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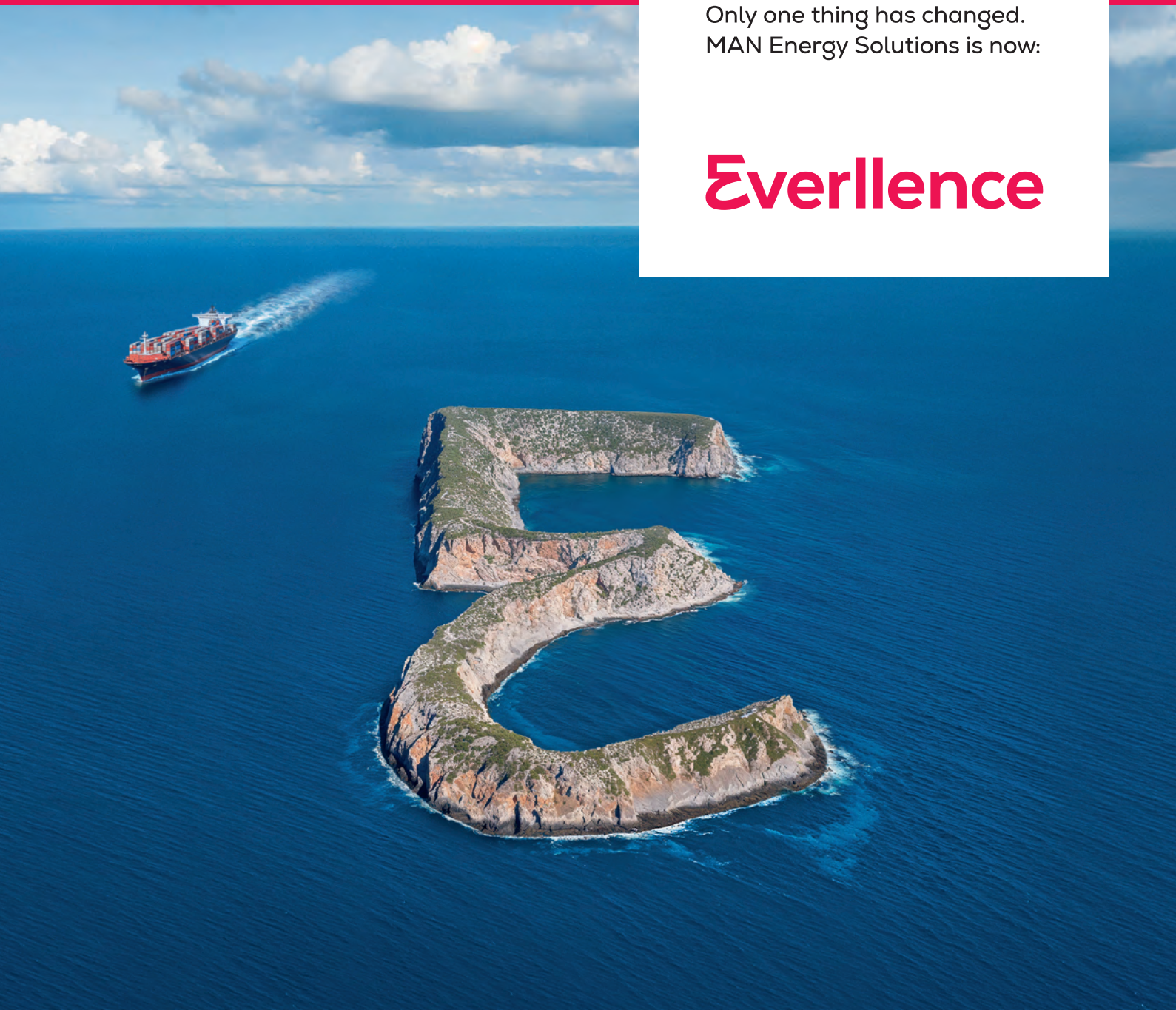

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THE NAVAL ARCHITECT

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Published by:
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Printed in Wales by Stephens & George Magazines.

ISSN 03060209

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FUTURE OF CRUISE SHIP ON BOARD

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FUTURE ON BOARD

CALLS FOR UNITY TO TACKLE SUICIDE AT SEA

Long periods of isolation can negatively impact seafarers' mental health (image: VIKAND)

While *The Naval Architect*'s focus is primarily on naval architecture, ship design and shipbuilding and repair, it's important to acknowledge that we don't operate in isolation from the wider maritime sector. Therefore, it was with concern that we recently saw healthcare provider VIKAND cite disturbing statistics from Gard's 2025 Crew Claims Report to raise awareness of the importance of safeguarding seafarer mental health.

The Gard stats – based on 2024 claims data and feedback from more than 6,000 seafarers – indicate that, between 2019-2023, 11% of all seafarer deaths were due to suicide, surpassing the number of deaths caused by onboard injuries. "Suicide at sea is a harsh reality we can no longer ignore," commented Ronald Spithout, MD of OneHealth by VIKAND. "The silence, the stigma and the systemic underreporting must end...we need to ensure a more structural approach and support for seafarers before more lives are lost."

VIKAND also draws attention to research by Yale University, conducted in 2020 for the ITF Seafarers' Trust, which found that 20% of surveyed crew members had experienced suicidal thoughts. VIKAND says: "Unique pressures of life at sea, including long isolation, communication challenges and cultural taboos, make seafarers especially vulnerable. Most suicides occurred among crew members under age 41, with officers disproportionately affected. Compensation exclusions for suicide further compound the trauma for grieving families."

VIKAND's statement includes the case of two Filipino crew members, both described by their colleagues as "outgoing, engaged and sociable" team players, who nonetheless took their own lives following family and relationship problems, exacerbated by their isolation at sea. "Neither had a known mental health history or showed visible warning signs," VIKAND writes. "In each case, psychological support and crew training were implemented – but only after the tragic events."

"Between 2019-2023, 11% of all seafarer deaths were due to suicide, surpassing the number of deaths caused by onboard injuries"

VIKAND is now urging maritime industry leaders to improve reporting standards, step up mental health support services and push for a "cultural transformation" to remove the stigma about mental health issues, "so seafarers feel able to ask for help without fear of judgement or shame". This strategy would involve greater use of pre-employment psychological screening, to identify vulnerabilities before crew members take to sea, and targeted training for officers and crew, helping them to spot early signs of distress among their colleagues and to react accordingly. "Fragmented, reactive approaches to mental health are no longer sufficient," VIKAND warns. "More effort must go into receiving even the faintest early warning signals."

As some readers may be aware, VIKAND also provides 24/7 helplines for immediate support. "This isn't about checking a box – it's about proactively trying to save lives," says Spithout. "Together, we can build a maritime culture where every seafarer feels seen, supported and safe." It's a message that *The Naval Architect* can fully get behind, and not just as a 'nice idea', but as more of a duty to the seafarers who keep our industry alive. ■

Martin Conway,
Managing Editor

NAVAL VESSELS

MORE PPA MULTIPURPOSE COMBAT VESSELS FOR ITALIAN NAVY

Fincantieri will build two more PPA multipurpose combat ships for the Italian Navy

The Italian Navy has placed a contract with Fincantieri to build two more PPA multipurpose combat vessels. The new vessels will replace those earmarked for transfer to Indonesia.

The contract for the new vessels, managed by the Organisation Conjointe de Coopération en matière d'Armement, was placed with a consortium comprising Fincantieri as lead contractor and Leonardo as its principal partner. The value of the contract for Fincantieri is approximately €700 million, including work already carried out on the units now destined for Indonesia.

The new PPA multipurpose combat ships will be delivered in the 'Light Plus' configuration by Fincantieri's shipyards in Riva Trigoso and Muggiano. Deliveries are scheduled for 2029 and 2030, respectively. Fincantieri CEO Pierroberto Folgiero says: "The new units will bolster the national supply chain, ensuring production continuity and employment stability, while also strengthening Italy's role as a central player in the global defence landscape, where shipbuilding is increasingly a key element of influence and international cooperation."

The new vessels will be capable of undertaking multiple missions, including patrol, search and rescue and civil protection operations, and are considered first-line fighting vessels. The PPAs are designed to be 'fitted for but not with' so that additional capabilities can be integrated over time using a shared platform. They will have a length overall of 143m, speed in excess of 31knots and a crew of 171, plus a combined diesel and gas turbine propulsion plant and an electric propulsion system. ■

INLAND VESSELS

NOVA FORERUNS AUTONOMY ON THE RHINE

Designed as a demonstrator for eco-friendly, part-autonomous inland shipping, the 15m x 7m catamaran *NOVA* is currently transiting the Port of Duisburg on the Rhine and in canals across the Ruhr region – and purely on electric power.

The cat was jointly developed by the University of Duisburg-Essen (UDE) and the Development Centre for Ship Technology and Transport Systems (DST) to carry passengers and cargo, and was built by the Felleryachting shipyard. The developers hope that *NOVA* will forerun a wider roll-out of low-to-zero-emission inland vessels in the region within the next eight to 10 years.

Torqeedo integrated the vessel's powertrain, which includes two Deep Blue 50i motors, each rated 50kW, and four Deep Blue Battery 80 units, featuring a combined capacity of 320kWh. The batteries power the motors and all onboard electronics, instruments and lighting. Torqeedo tells *The Naval Architect* that this arrangement grants *NOVA* an average operating speed of 8knots, and that the batteries will be recharged by two 22kW shore power chargers on the vessel's route. The supply package also includes a pair of Torqeedo System Management Units, to enable continual monitoring of the powertrain's performance. ■

***NOVA* features 320kWh of battery capacity**

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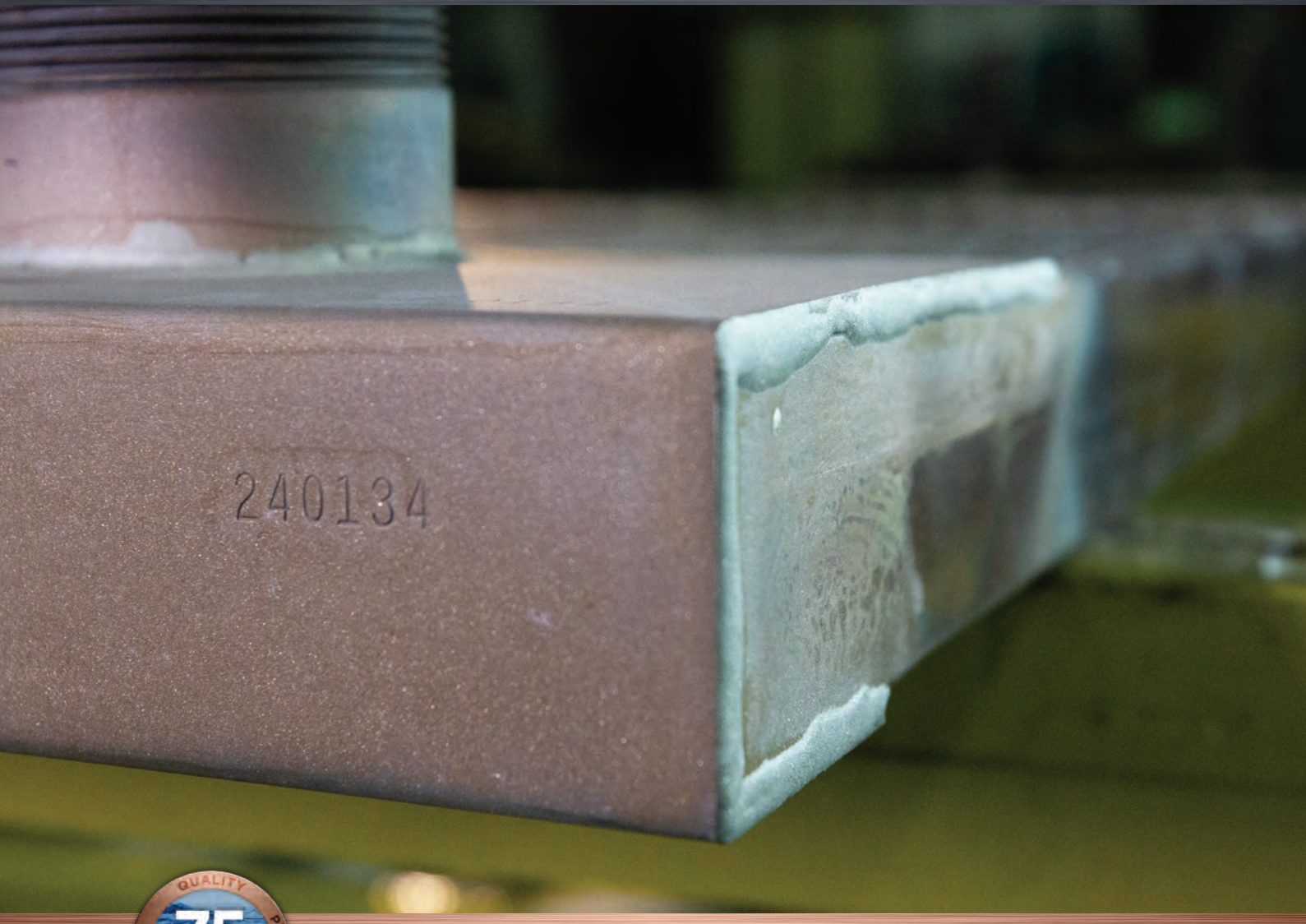

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PATROL AND RESCUE VESSELS

NEW FIREFIGHTER ON SINGAPORE DUTIES

Naval architect and designer BMT and Singapore-based boatbuilder Penguin Shipyard International have delivered a fire and rescue vessel to the Singapore Civil Defence Force (SCDF). The Blue Dolphin MFV-R (standing for 'multi-role fire vessels – rescue') is the first of two 38m sisters for the SCDF, featuring an aluminium monohull and an external firefighting system comprising three fire monitors and three pumps, capable of delivering a combined flow rate of 3,600m^3 per hour.

The vessel has 12,000litres of foam capacity. BMT says: "This is further supported by a self-protection water curtain, giving the vessel a fully redundant and highly capable firefighting configuration that exceeds standard FiFi Class 1 requirements." The vessel also houses advanced chemical, biological and radiological (CBR) protection systems, plus a decontamination room, a first aid station and a rescue lounge for up to 30 survivors and eight firefighters. Infrared sensors enable the detection and classification of chemical warfare agents and toxic industrial chemicals at ranges of up to 5km, BMT adds.

The vessel can reach speeds exceeding 30knots, and comes with biofuel-compatible engines and solar panel charging systems. A high-speed RIB is also stored on board, which can be launched for near-shore search and rescue operations. The vessel is also equipped with a virtual anchoring system, to reduce the crew's workload during station-keeping operations. ■

The Blue Dolphin MFV-R was developed for firefighting and rescue operations in Singapore

TUGS

LOW-NOX TUG ON ORDER FOR NEW ZEALAND

Damen Shipyards Group is to build an ASD Tug 2312 unit for Port Marlborough New Zealand (PMNZ), which will use it to provide towage services at Picton Harbour, where approximately 3,000 vessels call annually. The tug, to be named *Kaiaua*, will work alongside an existing ASD Tug 2111 type, *Kaiana*, which Damen delivered to PMNZ last year.

The ASD Tug 2312 features a length overall of 22.8m, a breadth overall of 12.03m, a depth of 4.4m and a draught of 5.6m. The model also has a bollard pull capability of 70tonnes ahead and 65tonnes astern, and can achieve a speed of 12.4knots, utilising twin Caterpillar 3512C engines (rated a combined 3,804bkW) and Kongsberg Maritime US 205S FP azimuthing thrusters.

Part of Damen's 'Compact Tugs' series, the class is arranged for 360° visibility from the wheelhouse and clutter-free decks. *Kaiaua* will also be equipped with a single winch for both fore and aft operations, installed in the deckhouse to protect it from the elements. Damen has also outfitted the vessel with its own selective catalytic reduction (SCR) system, the Marine NOx Reduction System, which, it says, can reduce NOx emissions by up to 80%, enabling compliance with IMO Tier III requirements. Damen says: "Although the regulations do not yet apply in New Zealand, PMNZ has committed to providing a more sustainable operation." ■

The ASD Tug 2312 series has a bollard pull of 70tonnes ahead

HEAVY-LIFT VESSELS

SIXTH AAL SUPER B-CLASS READY FOR ACTION

Heavy-lift vessel operator AAL Shipping (AAL) is preparing to take delivery of the sixth in a series of eight Super B-class "powerhouses". The 179.9m x 30m, 32,000dwt methanol-ready vessel, christened *AAL Dammam* in a naming ceremony at the Guangzhou facility of Chinese builder CSSC Huangpu Wenchong Shipbuilding, will handle various multipurpose cargoes, including heavy-lift project components, breakbulk and dry bulk, on a single voyage.

AAL Dammam has a depth of 15.5m and draws 6.5m. The 41,500m^3 vessel can accommodate more than 100,000 freight tonnes of breakbulk and heavy-lift cargo, and is fitted with three 350tonne-capacity heavy-lift cranes, which can be combined to handle a maximum of 700tonnes. AAL says: "Two large, box-shaped cargo holds are optimised for dry bulk, featuring adjustable pontoon triple decks and no centreline bulkhead."

The seventh and eighth Super B units on order, *AAL Newcastle* and *AAL Mumbai*, are scheduled for delivery from CSSC Huangpu Wenchong Shipbuilding in 2026, though each will feature a higher maximum lift capability of 800tonnes.

Kyriacos Panayides, AAL CEO, comments: "Whilst the current geopolitical landscape makes short-term planning extremely difficult, the long-term forecast for the global industrial sector...is nevertheless strong. Global industry is experiencing record levels of capital input, with clean-energy investment alone expected to hit US$2.2 trillion in 2025, according to the International Energy Agency. And, whilst renewables continue to lead new project activity, we are not dependent on a simple 'fossil-to-clean' shift for cargo volumes, but rather a layered build-out across all industrial energy and resource sectors." ■

***AAL Dammam* was christened at CSSC Huangpu Wenchong Shipbuilding's Guangzhou yard**

RESEARCH VESSELS

NEW RESEARCH SHIP FOR INKFISH

Ship designer and builder VARD has signed a €200 million contract to provide a new vessel for research organisation Inkfish. The newcomer, provisionally named *RV6000*, will be built to the specs of VARD's 9 33 design and will be used to collect subsea data for distribution across open-source databases.

RV6000 features a length of 100m and a 20.7m beam, providing enough space to carry an ROV, rated for depths of 6,000m, plus two crewed submersibles. Equipped with electric Voith Schneider Propellers (eVSPs), the vessel will be capable of a top speed of 15knots and up to 30 days of autonomy. An A-frame is mounted on the stern, while the starboard side features an active heave-compensated offshore crane configured for operations down to 2,500m. The ship will also boast the capacity for 70 crew members and scientists, and a helideck. Delivery is scheduled for Q2 2028. ■

Research vessel *RV6000* will have 30 days of autonomy

EMISSIONS REDUCTION

NEW SCR SYSTEM FROM YANMAR

Yanmar Marine International has unveiled a new selective catalytic reduction (SCR) system, primarily designed to slash NOx emissions from commercial ships with engines exceeding 130kW in output. The SCR system reportedly ensures a 60-90% reduction in NOx emissions, thus meeting IMO's Tier III emissions requirements and enabling these vessels to enter emission control areas (ECAs).

In addition to commercial ships, Yanmar says, the SCR system can be fitted aboard larger leisure vessels exceeding 24m in length. The system is compatible with the company's 6LY engine family, which is rated between 400-440hp (298-328kW) and weighs 86kg.

The SCR system uses sensors to measure temperature and NOx before it enters the catalyst. Yanmar says: "An electronic control unit calculates the correct volume of diesel exhaust fluid [DEF], also known as AdBlue, which needs to be injected, which then binds with the NOx, reducing emissions down to near-zero levels."

