitec is calling for an industry review of current practice to determine if more oversight and governance, and more quality control procedures are required to protect crew and vessel safety. The company's white paper does appear to highlight some deeply worrying concerns. It's imperative that fire safety equipment can be relied upon to work efficiently, especially as the industry moves forward with the development and introduction of alternative fuels and new ways of working. ■

NEWS

DIGITALISATION

LR ONEOCEAN EXPANDS DIGITAL PORTFOLIO WITH OCEAN TECHNOLOGIES GROUP ACQUISITION

LR WILL BE ABLE TO OFFER OTG'S SOLUTIONS ACROSS A FLEET OF MORE THAN 30,000 VESSELS. SOURCE: SHUTTERSTOCK

Class society Lloyd's Register (LR) has announced an agreement to acquire maritime e-learning software provider Ocean Technologies Group (OTG) from private equity firm Oakley Capital.

The buyout means that OTG, which provides critical training, compliance, operational and HR software to more than 1,000 shipowners and operators and in excess of a million seafarers globally, will now be amalgamated into LR OneOcean, LR's digital services division. LR in turn will be able to offer OTG's solutions across a fleet of more than 30,000 vessels.

LR OneOcean, which itself was previously a separate company acquired by LR in 2022, has expanded rapidly and will employ around 800 staff after the OTG acquisition is completed. In 2023, LR also acquired a 50% interest in crew compliance software solution ISF Watchkeeper.

Martin Penney, CEO of LR OneOcean, tells *TNA* that while traditional classification remains at the core of LR, the society wants to offer today's shipowners much more. He says: "It's all well and good to build a good ship, but we need to make sure that it's operated and maintained correctly through the use of cloud-based fleet management.

Penney believes that OTG's services represent the "third leg on the stool", in that the buyout means LR can offer shipowners and operators quality assurance across a comprehensive portfolio of services.

"We understand the design and construction of safe ships and we understand operation from a mechanical point of view," he says. "But we didn't necessarily touch seafarers directly and that's where OTG comes in, [so] we know it's a well-built, well-designed and well-operated vessel with competent crew on board."

In recent years many of the leading classification societies have sought to diversify their services through acquisitions. Penney says that LR's own strategic choices are borne of customer demand, with many shipowners seeking help from LR on matters such as the availability of alternative fuels – as well as the handling and operational requirements – before ordering new ships. The OTG acquisition gives LR access to the e-learning market, one which Penney thinks is likely to grow significantly with that transition to new fuels.

"People need to know how to handle those fuels," says Penney. "Ocean Technologies has a fantastic Ocean Learning platform and LR brings the expertise to make new courses available on that platform to help drive the energy transition. At LR OneOcean we're really trying to push digitalisation of the industry; part of decarbonisation is bringing the industry closer together and the way to do that is through having a common set of data."

Increasingly, e-learning of crew extends above and beyond the minimum requirements. In early September, the Oil Companies International Marine Forum (OCIMF) announced that its newly digitised Ship Inspection Report Programme (SIRE 2.0) is now live. Effectively the standard for tanker inspections, SIRE 2.0 places increased emphasis upon crew behaviour and requires more diligent enforcement of training. With BIMCO also contemplating similar measures for the dry bulk sector, e-learning is a cost-effective means of supplementing basic training.

"One of things our customers found during Covid, as we all did, is there are plenty of things that we thought could only be done face-to-face can actually be done online very well. There are lots of technologies now with AI to make sure it really is the person taking the test and they're not looking things up online," says Penney.

He adds that as a member of IACS and an organisation that works closely with flag states, LR is well positioned to provide OTG with guidance on the regulatory direction of travel to ensure crew competence is aligned with that.

LCO2 CARRIERS

APPROVAL IN PRINCIPLE ISSUED FOR LARGE LIQUEFIED CO_2 CARRIERS

AIP CERTIFICATE HANDOVER CEREMONY. SOURCE: CLASSNK

A design concept for large liquefied CO_2 carriers of 50,000m^3 and 23,000m^3 developed by a Japanese consortium has been given approval in principle (AiP) by ClassNK.

The consortium includes Kawasaki Kisen Kaisha, Mitsui O.S.K. Lines, Nihon Shipyard, Nippon Yusen Kabushiki Kaisha, Mitsui, Mitsubishi Corporation, and Mitsubishi Shipbuilding. The companies believe that as carbon dioxide capture and storage (CCS) projects proceed worldwide, demand for liquefied CO_2 carriers that transport CO_2 from the capture site to the storage site will expand greatly.

"This AiP is a step toward standardising hull designs, which is necessary in order to realise a sufficient number of liquefied CO_2 carriers to meet such demand," says ClassNK.

The classification society carried out a design review of the ships based on part N of its 'Rules and Guidance for the Survey and Construction of Steel Ships', which incorporates the IGC Code, an international code for the construction and equipment of ships carrying liquefied gases such as liquefied CO_2 and LNG in bulk. The AiP was issued after it was confirmed that the prescribed requirements were met.

The AiP includes a tank safety assessment process based on a fracture mechanics technique called Engineering Critical Assessment (ECA) to omit post-weld heat treatment (PWHT), which can be a bottleneck in tank manufacturing.

MULTIPURPOSE VESSELS

SPLIETHOFF EXPANDS FLEET WITH L-TYPE ORDER

Dutch shipowner Spliethoff has placed an order with Wuhu Shipyard in China for the construction of a new series of eight multipurpose vessels with an option for two additional units.

With a total capacity of around 33,700m^3, the so-called L-type ships have been designed for the transportation of various dry cargo types, including paper products, bulk cargo, project cargo and containers. They will feature slender hull lines and be prepared for the use of future fuels.

The vessels, with the bridge located at the front, will be equipped with five lifts (side loaders) and three cranes with a capacity of 150mt each, combinable to 300mt SWL. Once constructed, the 1A ice-classed, 28,600dwt ships will measure 203.25m in length, 28.25m in width, and will have a maximum draft of 10.5m.

The first vessel in series is scheduled for delivery in early 2028 and will become the largest ship in Spliethoff's fleet, which currently consists of more than 50 multipurpose, geared, tweendeck vessels, ranging from 12,000 to 23,000dwt.

"We are convinced that we will have secured the excellent service to our clients for the future and look forward to welcoming these energy-efficient vessels into our fleet. We are proud of this step forward and believe that the L-type will play an important role in the sustainable future of our company," says Michael van den Heuvel, CCO at Spliethoff.

L-TYPE VISUAL. SOURCE: SPLIETHOFF

SHORE POWER

PORT OF OSLO OPENS NEW SHORE POWER PLANT FOR CRUISE SHIPS

The Port of Oslo in Norway has officially opened a new shore power plant at Revier Quay which is expected to help significantly reduce the carbon emissions of cruise ships visiting the city.

The *Oslo Climate Report 2022* shows that cruise ships emit around 8,000tonnes of CO_2 within Oslo's municipal borders. The Port of Oslo aims to reduce greenhouse gas emissions by 85% by 2030 and eventually become a zero-emission port.

The opening of the 16MW-capacity shore power plant coincided with the arrival of the cruise ship *AIDAluna*, which was connected to shore power.

"Shore power is a relevant technology for us on the way to net-zero emissions in ship operations. With the commissioning of this system, our cruise ships can now obtain green energy from shore in 12 ports in six European countries," says Dirk Inger, SVP of public affairs, communication and sustainability, at AIDA Cruises.

In 2025, the Port of Oslo will also open a shore power plant for cruise ships moored at Filipstadkaja Quay. As a result, both cruise quays in Oslo will be equipped with shore power facilities. These new installations could help reduce emissions from cruise ships within Oslo's maritime border by up to 80% over the next three to four years, as all cruise ships will be required to connect to shore power.

"This is an important step towards achieving our ambitious climate goals for the port and for the city. Oslo has ambitious climate goals, and it is a clear expectation from us that all businesses operating on water and on land in Oslo support that vision," says Anita Leirvik North, Oslo's Vice Mayor for Culture and Business Development.

SOURCE: HANS KRISTIAN RIISE/OSLO HAVN

SAFETY

CAR CARRIER RECOGNISED FOR ENHANCED FIREFIGHTING CAPABILITIES

Japan's Mitsui O.S.K. Lines (MOL) has received certification for its voluntary efforts to improve fire-fighting measures on the car carrier *Cerulean Ace*.

The LNG-fuelled vessel has been granted ClassNK's 'Additional Firefighting Measures for Vehicle Carrier (AFVC)' notations for measures that prevent onboard fires during the transport of electric vehicles (EV).

It is the first vessel in the ClassNK registry to receive the 'AFVC' notations, and the award marks the world's first case of a shipping company's voluntary and customised approach to the safe maritime transport of EVs being recognised through a notation.

Shipping companies are implementing various measures to address EV fires, which raise concerns due to difficulties in extinguishing and the risk of re-ignition. To support these efforts, ClassNK has issued the 'Guidelines for the Safe Transportation of Electric Vehicles'. These guidelines explain the characteristics of EV fires and provide guidance on how to respond, while also setting out five types of 'AFVC' notations according to various safety measures.

Cerulean Ace was certified as meeting three of the guidelines' requirements: FD (Fire Detection), FF (Fire Fighting) and EFF (Enhanced Fixed Fire-extinguishing system).

CERULEAN ACE. SOURCE: MOL

NEWS ANALYSIS

BIOFUEL AND CCS TALKED UP IN ADVANCE OF MEPC 82

By **Malcolm Latarche**

As this month's News Analysis is being written, the discussion of future marine fuels and greenhouse gas (GHG) emissions is just getting underway at the IMO's ISW-GHG 17 meeting in preparation for further discussion at MEPC 82 taking place from 30 September to 4 October. Predictably, interested parties are taking positions on the matter.

Simultaneously, hostilities in the Middle East are increasing as Israel and Lebanon-based militia group Hezbollah intensify actions effectively adding another front to the events in Gaza that have been ongoing now for almost a year.

The latest events mean that as the Houthis continue to target shipping in the Red Sea in support of Hamas and Hezbollah, an end to the diversion of ships around South Africa looks further away than ever. That, along with growing demand for shipping due to trade growth, suggests that any significant reduction in GHG emissions from the industry is also moving out of reach.

A small reduction may come about with more use of LNG and methanol but while ammonia as fuel for newbuildings seems to be making some headway so far this year, it cannot be denied that fossil fuel use is increasing as things stand. September saw Maersk CEO Vincent Clerc, in a LinkedIn post, reiterating his support for the introduction of a global fuel standard and a pricing mechanism that would penalise use of fossil fuels.

Backing that view the World Shipping Council (WSC) has submitted an updated proposal for a Green Balance Mechanism to the latest round of IMO talks. In his post, Clerc said: "Governments at the IMO have only six months to a reach consensus on effective measures that will make green energy projects bankable in the short term."

Although there was some growth in support for more measures at MEPC 81, it may be difficult for any consensus to have coalesced around the idea. It should be remembered that MEPC 81 also saw calls for carbon capture and storage (CCS) on ships to be included in the basket of GHG reduction measures and for standards to be drawn up. That would suggest that operators would rather continue to operate on fossil fuels rather than switch.

A small number of ships have already been fitted with CCS systems and even as the ISWG-GHG meeting started, Wärtsilä was announcing that it had been contracted to supply its latest CCS-ready scrubber systems for three container ships owned by German operator Leonhardt & Blumberg (see p.13).