Yanmar is also offering an optional heater kit to prevent crystallisation of the DEF, which can occur at -13°C, should the vessel enter ECAs in colder regions such as the Nordics and Baltics. The DEF is stored in a 50litre-capacity plastic tank and a 150litre-capacity stainless steel tank. ■

Yanmar's SCR system is designed for commercial ships and 24m+ leisure vessels

VIRTUAL/AUGMENTED REALITY

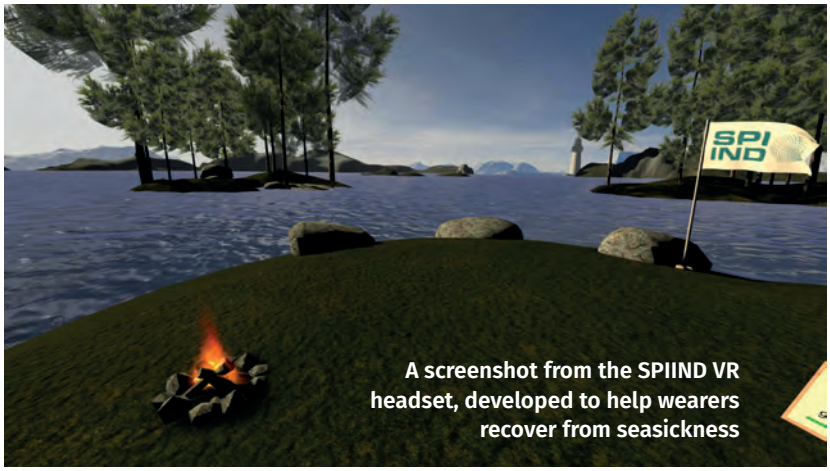
A VR ESCAPE FROM SEASICKNESS

Loki Dynamics' new SPIIND VR virtual reality headset promises to assist crew members and offshore technicians undergoing seasickness by immersing them in relaxing scenes featuring trees, water, a campfire or a mountain range in the distance.

Internal tracking gyros mean the wearer can look left, right, up and down – but, as in the real world, more distant objects remain comparatively anchored: the wearer is not left with a sense-scrambling, foreshortened view, such as the back of the seat in front. "Often a reaction to early feelings of nausea is to look for the horizon and to step outside, regardless of the personnel protection required in colder sea-air temperatures," says Sarah Honebon of Loki Dynamics. "I have seen several people hospitalised with mild hypothermia."

There are surreal elements to the VR scene: 'down' is pictured as grass without your feet or knees in the frame, and the gently falling leaves disappear on touching the ground. Still, the effect is rather meditative: "The VR headset dulls the sensory fight or flight instincts [that result] when the mind and body's stress and distress levels increase," explains Honebon.

The SPINND VR won Seawork's 2025 'Spirit of Innovation' award and there is interest from CTV operators. Just a couple of headsets should cover the needs of 24 technicians, since recovery usually takes 10 to 20 minutes, Loki Dynamics says. ■



A screenshot from the SPIIND VR headset, developed to help wearers recover from seasickness

IT AND COMMUNICATIONS

DANELEC: REAL-TIME DATA TRUMPS NOON REPORTS

A report commissioned by maritime tech firm Danelec, titled *From Data to Action*, claims that more than 70% of vessels currently depend on once-a-day 'noon reports' for performance data, despite modern technology enabling second-by-second updates.

Casper Jensen, Danelec CEO, comments: "If you only check your vessel's vitals once every 24 hours, you're operating with blind spots." The report cites a case where a ship's crew, lacking real-time data, missed an inefficiency that led to US$4,300 in excess fuel costs on one voyage. According to the report, continuous high-frequency data (HFD) flow could help a vessel to save nearly 9,000 metric tonnes of fuel over its lifecycle, equating to several million dollars in savings.

"By relying solely on noon reports, shipowners risk losing their competitive edge," Danelec says. "Fleets leveraging live data are better positioned to command higher time-charter rates and demonstrate transparency, both of which are key factors in reducing disputes and ensuring operational accountability."

Jensen tells *The Naval Architect*: "It's a common misconception that HFD means high bandwidth usage; HFD is typically structured, compressed and selectively streamed to minimise impact on data plans. With modern connectivity solutions like VSAT and Starlink, most vessels today operate on monthly data packages where this type of transmission fits comfortably within the allowance.

"While more frequent data transmission does have a cost component, it's marginal compared to the value it unlocks. Catching a fuel inefficiency in real time, enabling predictive maintenance or giving shore teams live insights to support the crew...often translate to hundreds of thousands in annual savings for larger vessels." ■

Relying solely on noon reports means "you're operating with blind spots", Danelec opines

FUELS AND LUBES

NANOFILTER TO PREVENT 'OIL AGEING'

A new type of nanofilter launched by Delta-Xero is intended to mitigate the ageing process in hydraulic and lubrication oils, using nanofiltration to "stop or even reverse it", claims David Moss, business development manager.

Filtering down to 0.1 micron without removing additives or affecting viscosity can "make certain oils last indefinitely...and for every litre of oil that doesn't go to waste, that's between 2.2-2.5kg of CO_2 not released into the environment", Moss says. It can also extend the life of components like bearings, shafts and gears by eight or nine times, he says, adding: "Each kilogramme of steel you don't have to replace saves about 5kg of CO_2."

The technology uses 'smart', 100% recycled media that responds to the oil or fuel by creating millions of capillaries between 12-20 microns, depending on the liquid. The process can also be applied to fuels, making an "almost perfect burn" possible, Moss says – which in turn raises efficiency while reducing both emissions and engine wear. ■

The Delta-Xero nanofilter was designed to mitigate the ageing process in oils

WIND-ASSISTED PROPULSION

VENTOFOILS FOR FOURTH TANKER

Wind-assisted propulsion systems manufacturer Econowind reports that it has installed four of its 16m VentoFoil suction wings aboard Uni-Tankers' 124m x 20m chemical tanker *Jutlandia Swan*. The foundations for the ATEX-proof sails were added to the ship during a scheduled drydock in Turkey, and the sails then installed in the Port of Rotterdam, by Rotterdam Offshore Group, over the course of four days.

A spokesperson for Econowind comments: "The system is currently undergoing classification with Bureau Veritas and is expected to deliver strong performance: a 10% improvement in EEXI and a 3% contribution towards FuelEU Maritime compliance. This makes the business case not only technically viable but also economically compelling."

Kristian Larsen, technical director at Uni-Tankers, adds: "Wind-assisted ship propulsion has clear potential – but its real value depends on how well it integrates into daily operations. Now, we'll be able to test how these sails behave at sea, what they mean for fuel efficiency and how the crew can work with them in practice."

Econowind says that *Jutlandia Swan* is the fourth tanker it has retrofitted with VentoFoils. In December 2024, the company announced that it will work to develop larger VentoFoils, measuring 24-30m, to complement its range of 16m units. ■

Chemical tanker *Jutlandia Swan* has been retrofitted with four Econowind VentoFoils

CONDITION MONITORING

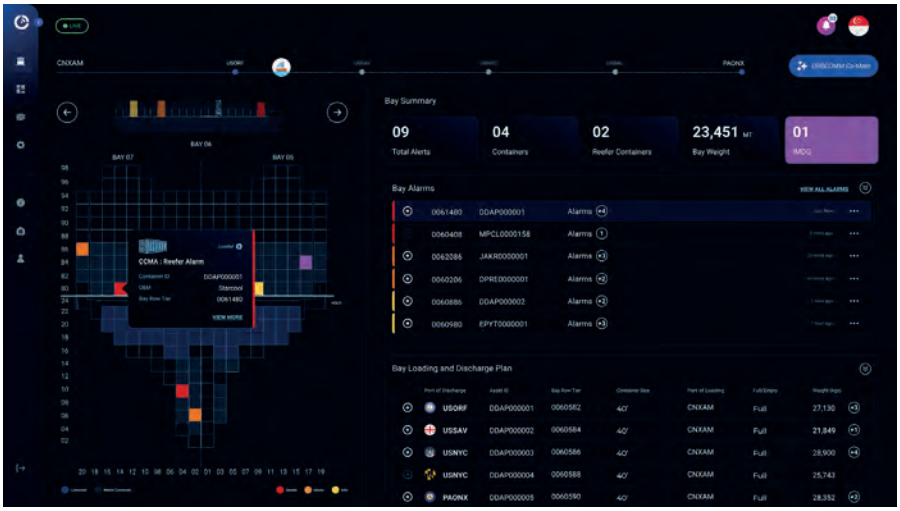
24/7 EYE ON CONTAINER STATUS

Cargo monitoring and IoT services provider ORBCOMM has launched CrewView, an onboard solution that allows crews to monitor and manage smart refrigerated and dry containers in real time at sea. CrewView reportedly sends SMS alerts directly to crew members' mobile devices in the event of a problem – including "temperature deviations and power failures", ORBCOMM says – thus giving them an early warning of potential hazards, even in the absence of satellite connectivity.

"Vessel-to-shore data transmission ensures onshore monitoring," ORBCOMM continues. "Container loading and stowage information automatically displays interactive bay, row and tier maps...APIs allow seamless data exchange with third-party platforms and enable alerting from third-party devices."

CrewView is also intended to reduce the need for frequent manual reefer checks, freeing up crew members' time and sparing them from having to walk the deck and ascend ladders in harsh conditions, ORBCOMM says. ■

CrewView instantly alerts personnel should a smart container encounter a problem (image: ORBCOMM)



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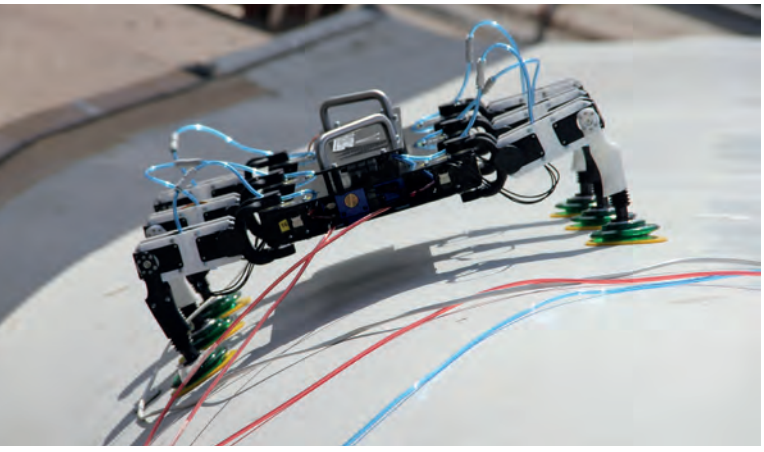


Robotics may be the safest option for wind turbine blade inspections, says RenewableUK

The UK offshore wind industry must exploit robotics and autonomous systems to the hilt if it is to thrive, according to a report issued by the Offshore Renewable Energy (ORE) Catapult. Titled *Robotic & Autonomous Systems For Operations and Maintenance In UK Offshore Wind*, the report, produced in partnership with Innovate UK's Workforce Foresighting Hub and sponsored by RenewableUK, claims that robotics provide "an efficient alternative" to personnel working offshore, especially for tasks such as turbine blade inspections.

"There are currently 30,000 blades at UK offshore and onshore wind farms," says ORE Catapult, pointing out the additional presence of "10 million bolts", which must be regularly checked for "loss of tension and integrity". ORE Catapult adds: "There are 40,000 people currently working in the offshore wind industry. To meet the UK's Clean Power 2030 targets, this workforce is forecast to increase to at least 74,000. A big uplift in the development of robotics and autonomous systems is required, alongside a workforce that has the skills to realise its full potential."

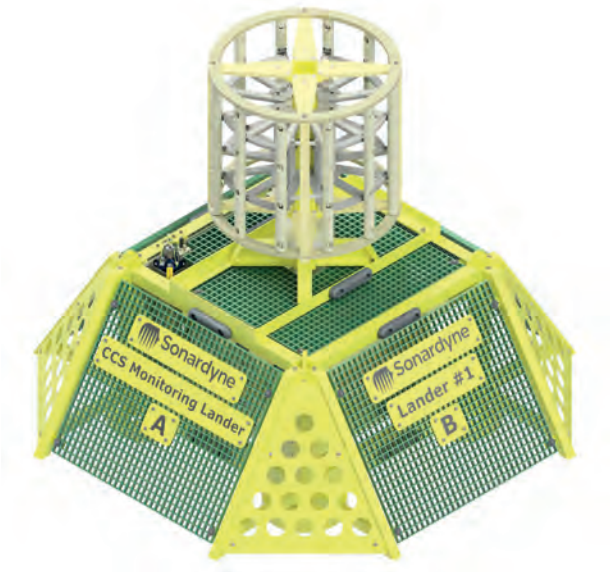
Scott Young, RenewableUK's head of skills, says: "The UK is set to ramp up offshore wind deployment significantly in the years ahead to meet the government's targets of clean power by 2030 and net zero by 2050. We will be building new projects in deeper and more remote waters where using state-of-the-art robotics is the safest option, and therefore the most appropriate course of action." The report calls for expanded robotics content in existing college courses and greater opportunities for on-the-job training in this field. It also urges increased industry collaboration, recommending that turbine manufacturers and wind farm developers work more closely with robotics designers to optimise operations. The report can be downloaded for free at the ORE Catapult website. ■

SUBSEA SOLUTIONS

SEABED LANDERS SUPPORT NORTH SEA CCS

Sonardyne has been contracted by the Northern Endurance Partnership (NEP) to deploy seabed monitoring landers for the UK's first offshore carbon capture and storage (CCS) site. The landers will be positioned above and around the subsurface Endurance site in the southern North Sea, 145km off the coast of Teesside, where up to 450 million tonnes of CO_2 captured from various land-based industries is set to be stored.

Sonardyne says: "Monitoring of the site will begin in the summer of 2026 to provide baseline data for a duration of two years before the transportation and storage of captured CO_2 commences." The battery-powered seabed landers will feature a passive sonar array and third-party sensors, enabling the units to detect changes in water chemistry across a significant area. "The data can be harvested, without retrieving the lander, using wireless subsea acoustic communication techniques," Sonardyne adds. ■



Sonardyne's seabed landers will monitor the water around the Endurance CCS site

LAUNCH AND RECOVERY

UPLIFTING DEAL FOR USV RECOVERY SYSTEM

Henriksen Hooks, Norway says it has secured the first sale for its SOLUS launch and recovery system (LARS), developed specifically for USVs. The buyer is compatriot offshore survey/inspection specialist Argeo, producer of the 9m Argeo Argus USV.

Henriksen explains: "The SOLUS enables the USV to be brought alongside and reconnected to the mothership's lifting wire by means of its telescopic mast. During launching and remotely controlled operations, the USV's mast is kept retracted within its structure. At the end of its mission, [the USV] is brought alongside the mothership and its mast is raised remotely by the USV's controller, so it reveals its lifting and painter lines."

The company adds that, even if the USV is pitching and rolling due to waves, the mast keeps the lines accessible for the mothership's crew. The crew uses a long boat hook to grab the USV's lines and, once connected, the mothership's crane wire is attached to the USV's lifting point.

Thorbjørn Rekdal, CTO at Argeo, says: "We want to transform ocean surveying and inspection by utilising our autonomous surface and underwater robotics solution. The ability to create a wider weather window for its operation is therefore seen as an important boost towards achieving that aim with enhanced productivity." ■

Henriksen Hooks' SOLUS LARS has been ordered by USV developer Argeo

OFFSHORE SUPPORT

FET ROVS BOUND FOR UAE

The Forum Energy Technologies (FET) Subsea product line is to supply two work-class ROVs to UAE-based offshore construction firm CCC (Underwater Engineering). The ROVs belong to FET's Perry XLX-C range, measuring 2.8m in length, 1.7m in breadth and approximately 2m in height, and featuring the capacity to descend to depths of 3,000m.

The ROVs will support CCC (UE)'s 149.5m dive support and construction vessel (DSCV) *Wadad Alethia*, which was delivered by Shanghai Zhenhua Heavy Industries, China in 2024. Both ROVs will primarily be used for construction, drill support, pipeline and platform inspection, survey, salvage and cleaning services. The first ROV will be delivered in November this year, with the second to follow in June 2026.

The XLX-C class is rated 200hp (149kW) and features a minimum payload capacity of 350kg, as well as FET's ICE Unity control system for heading, depth, altitude control and dynamic positioning. The ROV utilises seven 300mm thrusters – four horizontal, three vertical – for manoeuvrability, and has a bollard pull capacity of 800kgf, forward and laterally, and 700kgf, vertically. Standard payload features include up to eight cameras, six lights and a Doppler velocity log. ■

FET's Perry XLX-C range is rated for depths of 3,000m

OFFSHORE POWER SURGE

Martin Conway speaks to Bibby Marine about its forthcoming zero-emissions electric commissioning SOV (eCSOV), incorporating what may be the largest battery set-up for a vessel of this type

Offshore wind turbines and battery-powered support vessels seem like a perfect match, promising reduced fossil fuel use and a holistic solution for the wind power industry's success. However, can batteries – whether in a hybrid diesel-electric set-up or installed as a standalone solution – provide enough power for an 80m+ service operation vessel (SOV) to compete with similarly sized, conventional, diesel-powered units?

That's the challenge accepted by UK offshore services provider Bibby Marine, which has led to the development of its 89.6m electric commissioning SOV (eCSOV) concept. Incorporating dual-fuel engines and potentially the largest battery pack in this sector, and backed by AI and digital-twin technology, the forthcoming vessel is poised to overturn quite a few assumptions about what batteries can and cannot do in the field. With the ability to operate emissions-free for more than 24 hours in DP mode, and to recharge directly at wind farms in less than five hours, the eCSOV's goal is to slash CO_2 emissions and operating costs while still effectively competing with traditional SOVs.

Design evolution

Part of the Bibby Line Group, Bibby Marine was founded in 1807, making it one of the oldest family-owned maritime businesses in the UK. Initially a shipping company, Bibby Marine would later diversify into marine operations, with an emphasis on personnel transfers and offshore accommodation.

Then, in 2017, the company took its first steps into the offshore wind sector with the launch and delivery of *Bibby WaveMaster 1*: a custom-designed SOV. Built by Damen, the 89.65m-long, 20m-wide vessel has been operating on the spot market since delivery.

In 2019, Damen launched a sister SOV to *Bibby WaveMaster 1*, christened *Bibby Horizon*, which has been contracted with Siemens Gamesa, working on the Hohe See and Albatros wind farms in the North Sea. That year also saw Bibby Marine embark on its 'roadmap' to green operations, successfully applying for several Clean Maritime Demonstration Competition (CMDC) funding rounds and ultimately, in 2023, securing funding from the Zero Emission Vessels and Infrastructure (ZEVI) competition – part of the UK Department for Transport's UK SHORE initiative – with its plans for a zero-emissions electric commissioning SOV (eCSOV).

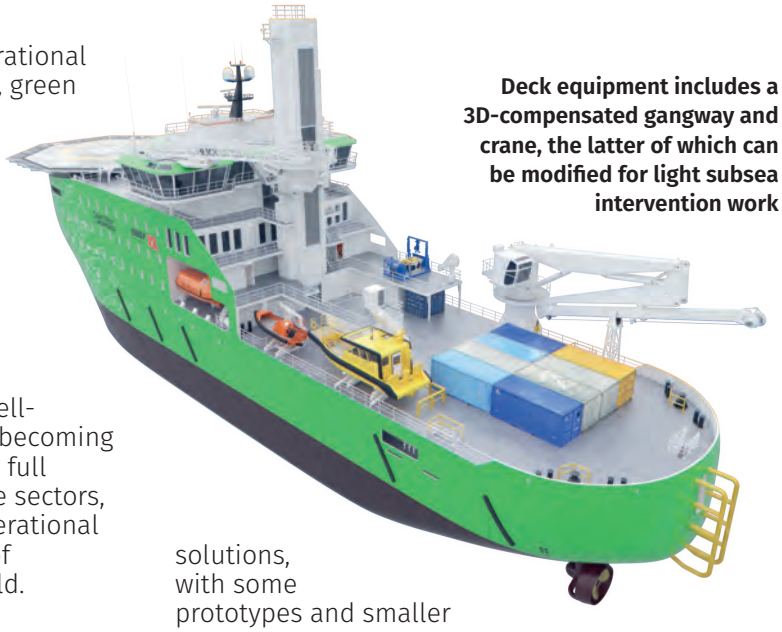
Having completed the concept design in partnership with UK-based naval architects Longitude Engineering, Bibby Marine progressed to basic design and model testing with Spanish ship designer Seaplace. The keel for the eCSOV was laid by Spanish shipbuilder Astilleros Armon in July 2025, with delivery scheduled for mid-2027.

"Technically feasible"

Gavin Forward, head of newbuild projects at Bibby Marine, tells *The Naval Architect:* "The eCSOV

The eCSOV concept has a range exceeding 130nm on battery power alone

has been designed with maximum operational flexibility, capable of running on diesel, green methanol or battery power – and seamlessly switching between them without any loss of efficiency or operability.



Deck equipment includes a 3D-compensated gangway and crane, the latter of which can be modified for light subsea intervention work

"Electrification is a natural fit for offshore wind support vessels, as you have renewable energy available at source. The vessel's latest-generation battery system and emerging offshore charging infrastructure are based on well-established technologies that are now becoming increasingly commercially viable. While full electrification may not suit all maritime sectors, it aligns exceptionally well with the operational profile of CSOVs, particularly in terms of predictable, daily power demand in-field.

"As a relatively small player, we're taking a big step with this vessel. We're proving to the market that it's commercially viable and technically feasible, so there's no reason not to do this: it's the right thing to do."

The vessel's flexibility in fuel choice is crucial for now, given current gaps in shore-based charging infrastructure. "Once shore and offshore charging become standard, we could put the whole operational envelope under battery power," says Forward. "Globally, most wind farms are located within 40nm of port and we have a range of over 130nm on battery power. We would never have to use any fuel – but, in reality, we just don't have that shore power availability in the UK right now. So, the idea is to sail to the wind farm on traditional fuel or green methanol; then operate in-field on electric power, before sailing back to port on fuel; and then conducting all port operations on batteries with zero emissions."

Offshore charging

Key to the success of electrification of offshore wind operations is the ability to charge the vessel directly in-field. Several suppliers are working on solutions, with some prototypes and smaller CTV charging systems having already been deployed by the likes of Stillstrom, MJR Power & Automation, Oasis and Seaonics, to name but a few. "We have worked closely with all suppliers to ensure our vessel will be compatible," says Forward. "We have a collaboration agreement with Stillstrom, where we have really dived into every detail, both operationally and technically. It is promising to see that these solutions are all aligned with respect to their technical ability and power, and that the industry is standardising this at an early stage".

Typically, the offshore charging system would be mounted on a turbine, a monopile, a substation or even an on-site buoy. Forward reveals: "We've been trialling all solutions and approaches, so that we're prepared for whatever becomes the industry standard. We think installing the charging system on the monopile is going to be the best technical option, but it depends on how developers want to set up their fields." The eCSOV will remain in DP mode for charging, maintaining positioning on battery power and obtaining a full state of charge in less than five hours, with a once-per-day charging cycle.

A render of the mess room: the eCSOV accommodates up to 120 personnel

Battery power

The eCSOV has been designed to primarily operate on battery power, with the engines only being used to charge the battery pack where offshore charging is not available, or during longer transits. The dual-fuel engines run at a fixed, optimised load and speed, and recharge the batteries when required, rather than directly powering the vessel or using the batteries to supplement engine power, which is a more typical approach in hybrid set-ups. "This has also allowed us to optimise the size of the engines and to run them at their most

efficient configuration, seeing significant savings over a conventional hybrid set-up and significantly reducing engine maintenance," says Forward.

For this project, Bibby Marine selected a 24.4MWh Corvus Energy lithium iron phosphate battery pack. Forward says: "The battery pack is sized to accommodate the intended operational daily power requirements whilst giving significant flexibility and redundancy for what is a 'world first' in this market sector."

TECHNICAL PARTICULARS

Bibby eCSOV – Series 1

Length, oa	89.63m
Breadth, moulded	19.8m
Depth, moulded	7.55m
Draught, design	5m
Gross tonnage	6,773gt
Deadweight	2,283tonnes
Predicted speed	13knots@5m draught (calm weather/clean hull)
Eco speed	10knots@5m draught
Range	130nm
Engines	2 x 3,480kW@750rpm
Battery	24.4MWh LFP
Thrusters	2 x 2,000kW (main azimuthing)
	2 x 1,500kW (tunnel)
	2 x 1,200kW (retractable)
Onboard capacities	
Fuel oil (MGO)	501m^3
Fuel oil (methanol)	450m^3
Fresh water	270m^3
Persons on board	120
Cabins	120 (including 84 single cabins)
Classification society	DNV
Notations	+1A Windfarm Service, Battery Power, E0, LFL Fuelled , DYNPOS(AUTR-CB), COMF(C-2, V-2), SPS, Walk2work, Clean (Design, Tier III), Cyber Secure (Essential), LCS, BIS, Strengthened(DK), Smart(EEN), BWM(T), ER(SCR),HELDK(SH) Recyclable, Shore power, NAUT (OSV), Silent (A), Silent (E)

Weight-wise, the battery pack arrangement did not present any problems. In fact, Forward points out: "If anything, the battery pack could have been a bit heavier, for stability. The biggest issue was fitting in the safety systems around it. We split the batteries into three sections, matching the three split switchboard sections on our DC BUS, for increased redundancy. The ability to operate in diesel/green methanol mode or battery mode ensures maximum flexibility and redundancy in the design, with seamless power delivery across all modes of operation."

Bibby Marine has calculated that the eCSOV's battery pack would be able to run for more than 24 hours between charges in calm conditions; for more than 20 hours in a medium sea state; and for more than 15 hours in rough conditions, thereby providing a wide operational window even in inclement weather. When fully charged, the batteries would permit a range of more than 130nm at 10knots. As mentioned, a full charge is achievable in less than five hours, making it simple to recharge the vessel overnight during operational downtime.

The eCSOV carries DP2 station-keeping notation and incorporates a DC switchboard with the closed BUS notation DYNPOS AUTR-C8. Bibby Marine opted for dual-fuel engines from Wärtsilä – selected for their ability to run on a 99% methanol mixture, Forward says – while Kongsberg rim-driven thrusters were picked to maximise efficiency and station-keeping, and to help minimise underwater radiated noise (URN). "By integrating rim-driven propulsion thrusters, we are able to achieve a 40-60% reduction in URN, depending on operational conditions," says Forward. "The eCSOV is designed to be one of the quietest offshore vessels on the market – and we hope to achieve Silent-E and Silent-A notation from DNV."

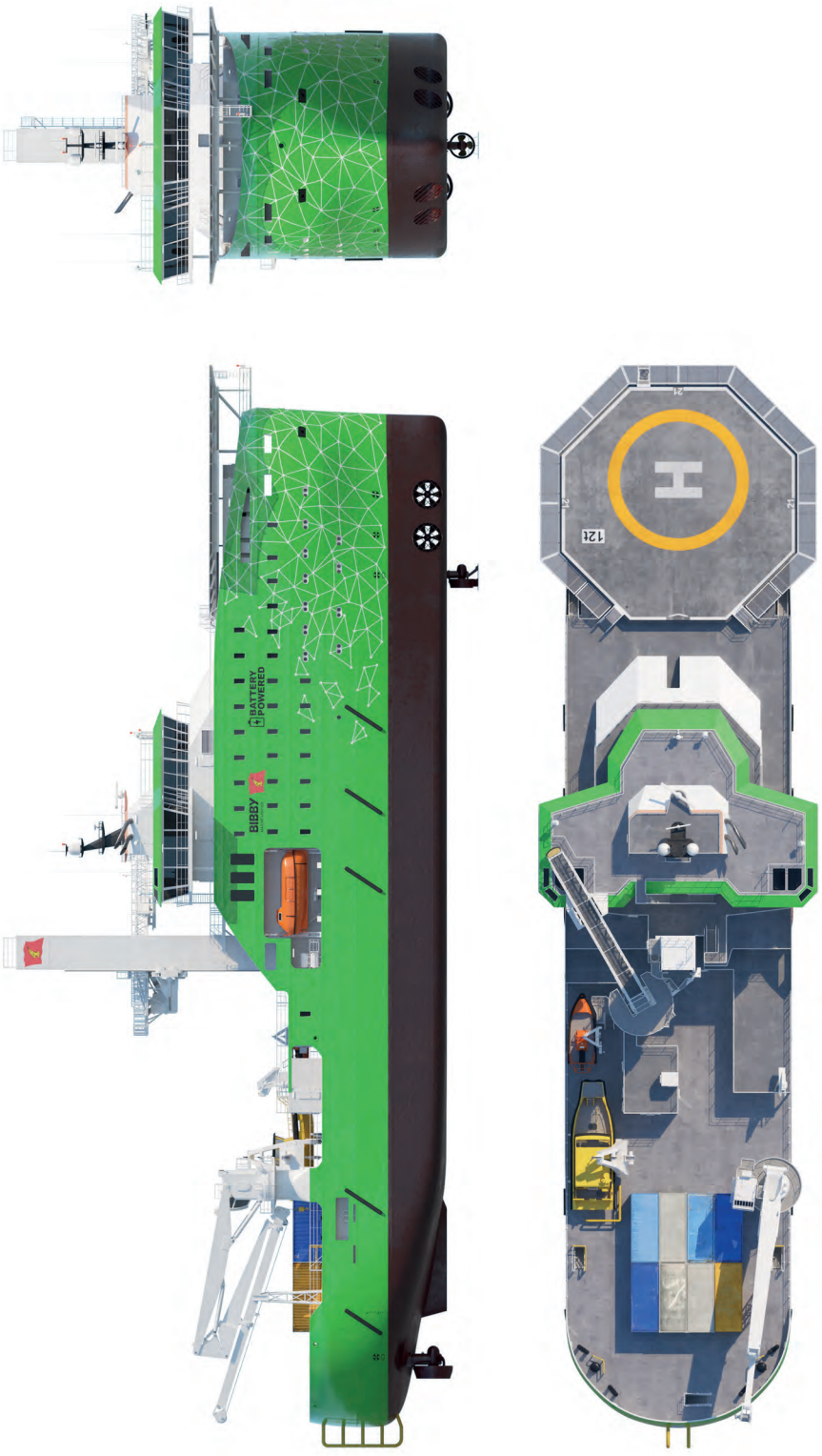
Optimised space

"This vessel's been designed from the ground up; we didn't take the concept off the shelf," Forward continues. "One challenge was how to fit all this equipment in – the large battery pack and the methanol fuel system – while still optimising the amount of space on board."

To this end, Bibby Marine and Seaplace have worked alongside DNV to assess parameters like the overall weight of the batteries, proper venting of the onboard methanol tanks and the ship's compatibility with high-voltage offshore charging systems. "We hope to soon secure the first offshore charging notation – similar to the shore power notation – from DNV," says Forward.

A total of 120 cabins, including 84 single units, provide hotel-standard accommodation for the offshore personnel, who typically spend two weeks

The general arrangement of Bibby Marine's eCSOV concept



Bibby Marine is now tendering for more vessels as part of its fleet expansion programme

on site before returning to shore. Work conducted in the design and layout of the accommodation included maximising natural light, separating working spaces from living spaces to reduce noise, and ensuring smooth flow on board for personnel and cargo.

Similarly, the eCSOV was designed for optimal efficiency. "For example, we can use the gangway on the port or starboard, and at a 60° heading angle, which maximises the opportunity we have to position the vessel," Forward says. "In turn, this reduces the amount of thruster power needed to maintain the ship's position, which maximises the battery operation."

Cranes, ROVs and AI

The eCSOV has been designed to support both the commissioning and operations & maintenance (O&M) phases of offshore wind farm development. The vessel can accommodate an optional ROV, stowed on the mezzanine deck, and is equipped with a 3D motion-compensated crane with a standard lifting capacity of 10tonnes, upgradeable to 40tonnes to enable light subsea intervention work. Additionally, the vessel is configured to support a large hybrid or fully electric daughter craft, which can be charged on board, further extending the vessel's zero-emission operational envelope. The vessel also features a 3D motion-compensated gangway from SMST, controlled remotely from the vessel's bridge and providing safe transfer of personnel.

Bibby Marine has also made a significant investment into the vessel's digital and AI infrastructure, Forward highlights, having equipped the eCSOV with an array of onboard sensors that collect real-time data from machines and equipment across the vessel and send it to Kongsberg Maritime's Kongsberg Information Management System (K-IMS). Then, a combination of AI and digital twin technology analyses this data in real time, using it to adjust operational parameters such as energy usage and propulsion settings.

Next series incoming

While Armon works to complete the first eCSOV within the next 24 months, Forward reveals that work has already commenced on the 'Series 2' design, set to feature the same benefits as the first vessel but "in a further optimised solution, taking on board the key requirements from our clients and utilising the latest technologies in the market", he says. For example, the Series 2 model will feature a reduced-size battery pack, made possible by design refinements following the first vessel.

"Our initial assumptions have now been validated through physical model testing," Forward explains. "We've further optimised the electrical architecture and are benefiting from rapid advances in battery technology, even over the past 18 months." He adds: "We're currently tendering for more vessels as part of our fleet expansion programme, and we've brought the cost of the next-series design very close to that of a conventionally fuelled CSOV. We believe this next generation of eCSOVs will set a new benchmark for the industry – proving that electrification is not just the right environmental choice, but also the smart commercial decision when investing in an asset designed to operate for the next 20 years or more.

"Energy security will become increasingly critical, with rising costs for conventional fuels and tighter carbon taxation. We're already seeing this through the latest IMO regulations and upcoming EU measures such as the EU ETS and FuelEU Maritime." ■

MED MARINE
SINCE 1995

VOLTRA 2300

23.45m Length
11.9m Beam
70 tons Bollard Pull
3600kWh Battery Capacity

VOLTRA

BATTERY ELECTRIC TUG

ROBERT ALLAN

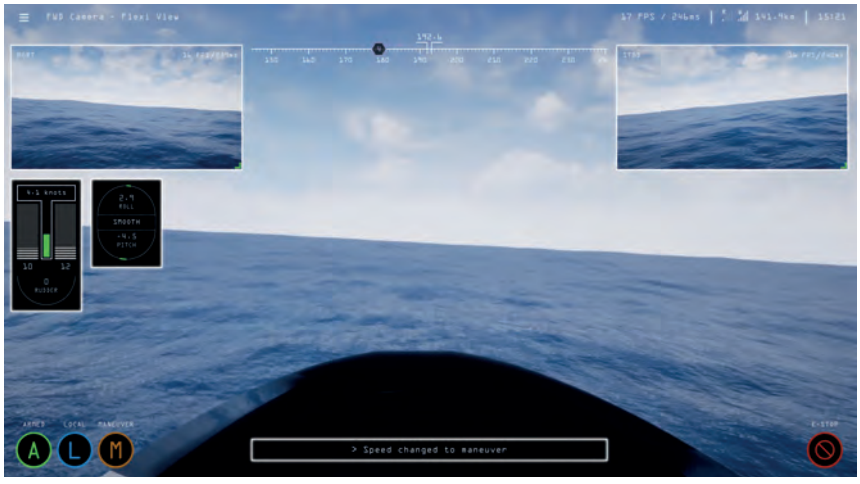
UNDER AN AUTONOMY-ENABLED, WATCHFUL EYE

Stevie Knight speaks to Greenroom Robotics about its drive to make vessel autonomy seamless and flexible, in anticipation of mass adoption across the maritime and offshore sectors

There's definitely both carrot and stick in the move toward vessel autonomy. On one side, commercial marine has been having a harder time getting people to go to sea. There's also the military aspect: fewer people willing to put themselves or their fellow humans in harm's way. The UK's Royal Navy, for example, is phasing out its traditional minehunters and moving to uncrewed craft, but alternatives have become viable for many spheres of operation.

Take, for example, the Aircat Bengal MC, a 36m multi-mission surface effect ship (SES).

Keeping a watchful eye on our infrastructure "can mean that incidents don't happen", says Harry Hubert, CTO of Greenroom Robotics



Developed by Aircat, Eureka and ESNA Naval Architects, with autonomy and AI provided by Greenroom Robotics, this takes advantage of the SES' particular architecture, which floats the ship on an air cushion between two hulls, reducing draught from 2.4m to 0.8m and therefore reducing resistance by up to 80% despite a 13.9m beam.

The result is an autonomous vessel that squeezes over 50knots from its four 1,440kW MTU engines and Kongsberg waterjets: far faster than typical navy ships. It also has a lightweight range of 1,000nm at around 40knots but can carry a 40tonne payload – launching missiles as well as serving in transport, drone and mine warfare roles (see *The Naval Architect* March 2025).

Acceptance is also arriving through innovations in other areas, such as drones and self-driving cars, says Harry Hubert, Greenroom Robotics CTO. However, he underlines, the automotive analogy is somewhat misleading, because at sea "you're continually evaluating intent and context and everything's an edge case". He adds: "That's something that AI is not yet very good at – dealing with edge cases all the time. No two days are alike on the ocean."

In fact, AI or machine-learning models can't, alone, deliver a robust system. But neither can the usual technologies. "Obviously you don't want to trust any one, single sensor 100% because systems can go wrong or can be spoofed," says Hubert. That last point is a growing issue: the effects of jammed, hidden and falsified data has recently been described as a 'digital fog'.

Clever blend

Therefore, Greenroom's solution, Greenroom Advanced Maritime Autonomy (GAMA), is a clever blend: "We've had to utilise well-trusted methods as well as adapting this technology to work in the maritime environment," says Hubert. A big element mimics the skillset of traditional mariners, he explains.

GAMA integrates more typical cameras, radar and sonar, along with technologies such as inertial navigation and Doppler velocity logs that make GPS-denied missions possible. There are others that change with the type of application: for example, towed arrays, forward scanners and LiDAR. "That last is typically used in the automotive industry, but on board it allows for really close-in, fine manoeuvring," says Hubert.

On the mast, there are usually between four to eight cameras, optionally including heat-imaging as well as colour-imaging: "A really critical input is our vision-based system, which is looking around, watching how things are going," says Hubert.

To the uninitiated, this kind of evaluation sounds like the kind of thing only trained personnel could do, but merging data streams to effect decision-making is exactly what GAMA was developed for. As Hubert explains, a properly trained mariner can get a location fix through various features,

including water depth – and then respond accordingly. "We're using robotics and AI to do the same thing: for example, picking up an image of a lighthouse on the camera and a body of land, and saying, 'that's probably this particular lighthouse, from this angle'," he says. And that might lead to a course correction.

"We also have a quite advanced 'probability engine' running in the background," says Hubert. "This looks at the situation ahead and says, OK, if everyone keeps doing what they're doing, this is the best option to navigate adhering to COLREGs."

The design of the Aircat Bengal MC is an interesting combination of SES technology and autonomy

Light-touch approach

However, keeping our marine infrastructure safe won't only rely on fully armed naval ships: it'll likely be smaller drones maintaining background surveillance, even if the vessels have no AIS. Further, this can be put in place by ports and harbours. "Like putting a security camera on your garage, it can mean that incidents don't happen," says Hubert, adding that, since ships behave in a predictable manner, it's straightforward to spot when something looks wrong or a ship gets too close to critical infrastructure. It's a light-touch approach. "We can use this technology to create a persistent presence," he says. "That's one deterrent that we can start now."

There are still practical choices to be made for larger, longer-distance vessels when it comes to onboard personnel, because many still do need the option of human support – though perhaps not all the time.

Challenges can arise on taking an autonomous vessel into a new place with regionally specific rules. "For instance, in Sydney Harbour you've got an amber light on ferries and they have ultimate right of way, even over sailing vessels, but that's like nowhere else in the world," says Hubert. "So do you focus on Sydney Harbour? Or do you say, 'We won't support it – if you want to go there, you need to put someone onto the boat and they can drive it in...or transfer to remote control with a pilot'?" That's been made plausible by the entry of Starlink, which allows for remote visualisation of all the information available on board, as well as being less expensive than previous data transfer tech.

Adjustable autonomy

While it's possible to achieve granular details, the point Hubert makes is the effort is likely unrewarding compared to employing a human resource where pragmatic. That means full autonomy can, for example, remain focused on waters 20 miles offshore while reverting to remote operations for nearer-shore handling, making these operations a lot more straightforward and, therefore, more cost-effective.

"It's not about solving the complete problem: it's about providing enough value, enough risk reduction, right now, to make sense for commercial companies and military forces to use it," says Hubert. "Even if that's limited to, say, 80% of the time, it's still a big improvement."

Utilisation doesn't always mean running full pelt at autonomy, and each company or organisation will have different needs and different pathways. Hubert underlines that the way forward, for most of these bigger vessels, is "let's first help the crew". That means providing a system that can enhance situational awareness, reduce mistakes and pave the way for future acceptance. But even though many of the larger vessels are designed to work both with and without crew, the numbers of onboard personnel can be lowered, reducing the demand on space. So, despite all the advanced kit, autonomous craft like these could be cheaper to build and run.