SEPTEMBER'S ISW-GHG 17 MEETING AT IMO. SOURCE: IMO

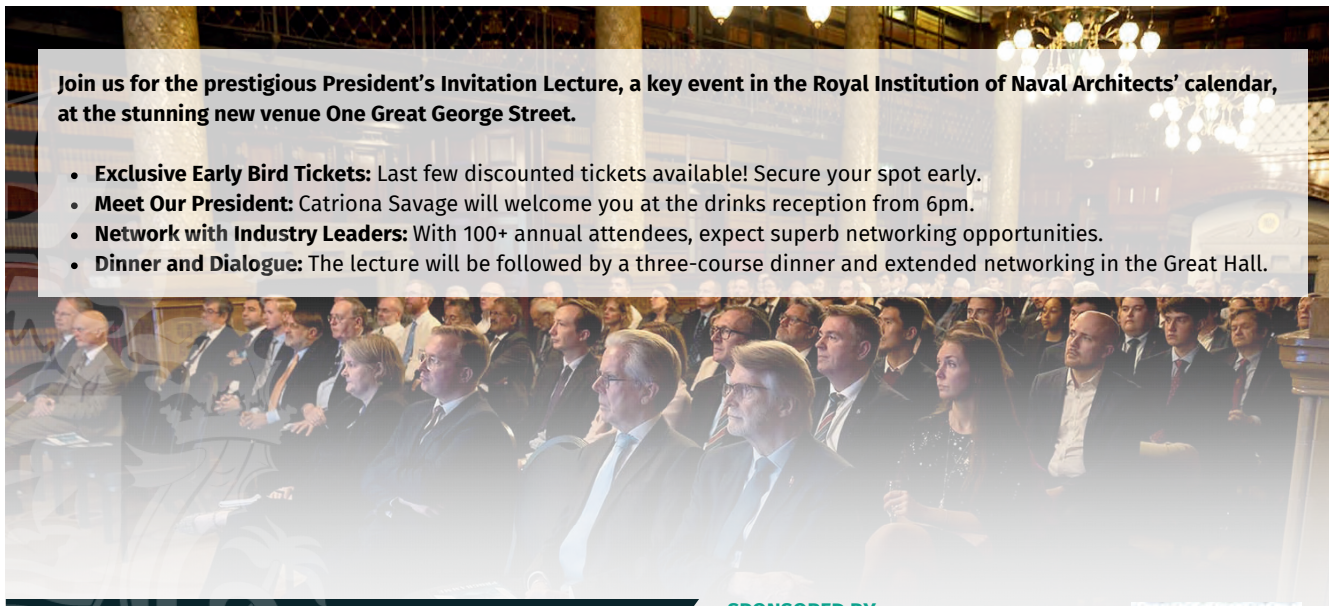
Interesting developments in the last month also highlight the potential of biofuels to reduce GHGs. Although biodiesel in practice has a very similar if not identical emission profile as fossil fuel, it gains from being able to be considered sustainable. At the beginning of September Lloyd's Register (LR) published a report on the potential of biofuels with ABS doing the same a few days later.

Several operators have trialled biofuels in recent years and have reported few problems in operations. The LR *Fuel for Thought: Biofuel* report highlights as 'drop-in' replacements for traditional fuels, biofuels require minimal changes to machinery and operations and offer GHG emissions savings of up to 84% compared to traditional fuels.

The ABS *2024 Sustainability Outlook* report echoes these sentiments saying: "In order to achieve carbon net-zero emissions in 2050, drop-in fuels such as e-diesel and biodiesel could contribute to lower the GHG emissions from international shipping".

The report also suggested that biodiesel was the second cheapest of the fuels covered in the report behind very low sulphur fuel oil (VLSFO). However, looking ahead, ABS forecasts VLSFO becoming cheaper while a significant drop in blue liquid hydrogen prices takes it to second place, pushing biodiesel to third. Fuel costs aside, a switch to biofuel would have minimal or no CAPEX investment needs as most existing engines could run on it with minimal modifications.

There is a downside for operators contemplating biofuels as an emission reduction strategy since most analysts believe that available stocks of biofuels will be taken up by the aviation and land-use sectors leaving little if any available for shipping. ■



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NEWS EQUIPMENT

PROPULSION

SCHOTTEL PROPULSION SELECTED FOR OCV NEWBUILDS

THE NEWBUILDS ARE BEING CONSTRUCTED BY WUCHANG SHIPBUILDING. SOURCE: SALT SHIP DESIGN

Schottel in Germany has been picked to supply a comprehensive propulsion concept for four new offshore construction vessels (OCVs) being built by China's Wuchang Shipbuilding Industry Group.

The vessels have been designed by Norway's Salt Ship Design under the name Salt 308 OCV. The customer for the vessels, an undisclosed European owner, will operate them in the traditional offshore oil and gas industry as well as in the offshore renewable energy industry.

According to Schottel, the propulsion system requirements are very specific due to the need to operate offshore at depths of up to 3,000m in complex sea conditions.

"We would like to thank all project partners for the confidence they have placed in Schottel to equip this series of OCVs with our thrusters," says Roland Schwandt, deputy CEO of the Spay-based company. "The propulsion package of five thrusters per vessel will provide the future operator with the very best technology available on the market for dynamic positioning in heavy duty offshore applications."

The order volume per vessel is 2x dynamic rudder propellers type SRP 610 DL; 1x retractable rudder propeller type SRP-R 380 L; and 2x transverse thrusters type STT 6.

The new design Salt 308 OCV shows a length of 100m, a beam of 23m, a draught of 6.5m and a deck area of 1,150m^2. It will be prepared for operation on alternative fuels. The first vessel is expected to be delivered in late 2026.

SOFTWARE SOLUTIONS

OCEANSCORE LAUNCHES FUELEU MARITIME TOOL

Software solutions provider OceanScore has launched a new planning, simulation and budgeting tool to assist shipowners and operators with the European Union's upcoming emissions regulation FuelEU Maritime.

The Hamburg, Germany-based company's FuelEU Planner is the first in a suite of solutions geared to supporting complex decision-making processes with the regulation, which comes into effect on 1 January 2025.

Part of the EU's 'Fit for 55' package, FuelEU Maritime entails new operational challenges as vessel owners and operators must carefully manage and monitor their fuel mix across voyages to optimise compliance and minimisea penalties for non-compliance with GHG intensity reduction targets.

OceanScore's FuelEU Planner is a web-based solution that can evaluate the various options for reducing GHG intensity, vessel optimisation and managing compliance balances. It is able to simulate the effect of different fuel and investment strategies on a per-vessel and per-fleet basis to determine the impact on compliance balance and total cost so that companies can effectively plan bunker procurements and future operations for budgeting purposes and charter parties for 2025 onwards.

The solution also facilitates discussion of how compliance balances should be handled in terms of either paying penalties, borrowing and pooling in the case of deficits, or banking and pooling in the case of surpluses.

OceanScore plans to complement the FuelEU Planner tool with FuelEU Manager and FuelEU Marketplace tools once FuelEU Maritime is up and running.

THE FUELEU PLANNER TOOL WAS DEMOED AT THE SMM EXPOSITION IN HAMBURG

SCRUBBERS

GERMAN OPERATOR FUTURE-PROOFS CONTAINER VESSELS WITH CCS-READY SCRUBBER TECHNOLOGY

Finnish technology group Wärtsilä has been contracted to retrofit its latest carbon capture and storage (CCS)-ready scrubber systems on three container ships owned by German operator Leonhardt & Blumberg.

According to Wärtsilä, the solution significantly reduces a vessel's operational expenses by enabling it to operate with less costly and more readily available fuels such as HFO, while at the same time helping to reduce the ship's carbon footprint in line with the industry's decarbonisation targets.

"Our CCS-Ready scrubber technology has been proven in extensive testing over the past two and a half years. It is based on our deep experience and in-house know-how and will deliver a significant contribution to the industry's efforts to reduce shipping's environmental impact," says Sigurd Jenssen, director of exhaust treatment at Wärtsilä Marine.

Each of the three 3,600TEU container vessels will be installed with a CCS-Ready, Vessel General Permit (VGP)-compliant, 27.5MW Wärtsilä scrubber system to ensure regulatory compliance for SOx emissions worldwide. As part of their installation, Wärtsilä will perform additional design and engineering work to ensure that future retrofits for a full CCS system on the vessels are accounted for.

THE CCS-READY SCRUBBERS WILL BE INSTALLED ABOARD THREE LEONHARDT & BLUMBERG VESSELS. SOURCE: WÄRTSILÄ

Working in harmony with a scrubber system, the future integrated CCS system will be based on the principle of removing as many main pollutants from the exhaust as possible, tackling each pollutant in a modular fashion. Once other gases are removed, the remaining exhaust can then be scrubbed for carbon which can be safely stored on board and disposed of on arrival at port.

The retrofit engineering and installation of the equipment aboard the vessels will be undertaken by marine and offshore engineering services company Greentec Marine Engineering.

BALLAST WATER MANAGEMENT

REPLACEMENT BWMS MARKET RAMPS UP FOR ALFA LAVAL

Alfa Laval reports it has received an order to replace 18 ballast water management systems (BWMS) on board vessels belonging to an unnamed major European shipowner.

The company says the order shows the high demand for the replacement of malfunctioning systems and a growing market for its BWMS replacement offering.

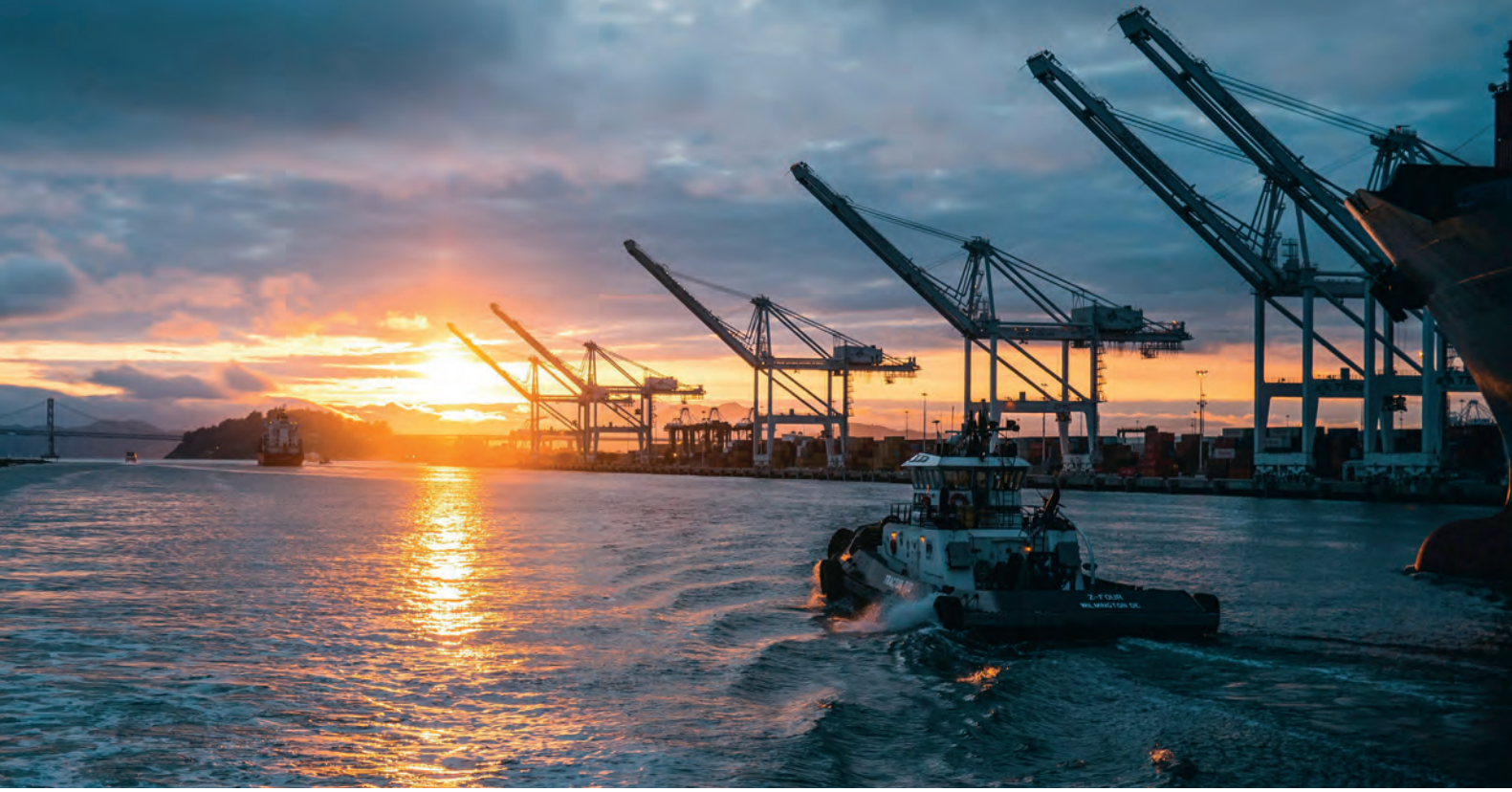
According to the firm, over the past two years it has replaced more than 250 systems from 30 different manufacturers, and its orderbook for replacement continues to grow.