"I'm a naval architect by my training," says Hubert. "You're always taught about the human element." He points out that "changing that means you change the fundamentals".

Those 'fundamentals' could also push the maritime industry into new developments. Having no-one on board to do things like replace oil filters means engine and parts manufacturers will start to evolve their designs, allowing ships to tour for months without maintenance. ■

BEYOND THE DRY DOCK

New approaches may be needed to overcome capacity bottlenecks at dry docks and repair facilities, including taking complex retrofit work to sea, writes **Clive Woodbridge**

There are growing concerns that the amount of global shipyard capacity available to undertake significant, large-scale vessel retrofits – largely to meet environmental regulations but also to improve operational efficiency – may soon be outstripped by demand. In a recent study, class society Lloyd's Register (LR) calculated that the current retrofit capacity worldwide is around 465 vessels a year, well below its projected peak demand of over 1,000 vessels annually.

This is primarily due to a relatively low number of shipyards that can handle the major conversion work necessary to enable vessels to run on alternative, more environmentally friendly fuels, such as methanol or LNG. While this number of yards has grown in recent years, LR points out that overall capacity remains a significant potential bottleneck. It concludes that while current capacity is adequate in the short term, it will be insufficient to meet the shipping industry's requirements further down the line.

New approaches may therefore be needed to overcome the shortfall, suggests Monaco-based Bluestone Group, which offers vessel retrofit capabilities among other services. The company, co-founded in 2018 by former V.Group executive Matteo Di Maio and Giuseppe Costa, former MD of Seatec Repairs, supports owners in delivering clean-technology retrofits, including upgrading ships to support methanol engines and installing batteries, exhaust gas cleaning systems, ballast water treatment systems (BWTS), advanced electrical systems, air lubrication systems and advanced waste treatment technologies.

Bluestone's retrofit activity tends to focus on high-value, operationally intensive vessels like cruise ships, offshore support vessels, LNG carriers and cable-layers, where retrofit planning must align closely with technical constraints, safety standards and commercial pressures, and where there is more likely to be an economic payback from retrofit investment.

At-sea retrofits

Di Maio, who holds an MSc in naval architecture from the University of Genoa and is a Fellow of RINA, says he co-founded Bluestone "to deliver a more agile, engineering-led technical services model that meets the demands of modern vessel operations and decarbonisation timelines". He adds: "Traditional yard-based retrofit models simply do not align with the realities of tight schedules, cost sensitivity and limited dry dock availability. We help owners take a lifecycle-led approach to retrofits, including the integration of clean technologies during vessel operations, where feasible.

"It is clear there is a shortage of capacity to satisfy retrofit demands, both for green retrofits that are needed to comply with new regulations, but also the high demand for retrofits that owners are undertaking because technology is improving and they want to take advantage. Some of this work has to be carried out in dry dock; but equally a lot can be done entirely, or in part, while the vessel is operational. And that is where we come in."

Bluestone has built up a portfolio of around 700 projects, where it has undertaken retrofits partially or entirely at sea

Bluestone's expertise is its ability to maximise and optimise the work that can be done while the vessel is at sea. The outcome can either be to avoid dry docking completely, keeping the vessel trading throughout, or by undertaking sufficient pre- and post-dry docking work to minimise the length of any stay in the shipyard. Additionally, Bluestone argues it is well-placed to meet the needs of fleet-wide upgrade projects. As Di Maio explains: "Rather than having to deal with multiple

Matteo Di Maio, Bluestone Group: "We are complementing the shipyard, not competing with it"

shipyards in various parts of the world, shipowners can use us as a single point of contact and be assured of consistent project execution."

OEMs also recognise the value of partnering with a global integrator when retrofitting their latest technologies, Di Maio says. As manufacturers retain responsibility for design and project management, they are increasingly outsourcing installation to trusted partners who can deliver smooth, standardised integration across diverse fleets and vessel types.

Multiple projects

To date, Bluestone has built up a portfolio of around 700 projects, where it has undertaken retrofits partially or entirely at sea. One notable example is the recent installation of flow meters on board vessels owned by one of the world's biggest container ship operators. Around 20 vessels have been successful retrofitted with new generation flow meters so far, out of 30 vessels contracted, and all of this work was completed while the ships were at sea.

Bluestone has also been working to install Silversteam air lubrication systems on a series of vessels for a leading cruise operator. This has involved the installation of piping, cabling and air compressors on board over several weeks while the vessel was operational, leaving the vessel ready to complete the final external works within a short timeframe in dock.

Di Maio says: "In effect we are complementing the shipyard, not competing with it. The shipyard and its workers perform those elements of the project that they are best equipped to carry out, leaving our

Bluestone workers rigging up a new high-efficiency chiller unit on a passenger vessel: the group has worked with many ferry and cruise operators

specialist tradespeople to carry out the onboard works. Bluestone is not a straight alternative to shipyards, as there is often some part of the project that requires dry docking. But we can keep that element of the work down to a minimum, saving time and money for the owner, and reducing demand on scarce shipyard capacity."

Generally, the rule of thumb is that Bluestone undertakes those parts of a project where the component does not require a hull opening to install, or those jobs that do not impact directly on vessel operation. A good example was a recent project to replace a large chiller unit on a cruise vessel, to enhance energy efficiency and ensure operational reliability.

An obsolete, low-efficiency AC chiller unit was replaced with a more efficient AC centrifugal compressor unit. The scope of work included upgrading the existing system with a liquid-cooled, low-voltage variable speed drive, integrated by a 1200kVA step-down transformer. Bluestone also installed a new low-voltage electrical motor within the chiller compressor to replace the existing high-voltage motor and rerouted and modified the existing high-voltage power cable.

Bluestone was able to carry out its programme of work without any disruption to passenger services. However, the size of the chiller unit required a shipyard to open up the hull and close it again, with Bluestone taking over once that phase of the works was completed.

Bottleneck warning

Another notable cruise ship retrofit involved the installation of a Wärtsilä Membrane BioReactor, to replace the existing wastewater treatment system. This required an extensive programme of work involving 1,400m of piping and 9,000m of electrical cabling. “Our team stayed on board for six months to install the necessary components,” says Di Maio. “We were able to maximise what could be done before a final visit to a shipyard to complete the works.”

Bluestone has also recently been working with the Mediterranean ferry operator Corsica Linea, carrying out energy efficiency upgrades as part of a wider programme to decarbonise its fleet. Fleet upgrades have included new bulbous bows, propeller re-blading, the modification of vessel appendages, special coating applications, advanced fuel systems and upgrades to exhaust gas cleaning systems.

Green environmental retrofits are not the only area of activity, however. The company has recently been involved with the installation of new waterparks on two Carnival Australia vessels. These upgrades required 10 days of preparatory work before wet docking and then 10 days post-docking commissioning work.

Looking ahead, Di Maio is optimistic about demand for the type of services Bluestone provides. He says, “Owners have not yet fully appreciated the scale of the bottleneck that lies ahead. They are taking a ‘wait and see’ approach when it comes to alternative fuel systems – for example, similar to what happened with BWTS, when everyone held back and there was a huge rush to ensure compliance at the end. That will change.”

He concludes, “Yards are busy enough now, but there is even more pressure to come. So we are developing an alternative model to help relieve those pressures and develop solutions that will be needed when the conversion to alternative fuels triggers a massive upturn in retrofitting, not just to replace engines but all the subsidiary systems as well.” ■

PUMP UP THE VOLUME

SRC Group's Methanol Superstorage solution, which eliminates traditional tank cofferdams to enable higher volumes of onboard methanol, scooped this year's RINA Maritime Innovation Award

Methanol's known benefits as a marine fuel include a significant reduction in NOx, SOx and particulate matter (PM) emissions when burned, compared to traditional HFO/MGO. Producers can also create 'green' methanol through renewable sources and 'blue' methanol through carbon capture and storage.

However, methanol has a lower energy density relative to conventional marine fuel oils, which necessitates larger onboard fuel tanks to store an equivalent amount of energy – making methanol a tough choice for vessels that need to keep their weight down.

As maritime methanol advocate SRC Group puts it: "Aligning with IMO targets to reduce greenhouse gas emissions over the coming decades and achieve Net Zero by or around 2050, a ship fuelled by green methanol could reduce carbon emissions by up to 95%. However, methanol has significantly lower volumetric energy content than HFO. Owners working with the fuel either need to bunker more frequently or factor in around 2.5 times the fuel storage capacity to produce equivalent energy."

This conundrum inspired SRC Group and Green Marine to devise a new type of fuel tank to address these weight- and space-related concerns. The Methanol Superstorage tank is intended for installation aboard both newbuilds and retrofits, and is designed for scalability – from 2m^3-capacity applications to as big as 700m^3 and beyond. The technology was recently recognised by The Royal Institution of Naval Architects (RINA), which awarded Methanol Superstorage its 2025 Maritime Innovation Award.

Volume gains

SRC Group says it has achieved the balance between restricting weight and guaranteeing enough methanol for extended journeys at sea by replacing the traditional cofferdams that separate the gas tank walls with the sandwich plate system (SPS) developed by SPS Technology. The SPS comprises two metal plates, bonded together with a solid polyurethane elastomer core.

SRC Group has calculated that, by applying the SPS to the Methanol Superstorage tank and subsequently removing all cofferdams, the unit could boost shipboard methanol tank volumes by as much as 85%. As another advantage, the steel-polymer-steel barrier used in the SPS has been approved by IACS members for permanent repairs for more than two decades, and class lab tests of the SPS have revealed that the solution has high levels of chemical resistance, making it suitable for long-term exposure to methanol.

"Conventionally, the tanks used to store low flash-point fuels on ships feature internal and external walls that are separated by cofferdams spanning a minimum of 600mm," says SRC Group. "Methanol Superstorage meets the storage challenge by replacing this with 25mm-thick SPS technology."

Class society Lloyd's Register (LR) has granted Approval in Principle (AiP) status to the Methanol Superstorage concept, in accordance with LR's Rules and Regulations for the Classification of Ships using Gases or other Low-flashpoint Fuels (July 2022), as well as Appendix LR1 – Requirements for Ships Using Methyl Alcohol (Methanol) or Ethyl Alcohol. The solution has also received AiP from Italian class society RINA.

Speaking at RINA 's Annual Dinner, hosted in London on 22 May, Hannes Lilp, SRC Group CEO and chairman, commented: "The SRC team is truly honoured to accept RINA's Maritime Innovation Award, which considers developments in hydrodynamics and propulsion, structures and materials from across academia and industry. Given that our focus in growing SRC over the last 25 years has been on the complex ship project work we do day to day, it is especially rewarding to be recognised for the engineering innovation that has gone into developing Methanol Superstorage." The company has already undertaken detailed studies covering the use of the Methanol Superstorage solution on board cruise ships, container ships, ferries, tugs, offshore support vessels and yachts. ■

SRC Group's Hannes Lilp, CEO (left) and Alex Vainokivi, innovation manager, were awarded RINA's Maritime Innovation Award 2025 for the group's Methanol Superstorage solution

THE CHALLENGE OF MARITIME CYBERSECURITY

Dinos Kerigan-Kyrou AMRINA introduces the RINA Maritime Cybersecurity Task Force, and gives an overview of the extent of the problem

Maritime cybersecurity has a definition problem: few of us try to define what maritime cybersecurity actually means. The term has become synonymous with computers and IT paraphernalia but, while IT is clearly a critical component of cybersecurity, what is not fully realised – including by many in the 'cybersecurity industry' – is that cybersecurity also includes the disciplines of law, criminology, business, politics and international relations, organisational behaviour, psychology and human interactions (aka human factors).

Cybersecurity can be defined as the security of cyberspace, the online environment in which everyone now lives and works. In the maritime environment, cybersecurity is part of everything we do – in port, on rivers and at sea, within the shipyards and within our supply chains. Cybersecurity also concerns our critical maritime infrastructure, including our underwater critical infrastructure, such as subsea communications and energy cables, offshore energy platforms and underwater sensors.

Unfortunately, this misconception of cybersecurity over the past 20 years now directly and negatively affects the safety of vessels, the lives, safety and welfare of crews and the global economy that depends on a safe and secure maritime environment.

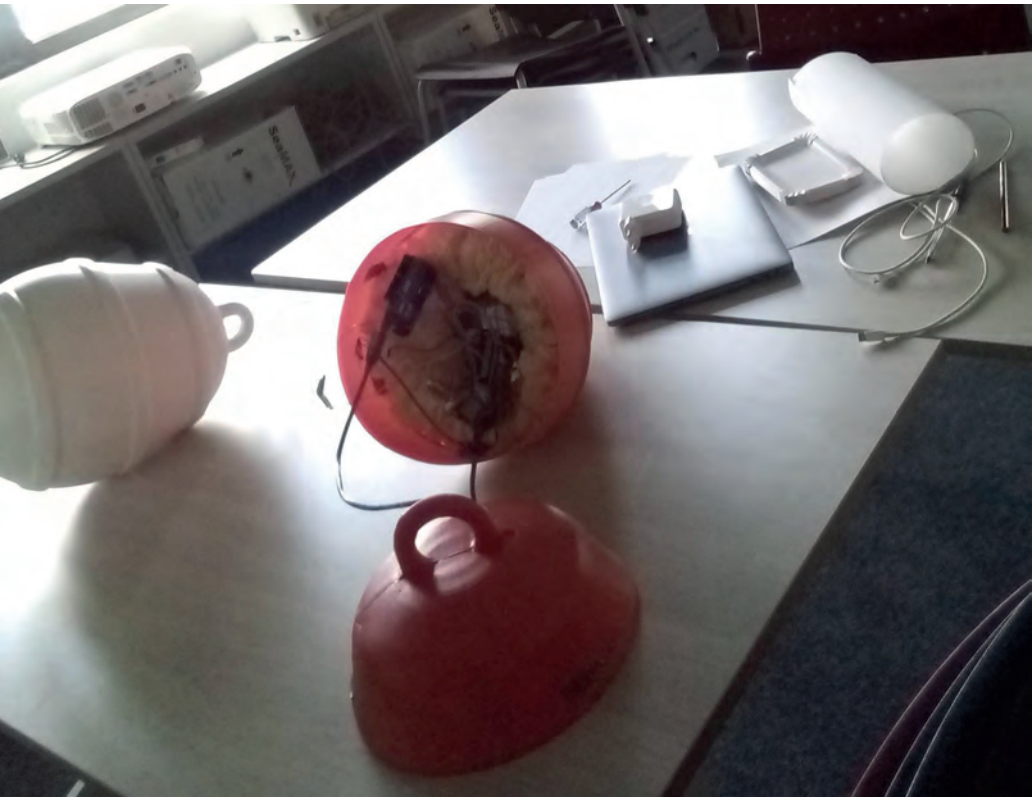
IoT vulnerability

Nefarious actors – be they hostile states, terrorists, activist extremists or criminals – target the maritime environment in a combination of ways.

Firstly, cyberspace is the facilitator for all nefarious maritime activity. Human trafficking, narcotics, wildlife and antiques smuggling facilitates the financing of organised crime and terrorist activity.

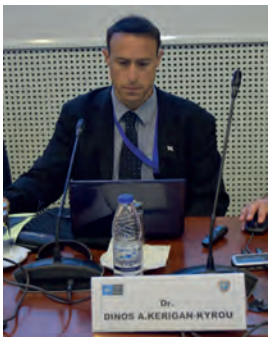
Cyberspace also provides 'gateways' for nefarious actors to target maritime activity. One gateway is the targeting of connected devices – sometimes called the Internet of Things (IoT). A modern vessel is increasingly connected online via IoT (alternatively known as 'cyber-physical systems') and data-receiving/transmitting devices. These devices contain sensors and actuators able to perform critical functions. These devices are, in effect, computers running software and 'firmware' (a computer programme stored within the hardware).

A buoy, fitted with a Raspberry Pi computer, can create a fictitious 'spoof' vessel wherever the buoy is located (image: Dinos Kerigan-Kyrou)



Vessels are increasingly equipped with IoT-enabled control systems connected to online networks. The list of IoT aboard and ashore is growing exponentially. They include: power management systems; loading, stability and container monitoring systems; alarms and the bridge control console; ECDIS, AIS and navigation decision support (NAVDEC); voyage data recorders; computerised automatic steering; and the global maritime distress and safety system (GMDSS).

Ports also increasingly comprise multiple examples of IoT, including: port security; access control and ID cards; CCTV; automated cargo-handling equipment;



Dinos Kerigan-Kyrou: "Extensive maritime IoT testing has found significant vulnerabilities"

terminal operating centres; cranes; and integrated supply chain logistical systems. Moreover, port IoT devices are directly interacting with vessels' IoT, including communications, the GPS, lock operations, maintenance and management, pollution and environmental control systems.

Extensive maritime IoT testing has found significant vulnerabilities, creating a situation where connected devices can be directly targeted. This includes device 'spoofing', where vessels' positions can be faked. For example: the photo on page 30, taken by the author at a European university maritime cybersecurity research lab, shows a buoy fitted with an inexpensive Raspberry Pi computer. This can easily create a fictitious 'spoof' vessel wherever the buoy is located.

Moreover, devices belonging to maritime personnel (at sea or ashore) are targeted directly. The cybersecurity risks created by personal devices – laptops, tablet computers, smartwatches, virtual assistants, and smartphones, all of which have cameras and microphones – can be as great as those of the devices built-into vessels.

The social element

Maritime personnel are also targeted online via social engineering. These types of attacks comprise 90% of cybersecurity challenges for companies and organisations. People at every level in our organisations – including our supply chains – are targeted by nefarious actors.

Employees and suppliers can be targeted for bribery. They can be socially engineered online – not only to click the well documented 'phishing links' but also personally blackmailed or persuaded to send money or illicit cargoes to criminals. Maritime personnel can be targeted with threats of blackmail and extortion to conduct a range of activities for criminals, terrorists and hostile state actors. Sextortion – blackmail following the exchange of images online, which someone has been tricked into sending – is today the number one way for a nefarious actor or hostile state to target a company or organisation.

MEMBERS OF THE RINA MARITIME CYBER TASK FORCE

- Ali Ashour, Kuwait Ministry of Interior
- Chris Boyd, previously RINA
- Dinos Kerigan-Kyrou, NATO Maritime Interdiction Operational Training Centre
- Mark Oakton, Cyberplus
- Chris Parker, Fortinet
- Amy Stokes-Waters, The Cyber Escape Room Co.
- Malcolm Warr, Critical National Infrastructure Scotland
- Craig Wooldridge, IASME

The maritime environment is no exception to this situation. Such social engineering targeting can even include recruitment by terrorist organisations (in 2022, a serving Irish Defence Forces soldier was convicted of ISIS membership, having been recruited online by sophisticated ISIS propaganda and disinformation). In other words, nefarious actors do not need advanced technical 'hacking skills'; instead, they aim to find, target and socially engineer individuals online, whether working directly for maritime operators or within their supply chains. This critical vulnerability, comprising by far the greatest number of avenues for cybersecurity breaches, is conversely the least examined and the most poorly addressed of all cybersecurity challenges.

The solution

So, what is being done? IMO has produced *Guidelines on Maritime Cyber Risk Management* (updated in 2025), which provides a framework for the maritime industry to progress cybersecurity. This IMO document is greatly expanded upon by the UK and the EU – both of whom are making cybersecurity requirements legally enforceable.

Legislation in the EU and, soon, the UK is transforming the cybersecurity responsibilities of directors and boards. The EU's 'NIS 2' Directive, EU Cyber Resilience At, and soon the UK's Cyber Security and Resilience Bill place cybersecurity responsibilities squarely on directors, including for the security of their supply chains (the EU legislation applies to any company with even just one EU/European Economic Area customer, regardless of its global location). In other words, failure of maritime board directors to address their cybersecurity and that of their supply chains in the EU (and soon the UK) is now a criminal offence.

The Royal Institution of Naval Architects (RINA) is playing an increasingly critical role in developing maritime cybersecurity, having established a Maritime Cybersecurity Task Force in the past year. The group aims to bring together RINA members with world-leading expertise, to share information and make cyberspace safer for everyone in the maritime environment. Crucially important is that RINA supports and endorses the Maritime Cyber Baseline certification established by IASME (a UK cybersecurity certification company that is also the delivery partner for the UK National Cyber Security Centre's 'Cyber Essentials' certification).

The Maritime Cyber Baseline develops maritime cybersecurity in an achievable and holistic way (ie, across the whole maritime organisation). Moreover, the Baseline certification covers all vessel classifications and supports a pathway toward compliance within the IMO Guidelines mentioned above. The IASME Maritime Cyber Baseline is a world-first maritime cybersecurity certification; it sets the standard for vessel owners, operators, managers and builders to improve the cybersecurity systems and helps reduce the possibility of a cyberattack occurring. It is one of RINA's most important and developing partnerships.

An enabler

To conclude, maritime cybersecurity should not be viewed only through the focus of cost and expense, but rather as an enabler. Cyberspace-connected technologies, and the ever-expanding developments in AI, allow us to progress to vastly more efficient, sustainable operations in transport, logistics and the whole of the maritime environment. Good cybersecurity both enables this progress to occur and enhances the efficiency of the new technology.

As Google's chief information security officer Phil Venables recently stated, no-one can utilise all the new technology coming on stream unless they also develop a good understanding of resilience, compliance and the cybersecurity of the new tech. Cybersecurity should therefore be viewed as a facilitator, enabling an ever more efficient, safe, environmentally sound, sustainable and productive maritime environment. ■

More details about the Maritime Cyber Baseline can be found at: iasme.co.uk/maritime-cyber-baseline

Dinos Kerigan-Kyrou *AMRINA is a NATO Defence Education Enhancement Programme (NATO DEEP) instructor, and assistant instructor at the NATO Maritime Interdiction Operational Training Centre (NMIOTC), Greece. He is a co-founder of the RINA Cybersecurity Task Force. Between 2017 and 2024 Dinos was the cybersecurity and hybrid threats director and lead instructor to the Joint Command & Staff Course of the Irish Defence Forces.*

A FIN-FIRST APPROACH TO SUB DISPOSAL

A demonstration project is showing a new way to dismantle nuclear-powered submarines in a sustainable way, writes **David Foxwell**

The UK is pioneering new ways to dismantle nuclear-powered submarines, and recently reached an important milestone in a demonstration project paving the way for work to be undertaken on other subs awaiting disposal.

The work on the decommissioned nuclear-powered submarine *Swiftsure* is taking place at Babcock's Rosyth yard in Scotland, where the company and its contractors recently made the first cut on the submarine's exterior and removed its fin. As part of Babcock's wider through-life support to the UK Royal Navy's submarine fleet, the work on *Swiftsure* is laying the foundation for a proven, long-term and sustainable dismantling programme.

There are currently seven decommissioned and defuelled nuclear-power submarines in Rosyth Royal Dockyard, and others at the Devonport dockyard in England, all of which will need to be dismantled in due course. The long-awaited, somewhat delayed process will see learnings from the dismantling of *Swiftsure* used to provide more certainty about the schedule for dismantling the remaining submarines.

Dismantling process

Working in close collaboration with the Defence Nuclear Enterprise, demolition contractor KDC Veolia Decommissioning Services UK Ltd and Rolls Royce – which provided technical advice on removal of the submarine's reactor pressure vessel – Babcock aims to have fully dismantled *Swiftsure* by the end of 2026.

Lorraine Russell, senior responsible owner for the Submarine Disposals Programme, said that the project "showcases a commitment to sustainable disposal practices" and that recycling materials wherever possible "will ensure these vessels that served the nation so well continue to provide value even after decommissioning".

Speaking exclusively to *The Naval Architect*, a spokesperson for Babcock said the dismantling process "differs from disposal processes used elsewhere". "Our world-first methodology relates to how we are removing the reactor systems and pressure vessel from the reactor compartment and consigning for final disposal," he explained. "Other countries cut out the reactor compartment, blank the ends and then store.

"Now that the first cut to the external structure has been made and the fin removed, the submarine has been divided into numerous sections. The forward ballast tanks will be next to be removed, then the aft tanks. The process is then repeated: remove a section of the forward compartments, then more of the aft – in effect, cutting sections away, leaving the last section, that is the centre section. At this point, the reactor pressure vessel will be removed and then the remaining elements of the reactor compartment will be radiologically cleared and removed for recycling."

Repurposing steel

Asked which steel elements of the submarine are expected to be reused/repurposed, the spokesperson said an estimated 90% of *Swiftsure*'s total weight will be recycled, with some of the high-quality steel repurposed into components for future Royal Navy submarines. He explained that, on being removed from the submarine, the waste will be stripped, cleaned and segregated into associated materials such as steel, copper, wood and plastics.

These materials will then be disposed of by the UK Ministry of Defence via multiple recycling partners, for future use. The process is taking place in a specially designed in-dock facility at Rosyth that was design and built for the dismantling process. ■

Removal of the fin from *Swiftsure* was an important milestone in the submarine dismantling project

United European Car Carriers is already operating pure car and truck carriers on LBM supplied by Titan

THE STATE OF PLAY FOR LBM

Liquefied biomethane, aka bio-LNG, is emerging as a technically mature and scalable marine fuel, writes **Maro Varvate**, business development manager of Titan Clean Fuels, as she assesses the availability, emissions and costs

Liquefied biomethane (LBM) is included in the broad definition of 'biofuels', which includes any fuels derived from biomass feedstocks. This includes biodiesel and ethanol, as well as biogas, which is upgraded into fuels like biomethane and biomethanol. There are important distinctions between these fuels, especially in how they are produced.

LBM is derived from biogas, produced through anaerobic digestion (AD) of organic waste, including animal manure and wastewater. It can also be produced through gasification of cellulosic waste, such as sludge and agricultural residues, although this uses less mature technology.

During AD, microbes break down these feedstocks in an oxygen-free environment, producing biogas – a mixture of methane (CH_4) and carbon dioxide (CO_2). The biogas is then upgraded to biomethane by removing CO_2 and other impurities and is finally liquefied at -162°C using cryogenic technology – the same used in LNG production.

Feedstock potential

A recent International Energy Agency (IEA) report highlights biogas as a vastly underutilised energy source. Current global production could be increased over fourfold using existing sustainable feedstocks. If fully realised, this could meet around 20% of today's global natural gas demand.

Feedstocks are regulated by sustainability frameworks such as the EU Renewable Energy Directive (RED III) and the US Renewable Fuel Standard (RFS). These ensure that LBM production does not interfere with food systems or biodiversity, and is certified by schemes like International Sustainability and Carbon Certification (ISCC).

While specific emissions reductions depend on feedstocks and production processes, LBM can offer deep decarbonisation of, on average, over 80% on a well-to-wake (full lifecycle) basis. It has the potential to be net-zero and can even be deemed 'net-negative' if avoided emissions from waste are considered. As with LNG, LBM also offers a 95% reduction of NOx and achieves virtually zero SOx and particulate matter emissions.

Infrastructure integration

Availability is not only about production but also about infrastructure. It can be 'dropped into' existing LNG infrastructure (including vessels) and blended with LNG at any ratio, with minimal, if any, changes required to equipment. Both fuels can also be blended with renewable hydrogen-derived e-methane once it becomes available – which should be soon.

LNG is already a quite mainstream, commoditised marine fuel that is bunkered at scale. Therefore, it

UNITED GOALS

The biomethane supply deal signed between UECC and Titan last year has seen an upswing in LBM/bio-LNG adoption across the former's fleet. Between July-December 2024, more than 95% of the fuel delivered to UECC's pure car and truck carriers (PCTCs) by Titan comprised LBM.

As a result of this fuel take-up, UECC estimates that it prevented 30,000tonnes of greenhouse gas (GHG) emissions within that period, and the operator expects to prevent 75,000tonnes of GHG emissions throughout 2025 – "equivalent to the annual emissions of around 10,000 EU citizens or 540 million km driven in an average car", UECC notes.

Maro Varvare, Titan Clean Fuels: "Global [biogas] production could be increased over fourfold using existing sustainable feedstocks"

has expansive established infrastructure. According to the SEA-LNG coalition, LNG bunkering is available in approximately 198 ports worldwide, and there are now more than 60 LNG bunkering vessels in operation globally. A total of 1,154 LNG-powered vessels are expected to be in operation by the end of 2028.

Essentially, decades of investment in LNG have set a solid infrastructure platform for LBM that lowers supply costs. Plus, based on the existing fleet and orderbook, the total addressable market for LNG pathway fuels like LBM in 2028 is expected to be enormous. As well as emissions and availability, costs and prices are key factors to evaluate LBM on, compared to other clean fuels and conventional fuels.

Increasingly mature soft infrastructure, including mass balancing processes, significantly help to reduce costs and prices. Looking ahead, LBM and LNG infrastructure will also be compatible with renewable synthetic methane (e-methane), derived from green hydrogen and captured CO_2, further future-proofing existing assets.

Performance within regulations

Emissions pricing and trading systems are also set to reduce the cost of operating ships when using LBM and other clean fuels. As United European Car Carriers (UECC) is already finding with LBM supplied and bunkered by Titan, the fuel offers overcompliance with FuelEU Maritime across its overall fleet, so UECC is actively exploring pooling and banking options to gain commercial advantages (see box, page 34).

While the default emissions factors remain to be decided, LBM is expected to offer long-term compliance and overcompliance with the IMO's new Net-zero Framework regulations too. With a maze of other environmental regulations – including IMO's Carbon Intensity Indicator (CII) and the EU's Emissions Trading System (EU ETS) – the value proposition for all zero- or near-zero-emission (ZNZ) fuels is enhancing.

With deep emissions cuts, growing infrastructure and strong regulatory alignment, LBM is a practical, scalable marine fuel. As costs fall and production expands, LBM is set to play a key role alongside other clean fuels in shipping's transition to net zero. ■

CYBERSECURITY: AN OVERVIEW

With growing cyber-threats, class societies have formalised cyber-resilience as a condition for compliance and certification. **Gary Miles** MCIIS ChCSP, Fortinet UK&I operational technology cybersecurity specialist, explains how implementing unified applicable requirements and standards can improve maritime cybersecurity

In today's digital maritime environment, shipbuilders, owners and operators face escalating complexity and rising cyber threats. Operational technology (OT) is vital to safety and performance, yet, as vessels become more connected, cyber vulnerabilities multiply, demanding a robust, risk-managed security strategy.

For naval architects and marine engineers, cybersecurity is becoming a core element of vessel design and lifecycle management, from safeguarding bridge systems and propulsion controls to meeting the evolving requirements of classification societies. OT cybersecurity isn't just an IT concern; it's about ensuring the safety, reliability and compliance of critical shipboard systems across their operational lifespan.

The OT security imperative

OT encompasses the hardware and software used to monitor and control ships' physical processes. Unlike traditional IT, it's closely tied to safety and mechanical reliability, making cyber incidents potentially catastrophic. Key risk areas include:

- Digitised propulsion and power systems;
- Networked bridge control and navigation equipment; and
- Automated remotely monitored systems communicating in real time.

Despite its critical role, maritime OT systems have historically lacked secure-by-design principles. Familiarity with cybersecurity regulations and standards is crucial to securing these environments.

Regulatory anchors: UR E26 and UR E27

As digitalisation accelerates, classification societies now require cyber resilience as a formal criterion for achieving compliance and certification. To address emerging threats, the International Association of Classification Societies (IACS) developed Unified Requirements UR E26 and UR E27:

- UR E26 – Cyber resilience of ships: this guideline emphasises governance and defines minimum resilience requirements for ships. It advocates lifecycle risk management aligned to the NIST Cybersecurity Framework: identify, protect, detect, respond, recover [1].
- UR E27 – Cyber resilience of onboard systems and equipment: this UR establishes cybersecurity system requirements (SRs) for the integration and maintenance of a ship's systems, drawn from the ISA/IEC 62443-3-3's foundational requirements (FRs) [2].

It also stipulates that security should be built into the entire OT lifecycle via the secure development lifecycle requirements, aligning with the ISA/IEC 62443 automation solution security lifecycle to future-proof vessels against evolving threats [3].

Although both URs E26 and E27 apply primarily to commercial vessels, they can be used as non-mandatory guidance for 'ships of war and troopships', alongside applicable military-specific guidance such as UK Defence Standard 05-138 or MOSAICS in the US. UR E26 and E27 help shipbuilders integrate cybersecurity into their workflows, as a foundation rather than a bolt-on. In addition, IASME's Maritime Cyber Baselines Scheme, supported by RINA, is also designed to certify the cybersecurity of commercial vessels of all sizes and classifications.

ISA/IEC 62443 standards

The ISA/IEC 62443 series of standards sets best practices for industrial automation and control systems security, and offers a structured, scalable approach to OT cybersecurity for any OT environment. It fits within the maritime sector by providing:

- Defence-in-depth architecture: segmentation of systems based on risk and criticality. Application of the zones and conduits concept to contain threats and prevent lateral movement within onboard networks.
- Security levels and requirements: defines tailored security objectives based on asset function and exposure. This enables risk-based implementation, ensuring that systems like propulsion control receive the highest protections.
- Lifecycle approach: from concept to commissioning to operation, ISA/IEC 62443 supports secure development practices, helping manufacturers and integrators bake security

Gary Miles, Fortinet: "Cybersecurity is becoming a core element of vessel design and lifecycle management"

OT encompasses the hardware and software used to monitor and control ships' physical processes

into each phase, reducing vulnerabilities before ships become operational.

The secure ship of tomorrow

Fortinet's *2025 State of Operational Technology and Cybersecurity Report* provides critical insights for OT security, and details the following OT cybersecurity best practices:

- Deploy segmentation;
- Enhance visibility and compensating controls for OT assets;
- Embrace OT-specific threat intelligence and security services;
- Integrate OT into security operations (SecOps) and incident response planning; and
- Consider a platform approach to your overall security architecture.

Cybersecurity in the maritime sector is no longer optional; it's mission-critical. As attackers target embedded systems and exploit legacy OT vulnerabilities, maritime stakeholders must act decisively. ■

Gary Miles is one of Fortinet's UK & Ireland OT experts. He is a Chartered Cybersecurity Professional for Governance and Risk Management, and possesses ISA/IEC 62443 Expert, GICSP and NIST Practitioner qualifications.

References

1. UR E26 Requirements, shown against the NIST Cyber Security Framework V2.0 (https://nvlpubs.nist.gov/nistpubs/CSWP/NIST.CSWP.29.pdf. Accessed 9 July 2025)
2. ISA/IEC 62443 Requirements described within UR E27 (foundational requirements detailed within IEC 62443-3-3:2013)
3. ISA/IEC 62443 Automation Solution Security Lifecycle (https://gca.isa.org/blog/defining-security-lifecycles-in-the-isa-iec-62443-series-guide-)

FOILING INTO FERRY ROUTES

The prototype Solent TriFoiler, profiled at Seawork 2025, could pave the way for energy-efficient passenger ferry operations, if certain design challenges can be resolved. **Stevie Knight** reports

The sleek, black trimaran set outside Seawork's main gate this summer was riveting, and not just for its triple-hulled design: more unusual were the bright orange foils extending beneath.

However, what's important isn't novelty and excitement: rather the reverse. The idea, underlines Chris O'Neill, technical director at Chartwell Marine, is to explore how foiling can be made more reliable, robust and, for ferry operations, a safer bet in all senses. Yet, there are still questions that need to be answered to determine the next steps for this collaboration between Chartwell, Newcastle Marine Services and Solent University.

The 9.4m-long Solent TriFoiler has been running sea trials for the last few months under the UK's Clean Maritime Demonstration Competition (CMDC3). First of the proven 'wins' is that the TriFoiler is five times cheaper to run than an equivalent fossil fuel-powered monohull. Likewise, it could have several times the endurance of a similar, fully electric displacement vessel.

The TriFoiler runs on "about the equivalent of three electric home showers... roughly 27kW" when foiling

But how does it compare with other foiling designs? In fact, this prototype also demonstrates that, compared with a monohull or catamaran, a trimaran form lowers the power required to get up to foiling speed. "Normally, you've got your highest resistance just before take off because you've still got the hulls in the water," explains Solent University's senior design and engineering lecturer Giles Barkley.

The TriFoiler does things differently. By lifting the two, shorter sponsons slightly before the main hull, it lowers 'peak' resistance and effectively spreads take-off loads. As a result, this approach can reduce installed power and, therefore, weight.

Further, as Barkley explains, once you're foiling, drag drops significantly anyway: "Take off might be at 10 or 12knots – but you can go straight to about 18-19knots for roughly the same power." Barkley adds that, when foiling, "it's running on about the equivalent of three electric home showers: roughly 27kW".

Full-size ferry?

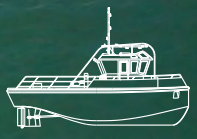
Despite the focus on foiling mode, the hullform remains interesting. The TriFoiler's total beam is 3.7m and the sponsons have a beam of around 0.4m each, while the main hull measures 1.1m at the waterline. As Barkley explains: "You want the displacement in narrow hulls for take-off and landing." Likewise, the wetted surface has a high length-to-width ratio to minimise resistance.

There is more to consider than efficiency. While slowing presents a 'glide' down, Barkley points out: "If you're up on the foils and you're going to come down suddenly, the slamming from a very flat bottom could hurt. But the deeper the V shape, the more gentle the landing."

Given these requirements, O'Neill notes, there's more freedom in the design above the waterline. Here, the form steps out, broadening substantially to give a much fuller volume. While the prototype holds enough room for the driver, power and controls, a larger ferry version should be capable of carrying 35 or 40 passengers. Therefore, this prototype could eventually provide the basis for a 24m foiling ferry with a couple of hundred kilowatts of batteries onboard, capable of flying along at speeds of 26-28knots in categorised waters – up to around 1.5m Hs.

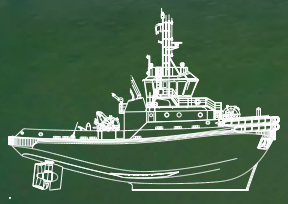
"The eventual design is aimed at being able to take on off-peak runs between Southampton and Cowes," explains O'Neill, "but using a lot less energy than current fast ferries, which burn huge amounts of fuel even when empty. This boat has roughly 50kWh of batteries, but that takes it surprisingly far. If you scale up to a full-size ferry,

Z-Tech Series



Mooring Launch Series

RAstar Series



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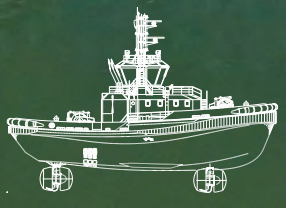

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it could probably do around two return journeys before you'd need a recharge."

Keep it simple

However, top of the list of notable differences between this and other foiling designs is simplicity. There is a reason that foiling is often called 'flying': the physics are very similar to that of aircraft and so far, they equally rely on sophisticated articulation – even down to 'ailerons' on the foils' trailing edge. But the forces are several hundred times greater since water is thicker: plus, it can come with unexpected lumps in the way of debris or biofouling.

In short, there's potential for failure. O'Neill asks: "Do we believe that it's realistic to demand operators carry out a complete set of preflight checks on all the foiling systems - as you would on an aircraft – before going up onto a foil at high speeds with a lot of passengers onboard?" Therefore, this alternative aims to keep it simple. The central twin-legged foil has two pod propellers of 20kW each, set at the crosspieces, but it's a fixed design with no ailerons or other flaps to control lift.

Instead, this is achieved by the extended vertical shaft of the rear foil, which has the appearance and function of an elongated rudder. Like the forward set, it's made of carbon fibre but, in this case, it's also reinforced with steel as it has a hefty job to do.

"The rear foil and rudder combination articulate fore and aft so you can change the pitch and yaw," says O'Neill. This gives roughly 5° and 15° of freedom respectively. It's moved by electrical linear actuators, integrated into the boat's ride control.

Most important is how it interacts with the main foil. "The idea is that as you get toward take-off speed, this foil is pitched in such a way that you slightly dig the back end down," O'Neill explains. "That creates more lift on the central foil as you come up out of the water. As you speed up, it alters, nosing the boat down until you're straight and level."

All this is controlled from inside the main hull – so, apart from the twin electric propulsion pods, there are no moving parts below the surface. That should make it attractive to ferry operators in particular, says Barkley.

"If something breaks or gets badly fouled on a ferry, bringing it out of the water, fixing the problem and putting it back in again means you're going to be out of action for quite some time," says O'Neill, pointing out that's anathema to a ferry schedule. However, on this design, "any problem will likely be located on the top of the boat, where you can just unbolt it", he says, adding: "It makes for easier maintenance and therefore better reliability." Simplicity is also at least partially key to keeping costs down: "When you scale up, the components will be available off the shelf: you could use car motors, for example," says O'Neill.