TOBIAS DOESCHER. SOURCE: ALFA LAVAL

"With the consolidation of the BWMS market, we see a growing need for replacing installed BWM systems," says Tobias Doescher, head of global sales, business development and marketing, Alfa Laval PureBallast. "We have been contacted by an increasing number of shipowners and ship management companies worldwide who are experiencing issues that their current supplier cannot resolve. We are happy to step in and support our customers with cost-efficient and sustainable solutions."

Alfa Laval has experience replacing systems using both electrochlorination (EC) and UV technology. The company says its replacement process involves a thorough onboard assessment of the existing system by a qualified expert. This evaluation determines any replacements that are necessary and identifies components that can be reused.

"The success of this offering validates the way Alfa Laval has chosen to work - partnering for the entire lifecycle of ballast water management equipment rather than being a one-time supplier," says Peter Sahlén, head of Alfa Laval PureBallast.



SOURCE: RONAN FURUTA/UNSPLASH

OPINION

TIME TO POWER UP SHORE POWER

With impending FuelEU Maritime regulations also covering shore power connections, alongside a clear need to reduce greenhouse gas and local emissions in ports, it is time to consider alternative shore-to-ship power options such as fuel cells, says **Dr Andreas Bodén**, chief technology officer of PowerCell Group

While the European Union's FuelEU Maritime regulations are predominantly focused on incentivising the use of low-carbon and renewable fuels, there is also important legislation pertaining to shore-to-ship power connections, also known as cold ironing or onshore power supply (OPS). From 2030, it will become an obligation for container and passenger ships greater than or equal to 5,000gt to use shore power supplies for all electricity needs while moored in major EU ports.

With several densely populated towns and cities nearby to ports, the UK is also acutely aware of the port emissions challenge. The Port of Southampton in the UK has seen a dramatic rise in greenhouse gas (GHG) emissions from cruise ships, according to a recent study from environmental campaign group Transport & Environment (T&E). While all ships need power, and therefore produce emissions in ports, cruise ships have particularly high power demands for their hotel operations. Plugging into suitable shore power connections would eliminate these emissions.

There is also growing political pressure in North America and at many of the biggest ports in Southeast Asia to better regulate shipping emissions in ports. Additionally, there are calls in these regions especially to enhance the resilience of power supplies in ports. Hurricanes on the Gulf Coast, for example, have become regular causes of blackouts. With climate change, these regions are expected to more regularly see extreme and impactful weather events.

The status quo

There is currently a shortage of shore power connection infrastructure both on board ships and on shore in several harbours around Europe, as well as limits to the energy grid's capacity. This lack of available energy and infrastructure has especially been identified by reports in the UK, but it is a common challenge experienced by the marine industry and ports worldwide.

According to the aforementioned T&E report, there are currently two cruise ship berths with shore power connections in Southampton, but less than 10% of cruise ship calls in 2022 connected to this shore power. With peaks of 10 cruise ships on one weekend in Southampton, there is simply not sufficient energy from the grid to supply power to all of them, not to mention the other vessel types using the port.

As a result, ships remain predominantly powered by auxiliary engines when docked in ports, providing

energy while the main engines are shut down. Unfortunately, these auxiliary engines are typically powered by marine diesel oil (MDO) or marine gasoil (MG) and are sometimes powered by heavy fuel oil (HFO) in ports in developing countries.

The inconvenient truth is, for decades a ship's auxiliary engines have provided reliable and relatively low-cost energy while in port. However, these engines emit local emissions of nitrogen oxides (NOx), sulphur oxides (SOx) and particulate matter (PM) such as black carbon, and they do this around densely populated port cities. Good air quality is important for seafarers, shoreside crew, passengers and coastal residents as research indicates that local air pollution can damage human lung health. Auxiliary engines running on oil-based fuels also emit carbon dioxide (CO_2) and other greenhouse gases, which are released into the atmosphere further fuelling atmospheric pollution and climate change.

A complex problem

So, it is clear there is a growing regulatory and social pressure to change the status quo and seek alternative zero-emission and resilient power generation solutions in ports. However, it's a complex challenge. Firstly, it is important to not overlook the scale of the energy requirements of ports. The Port of Rotterdam Authority, the world's tenth busiest port, has calculated that the total energy demand and consumption of sea-going vessels at its berths amounts to approximately 750-850GWh (equivalent to 250,000 households) each year.

Solving this problem is made more complex by ports' varied set of stakeholders, including utilities companies, national grid representatives, the local government and the port itself. These stakeholders frequently have different incentives, and it is often unclear which group should drive the energy infrastructure improvements. Underinvestment in ports has also been recognised at the highest levels because of the supply chain crisis following Covid-19 and a series of subsequent 'black swan events' impacting and delaying port operations.

Solution thinking

Can we expand shore power connections to the national grid? Simply put, not easily. Expanding the capacity and subscriptions for grid power can take a long time, be costly, and require coordination and collaboration from the diverse stakeholders. Plus, while this would solve the local emissions challenge, you would just be moving the GHG emissions elsewhere as grid power is mostly still derived from fossil fuels.

What other technologies can we use? Fuel cell power generators can offer an interesting zero-emission and 'off-grid' solution. For example, PowerCell Group and Hitachi Energy recently announced the development of a new containerised hydrogen fuel cell solution called hyflex. Together with Skanska, the Port of Gothenburg and Linde Gas, they collaborated on a demonstration in the Port of Gothenburg in March 2024.

The demonstration from PowerCell Group and partners focused on off-grid power generation for a construction site in the Port of Gothenburg, but the wider port and marine applications were highlighted. The system uses a 100kW hydrogen fuel cell combined with batteries to generate power and this can be scaled up to 1MW. It produces zero GHG emissions on a full lifecycle basis when using green hydrogen as fuel.

The containerised fuel cell generator set can also be used to add a layer of resilience to a port's energy supplies. If, for example, the grid is unstable or goes down the fuel cells act as an independent back up. They can also be used to stabilise power supplies during peak times of demand, and by supporting this 'peak shaving' they can also lower ports' energy costs.

Ship and shore alignment

Ensuring that onshore and onboard infrastructure are interoperable will be key to solving the shore power connection challenge. Shore power requires an onshore power connection and ships that can connect to this power source. For this reason, shore power is most feasible right now for point-to-point connections, such as ferries, container lines and ro-ro ships.

It's also useful if shore power solutions can fit with the wider infrastructure that ports are investing in. While fuel cells can be fuel agnostic with reformer technology, hydrogen fuel cells align well with the hydrogen infrastructure many ports are developing or planning to implement. The Port of Rotterdam, for example, is working on its 'hydrogen backbone' and hydrogen infrastructure is being assessed globally to support the development of e-fuels.

So, in a nutshell, shore power connections need expanding and upgrading. Regulatory and societal demands to reduce local and GHG emissions, as well as to develop supply chain resilience in ports, are only strengthening. The reality is, ports will likely need a basket of solutions and infrastructure investments to meet their energy needs, however fuel cell technology has matured fast and is relatively simple and sustainable to implement. Regardless of what port owners choose to invest in, the key is that they collaborate with shipowners to align the ship and shore technology. The bottom line is, it's a sure thing that port shore power connections need addressing today! ■

DR ANDREAS BODÉN, SVP AND CTO, POWERCELL GROUP

DECK & CARGO EQUIPMENT

CAN CONTAINER OPTIMISATION OFFER A BOOST TO DECARBONISATION?

By **Richard Halfhide**

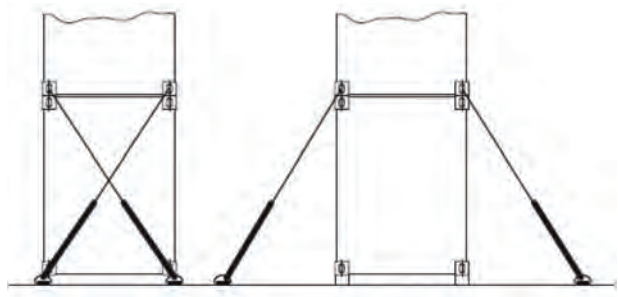
Much of the discussion concerning maritime decarbonisation focuses around solutions that will be familiar to readers of *The Naval Architect*: hull form optimisation, speed reduction and engine de-rating, the adoption of new fuels and energy storage, and emerging technologies such as wind propulsion and carbon capture and storage.

But a somewhat neglected component is maximising a vessel's cargo-carrying potential; something that's particularly true of many container ships, according to cargo handling specialists at MacGregor. The company calculates that its own Cargo Boost solution could reduce the environmental footprint of container shipping by more than 10%. This can be achieved for an individual ship whose cargo system will be upgraded, but as an example it can be also thought that this could be done through cutting the number of vessels required for transportation. In simple terms – contingent upon size and operating profiles – where currently 11 vessels are used with optimal utilisation it might be possible to use only 10.

"Nobody is really focusing on improving the cargo system, although all the top 10 liner operators understand its importance. We are working on several projects with leading global shipping companies like Hapag Lloyd, but in the broader industry it's not as widely recognised," says Arto Toivonen, MacGregor's sales manager for Lashings and Cargo Boost.

When it comes to container shipping, cargo optimisation is a specialised discipline that may not always receive the same level of focus at shipyards, where the primary emphasis is often placed on key elements such as hull design, main engines, and the deckhouse. Even while container ship sizes and capacities grew exponentially over the last 15-20 years, many yards continued to make lashing bridges too low and with low stack rate hatch covers.

ISO GAP ADAPTERS MAKE IT POSSIBLE FOR 'RUSSIAN STOW' OF 40FT CONTAINERS OVER HATCH COVERS



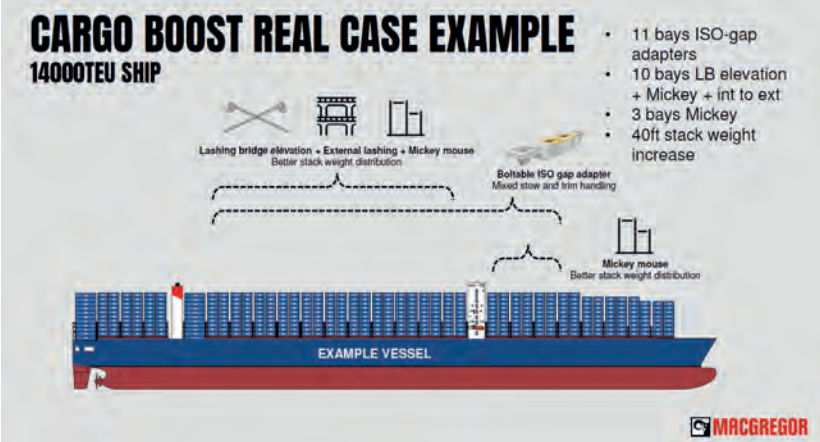
THE ADDITION OF 'MICKEY MOUSES' TO LASHING BRIDGES IS ONE MEANS OF INCREASING CAPACITY, OFTEN IN CONJUNCTION WITH AN EXTERNAL LASHING SYSTEMS THAT ALSO BRING GAINS TO THE PAYLOAD

Toivonen explains: "They didn't always appreciate that as the ship grows bigger the cargo system has to perform better. Because the vessel is wider you can load much more stability wise. Suddenly, the lashing system started to become a bottleneck. If you have a 16,000TEU vessel and have only two-tier-high lashing bridges instead of three- or four-tier-high then you can't put heavy containers on deck, everything is in the hold. This makes GM high and the cargo carrying capacity inefficient."

To complicate matters further it's not uncommon for the lashing bridges, lashing systems and other equipment used to hold the cargo in place to come from multiple suppliers, creating problems with compatibility. Small wonder then that many container ships only operate to around 80% of their theoretical capacity.

Cargo Boost

MacGregor is regularly consulted in newbuilding projects and works closely with many shipyards and shipowners in developing optimal stowage solutions, but there is also a burgeoning market in aftersales and retrofits. First



USING CARGO BOOST, MACGREGOR SAYS IT CAN INCREASE A VESSEL'S UTILISATION RATE FROM 80% TO AROUND 90-95%. INCLUDING STEEL AND FABRICATION, SUCH A PROJECT WOULD COST AROUND US$2.9 MILLION FOR A 14,000TEU VESSEL

launched around a decade ago, MacGregor Cargo Boost is a service designed to maximise cargo space utilisation and help the competitiveness of those older vessels in particular, bringing them closer to their theoretical capacity.