Design alterations

Despite this, the path is not always smooth for any significant development and there have been

The TriFoiler, pictured at Seawork 2025, showing its rudder foil

The prototype could provide the basis for a 24m foiling ferry, capable of speeds of 26-28knots

changes along the way: "One of the original ideas was to put the batteries – which are potentially a fire hazard – out in the sponsons," he explains. "However, we found that as the boat rolls, the inertia is too hard to correct adequately, so we've had to relocate the batteries in the main hull."

Moreover, there are still points to address that could substantially change the design. One issue is that while the prototype is good at flying straight, it needs a very broad turning circle, which means it can come off the foils on tighter corners. This is not a deal breaker as, given the radical departure of the design, it's been developing at a considerable pace. In fact, the Innovate UK project that helped bring the boat to sea trials spanned just 24 months, from April 2023 to March 2025.

What next? O'Neill and Barkley say there are various ways to move the design forward, including a rethink around how to enhance stability while retaining foiling's advantages and the 'simplicity' principle. Here, Solent University has played an important role by creating a digital twin to replicate the TriFoiler's performance. Barkley adds that this, combined with validated data from the trials, should pave the way for future designs and help the next generation of naval architects to think outside the box. ■

COMMUTER CHARGE

Auckland, New Zealand has welcomed the first of two new all-electric ferries developed by EV Maritime and built by McMullen & Wing, as the city looks to clean up its waterborne urban commuter runs

New Zealand-based electric ferry designer EV Maritime has announced the launch of its first pure-battery urban ferry, the EVM200. Developed with support from the New Zealand Government for operation by Auckland Transport, the 24m-long EVM200 will provide a passenger service between downtown Auckland and the suburb of Half Moon Bay, spanning 16km. The debutante is the first of two vessels in this class, each being capable of a service speed of up to 25knots and a range of up to 32km.

According to EV Maritime, diesel-powered ferries undertake approximately 6 million passenger journeys in Auckland annually, guzzling 13 million litres of fuel and emitting 34,000tonnes of CO_2. The roll-out of the EVM200 models is intended to correct this pollution, while simultaneously "maintaining the reliability and convenience of water-based public transport", says EV Maritime CEO Michael Eaglen. He adds: "Our technology-transfer business model also supports local shipbuilders in becoming electric vessel manufacturers – boosting regional capability and growing confidence in sustainable solutions."

Charger first

Each vessel accommodates up to 200 passengers on the enclosed main deck, while the upper deck offers additional seating for 30 people. EV Maritime adds: "Amenities include three restrooms – one of which is ADA-accessible – and a small onboard kiosk serving barista coffee, cold beer and wine." Each ferry can also carry up to 20 bikes and scooters in an enclosed area with racks.

The ferry type's naval architecture and design was led by EV Maritime, with Finland's Danfoss providing the motors and power electronics and compatriot tech specialist HamiltonJet supplying the boat's four LTX-model waterjets. For this project, EV Maritime also collaborated with the Auckland-based competitive sailing team Emirates Team New Zealand on the hull, developing a "low-drag, low-wash" hullform for efficient operation at cruising speeds, EV Maritime says. The hull has been built from carbon-fibre composite, with McMullen & Wing handling ship construction duties.

The debut EVM200 vessel also features the first maritime deployment of the CharIN Megawatt Charging System (MCS), a fast-charging solution that has previously been used to power heavy-duty vehicles such as electric trucks and buses. The system can reportedly deliver up to 3.75MW of power, significantly reducing charging times for large battery packs to 15-20 minutes in some cases.

EV Maritime comments: "The journey between downtown Auckland and Half Moon Bay takes approximately 35 minutes. While the ferry's batteries hold enough energy for a full round trip, the vessel will typically recharge during a 10-minute turnaround at the terminal [at Half Moon Bay], using two MCS inlets rated 1.1MW each." This shoreside power upgrade has also been overseen by Auckland Transport. The MCS additionally has the potential for bidirectional power transfer, which would enable both vehicles and vessels to act as mobile power sources, which could be useful in applications like grid support or emergency power supply.

Overseas orders

Looking beyond its borders, EV Maritime is now expanding internationally, and more electric ferry launches are in the pipeline. For example, the company established a North American branch last year, and is currently working on a plug-in hybrid-electric vessel for Angel Island Tiburon Ferry, for operations in the San Francisco Bay Area. This project is being funded by the California Air Resources Board (CARB) to the tune of US$12 million, and the vessel, scheduled for launch in Q1 2027, will feature a length of approximately 20m. Additionally, the operator intends to retrofit two of its existing ferries with electric motors in early 2026.

EV Maritime is also working with Canadian boatbuilder AF Theriault to provide a series of up to five all-electric ferries for Halifax Regional Municipality, in a contract valued at just under US$190 million. These newbuilds, which will operate in Nova Scotia, are slated for completion between 2027-2028.

The EVM200 will be able to recharge during a 10-minute turnaround at the terminal (image: Catalina Garcia)

ALL IN FOR AFRICA

A new memorandum of understanding will see Interferry support domestic ferry safety efforts in the West and Central African sub-region

Late June saw industry association Interferry sign a memorandum of understanding (MoU) with the Maritime Organisation for West and Central Africa (MOWCA) and the Lagos Waterways Authority (LASWA), in a bid to boost ferry safety across West and Central Africa. The signing followed immediately after the two-day Lagos Ferry Safety Conference, hosted by the abovementioned groups and attended by 220 delegates, which focused on how best to establish safe and sustainable ferry transportation within this sub-region.

The MoU sets out a plan to establish training seminars for maritime/technical personnel and safety officials. The partners will also cooperate on developing safety campaigns for both policymakers and the public, while working to bolster regulatory frameworks to combat domestic ferry accidents. As reported in the June issue of *The Naval Architect*, LASWA was proactive in introducing 15 new 40-seater passenger waterbuses, built locally by Caverton Marine, to the waterways under its jurisdiction in 2024.

For a long time, though, domestic ferry operations in Western and Central Africa have been plagued by ageing and unsafe vessels, deficient infrastructure and insufficient crew training – all capped off by inconsistent enforcement of safety regulations. In the case of Lagos, the Mile2 ferry terminal is currently out of service, and operators often reduce the frequency of trips due to high fuel costs. Despite its access to water and wetlands, ferry trips only constitute a tiny fraction of travel in Lagos State, with road transport dominating.

This state of affairs inspired Interferry to host its Africa Safety Seminar in Dar es Salaam, Tanzania, followed by an Africa Safety Workshop in Marrakech, Morocco, in 2024, in advance of this year's conference in Lagos. These gatherings, plus the latest MoU, stem from Interferry´s FerrySafe project, which aims to raise awareness of, and devise solutions for, the volume of domestic ferry accidents in developing countries.

"Exchange and dialogue"

Dr Paul Adalikwu, MOWCA secretary general, told conference delegates: "We believe that through collective effort and the sharing of expertise, we can achieve significant advancements in ferry safety and create a more secure environment for waterborne transportation. Over 8,000 lives have been lost in ferry-related incidents within the sub-region in the last decade, with Nigeria, Senegal and the Democratic Republic of Congo being the hardest hit." One of the goals of MOWCA, which is headquartered in the Ivory Coast and comprises 25 African nations, is to attract investments into West and Central Africa to raise ferry safety standards.

"Over 8,000 lives have been lost in ferry-related incidents within the sub-region in the last decade"

Adalikwu also cited stats from the Worldwide Ferry Safety Association (WFSA): "The WFSA has [kept] 2,000 records of media reports of ferry fatalities the world over, and noted that most of the accidents in that region in the last decade were by [nameless] vessels – hence unregulated and uncontrolled."

Oluwadamilola Emmanuel, general manager, LASWA, explained: "In Lagos, we live on, with and from the water. Shipping is the best means of transportation in a city located in a lagoon. That's why we want to build dozens of new piers and put more ferries into service to facilitate the daily journeys of our inhabitants. We are seeking exchange and dialogue with Interferry and MOWCA to evaluate how we can best benefit from their experience for safe ferry transport in our urban structure."

Post-conference, Interferry announced: "Studies on domestic ferry markets, including needs assessment and infrastructure sustainability, are also planned. The agreement also facilitates the exchange of information and mutual invitations to meetings, ensuring continuous dialogue."

Predictive maintenance

Topics addressed at the Lagos conference included: navigation and weather forecasting (including the use of weather data software); the use of buoys and channels as visual indicators of the safest waterways to navigate; and the importance of fleet maintenance, ensuring that domestic ferries stick to drydocking schedules. There was also agreement on the necessity of employing predictive maintenance regimes for the ferries' engines. On the issue of human factors, speakers stressed the need for more placements for African cadets.

Dr Roberta Weisbrod, executive director of the WFSA, also attended the Lagos event. She writes: "The Governor of the State of Lagos, Babajide Sanwo-Olu, just gave the go-ahead for the Omi Eko project: with a budget of US$464 million, there will be 78 electric ferries, dredging of 140km of waterways and new floating jetties to handle the 1m tidal range.

"Terminals will be upgraded to accommodate electrification. Most of the funding comes from European sources together with Lagos State and private sector sources."

Now, Interferry aims to advance the dialogue with further discussions at its 2025 conference, which will be hosted in Sorrento, Italy in October. ■

The PES frigates will be the first vessels of their type built in Colombia

FRIGATE FIRST FOR COLOMBIA

Colombia's plan for domestic construction of a new class of frigates – a first for the South American country – is about to enter the execution phase, writes **David Foxwell**

The Colombian Navy has embarked on an ambitious project to build a new class of frigates in Colombia, in so doing becoming only the third South American country, after Brazil and Mexico, to build ships of this type.

The frigate programme, which dates back to 2007, forms part of an ambitious programme agreed between the Colombian Navy and Cartagena-based COTECMAR for the construction, integration, testing and commissioning of: the first 'Plataforma Estratégica de Superficie (PES)'/strategic surface platform frigate; an 'oceanic patrol vessel' that is currently under construction; and a logistic support vessel.

The three ship types form part of the Colombian Navy's 2042 Naval Development Plan that will upgrade its fleet and, it is hoped, create thousands of jobs in the country, strengthening Colombia's defence industry and self-sufficiency.

Class involvement

Based on Damen's SIGMA 10514 design, previously built for Indonesia and Mexico, for which an initial contract was agreed between Damen and COTECMAR in 2022, the PES frigates will replace the Colombian Navy's ageing Amirante Padilla-class frigates, and will be built in Colombia with technical support from the Dutch yard.

Following completion of the initial contract with COTECMAR, Damen Naval in August 2024 signed a contract for the delivery of engineering, technical support and shipbuilding materials and equipment for the first frigate in what is expected to be class of five vessels. Construction of the first frigate at COTECMAR is due to get underway by the end of 2025, and delivery and commissioning is due to take place in late 2029 or early 2030.

Shortly after the construction contract was agreed, Damen Naval also agreed a contract with classification society Lloyd's Register (LR) for full plan approval for the PES. LR has been involved with the project since the end of 2022, initially for basic plan approval services within the design study contract.

Supply contracts

In advance of construction, a number of contracts have recently been confirmed with leading suppliers for systems and equipment for the frigates. Damen Naval has agreed a contract with Nevesbu for the platform engineering for the PES frigates and Swedish defence firm Saab will provide the combat management system (CMS) for the first of the new frigates, under which it will fit the PES with systems including Sea Giraffe 4A radars, 9LV combat management and fire control systems, a Ceros 200 radar and optronic tracking system, plus EOS 500 electro-optical fire-control directors.

In June 2025, Kongsberg Maritime signed a contract with Damen Naval to supply twin controllable-pitch propellers and shaftlines for the vessels. At

Based on Damen's SIGMA 10514 design (pictured),the PES frigates will replace the Colombian Navy's Amirante Padilla-class vessels

about the same time, Netherlands-based Alewijnse was awarded a contract for the design, engineering and testing of all onboard electrical systems, a deal that includes full cable routing across the vessel and the supply of key systems such as power management, propulsion, entertainment and navigation lighting. Alewijnse will provide the drives for the frigate's propulsion system in partnership with Van Meer, a longstanding partner of Damen Shipyards. It will also supply the ship's integrated platform management system, which will be developed and delivered in cooperation with Praxis Automation, and integrated bridge management system, which will be supplied in collaboration with Anschütz.

June 2025 also saw Portuguese defence technology company EID awarded a contract for the delivery of the integrated communications control system for the PES.

Anti-air capability

With a length overall of 107.5m and a beam of 14.02m, the frigates will enhance the Colombian Navy's anti-submarine and anti-surface vessel capability and its ability to project power in the region. Displacing 2,808tonnes, the newbuilds will have a crew of around 100 and range of up to 8,200nm. They will have a maximum speed of 26knots and a combined diesel or electric (CODOE) propulsion system based on two 10MW diesel engines and electric motors, and one 200kW and four 940kW diesel generators.

Relatively few details have been confirmed about the frigates' weapon systems, although they are expected to be fitted with a vertical launch system for air defence missiles, and with surface-to-surface missiles. BAE Systems will provide the Bofors 40 Mk4 main gun for the vessels, which will form part of their anti-air and anti-surface vessel capability. ■

AUSTRALIAN ARAFURA CLASS INCOMING

With greater range and endurance than the Royal Australian Navy's Armidale-class OPVs, the Arafura class can undertake multiple missions that would require numerous smaller, less capable ships, writes **David Foxwell**

On 28 June 2025, the Royal Australian Navy commissioned HMAS *Arafura*, the first of a new class of long-delayed offshore patrol vessels (OPVs). Described by Australian deputy prime minister Richard Marles as "a major milestone in the Australian Government's implementation of the Surface Fleet Review," HMAS *Arafura* entered the fleet at a commissioning ceremony in Western Australia.

The Australian Department of Defence accepted delivery of the vessel in January 2025, ahead of a period of tests and evaluation prior to delivery to the Royal Australian Navy and the now completed commissioning milestone.

The keel of the new vessel was laid on schedule in 2020, and the new vessel was launched in late 2021. Subsequently, delays to the programme led to a reduction in the number of Arafura-class OPVs the Royal Australian Navy plans to acquire from 12 to six vessels, with the 'capability gap' that this created being filled by additional Cape-class and Evolved Cape-class patrol units. Such was the extent of the delays – which revolved primarily but not exclusively around problems integrating the main gun originally selected for the project into the design – that, in October 2023, the Arafura-class programme was listed on the Australian government's 'Projects of Concern' list.

Greater range

The Arafura-class vessels will be part of a wider Navy minor war vessel fleet supporting civil maritime security and enhanced regional engagement in the southwest Pacific and southeast Asia. They will primarily patrol and secure Australia's maritime border, working with the Royal Australian Navy's and Australian Border Force's shared fleet of Evolved Cape-class patrol boats. They will also play a role in humanitarian and disaster relief, enhance regional engagement and support other Royal Australian Navy missions.

The new vessels are larger and have a greater range and endurance than their predecessors, the Armidale-class patrol boats, and can also perform tasks and roles that previously required several different vessel classes. The OPVs also have improved living quarters and amenities to better support personnel.

The Australian Government's Independent Analysis into Navy's Surface Combatant Fleet (Surface Fleet Review) reaffirmed the need for the Arafura-class OPVs whilst recommending they operate alongside the Evolved Cape-class patrol boats.

HMAS *Arafura* is the first of what will now be a class of six OPVs for the Royal Australian Navy

RIB-equipped

HMAS *Arafura* was built by German shipbuilder Lürssen Australia at the Osborne Shipyard in South Australia. The second OPV, *NUSHIP Eyre*, is completed and awaiting acceptance by the Royal Australian Navy. It commenced initial sea trials at the end of June 2025.

The remaining four ships are under construction at the Henderson shipyard in Western Australia. OPV3 will be named HMAS *Pilbara*; OPV4 will be named HMAS *Gippsland*; OPV5 will be named HMAS *Illawarra*; and OPV6 will be named HMAS *Carpentaria*.

The vessels are based on the Lürssen PV80 design also used in the Darussalam-class OPVs operated by the Royal Brunei Navy. They will support specialist mission packages, such as maritime tactical unmanned aerial systems. It is anticipated that they will also support rapid environmental assessment and deployable mine countermeasures capabilities.

With a length of 80m and beam of 13m, the new OPVs have a draught of 4m and a maximum speed of 20knots. With a range of 4,000nm, they have a crew of 40 and accommodation for a total of 60 personnel. The main machinery takes the form of two MTU 4,250kW diesel engines.

In keeping with their primary roles, the Arafura-class OPVs will be equipped with two 8.5m Boomeranger FRB 850 RIBs, both crane-launched, and one 10.5m Boomeranger C-1100 RIB, stern-launched. They will be armed with a Northrop Grumman M242 Bushmaster 25mm gun on a Rafael stabilised mount and two 50-calibre machine guns.

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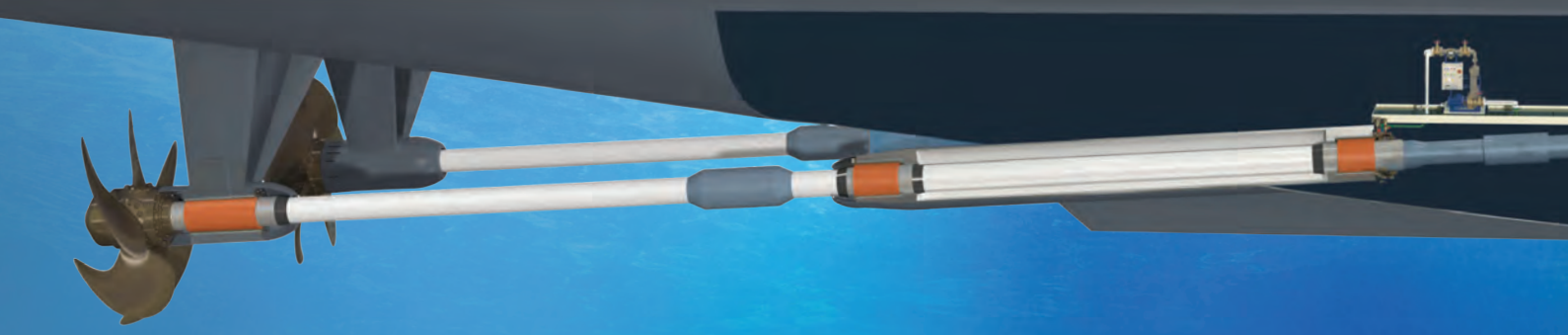

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FOLLOWING THE DIGITAL THREAD

Growing numbers of users are extending the traditional use of CAD/CAM as a ship design tool to also cover operational monitoring and maintenance. **Martin Conway** speaks to SSI's **Craig Tulk**

CAD/CAM solutions and digital twin technology, by their very nature, overlap – and this could yield excellent benefits for naval architects, shipbuilders and the owners and operators of new and existing vessels.

CAD enables users to create detailed digital designs, and CAM allows them to automate production, making it easier to build complex ships, and offshore platforms, accurately. Digital twins serve as virtual representations of real-world objects, enabling users to monitor, test and tweak them in real time.

As Craig Tulk, product business analyst at CAD/CAM solutions developer SSI, puts it: "A CAD model, whether it contains 2D or 3D info, is a form of a digital twin." This perspective highlights the foundational connection between CAD models and digital twins but also raises questions about how much detail – or "DNA" – a CAD model needs to qualify as a digital twin to suit its purpose.

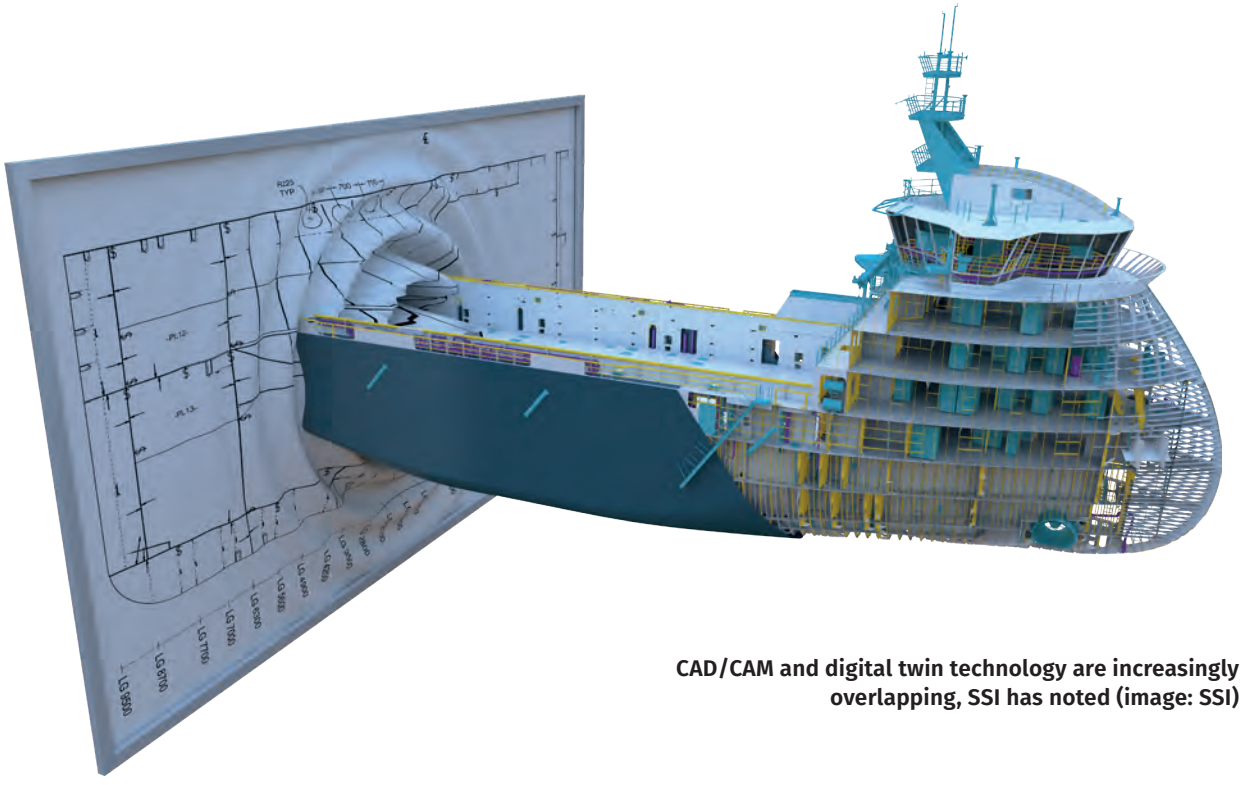
"The question is, what parts of the DNA does it actually need to carry to suit that purpose?" Tulk tells *The Naval Architect*. "A production-based CAD model design may carry a whole lot of DNA but might not break it down into all of the fine details you might require for a maintenance-based digital twin.

"For example, it would give you details about what engine model/version fits into a particular space and what connects up to it, but it wouldn't provide specific details about fuel injectors or turbo charger breakdown details, in a way that would be specifically useful to anyone who wants to service those engine parts later in the vessel's life. Yet, it can provide a faster path for them to get to that information through a linked digital thread from that engine model/version that was installed.

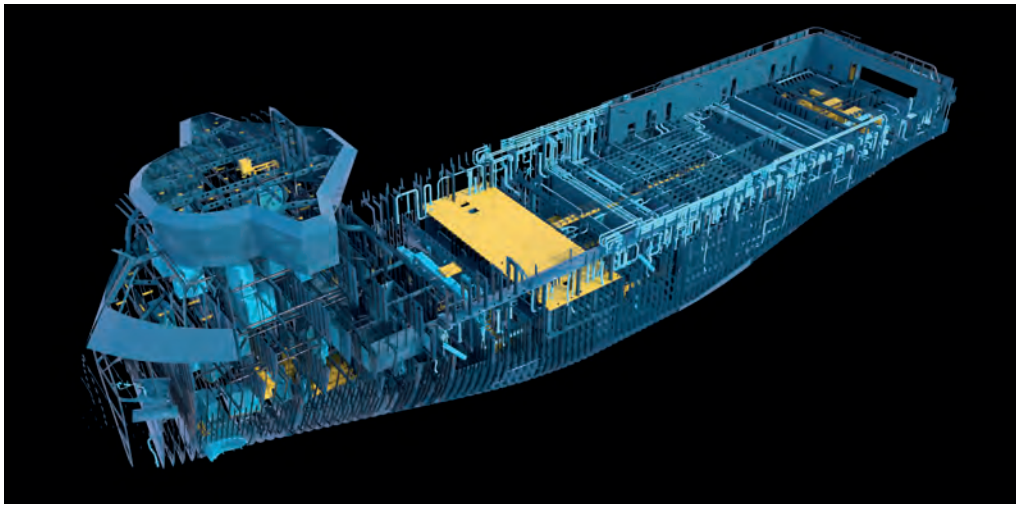
"It really depends on the purpose of what you're using the digital twin for. At the detail design and production stage, it may not be considered worth the money to spend adding details about where every onboard sensor will be located. Similarly, the ship operator may want these sensor details for operational monitoring, but doesn't need to know how the ships' block units were assembled. It all depends on what portions of the DNA you need to represent for the task in hand."

From design to training

SSI's offerings include ShipConstructor, an AutoCAD-based CAD/CAM software line, which enables designers to formulate and outfit "anything from small patrol boats to offshore structures", Tulk explains. The company has also developed ShipbuildingPLM, a vessel construction-specific product lifecycle management (PLM) platform that can be used to support digital twin construction, as well as maintenance, repair and overhaul activities, and which is compatible with Navisworks.



CAD/CAM and digital twin technology are increasingly overlapping, SSI has noted (image: SSI)



End users can tweak the "DNA" they require to suit the project at hand (image: SSI)

Tulk highlights that "we're seeing a metamorphosis in our industry", in which clients are extending the traditional use of CAD/CAM as a ship design tool to also cover post-delivery monitoring and maintenance.

"CAD/CAM is usually used for production design, which is where the costs are incurred – the cost of building a vessel is about 90% greater than the cost of designing it," he says. "In turn, the cost of operating the vessel can well exceed the costs of designing and building it, so customers now want to manage and maintain that digital thread from the earliest design stages right through to the operation of the vessel."

Additionally, using CAD/CAM data to create a digital twin of the vessel is proving beneficial when it comes to personnel training, especially in the naval and patrol vessel segments. "The digital twin shows all the compartments of the vessel and what they are purposed for: for example, where fire stations and life rafts are located on the ship," Tulk says, "so trainers can use that 3D model as a virtual representation for training purposes alone. We're tending to see this trend happening more with naval customers and bigger fleets, rather than with smaller tug fleets, but that is changing: as more bigger companies invest in this technology, the cost comes down, so it becomes easier for smaller operators to access."

Technology trends

Tulk highlights a paradigm shift in CAD/CAM and digital twin technology for shipbuilding. One recent trend is reusing early conceptual and preliminary design data, such as 3D hullforms, to streamline production of similar vessels.

"Traditionally, each ship's design started from scratch – conceptual, preliminary, contractual, then functional and production stages," Tulk explains. "Now, designers can reuse digital assets from early stages, saving time and costs." Another trend is hosting CAD/CAM models and digital twins on the cloud, which, Tulk notes, was "unthinkable a decade ago" due to technological limits. Cloud solutions enable real-time collaboration and data access, which in turn permit effective lifecycle management of the asset via the digital twin.

Tulk also highlights finite element analysis (FEA) and component traceability as emerging CAD/CAM and digital twin tech trends. FEA, now fully digital, allows designers to carry strength calculations from early conceptual and preliminary design phases – where hull shape and strength are defined – through to the final build, to help ensure the ship meets its initial performance and safety goals.

Track and trace

Additionally, the digital thread can be used to help owners and operators to trace designed parts to their physical counterparts. So, on a steel ship, Tulk offers as an example, should a plate fail to meet specifications, users can more easily trace it back to its source batch, identifying other potentially faulty components. "People can ask: 'This piece of steel came from this bad batch of plates – but what else that's on board came from it?". It's a faster, easier way to verify that what was factored into the design is fit for purpose and is safe."

Similarly, Tulk notes that more end users are combining PLM technology with CAD/CAM to track design alterations. "PLM lets you record why, when and how changes were made during production if they don't fully match the original requirements," he explains. "For example, in the case of creating a sister ship and maintaining the existing fleet, should a pipe system valve type used on earlier sister ships be altered – for example, perhaps it has been flagged as a safety risk by a class society, or as not reliable enough by the operator – the PLM tech allows clear traceability to the operators and maintenance crews, of which previous sisters need to be upgraded to the new valve type, and allowing the next ship built to incorporate this change to the design."

3D representations in CAD/CAM and digital twin technology are also increasingly being used to streamline ship repair and maintenance procedures. "When a ship comes to shore, 3D

Cloud connectivity and augmented reality are just two of the new tech developments fuelling shipbuilding and monitoring projects (image: SSI)

models help show what needs fixing and how to go about it, making planning faster and easier," Tulk explains. By visualising repairs in advance – whether for damaged components or routine maintenance – shipyards can assess issues quickly, reducing the time needed to prepare. "The more you can cut down the time it takes to evaluate a repair and avoid unnecessary downtime, the better off you are from an owner's or operator's perspective," Tulk adds.

Also, augmented reality (AR) is fast becoming a game-changer for shipbuilding inspections, ensuring that what's built matches the CAD/CAM design. "AR lets inspectors see early on if components, like brackets beneath a deck, match the original design's position or shape," says Tulk. "If brackets are slightly larger but don't affect the ship's weight, they're acceptable; if smaller, they may need an exception to pass the inspection. AR reduces the need for time-consuming manual measurements with tape measures, scaffolding or ladders." By overlaying digital twins onto physical structures, AR can quickly identify discrepancies and their causes, to help keep projects on track.

Shipyard projects

SSI's recent clients have included Australian vessel designer Incat Crowther, which used SSI's ShipConstructor software alongside Microsoft's Hololens solution to create a 3D digital twin of a planned 200-pax ferry design for the Parramatta River, enabling real-time collaboration and design validation and providing the scope for AR walkthroughs of the vessel. Meanwhile, Navalista, a Ukrainian marine design firm, says it has reduced typical ship drydock times, by eliminating error and reducing the need for manual measurements, through a combination of LiDAR, point scanning and ShipConstructor.

SSI also works with other industry partners and agencies to advance the use of CAD/CAM and digital twin and thread technologies. For example, SSI has collaborated with Lincoln Electric Automation and Wolf Robotics on a project, backed by the US National Shipbuilding Research Program (NSRP), to develop a computer-aided robotic welding module, to automate and speed up the welding process when building new ships.

"By overlaying digital twins onto physical structures, AR can quickly identify discrepancies and their causes, to help keep projects on track"

Another project, also supported by the NSRP, involves SSI using ShipConstructor for the lifting and turning of newbuild blocks. Tulk elaborates: "In the shipyard, large vessels are built initially as multiple blocks, and later joined and welded together. An individual block is initially welded upside down, to aid in welding processes. Eventually, to merge this block with the others and complete the final outfit of the vessel, these often large, heavy blocks of steel need to be flipped over – or lifted and turned – upright. The structure of an individual block, at this stage of the build, is not always stable for such a lift and turn process, and needs to be reinforced with material to make this operation safe – yet it also needs to be efficient.

"So, with some industry partners that create FEA software, and shipyards that are actively engaged in block lift and turn operations, we used the ShipConstructor block models to figure out how much the block weighs, its centre of gravity, where it needs additional strength and bracing and where to put grabs on it so it can be lifted up and turned over, and then what bracing and lifting lugs need to be removed prior to merging this block with others. To create even better efficiency for the lift and turn engineers that have to manage this potentially dangerous process, we are now able to export the ShipConstructor block models directly to FEA software, analyse it using FEA, add the extra bits required to make the operation safe to the FEA software, reanalyse/confirm, import it back into ShipConstructor with the extra parts, and incorporate the extra material into digital production information for the lift and turn operation – creating the efficiencies and safety they require to carry out this process." ■

PLUG-IN HYBRID OPS FOR EURO FERRIES

BLRT Repair Yards' Western Shiprepair facility has been entrusted with a project that will enable two ferries to reduce emissions by at least 80% on a route linking Denmark and Germany, writes **Clive Woodbridge**

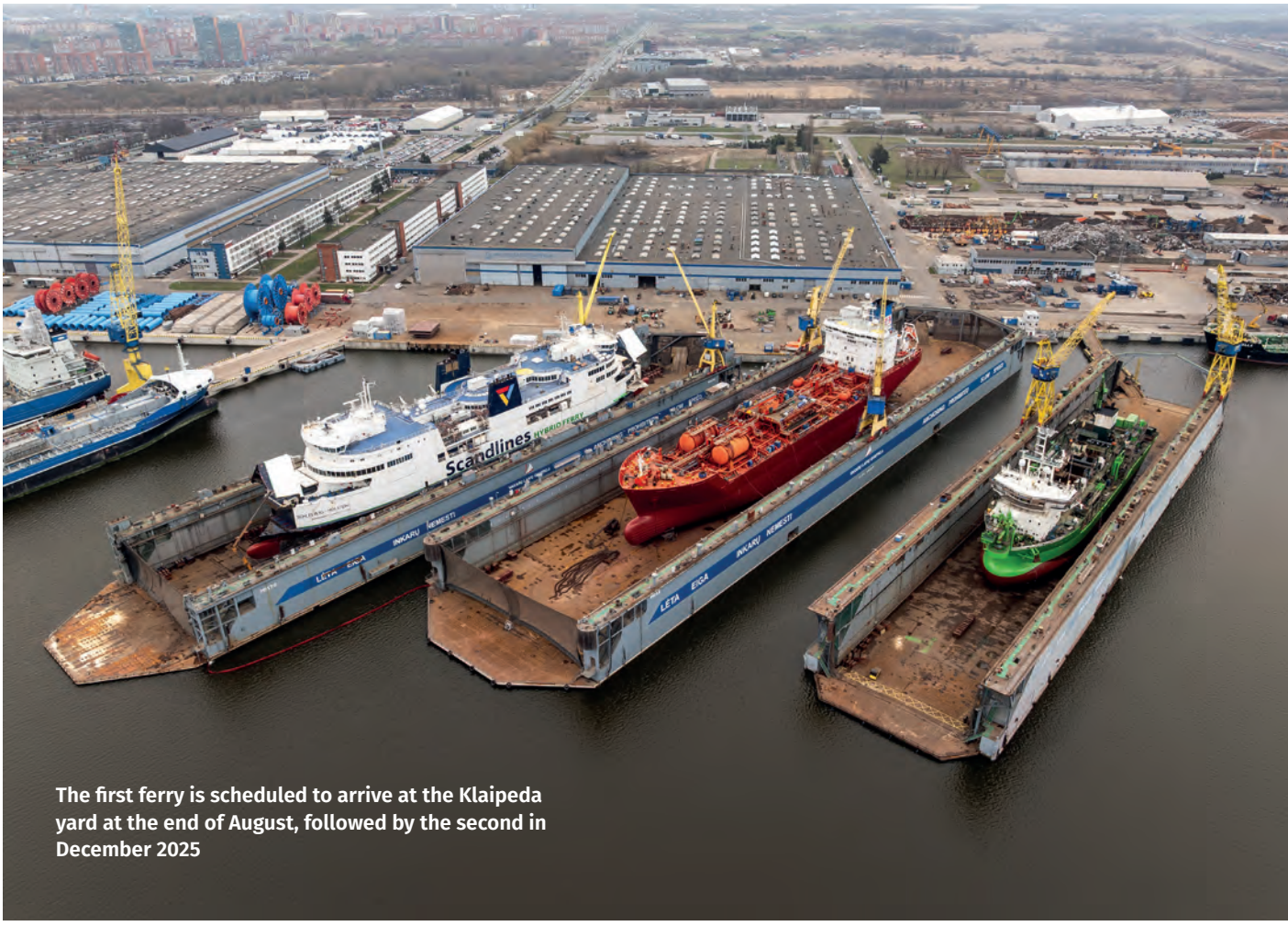
Baltic Sea ferry operators have been among the pioneers in decarbonising shipping operations, and this pattern has continued with the recent announcement that Copenhagen-based Scandlines is to convert two of the ferries operating the Puttgarden-Rødby route between Germany and Denmark to plug-in hybrid operation. Requiring an investment of around €31 million, partly funded by the German government, the refits include the installation of battery systems on each ferry, supported by charging facilities both onboard and at the Puttgarden and Rødby ferry berths.

Scandlines has signed a contract with Western Shiprepair in Lithuania, part of the BLRT Grupp, for the conversion work. The first ferry is scheduled to arrive at the Klaipeda yard at the end of August, followed by the second in December 2025.

These are bespoke conversions and will require the operator and yard to work together closely to overcome a number of significant challenges in completing the refits on the vessels selected for transformation to hybrid. As Ingrida Streckienė, director of Western Shiprepair, observes: "The most critical challenge in delivering this project is the need for effective and efficient planning. As the vessels will remain in operation until arrival at the yard, all the necessary preparations must be completed in advance to ensure smooth execution and timely delivery. Our project teams are consequently already working on a detailed schedule to minimise downtime."

3D simulation

Space limitations on board also present a significant constraint. As Streckienė points out: "Every millimetre counts. Our engineering team is



The first ferry is scheduled to arrive at the Klaipeda yard at the end of August, followed by the second in December 2025

utilising advanced 3D modelling to simulate the full integration of the new systems and identify potential collisions with existing structures. This proactive approach enables us to make all the necessary adjustments to the final design prior to the vessel's arrival, reducing risks and avoiding delays during the physical conversion phase."

While the ferries are in the yard, Western Shiprepair will carry out other works to support the hybrid conversion, including structural reinforcements, mechanical modifications and extensive electrical system upgrades to support integration of the new energy storage system (ESS). Safety systems are also being enhanced to meet the latest hybrid vessel requirements, and all of the work will be carefully coordinated to ensure that all onboard systems are fully optimised for hybrid-electric operation.

The project, secured by Western Shiprepair after an extensive tender process, continues a long-term working partnership between BLRT Grupp and Scandlines. Streckienė adds: "Over the years, we have built a strong foundation of trust and collaboration, successfully delivering complex repair and conversion projects together. The conversion of these two ferries operating on the Fehmarn Belt into plug-in hybrids is a significant step forward, not just for Scandlines' ambitious sustainability goals, but for the entire ferry industry."

Shore chargers

For these two ferries, Scandlines has specified the installation of lithium-ion battery banks rated at 5MWh. On average, the ferries' batteries will be charged in just 12 minutes, providing at least 80% of the energy needed for a crossing.

In many respects, investment ashore is as important to the conversion project as investment in onboard technology. In 2019, Scandlines invested in a 50kV/25MW power cable to Rødbyhavn, and subsequently this was extended by approximately 1.2km to a new transformer between ferry berths 2 and 3 in the Danish port. Norwegian Electric Systems (NES) has installed the transformer, control and switchgear equipment as well as the charging station for Scandlines' hybrid ferries.

A 8.6m-high ferry charger tower, developed by the German company Stemmann-Technik, has also now been installed on the quayside at ferry berth 3 in Rødbyhavn. The system stores the latest position of the ferry, so it is expected that only minor adjustments to the position of the charging pantograph will be required for each ferry call.

The ferry charging system is able to compensate for changes in water level and ferry movements and, as the ferry approaches the berth, the charging station is activated, the tower gate opens automatically and the charging plate extends. Once the ferry has moored alongside the berth, the charging pantograph connects to the onboard unit within a maximum of 15 seconds and starts charging the batteries. After charging, the tower gate rolls down again to protect the components from external influences.

Towards the end of 2025, Scandlines will also have a 30kV/15MW power cable, transformer and ferry charger tower installed in the port of Puttgarden, Germany. This will enable the ferries to charge in both ports in 12 minutes and maintain a crossing time of just 45 minutes.

Decade of investment

With these latest hybrid conversions, Scandlines is building on its already extensive experience of hybrid ferry operations. In 2013, the company converted the first traditional diesel-electric ferry into a hybrid ferry, combining diesel propulsion with electric battery propulsion. According to Michael Goldman Petersen, Scandlines COO: "As the conversion was a success, we converted the three remaining diesel-electric ferries operating our Puttgarden-Rødby route into hybrid ferries and also built two new hybrid ferries for the Rostock-Gedser route. Our extensive and very positive experience with hybrid ferries has demonstrated the concept is suitable for shorter routes like the ones we operate."