At the simplest level significant improvements can be achieved by what MacGregor describes as a 'paper exercise', scrutinising the vessel's Cargo Securing Manual to determine where gains can be made by updating to the latest class rules, which are often more sympathetic to increased payloads. Also maximum container stack weights can be increased by the paper exercise only, which further boosts the benefits gained from the latest class rules. MacGregor says that hundreds of vessels have benefitted from this service alone without any physical alterations to the vessel.

But even greater benefits can be realised with retrofitting of enhancements such as elevating existing lashing bridges or so-called 'Mickey Mouses' – towers on the wind-exposed outermost rows of lashing bridges – which make it possible to add additional tiers of containers while also building a windshield for the innermost rows of containers. These can be built on top of existing lashing bridges with some additional strengthening such adaptations also usually include a switch from internal to external lashing systems, which allow for a greater payload and lower the ship's GM.

Another commonly employed solution under Cargo Boost is the employment of ISO Gap Adapters; boltable fittings that can be installed on existing container sockets with 20ft lashing gaps in the middle of hatch covers. The advantage of this is that it enables what is known as 'Russian-stow' i.e. mixed stow – whereby 40ft containers can be loaded on top of two 20ft containers – which wouldn't otherwise be possible for older wide-beamed vessels.

"Without this you have to load heavy twenties at the bottom of the cargo hold and if the vessel is very wide it's usually too stiff, making accelerations less favourable. But if the heavy twenties can be stored on deck these movements can be much smoother, which means you can load more because the GM is lower," says Toivonen.

A vessel that has been cargo optimised also has benefits for fuel consumption as there should be less instances when ballasting is required, since cargo can be loaded more flexibly, therefore reducing the emissions per TEU. More cargo will be carried around with the same fuel consumption as before the cargo boost.

While it's theoretically possible to install a Cargo Boost solution within just a few weeks with adequate preparation they are more commonly carried out in parallel with other retrofitting projects such as scrubber installation. Toivonen says that from initial study, through to design and ultimately completion a more typical timeframe is around seven months and when incorporated into more extensive retrofitting like increasing the ship's draft or even extending its length then cargo capacity increases in excess of the theoretical maximum have been achieved.

To assist shipowners in better understanding the savings potential of their solutions it has also developed a Carbon Calculator that can be accessed on its website and allows users to insert a range of parameters to determine the savings both as reductions in ETS (Emission Trading Systems) payments and as fuel costs:

www.macgregor.com/intelligent-solutions/cargo-boost/carbon-calculator/

EARLIER THIS YEAR MACGREGOR COMPLETED CARGO SYSTEM UPGRADES FOR TWO THALASSA SERIES SHIPS, *NORFOLK EXPRESS* AND *SAVANNAH EXPRESS*, OPERATED BY HAPAG-LLOYD. THE PROJECT INCLUDED ELEVATION OF LASHING BRIDGES, ADDITION OF MICKEY MOUSES AND INCREASED FLEXIBILITY FOR MIXED STOW OF 20/40FT CONTAINERS ON DECK

CFD & HYDRODYNAMICS

BAR TECHNOLOGIES' NEW AEROBRIDGE IS SHAPING THE FUTURE OF SHIPPING DESIGN

By **Will Hopes**, simulation and performance engineer, BAR Technologies

The global shipping industry, frequently known for its conservative approach to change, is now standing on the edge of a significant transformation. Driven by environmental concerns and increasingly stringent regulations, the sector faces mounting pressure to adopt innovative technologies that can reduce fuel consumption and lower emissions.

One such design innovation to have recently emerged is BAR Technologies' AeroBridge, a new approach to a ship's superstructure design that promises impressive fuel savings through enhanced aerodynamics for bulk carriers and tankers.

The need for innovation in shipping design

The International Maritime Organization (IMO) has set ambitious goals for reducing greenhouse gases, including to reach net-zero GHG emissions from international shipping by or around 2050, with indicative checkpoints to reach net-zero GHG emissions for 2030 (by at least 20%, striving for 30%) and 2040 (by at least 70%, striving for 80%).

With these new goals, the industry must find ways to innovate without compromising profitability, cargo capacity, vessel safety or port operations. The need to balance these demands has led to the exploration of new designs and architecture that can optimise a ship's performance.

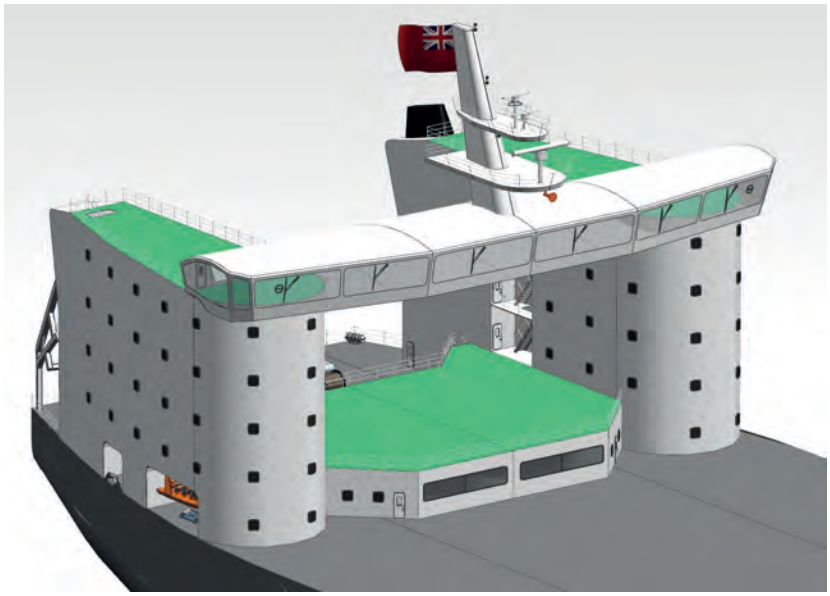
Traditionally, ship design has focused on optimising hydrodynamics. However, with increasing pressure to explore every option to increase fuel efficiency, forward-thinking designers are now looking above the waterline, exploring how aerodynamic improvements can contribute to overall performance.

WILL HOPES

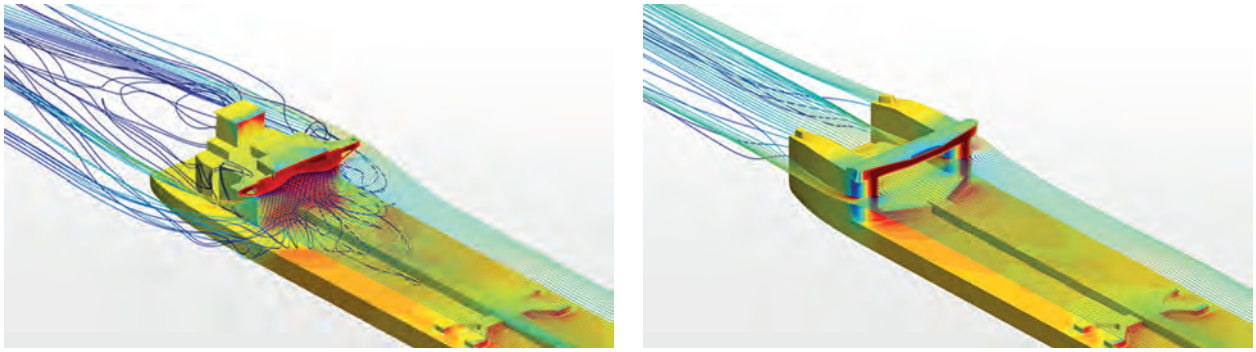
This shift in focus has led to the development of BAR Technologies' AeroBridge, a patent-pending superstructure design that aims to enhance the aerodynamic profile of ships, thereby reducing drag and improving fuel efficiency.

The AeroBridge: a new approach to a ship's superstructure

The AeroBridge is a noteworthy departure from conventional ship design. Unlike traditional monolithic superstructures that aerodynamically behave as a bluff body, the AeroBridge splits the superstructure into two aerofoil sections with a gap in the middle.



THE AEROBRIDGE SPLITS THE SUPERSTRUCTURE INTO TWO AEROFOIL SECTIONS WITH A GAP IN THE MIDDLE



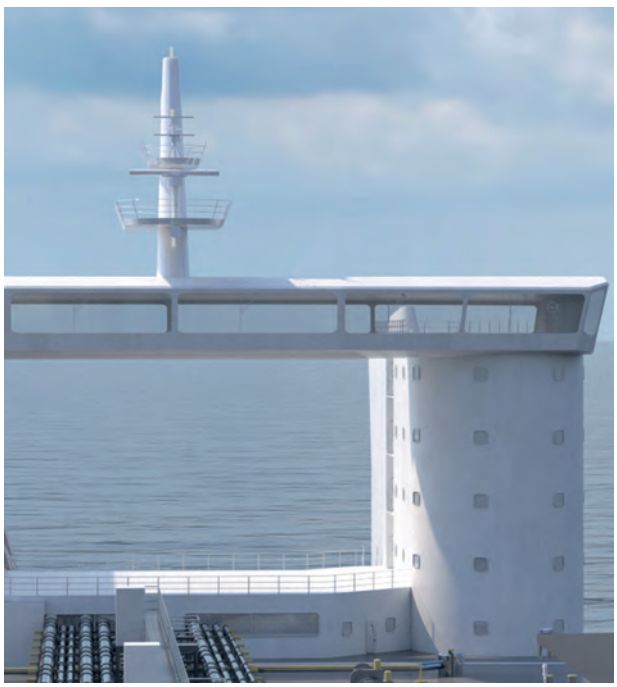
CFD SIMULATIONS MODELLED THE AIRFLOW AROUND THE SHIP IN A WIDE RANGE OF WIND CONDITIONS

This design, with its higher aspect ratio and streamlined shape, allows for quick recovery of smooth air flow in the wake of the vessel – significantly reducing aerodynamic drag. The reduction in drag translates directly into lower fuel consumption, which is a critical consideration for shipowners facing high operational costs and increasing regulatory pressures.

The AeroBridge's design offers more than just a reduction in drag. In certain wind conditions the aerofoil-shaped sections can also generate thrust, further contributing to fuel efficiency. This dual capability – reducing resistance while potentially aiding propulsion – is a significant advancement in superstructure design, where improvements in efficiency can have substantial financial and environmental benefits.

Real-world benefits: fuel savings, emissions reductions and improved crew conditions

Extensive computational fluid dynamics (CFD) simulations incorporated in BAR Technologies' design methodology have demonstrated its potential to deliver tangible fuel savings.



A FULL-WIDTH DECK TO PROVIDE COMMUNAL LIVING, DINING AND ENTERTAINMENT SPACES IS RETAINED AT THE BASE OF THE SUPERSTRUCTURE

For example, in a 20knot headwind, the AeroBridge can achieve fuel savings of 2.3tonnes per day on an LR2 tanker sailing at 13knots. Of course, headwind conditions aren't guaranteed. However, in low-wind regions, such as the Persian Gulf, Red Sea or Mediterranean, the speed of the vessel means the apparent wind angle is from the bow more often than not.

The AeroBridge was developed using BAR Technologies' simulation-driven design process, drawing on the company's experience of designing racing yachts for the America's Cup. Initially, CFD simulations are used to model the airflow around the ship in a wide range of wind conditions. AI techniques applied to these CFD results enable surrogate hydrodynamic and aerodynamic models to be developed, which, combined with engine, propeller, and wave models, enable rapid and accurate simulation of the entire ship. Using BAR Technologies' weather routing software, the ship is then simulated on typical trading routes, hundreds of times over multiple years of historical weather data, to optimise the design under real-world operating conditions.

Beyond efficiency, environmental and financial benefits, AeroBridge offers improved living conditions for the crew aboard the vessel. At the base of the superstructure, a full-width deck is retained to provide communal living, dining and entertainment spaces; aerodynamically, this full-width deck is largely hidden from the airflow by machinery and equipment on the deck of the ship.

By splitting all higher decks into two separate sections, the AeroBridge's design also provides an opportunity to increase the number of windows, bringing in more natural light and improving the wellbeing of the crew. As a result of this geometry arrangement, the design increases the internal volume of the superstructure compared to conventional superstructures, and there are notable other benefits, such as noise reduction.

Advanced development and industry collaboration

The AeroBridge is currently in advanced stages of development. Significant efforts have been made to ensure the design meets all necessary compliance standards. Additionally, direct collaboration with major shipyards, owners and operators has been a key part of BAR Technologies' process, since these industry partners bring valuable insights into the practical challenges of implementing new technologies in large-scale commercial vessels.

General arrangement drawings have also been developed including detailed layouts of accommodation rooms, escape routes and lifeboats, machinery, exhaust spaces and scrubbers, cranes and corresponding engine access points, and bridge visibility requirements.

Close collaboration with the industry also underscores the AeroBridge's potential for widespread adoption. By working in tandem with established players in the shipping industry, BAR Technologies is ensuring the design is not only innovative but also viable for integration into existing shipbuilding practices. This approach is critical in an industry where change is often slow, and new technologies must demonstrate clear, practical benefits before they are widely adopted.

A holistic approach to optimisation

The AeroBridge is part of a broader trend in the shipping industry towards holistic vessel optimisation. This approach considers the ship as an integrated system where every component – from the fuel, the hull, to the superstructure, propulsion and weather-routing systems – must work together to achieve maximum efficiency.

BAR Technologies' WindWings have become the market-leading wind propulsion system, launched in 2023 and currently installed on *Berge Bulk* and *Pyxis Ocean*, with multiple more orders in the pipeline. They harness wind power to reduce fuel consumption, offering another layer of efficiency.

When combined with the AeroBridge, these technologies create a synergistic effect, where the benefits of each component are amplified. In downwind conditions, the AeroBridge provides less disturbed air to the WindWings, improving performance compared to a conventional superstructure. In upwind conditions, the AeroBridge gives less blockage, therefore there is a reduced upstream effect of slowing the air flow down. Again, maximising the savings from WindWings.

The company also leverages its hydrodynamic expertise to provide full hull optimisation solutions. AI is again a key design aid used in a process known as 'dimension reduction', which rapidly optimises the hull across a large number of parameters. In-house weather routing enables the hull designs to be optimised on years of historical weather data to ensure the performance gains in operation match the performance gains in the simulations.

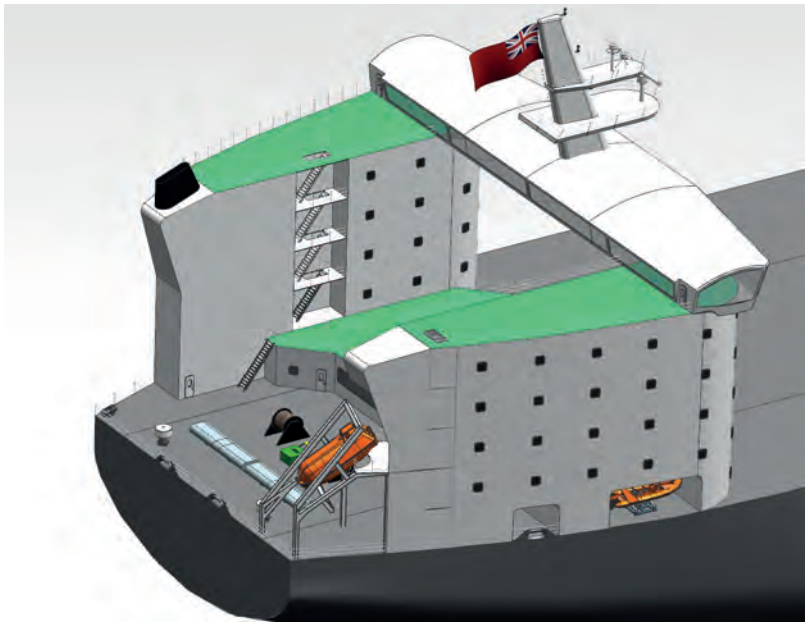
In simulations, the combined effect of WindWings, the optimised hull and AeroBridge can result in an average of 30% energy savings compared to a typical modern LR2 tanker design.

A breakdown of these savings shows that WindWings contribute approximately 16%, hull design around 10.5%, and AeroBridge about 3.5%. BAR Technologies' holistic approach could – using technology available today – achieve a significant proportion of the IMO's 2030 and 2040 targets.

Balancing tradition and innovation: a new path forward

The shipping industry's long-standing conservatism presents both challenges and opportunities when it comes to adopting new technologies like the AeroBridge. On one hand, the industry's cautious approach means that any new innovation must be rigorously tested and proven before it gains widespread acceptance. On the other hand, this same conservatism ensures that once a technology is adopted, it is likely to be implemented on a large scale, leading to significant industry-wide benefits – similar to how wind propulsion is gaining momentum with the number of units installed on the global fleet today.

Awareness of the AeroBridge is growing rapidly, particularly in regions like China, where several shipyards are now incorporating it into their newbuild designs. This move is driven not only by the AeroBridge's technical advantages but also by its potential to help shipowners meet future regulatory requirements. As the IMO's 2050



THE AEROBRIDGE IS PART OF A BROADER TREND IN THE SHIPPING INDUSTRY TOWARDS HOLISTIC VESSEL OPTIMISATION

COMBINING THE AEROBRIDGE WITH WINDWINGS CREATES A SYNERGISTIC EFFECT, WHERE THE BENEFITS OF EACH COMPONENT ARE AMPLIFIED

decarbonisation goals loom closer – and given their typical 25-year life – ships built from 2025 onwards must include technologies that deliver significant reductions in fuel consumption and emissions.

The role of advanced technologies in maritime design

The development of the AeroBridge also underscores the important role that advanced technologies like CFD, machine learning and AI will play in the future of maritime innovation.

BAR Technologies' design approach is deeply influenced by its experience in designing racing yachts for the America's Cup, where precision and efficiency are critical. The company's expertise in CFD and simulation distinguishes it from traditional maritime design firms. By leveraging neural networks and AI, BAR Technologies can model thousands of design variations, optimising for peak performance in real-world conditions. This allows the company's designers and engineers to push the limits of what is possible, exploring new configurations and enhancing performance in ways that were previously unimaginable.

The AeroBridge is a prime example of how these advanced technologies can be applied to create practical, real-world solutions. By rethinking the traditional approach to ship superstructures and leveraging the power of CFD and AI, the developers of the AeroBridge have created a design that is not only innovative but also ready for the challenges of modern shipping.

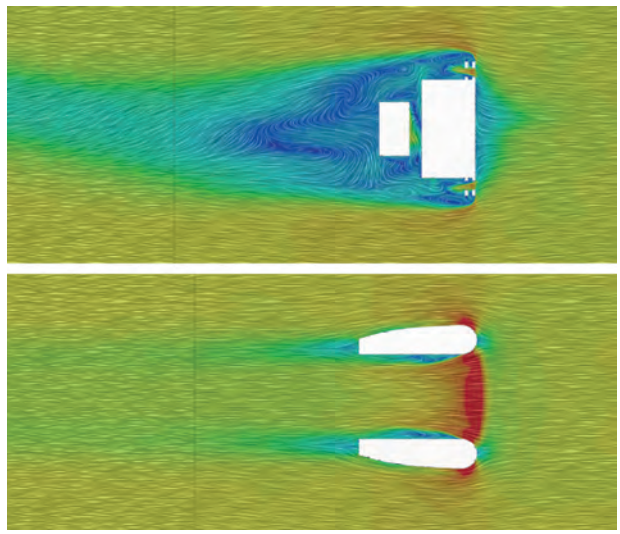
Embracing change and uncertainty

The need for more sustainable practices is clear. Innovations like the AeroBridge offer a glimpse of what the future holds – an industry where efficiency and sustainability are the design priority.

The AeroBridge, with its advanced aerodynamic design and proven fuel-saving capabilities, represents a significant step forward in this journey. It demonstrates that by embracing new technologies and thinking creatively about traditional problems, the shipping sector can meet the challenges of the future while continuing to thrive in an increasingly competitive global market.

As shipbuilders, designers and regulators work together to bring these innovations to market, the industry must recognise the importance of adopting these technologies today. Most ships built today will still be in service in 2050, and the risk of stranded assets is high. Decisions made now will have long-lasting implications for the industry's environmental footprint and economic viability.

In this context, the AeroBridge is not just a new superstructure design; it is a symbol of the industry's potential to change, innovate and lead the way toward a more environmentally sustainable future. ■



LEVERAGING THE POWER OF CFD AND AI HAS ALLOWED BAR TECHNOLOGIES' DESIGNERS AND ENGINEERS TO EXPLORE NEW CONFIGURATIONS AND ENHANCE PERFORMANCE

PROPULSION

BERG PROPULSION TARGETS CONTAINER FEEDER RETROFIT OPPORTUNITIES

By **Richard Halfhide**

"Right now there's quite a few different things realigning in the industry. This means there's quite a lot of movement happening with retrofitting from an energy and efficiency perspective," says Jonas Nyberg, Berg Proplulsion's managing director for advanced solutions.

Like others, the Swedish company is finding a potent combination of regulatory, cultural and economic factors are driving the need for new solutions and more efficient vessels. But while some operators are choosing to invest in new tonnage, most yards have lengthy orderbooks and owners and increasingly attracted by the possibilities of retrofitting ships to improve their competitiveness.

Berg Propulsion believes one segment that can benefit from the latter option is container feeder vessels. "When we apply these three factors to it, it shows a very favourable case for retrofits. Most container feeder vessels being built today are for much higher speeds than they actually operate. A Sietas 168, a very common container vessel, is built for 20-21knots but the average speed is 16knots. We have done retrofits on these vessels that have achieved 20-30% verified fuel savings," explains Nyberg.

Case in point is *Henneke Rambow*, an 868TEU feeder owned by Reederei Rambow and chartered to CMA CGM upon which Berg has recently completed a package of optimisation measures. These included replacing the propeller blades with ones hydrodynamically optimised for the ship's operating profile, upgrading the control system to Berg's MPC800 propulsion unit with Dynamic Drive and installing a custom-made Network Frequency Stabiliser that means the shaft generator can operate at variable speeds without compromising voltage to the main switchboard. In doing so the vessel is optimised for performance at a lower speed.

The opportunity to demonstrate the possibilities of propulsive retrofitting is one the company has been awaiting for some while, but previously has been thwarted by failing to connect with the right stakeholders. "We went to a technical management company and everyone thought it was a great idea, but it's the charterer who pays for fuel in the container trade... We had developed a solution but needed regulatory and socio-environmental factors to come into the equation," says Nyberg.

Berg breaks down a retrofit project into four key areas: hydrodynamics, control systems upgrades, power electronics and software solutions. Collectively, they can optimise a vessel for a fraction of the cost of an equivalent newbuilding. Notwithstanding advances in hull design and the capability to operate on new fuels the retrofitted vessel will perform to much the same standard.

HENNEKE RAMBOW RECENTLY RETURNED TO SERVICE AFTER A PROPULSIVE OVERHAUL

"When you look at the solutions we put into this field they are the same as those that nowadays you would put into newbuilds. Looking at the newbuild projects we have today there's an expectation that vessels will be built with far greater capability than there used to be. Of course, it's driven by the fact there's a completely different level of awareness about the impact these factors have on consumption and emissions, not to mention the regulatory requirements for newbuilds."

After a somewhat turbulent dozen years Berg is now growing quite rapidly under the ownership of Swedish investment group Gula Skrinet. Much of this expansion has been grounded in the burgeoning potential for propulsive optimisation, with another notable achievement being the innovative auxiliary system being supplied for the wind-assisted Neoliner, due for delivery next year (see *TNA*, Jul/Aug 2023).

With a growing emphasis on just-in-time arrivals Berg is also exploring the potential for greater in-journey optimisation; not only through speed and routing adjustments but also trim adjustments and ensuring the ideal combination of propeller pitch and engine speed. But container ships also spend more than half their time in port and the company anticipates shore power will be an area of focus in efforts towards emissions abatement.

Nyberg comments: "Shore power has so far focused on very big ships such as cruise ships, large container vessels and some larger tankers. We see that the next step will be that it makes its way into medium-sized vessels. It ties into the power electronics side of our offering but there will be a problem with standards not being established, so we will likely not be the integral partner there." ■

COMBINATION CARRIERS

KLAVENESS COMBINATION BET IS REAPING REWARDS

By **Richard Halfhide**

To an earlier generation the combination, or ore-bulk-oil (OBO), carrier was seen as the ideal 'everyman' vessel; capable of switching between dry and wet cargo depending on marketing fluctuations, or switching between cargoes on reverse voyages rather than an unprofitable return journey in ballast. But they were difficult to maintain, particularly if switching between carrying oil and a 'clean' dry cargo such as grain.

Although a spate of OBO accidents, such as the sinkings of the *Berge Istra* (1975), its sister *Berge Vanga* (1979), the infamous MV *Derbyshire* (1980) and its sister *Kowloon Bridge* (1986) did raise safety concerns about their durability and stability, they remained a popular choice until the early part of this century. However, many ended up trading in a single commodity, in part because it was difficult to put the contractual arrangements in place.

Smaller combination carriers continued to be deployed on inland waterways, notably by Russian operator Volgotanker, but for a time it even seemed their role in transoceanic transportation could be passing. Among the few to keep faith in the concept was Norwegian shipowner and operator Torvald Klaveness. Between 2001 and 2007 it took delivery of five caustic bulker (CABU) combination carriers, intended to transport caustic soda on one leg and various dry bulk products on their return. Three further 'Mark II' CABUs followed in 2016-17.

But Klaveness had bolder ambitions and in 2013 began exploring the feasibility of a next-generation combination carrier concept, the CLEANBU. In 2018, having raised capital and placed orders for the first vessels in the series, Klaveness Combination Carriers (KCC) was established as a separate entity and listed on the Oslo Stock Exchange.

The first CLEANBU vessel, MV *Baru*, was completed by China's New Yangzi Shipyard in January 2019, with seven more following by 2021. Boasting 40% lower CO_2 emissions per ton mile transported cargo compared to standard vessels, the 83,500dwt CLEANBU is classed as an LR1 tanker in wet mode and a Kamsamax when dry. Notably it has no centerline bulkhead, depending upon class-approved filling restrictions to maintain stability, with stricter self-imposed limits to bolster those safety margins.

The CLEANBU alternates between wet and dry modes on a continuous basis after each voyage, cleaning and isolating the cargo handling systems before loading. It is specifically designed to ensure that all areas of the hold and their surfaces are easily cleanable, with ample freshwater, eating and wastewater capacities. Since there is no standard for combination carriers, meaning that Klaveness has effectively had to create its own best practices, such as 360° pictures of the tanks after cleaning, allowing for virtual inspections. Drone inspections and AI-based cleanliness evaluations are also being explored.

By the company's own admission the CLEANBU project has been hard work. Notwithstanding the teething problems that arise with any new design, even after entering service, persuading charterers to embrace the new concept took some time. Indeed it wasn't until the start of last year that there was sufficient acceptance to achieve good operational efficiency of the fleet. Since then, charterer confidence has grown further, with KCC reporting record-breaking profits last year. A notable landmark in that progress was the three-year contract of affreightment (COA) signed with Brazilian company Raizen, which produces sugarcane-based biofuels, signed in early 2023. Raizen's requirements to transport liquid and dry produce in opposite directions between South America and India made KCC's ships uniquely attractive for this task.

Inevitably, with the growing cost of regulatory compliance and eventually zero or low-carbon fuels adding further to operating costs, KCC is leaning heavily into its sustainable credentials. In February, the company announced it had secured an A- rating for its efforts to tackle climate change as part of the annual CDP disclosure, placing it in the 'leadership' band of companies.

Meanwhile, KCC has also announced plans for a zero-emission-ready CABU III series of vessels for delivery in 2026, which the company says will achieve a 45% reduction in carbon intensity and intended to capitalise on an anticipated increase in caustic soda imports to Australia. The first of these new vessels is expected to be delivered in 2026. ■

MV *BANGUS*, THE FIFTH VESSEL IN KCC'S EIGHT-STRONG CLEANBU SERIES, WAS DELIVERED IN 2020

DIGITALISATION

SHELL MARINE'S DIGITAL PLATFORM PROVIDES USERS WITH COMPREHENSIVE PICTURE OF THEIR ENGINE'S HEALTH

By **Daniel Johnson**

In the maritime industry's ever-changing landscape, new regulations, new fuels, new engine designs and constantly changing original equipment manufacturer (OEM) requirements are just some of the issues adding to the complexity shipping operators must navigate. At the same time, a crew's understanding of their ship's engine performance can often rely on data collected in a way that makes it challenging to spot underlying issues or long-term trends.

These factors combined mean that operators are increasingly seeking technical expertise that helps leverage data inputs to optimise operations, says Marcus Schaerer, general manager of Services & Technical at Shell Marine.

"At Shell, we have invested a lot of time talking to customers and understand their pain points. What we have learned is that the crew need help to maintain the reliability of their two-stroke engines, especially in a world with new fuels, new designs and new lubricants," he tells *The Naval Architect*.

"For example, most crews still rely on traditional methods for cylinder monitoring, such as Excel. These methods haven't changed for 25 years," continues Schaerer. The implication of this, he explains, is that ships remain in a cycle of time-based maintenance rather than moving to a condition-based maintenance approach that could reduce instances of unplanned downtime and introduce significant efficiencies – when monitored properly.

"OEMs will give a lifetime for their cylinders of 16,000 to 20,000 hours. You can extend this up to 32,000 hours if you do condition-based monitoring," Schaerer notes.

Consolidating the data

As a way forward, Schaerer points to Shell Marine's digital platform Shell LubeMonitor, which he says surpasses traditional cylinder monitoring methods by combining data from onboard oil testing, engine operating conditions, Shell LubeAnalyst laboratory results, engine inspection photos and measurements to strike and maintain an acceptable balance between cylinder oil costs and wear-related cylinder maintenance expenses.

"Most operators already have all the data they need but it's scattered, in different formats and locations... aboard and onshore. And the challenge with scattered data is that it doesn't allow you to show trend lines and developments. You can't view it in an organised way," says Schaerer. Shell LubeMonitor automatically consolidates this data into a single platform, giving users a fuller picture of their ship's engine performance. "It gives you clear advice based on OEM recommended guidance that allows you to take the appropriate actions at the right moment to reduce issues on board, adjust your feed rates, save cost and reduce maintenance," Schaerer adds.

The platform offers several features that include enhanced vessel insights, from fleet level all the way down to individual cylinders, a step-by-step guide for onboard engineers to standardise the inspection process, and a comprehensive engine inspection feature that allows for the inclusion of recorded measurements such as piston ring clearance, piston ring coating and liner wear. It is available via the internet, iOS and Android operating systems, and has an offline logbook for easy submission of data, regardless of connectivity at sea.

Dedicated advisers

Additionally, the platform provides advice and recommendations from Shell Marine technical advisers. "Shell LubeMonitor is not just a software package," stresses Schaerer, adding that whilst crews rely on their individual experiences, Shell Marine can draw on decades of experience, a whole team of experts, and learnings from across many customers.

"I like to compare it to going to the doctors' or hospital if you a feeling unwell or need your regular checkup," says Schaerer. "The doctors are our technical experts. Like lubricant analysis, the first thing they do is take a blood sample to see what that's telling you. Then they run other tests and examinations and start combining the knowledge. If something is causing an irritation, then they say let's talk, and three or four doctors will come together to form a diagnosis and find the right therapy. That's very much what we are doing."

Although not a new solution, Shell LubeMonitor – like fuels,

SHELL MARINE'S MARCUS SCHAERER

engine designs and OEM requirements – keeps evolving, according to Schaerer. The original push for the platform, he says, came with two near-simultaneous events, the worldwide Covid-19 lockdown and the introduction of low-sulphur fuels in two-stroke engines following IMO's 2020 0.5% sulphur cap.

"Operators discovered that the heat and pressure low-sulphur fuels generate was creating deposits on the engine's power unit which can make the engine breakdown or run less efficiently. Deposits cannot be seen through [lubricant analysis] samples or onboard tests, only by visual inspection. So in just four months, which is lightspeed for a company like Shell, we developed an app to remotely assist crews with their inspections," he explains.

From there, other parameters were added to give operators and crew a more holistic view of operational conditions in the cylinders and combustion chamber, providing a "go-to place for all engine monitoring needs". Today, the platform can harness nearly 30 years of data, including a library of over 8,000 images and around 300,000 test samples, and uses artificial intelligence to filter information and help deliver meaningful advice.

A collaborative approach

Initially developed solely for Shell Marine lubricant customers, the next step for Shell LubeMonitor is to make it available to all shipowners and operators, no matter which brand of lubrication they use, and to integrate it with other systems. "We have some customers who, for commercial reasons, have decided to go for another brand of lubricant but still stay on the LubeMonitor, which demonstrates the value of the platform," says Schaerer.

"We also don't want to work alone, but instead connect it with other platforms, making sure that whatever knowledge we have is openly shared with whatever data model the customer is using," he adds. Schaerer concludes that he believes this collaborative approach is essential to tackling the complex challenges facing the maritime industry. ■

THE PLATFORM CAN COMPARE ONBOARD AND SHELL LUBEANALYST LABORATORY TEST RESULTS

TRANSITIONING TO NET ZERO THROUGH DATA-DRIVEN COLLABORATION

By **Daniel Johnson**

As the shipping industry moves towards more sustainable practices, there is an increasing demand for data-driven evidence to solve the ship design and operational challenges that lie ahead. Cooperation and unified efforts from all the sector's stakeholders will also be crucial to its decarbonisation journey.

Recognising these needs, global software and digital services provider NAPA has introduced NAPA Studios. The initiative, launched earlier this year, leverages the company's extensive digital technology and maritime expertise, and aims to foster cross-industry partnerships to resolve some of the critical uncertainties of shipping's shift towards a greener future.

"It's a monumental step for NAPA and the shipping industry at large," according to Naoki Mizutani, managing director of NAPA Japan and newly appointed executive vice president of NAPA Studios.

"No one technology or organisation alone can solve shipping's decarbonisation challenges, only collaboration will enable the industry to develop solutions. However, for such collaboration to happen in practice, it requires trust and transparency, which is built on the foundations of digital technology. This is where NAPA Studios can make a significant difference," he tells *TNA*.

Mizutani explains that the initiative will bring together shipowners, charterers, shipyards, classification societies, financiers and insurers in joint projects that will provide more clarity on the practical implications of deploying new technologies or contracts, and help develop the new technologies and operational frameworks needed for the transition to net zero.

Moreover, NAPA Studios will work directly with individual shipyards, shipowners, cargo owners and other supply chain stakeholders in tailored projects that will utilise NAPA's software, performance models and experience with digital twins and simulation tools. "This offering will, for example, enable shipyards to make greater use of ships' operational data to improve future designs, while other projects will support shipowners and charterers in assessing their fleet's environmental performance and potential emissions reductions and cost savings," says Mizutani.

NAPA Studios' launch builds on the success of recent partnerships involving NAPA, including a simulation study with clean technology provider Norsepower and shipyard Sumitomo Heavy Industries Marine & Engineering that measured the emissions reduction potential of combining rotor sails and voyage optimisation (see *TNA*, July/August 2024), and a joint research project with classification society ClassNK and shipowner Marubeni Corporation which found that voyage optimisation can reduce GHG emissions by 7.3% and extend CII compliance by up to three years.

Mizutani highlights another ongoing NAPA project targeting the creation of a secure data-sharing framework between shipyards and shipowners to advance the use of digital twins throughout a ship's lifecycle. It brings together several Japanese maritime majors and aims to enable the use of a vessel's unique design data to optimise efficiency and safety at sea as well the sharing of operational data to inform new designs.

"The project really captures the spirit of cooperation," says Mizutani, adding that initial results from its early phases have confirmed the feasibility of increased data sharing between relevant stakeholders by overcoming obstacles related to the sharing of sensitive design and operational data.

Over 30 potential use cases have been identified where the data and 3D models used to design the ship can be shared securely and used to create a vessel-specific digital twin that helps improve operational efficiency and safety throughout its lifecycle. Further analysis has confirmed the potential and value of digital twins in supporting loading calculations, ship condition monitoring and energy-saving device evaluation. The partnership has also explored ways in which operational data can be fed back to shipyards to provide insights on how their concepts perform in real life, thereby enabling naval architects to improve future designs.

The project's next phase – led by ClassNK as an impartial entity – will develop a new platform that will enable NAPA 3D models created during the design stage to be shared in a secure and access-controlled digital environment, together with new business models to implement this approach in practice in commercial agreements. This could create a new revenue stream for shipyards and solutions providers, as well as mechanisms to share benefits between stakeholders, points out Mizutani.

"At this critical time, digital twins are a key asset for shipping. Our Digital Twin project demonstrates that by building new types of partnerships we can break data silos and unlock new solutions that help reduce greenhouse gas emissions from voyages," he concludes. ■

NAOKI MIZUTANI. SOURCE: NAPA

ANALYTICS SPECIALIST METIS FINDS ITS FOCUS

By **Richard Halfhide**

Visit any maritime trade show nowadays – and SMM in Hamburg in September was no exception – and you'll find no shortage of companies offering a variety of performance monitoring solutions. Automated data collection and analytics is increasingly a key component of the modern ship operator's toolkit, particularly with the mandate of IMO's Carbon Intensity Indicator (CII) never far from thought.

Greek-based performance management specialist Metis, a subsidiary of engineering group Erma First, was among the earliest to offer automated real-time analytics for parameters such as fuel oil consumption, engine performance, operational and navigational data; launching its original platform onto the market in 2017.

"From Day One it's focused on what we call 'telemetry first' performance monitoring for vessels and fleets," explains Metis CEO Panos Theodossopoulos. "At that time no one could really access a lot of high-frequency data from vessel operations. So we started by designing our own hardware for operational data collection from the vessel, be that navigational, fuel consumption, machinery, etc. We then transfer that data onto our cloud and do the analytics necessary to provide value to shipping companies."

Earlier this year, Metis launched a revised version of its software intended to offer the user a more transparent summary view of key information, rather than the top-down information of earlier iterations. Theodossopoulos says that while the original version was good in terms of situational awareness of what was happening on board the vessel it wasn't necessarily answering straightforwardly all the important questions.

He explains that the redesign was based on three principles. First was the ability to offer a single summary dashboard view for both individual vessels and the whole fleet for a high-level picture. Secondly, information would now be grouped in four domains of focus: Emissions, Performance, Operations and Machinery. The third pillar of the new platform are the core scores, or KPIs, which denote how the vessel is performing in each of the four domains.

Shipping companies have more and more things to report and monitor, so the work for the superintendents and the fleet managers is getting bigger and bigger. So the fact that we give them ready-made Information and a summary view is taking part of the job off their hands," says Theodossopoulos.

Challenged by *TNA* whether perhaps Metis may have previously overestimated the ability of operators to analyse the data Theodossopoulos reflects that the onus is always on the vendor to provide a product that meets customer needs, rather than technology for its own sake. Indeed, so far feedback received about the new platform, and the narrative around it, has been extremely positive. "People are saying it's exactly what they've always wanted, to quickly understand where we have an issue and then drill down," he explains.

PANOS THEODOSSOPOULOS JOINED METIS AS CEO AT THE END OF 2023

At the same time, he thinks that the exigencies of decarbonisation extend beyond regulatory compliance. "I wouldn't quite say performance monitoring has gone from a 'nice to have' to a 'must have' but it's certainly higher in the visibility... you have to better understand what is happening inside your vessel in order to use the data and improve your day-to-day operations, aside from the design and hardware changes that one can implement."

There are also commercial elements. "It will be some time until we get to the point where we have new fuels with no carbon molecules, so one needs to use every single point of improving the emissions footprint and fuel optimisation. It's ok to install energy saving devices but you need to understand the 'before and after' story."

Additionally, Theodossopoulos believes the drive towards greater transparency, be that through regulatory compliance or the force majeure of securing financing through requirements such as the Poseidon Principles, is adding to the importance of operational data. While shipping may not be entirely comfortable with the idea of data sharing, the key will be finding a way whereby the shipping company maintains its commercial advantage while being accessible to those who need to know. Potentially that might even end the traditional conflict between shipowners and charterers.

"CII, to give one example, is a KPI which affects the owner but it's a result of the way the charterer operates the vessel. I think in the new era the digital platform will serve as an intermediary serving as a single point of truth for both parties. We're not there yet but we're starting to see elements of that puzzle with things such as the BIMCO CII clause for charter parties," he concludes. ■

LEVERAGE SIMULATION TECHNOLOGY IN THE MARINE INDUSTRY

Taking advantage of using existing 3D computational analysis with the executable digital twin

By **Philipp Mucha** and **Dmitry Ponkratov**, Siemens Digital Industries Software

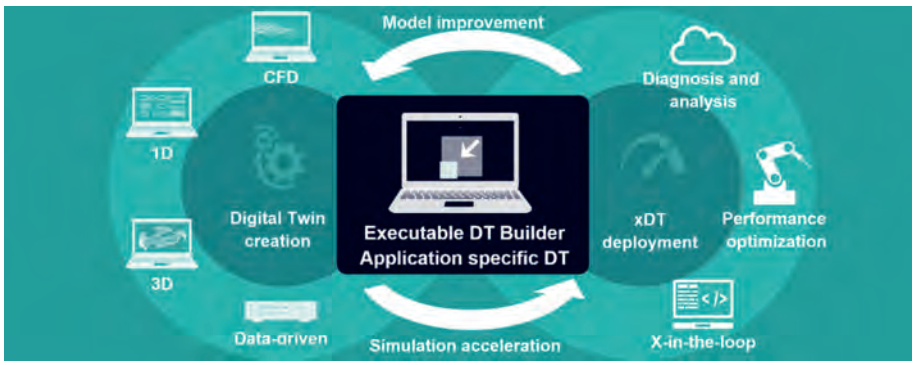


FIGURE 1. EXECUTABLE DIGITAL TWIN ECOSYSTEM. (VAN DER AUWERAER AND HARTMANN, 2022)

Do you and your team find yourself up against tight deadlines to design a new ship that will pass muster in the evolving regulatory landscape? Do you have the tools to assess whether the innovations you have developed will result in the energy efficiency gains and structural integrity improvements you anticipated, or is there simply not enough time to run computational fluid dynamics (CFD) or finite element analysis (FEA)? If so, it is time to rethink your concept of simulation technology, embrace the true essence of simulation-driven ship design (SDSD) and maximise its value.

The digital twin is governing the discussion about the use of SDSD in the marine industry as shipyards and operators face increasing pressure to stay competitive while addressing green shipping regulations. As such, the reduction of capital (CAPEX) and operating costs (OPEX) is at the forefront of decision-making in the stakeholders' process of restructuring their businesses. According to Fischer and Holbach (2011), approximately 85% of CAPEX is determined during the early design phase [1]. On the other hand, fuel consumption and berthing fees are the main OPEX drivers. Even a small percentage in power reduction yields millions of dollars in savings for the operators over the lifecycle of a ship. Many ships can be retrofitted: for example, they can be equipped with energy-saving devices, leverage wind-assisted propulsion or make use of onboard piloting assistance systems like weather routing or virtual arrival to pick the optimal route and service speed to minimise the total cost of a journey.

Simulation technology is required to increase profit margins because physical experiments are not scalable for design space exploration during the early phase. Therefore, they can't be used to slash CAPEX and inform retrofitting of existing ships. Developing and operating onboard piloting assistance systems can't be done with physical experiments because they are inherently digital. In contrast, digital tools are well suited to take into account legacy designs and the experience of ship designers who worked prior to the availability of simulation technology. But there are challenges. There are stringent requirements for using simulation technology. Simulations must be:

- Fast, often at real-time speed
- Acceptably accurate
- Interactive with application programming interfaces (API)
- Deployable on various hardware platforms
- Operable by a large and diverse group of users (democratisation)

So what exactly is a digital twin? How do stakeholders extract value from it? How do design departments leverage existing 3D computational analysis tools like

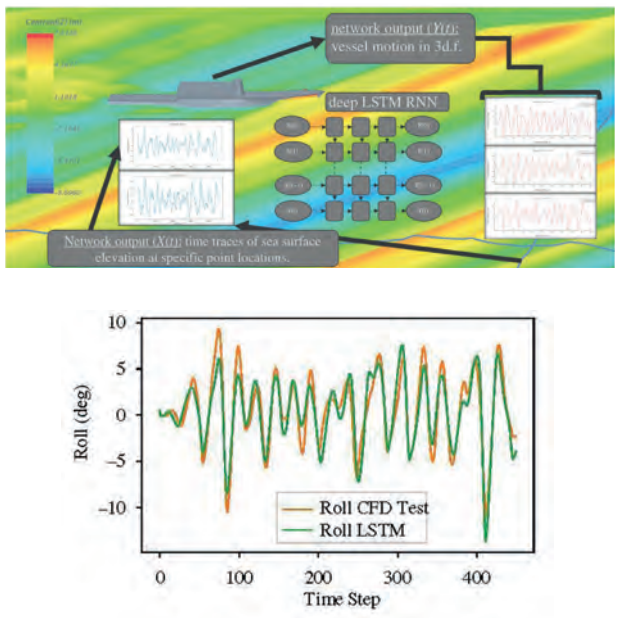


FIGURE 2. WORKFLOW OF USING LSTM NEURAL NETWORKS FOR PREDICTING VESSEL DYNAMICS IN EXTREME SEA STATES. (J. DEL AGUILA FERRANDIS, ET AL., 2020)

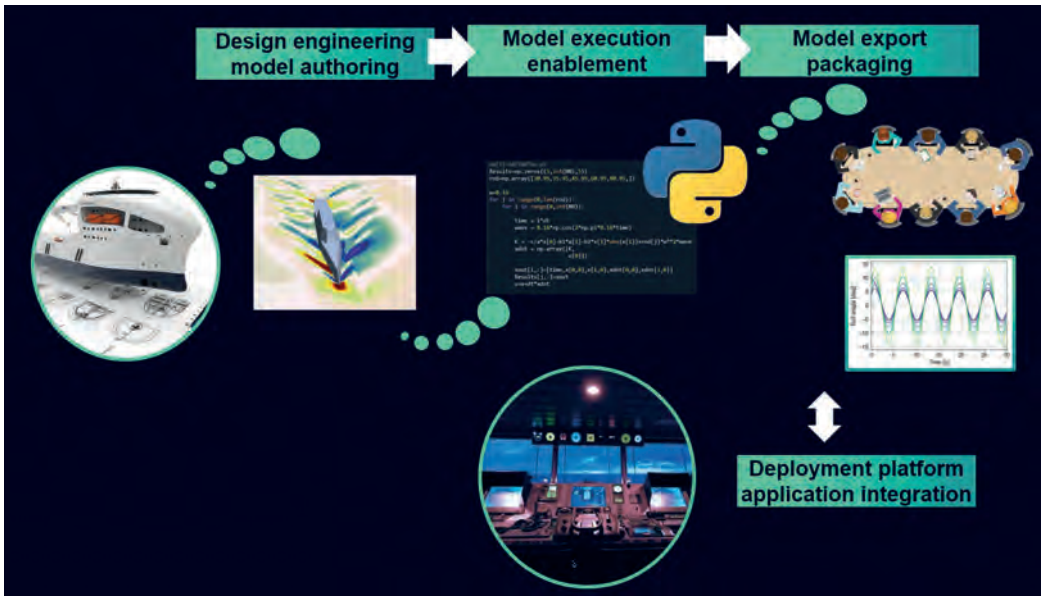


FIGURE 3. WORKFLOW FROM CAD, CFD, ROM BUILDING TO ONBOARD DEPLOYMENT OF A XDT FOR FUEL-EFFICIENT ROUTING

CFD, FEA or systems analysis? And how do they do it when these applications require experts and tools like CFD high-performance computing infrastructure?

Answers can be found using the so-called executable digital twin (xDT) and the technology enabling it, for example, reduced-order modelling (ROM) informed by 3D computational analysis. The value proposition of the digital twin rests on the connectivity of the digital model to the physical asset. Measurements from operating the physical asset will be used to verify, validate and improve its digital twin, while the unmeasurable can be computed and analysed using the digital twin. A bilateral stream of data and enhancements results from the inception of the design through the decommissioning of the physical asset. Van der Auweraer and Hartmann (2022) represent a primary reference for xDT [2]. According to them, xDT can be defined as follows:

> *"When a dedicated encapsulation is extracted from the digital twin to model a specific set of behaviours in a specific context, delivering a standalone executable representation, such instantiated and self-contained model is referred to as an executable digital twin."*

Furthermore, they propose a blueprint for xDT ecosystems, central to which is the xDT Builder, a platform connecting authoring tools like CFD, computer-aided design (CAD), FEA (3D), system simulations (1D) and data-driven methods (see Figure 1).

Engineering analysts will use these authoring tools to generate meaningful data to build a ROM of suitable complexity. Strategies are available to accomplish this task. Black-box methods do not use any detailed information (physical or mathematical) as input for the underlying problem and leverage technologies like artificial intelligence (AI) and machine learning (ML). Gray-box approaches necessitate a certain level of knowledge of the underlying models, for example, conventional linear regression or response surface modelling. Finally, white-box methods require full connectivity to all models and solvers defining the problem.

To realise the xDT, an encapsulation tailored to the target application needs to be extracted from the digital twin for the consumer using it in the target application area that is embedded in the operational environment. Consistent with the concept laid out in van der Auweraer and Hartmann (2022), the model is no longer holistic but only addresses the application-relevant problems of the system and can be adapted by calibrating it to the needs of the asset it is being integrated with. Another crucial property of the encapsulation is that the expert-level mathematical details of the model authoring and ROM building process are now masked, and such knowledge is not required by the consumer.

Examples from seakeeping, structural integrity and powering analysis are shown to demonstrate the sequence of performing engineering analysis, generating data with CFD or FEA and building a ROM.

Researchers at Massachusetts Institute of Technology (MIT) have developed a general framework for

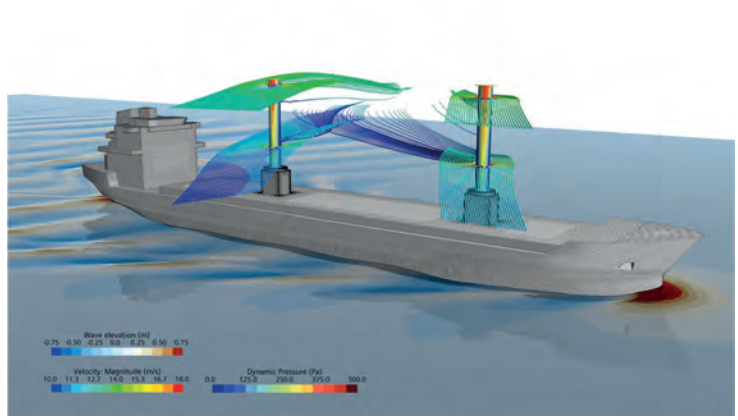
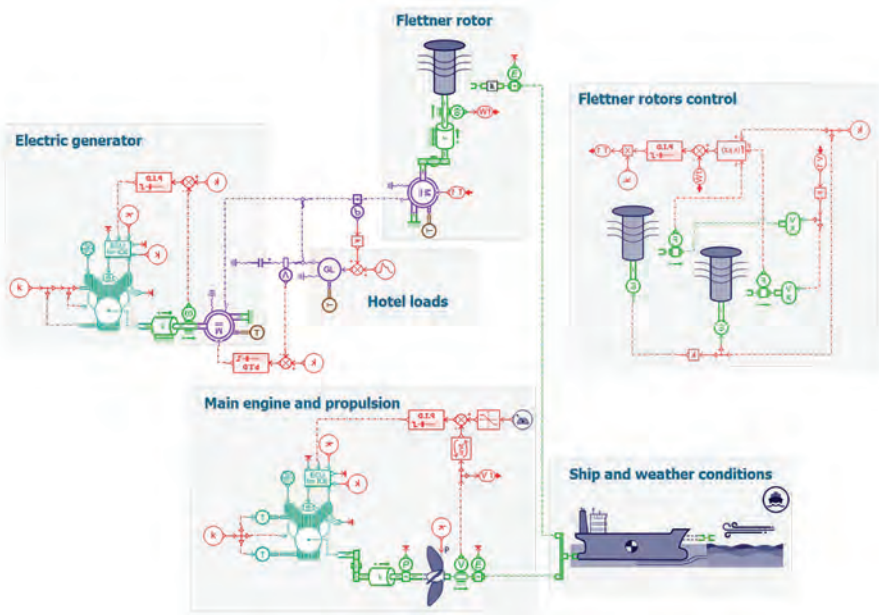


FIGURE 4. CFD SIMULATION OF WIND-ASSISTED PROPULSION USING FLETTNER ROTORS (CAPONETTO AND HUEBNER, 2024)

FIGURE 5. SYSTEM-LEVEL ROM IN SIMCENTER AMESIM FOR POWERING PREDICTIONS, INCLUDING WIND-ASSISTED PROPULSION THROUGH FLETTNER ROTORS



predicting ship motion in extreme sea states using long short-term memory (LSTM) type neural networks, a popular AI/ML technique for forecasting problems in engineering (Del Anguila Ferrandis et al., 2020 [3]). The framework is based on training data generated with Simcenter STAR-CCM+ software using CFD seakeeping simulations. Figure 2 shows a schematic of the workflow of the black-box approach and the validation of the resulting ROM prediction by comparing it to transient CFD simulation results of the roll motion of a surface combatant.

Simcenter is part of the Siemens Xcelerator business platform of software, hardware and services.

Prior to or during ship operation, you can account for sea-state dependent motion amplitudes in weather routing or optimising fuel economy. The 1D systems simulation software Simcenter Amesim offers a toolbox for detailed powering analysis carried out by a tailor-made ROM that uses resistance and propeller performance curves generated by CFD. Powering analysis can be enhanced to include a detailed model of the engine and drivetrain, allowing for quick system-level studies of different types of engines, for instance, conventional two-stroke diesel, diesel-electric or fully electric. Furthermore, comprehensive fuel consumption profiles can be determined for voyage planning (see Figure 3). Caponetto and Huebner (2024) [4] showcase the validity of CFD simulations of wind-assisted propulsion via Flettner rotors (see Figure 4). Wind-assisted propulsion devices are supported by Simcenter Amesim, allowing for fast comparative simulation studies providing emission savings projection envelopes for a large range of operating conditions or rotor designs (Figures 5 and 6).

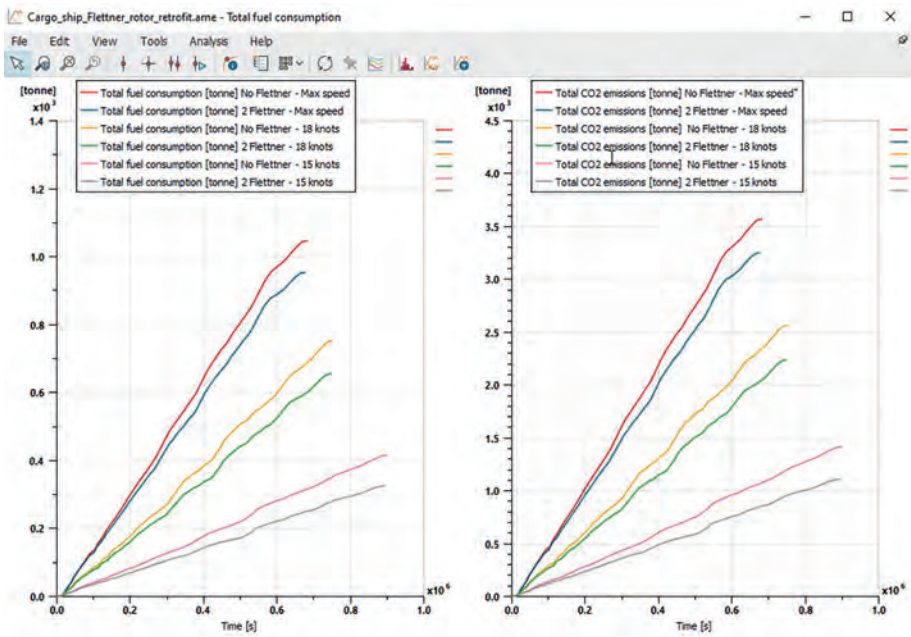


FIGURE 6. SIMCENTER AMESIM RESULTS FOR FAST-TIME FUEL CONSUMPTION AND CO_2 EMISSION PREDICTIONS

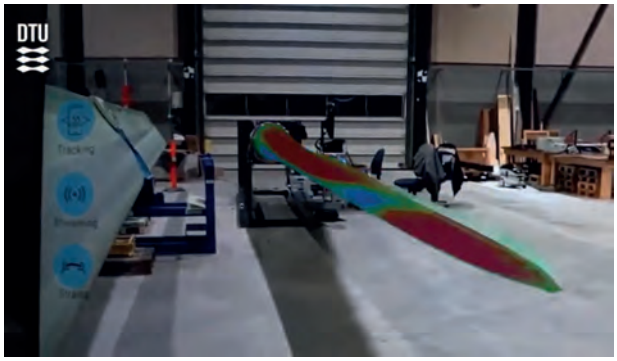


FIGURE 7. SIMCENTER 3D SMART VIRTUAL SENSING COMBINED WITH THE MODAL ANALYSIS OF A WIND TURBINE BLADE (COURTESY OF DTU

The last example stems from the field of structural analysis, a key step in delivering safe and efficient products in engineering. Simcenter 3D Smart Virtual Sensing is an innovative framework that enables you to leverage an executable digital twin for structural testing by combining the limited physical measurements with a FE ROM, creating virtual sensors that provide responses beyond what can be measured in the physical experiment. All this takes place in situ and in real time. It can offset both simulation model and measurement errors and generate high-fidelity estimations of the input loads, strains, acceleration, velocity and displacement of your mechanical system. Researchers at the Danish Technical University (DTU) showcased the technology during modal tests of a wind turbine blade (Figure 7). Physical strain gauges require instrumentation, which is a constraining factor because it can't be done in arbitrary locations. Additionally, many other critical metrics like stress, displacement or accelerations cannot be measured directly or can only be measured with additional effort and instrumentation. Although a numerical uncertainty is inherently attached to the FE ROM, the few available strain measurements on the physical asset can be used to minimise associated errors in real time. The results are an efficient symbiosis between the real system and simulation technology – the core value proposition of xDT. ■

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LETTERS TO THE EDITOR

SHOULD GM BE ABANDONED IN FAVOUR OF THE KN METHOD?

Dear Sir,

Other than for its original use as a measure of stiffness, is there still a role for GM or, indeed, for the metacentre itself?

GM is the slope of the GZ curve at upright; a straight line between adjacent points on that curve has slope: $(GZ_i - GZ_{i-1}) / (\phi_i - \phi_{i-1})$. At any point i on the curve, $GZ_i = KN_i - KG \sin\phi_i$ and, at sufficiently small angles, $\sin\phi = \phi$ (when heel angle ϕ is in radians). Substitution and rearrangement give a new expression for the slope close to upright: $(KN_i - KN_{i-1}) / (\phi_i - \phi_{i-1}) - KG$. With ϕ_{i-1} at zero and angle ϕ_i set conveniently at 0.01 radians (0.573 degrees), this gives the slope at upright: $GM = 100 (KN_{01r} - KN_0) - KG$. Comparing with the familiar $KG = KM - GM$, the term $100 (KN_{01r} - KN_0)$ is clearly equivalent to KM, yet is derived here from only a pair of KN values, without reference to the shape of the waterplane or to a metacentre.

My article *Coping without the Wall*, published in the latest issue of *The Naval Architect*'s sister magazine *Ship & Boat International* (September/October 2024), uses a similar argument to promote the use of KNs, rather than GM, in the derivation of KG (VCG) from inclining experiment data. That article demonstrates how reliance on GM can lead to errors in VCG and concludes that:

"*The magnitude of any error is best determined by comparison with a method known to be accurate – in which case it would seem logical to have used that method at the outset. Since the KN method will deliver a correct VCG for any hull form, at any angle, it has much to commend it over one which depends on an improbably wall-sided vessel being inclined to impracticably small heel angles to give imprecise results.*" ■

Richard Dunworth

email: richard@apex.net.au

Ed's Note: *Subscribers to Ship & Boat International can view the September/October 2024 issue online at https://content.yudu.com/web/60wf/0Ab1gi/SBISepOct2024/index.html*

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