Utilising the batteries in the most efficient way together with the gensets is a key issue. As Petersen points out, though: "As we converted the first diesel-electric ferry into a hybrid ferry, combining traditional diesel propulsion with electric battery propulsion, more than 10 years ago, we have since gathered extensive experience in the use of batteries. So, we have a very good starting point for our newly converted ferries.

"By electrifying two of our Fehmarn Belt ferries, we are moving much closer to our goal of making the route direct emission-free by 2030. This is what our customers want, and it will significantly strengthen our competitiveness."

Overall, between 2013 and 2024, Scandlines has invested more than €380 million in technologies to reduce emissions. As well as introducing hybrid ferries on the Rostock-Gedser route, the company has retrofitted rotor sails and installed new centre propeller blades on these ferries, installed more efficient and low-noise thrusters on the Puttgarden-Rødby ferries and coated hulls with algae-repellent silicone paint, which saves energy compared to conventional types of bottom paint.

The company also has a zero direct emission freight ferry, which will be fully electric in regular operations, on order at Cemre Shipyard in Turkey. This will feature one of the world's largest marine battery banks to date, at 10MWh, which will also be capable of being charged in 12 minutes. The latest green vessel in Scandlines' fleet will be able to operate in hybrid mode, as well as purely using battery power. ■

AN ON/OFF APPROACH

Rising interest in retrofitting wind-assisted propulsion systems has created a need for reliable real-world data to inform investment decisions. **Clive Woodbridge** reports

Working with Lloyd's Register (LR) Advisory, Anemoi Marine Technologies has developed a new methodology to verify vessel performance and predict fuel savings, not only for its own Rotor Sails but for all wind-assisted propulsion systems (WAPS).

Theoretical approaches using CFD or wind tunnel tests can provide indicative savings in advance but cannot capture accurately all the real-world effects on the vessel with the same level of confidence, the partners say. Likewise, direct thrust measurement on board can provide an insight into WAPS behaviour but misses the important effects of vessel hydrodynamics and propulsion behaviour that affect fuel and emissions savings.

Anemoi has therefore developed an approach, validated by LR, that considers WAPS devices as a key element of the ship and the ship-wide energy system. The impact of WAPS on ship propulsion performance can be quantified, and an existing model calibrated, by analysing data collected through 'on-off' testing. In other words, as part of the testing, engineers switch the WAPS on, allow the vessel to settle to a new equilibrium, and then turn it off again. This calibrated model can be used as part of a performance prediction programme, to predict fuel savings for each voyage with high levels of confidence.

The increase in WAPS retrofits has generated a need for a transparent, in-service testing methodology

Analysis minus downtime

By measuring the ship's response to on-off tests conducted during its normal operations, a broad envelope of different wind and wave conditions can be covered without diverting the vessel from its schedule. The analysis approach deals with variations in other uncontrollable factors, such as wind, sea state and currents. This allows for a high proportion of test results to be used, leading to a short period of verification with more relevant results. The method fits the ship model to data points acquired in testing so that performance predictions can be applied across the entire range of conditions, even if tests were not conducted in every condition.

Tests are conducted at a range of relative wind angles, from ahead to astern on both sides, and in various wind speeds. For the change in WAPS-generated thrust to be measurable through changes in the vessel's speed or engine power above their natural variations due to changes in wind and waves, the apparent wind speed should be at least 10knots, ideally 16knots or more, Anemoi suggests.

For these tests, the main engine rpm and ship heading are kept constant while the WAPS are turned on and off for short periods while the vessel speed and main engine power are measured. This method works well for conventional cargo ships with closed-loop control of the engine rpm, Anemoi states. Typically, the percentage change in speed is of the same order as the percentage reduction in engine power. Anemoi notes that the resistance increases approximately with the square of vessel speed. This means that about 75% of the WAPS' thrust is used to increase the ship's speed while only about 25% is seen as a direct reduction in main engine power.

If the design of the control system allows, Anemoi and LR agree there is merit in running some tests at wind angles small enough to give negative thrust, even though this would not be done in normal operation. This allows the angle at which zero thrust is produced to be estimated more accurately by interpolation rather than extrapolation from tests run at higher wind angles.

Through comparison of the changes in vessel speed and main engine power, the performance benefit of the WAPS can be derived for the particular relative wind conditions at the time of the test. The input power used to spin the sails are measured and included in the calculation of net power and fuel savings. ■

CONSIDERING CRP RETROFITS

Total cost of ownership should be the key consideration when considering propeller overhauls, Steerprop claims. **Clive Woodbridge** reports

Finnish marine propulsion system supplier Steerprop is urging owners to consider more technological advanced contra-rotating propellers (CRP) with azimuth propulsion when contemplating retrofits to convert vessels partly or entirely to electric power.

Steerprop argues that CRP propulsion – such as its Steerprop CRP LM unit, with integrated permanent magnet electric motor – which has been optimised for the particular vessel and specific route, can offer significant advantages over standard electrification processes. Benefits include: lower mechanical losses through the LM configuration and pressure lubrication; high-efficiency PM motors; and a smaller installation footprint.

One of the company's recent case studies has indicated that a CRP unit offers total propulsion efficiency that is 32% better than a conventional pull-type propulsor with a Z-drive connected to an induction electric motor. Moreover, Steerprop has undertaken modelling based on a case study of two 1,500kW units operating in open water, where the CRP LM is shown to deliver significantly reduced annual energy costs when compared to alternatives, including push induction and PM, and pull induction and PM types. This analysis shows that the CRP unit would achieve an annual saving of between 13-35% compared to the alternatives, and that over a 15-year life span the cost savings would be between US$3.14 million to US$9.5 million.

For ice-class vessels, the benefits would be even more pronounced, with efficiency gains of between 27-49%, and 15-year cost savings of between US$6.7 million and US$12 million, due to the benefits of using pressure lubrication with ice-classed propulsors instead of standard immersion lubrication.

Markku Miinala, Steerprop's cruise and ferry segment director, says: "When considering propulsion system retrofits, owners often select the option that is initially the cheapest. However they should instead be focusing much more on the overall total cost of ownership."

Other benefits of converting existing systems with a Steerprop CRP LM unit include lower noise and vibration, a reduced footprint and a need for smaller batteries and thereby shorter shore re-charging times.

Ferry and tug work

Steerprop can point to proven success with this concept, with a retrofitting project for Finferries' *Prostvik* passenger and car ferry. The ferry was built in the 1980s, and it was time to update the old diesel-mechanical propulsion system with a more modern electric distribution system to gain increased reliability, higher energy efficiency and decreased emissions.

The ferry was retrofitted with SP 10 CRP LM units with an integrated 400kW permanent magnet motor. According to Steerprop, data from operations have shown that the retrofit achieved a significant improvement in the ferry's energy efficiency.

In another recent retrofit, Steerprop upgraded the Alfons Håkans ASD tug *Artemis*, whose propulsion unit was 40 years old and nearing the end of its life cycle. It was decided that a major overhaul would be costly and take too long to perform. In this case, an innovative solution was adopted to address issues with ice fouling encountered in the past with the nozzles. Steerprop developed a design where, instead of welding the nozzles in place, they were bolted in, allowing them to be removed when required in winter. The retrofit using dismountable nozzles means that *Artemis* can now be used effectively during the most severe winter weather conditions, and returned to a conventional mode for summertime operations. The 'nozzle on, nozzle off' concept will now be included in the retrofit scope of another Alfons Håkans tug, *Apollon*.

Over the last year, Steerprop says that a key focus of its product development work overall has been improving energy efficiency, with achieved benefits ranging from 4% to over 20%, according to different project features. This work will have benefits for its retrofit activities as well as newbuilding projects, helping companies meet their environmental objectives. Steerprop is also focusing on integrating tunnel thrusters within a vessel's propulsion system, leading to lower power requirements and, in some cases, reduced component sizes, all enhancing energy efficiency and reducing emissions levels. ■

Finferries' 140-pax *Prostvik* has reportedly benefited from a Steerprop retrofit

ENERGY CAP

A University-led team has taken a science-backed efficiency solution from lab to foundry in less than a year, writes **Clive Woodbridge**

EcoNavis Solutions has begun production of its patented Eco Boss Cap propeller hub, the result of a university-led research project, which it is marketing as a retrofit solution for shipowners looking for greater fuel efficiency. The first unit, destined for installation on a general cargo vessel, has been cast at a foundry in China using designs optimised through computational fluid dynamics (CFD).

According to EcoNavis, the Eco Boss Cap eliminates the hub vortex cavitation that causes rudder erosion, vibration and thrust loss in conventional propulsion systems. Unlike finned boss caps, which only function optimally at narrow speed ranges, the Eco Boss Cap features a smooth, conical design with internal chambers and strategically bored holes. This configuration uses fluid pressure differences to improve flow uniformity, reducing torque while increasing thrust across a range of operating conditions.

The innovation has been produced by a research team at the University of Strathclyde, led by naval architect Dr Batuhan Aktas. "We started by identifying the failure points of existing designs," he says. "Fin-type caps tend to generate drag outside their designed speed. We wanted to create something simpler and smarter: in effect, a passive system that could dynamically adapt without complexity or cost."

Parametric optimisation

Initial CFD simulations showed performance gains of over 3% in efficiency and reduction in propeller hub vortex cavitation. However, early prototypes revealed a critical problem in that some hole placements actually reduced propeller efficiency.

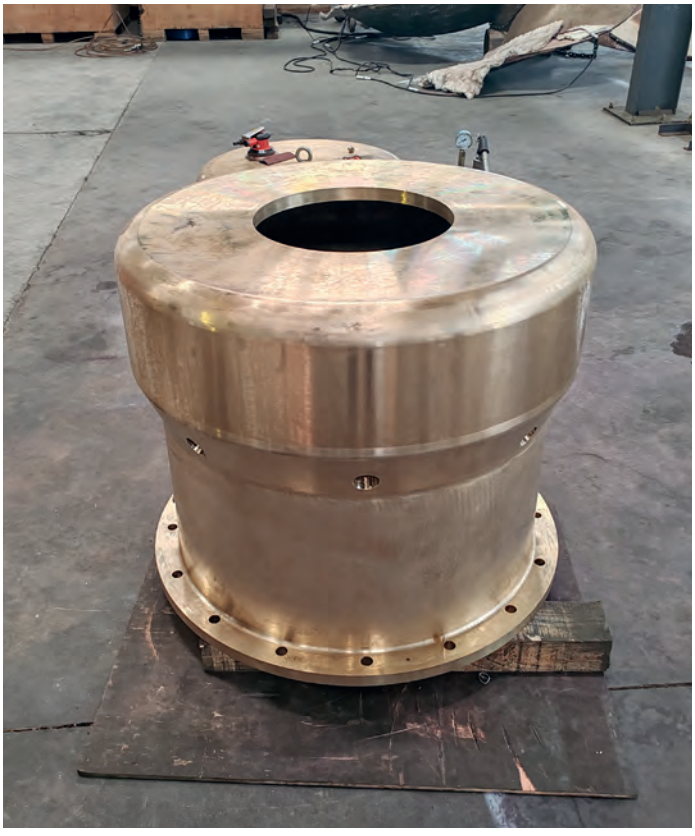
The team returned to first principles, iterating the design using advanced parametric optimisation tools. The breakthrough came when engineers redesigned the internal chamber to align the suction flow with stagnation pressure points, allowing the cap to draw water through its core without impeding thrust.

These insights led to successful trials at a European cavitation tunnel facility, where the final design is said to have outperformed other energy-saving caps. Now being manufactured under exclusive licence from the University of Strathclyde, the Eco Boss Cap is cast in a single piece, requires no moving parts and can reportedly be installed in five to six hours during a normal drydocking.

According to EcoNavis, it costs about 50% less to manufacture than typical fin-based units and is expected to achieve a return on investment in under six months for mid-sized vessels. Amitava Wye, EcoNavis' COO, comments: "What we have created isn't just another retrofit solution with bold efficiency claims, but rather a scalable propeller technology proven to reduce fuel costs across a broad speed range."

Early trials showed a 3.1% improvement in propeller efficiency, a 1.1% increase in thrust, a 2% reduction in torque and a 10% decrease in rudder cavitation. Noise was also reduced by up to 3dB, lowering the vessel's underwater radiated noise footprint.

The company has secured a contract with a Thailand-based ship management company for the first Eco Boss Cap in production. Follow-on orders are reported to be already under discussion. "We've moved from lab to foundry in less than a year and, with every unit, we're refining not just our technology, but how fast and affordably we can deliver it," Atkas concludes. ■



The first Eco Boss Cap retrofit is destined for a general cargo vessel

Cement carrier *UBC Cork* will be retrofitted with Seabound's containerised carbon capture system

CEMENTING ENVIRONMENTAL GAINS

Captured carbon from a retrofitted bulk carrier will be utilised at a pioneering cement plant in Norway, writes **Clive Woodbridge**

What is claimed to be a first-of-its kind carbon capture retrofit project has been confirmed by UK-based Seabound. Other participants in this project include the Hartmann Group, InterMaritime Group and Heidelberg Materials Northern Europe.

A compact marine carbon capture solution developed by Seabound will be used to retrofit the 5,700gt, 116.7m-long cement carrier *UBC Cork*, which is owned by Hartmann and managed by InterMaritime. The captured carbon, bound in limestone, enabling it to be stored safely on board, will be offloaded at the Port of Brevik, Norway and used in Heidelberg Materials' recently inaugurated Brevik cement plant, designed to produce net-zero concrete.

Seabound's containerised carbon capture system uses calcium looping technology to capture up to 95% of CO_2 and 98% of sulphur emissions from ship exhaust. The process uses calcium hydroxide, derived from calcium oxide, commonly known as slaked lime, to absorb CO_2 and convert it into limestone that can be stored on board until returning to port.

The containerised system facilitates installation, requires minimal vessel modification and is suitable for all vessel types, Seabound states. The design of this carbon capture system decouples carbon capture from post-processing, resulting in lower energy requirements, faster deployment and reduced cost compared to traditional liquefied CO_2 systems, the company adds.

"Suitable for retrofits"

Seabound founder Alisha Fredricksson says: "Our system is especially suitable for retrofits as the carbon capture device and storage system are all housed within modular units, which are the size of standard 20' shipping containers.

"This means that the main elements of the retrofit to a vessel relate to piping and the installation of certain process equipment to connect to the containerised units, as opposed to installing a fixed carbon capture device onto the vessel. Overall, this reduces the complexity and cost of the retrofit substantially."

A contract for a shipyard to undertake the retrofit has not been finalised yet and will take place after completing detailed engineering and class plan approval. "There are certain challenges that will have to be addressed on *UBC Cork*, which is a relatively small vessel with a compact engine room," Fredriksson points out. "The routing of the pipes from the engine to the containers with the carbon capture system inside is the main technical challenge for this project, but we believe we have found a suitable arrangement to overcome this."

This project is expected to be the start of a number of similar retrofits over the next few years. Seabound and Hartmann say they are committed to working together to expand carbon capture solutions throughout Hartmann's fleet, thereby helping to drive meaningful decarbonisation in maritime shipping.

Seabound completed its first onboard carbon capture pilot in late 2024, capturing CO_2 at around 80% efficiency on board a 3,200teu-capacity container vessel, *Sounion Trader*, operating in the Middle East, owned by Lomar Shipping and on charter to Hapag-Lloyd. The carbon emitted from the ship's exhaust in this case was captured and transformed into solid calcium carbonate pebbles, so that it could be offloaded at port.

RETROFITS OVER ALT-FUELS?

Swedish technology group Alfa Laval has extended its product range through acquisitions as well as investment in R&D, writes **Clive Woodbridge**

Alfa Laval reports that it is currently seeing greater activity around retrofits that reduce energy consumption versus switching to alternative fuels.

Sven Schreiber, president for business unit water, wind and fuel solutions, says: "In the market generally we are seeing a lot of uncertainty with respect to the use of alternative fuels. Owners know they have to go in that direction, but the predicament as to which fuel to use is holding decisions back.

"We are seeing that particularly with regards retrofits, where owners have a bit more time to consider choices, whereas for newbuildings there is more pressure to make a decision on alternative fuels now."

Nonetheless, the company has had some significant recent success stories relating to alternative fuel conversions. Most notably, it has recently completed work installing its FCM Methanol low-flashpoint fuel supply system to the 5,000teu-capacity container ship *Maersk Halifax*. While Alfa Laval has supplied a number of newbuidings with this technology, this was the first time that the system has been used as a retrofit.

The project involved adding a new fuel line for methanol alongside the traditional fuel line, and required overcoming challenges relating to the tight space constraints and demanding time schedule. The retrofit of the FCM Methanol on *Maersk Halifax* is described by Alfa Laval as being a "landmark" installation that required advanced engineering and a good understanding of the practical considerations of working with methanol.

Alfa Laval is now working on another retrofit involving FCM Methanol, this time involving an unnamed cruise vessel. It is anticipated that the necessary installation work will be completed in 2026.

R&D investment

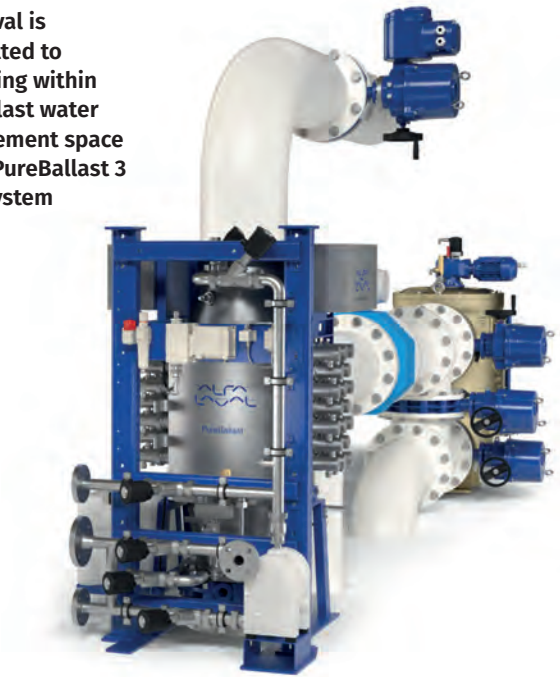
As indicated, most of Alfa Laval's environmental retrofit work at present relates to reducing fuel consumption, with a host of projects for different elements of its product portfolio underway at this time. One of the fastest growing areas is its Ocean Glide air lubrication system. "This technology is generating high levels of interest in retrofitting, because it reduces fuel consumption significantly, and the system can be retrofitted quickly during drydocking," says Schreiber.

The company continues to invest in research and development in technology that has a retrofit application, as well as newbuilding uses. A prime example is the recently launched Alfa Laval Aalborg fuel-flexible and electric hybrid marine boiler range.

Alfa Laval has also expanded its portfolio to include ultrasonic anti-fouling technology by acquiring UK-based NRG Marine, recognised for its Sonihull and Agitate brands, which prevent organic deposit build-up by using imploding microscopic bubbles to create surface agitation, passively cleaning surfaces and preventing biofouling. Installing the system lowers maintenance and cleaning costs while playing an important role in reducing fuel consumption and improving vessel CII ratings. "We are very excited about the future of this technology, applying it to ships in service as well as at the newbuilding stage," Schreiber adds.

In another initiative, Alfa Laval is rolling out PureBallast 3 Ultra, its latest ballast water management system (BWMS). The new system is said to deliver enhanced performance, greater energy efficiency and simplified installation, and is suitable for both retrofitting and newbuildings.

Despite a declining retrofit market, Alfa Laval says it made a business decision to invest in developing PureBallast 3 Ultra in order to demonstrate its commitment to remaining a partner in the ballast water management space. The system's compact design and reduced footprint have reportedly drawn a positive response from the market, particularly for tankers, where space is critical. Additionally, the integrated Cleaning-In-Place (CIP) and UV reactor module design is claimed to minimise piping requirements, reducing installation costs and complexity. ■



Alfa Laval is committed to remaining within the ballast water management space via its PureBallast 3 Ultra system

THE EVOLUTION OF PORTSMOUTH DOCKYARD

Mark Barton provides the first of a two-part overview of the earliest development of what we now know as Portsmouth Dockyard, with a look at other early British ports

It is just over 500 years since a major extension enabled Portsmouth Dockyard's main dock to accommodate the warship *Henry Grace à Dieu* that Henry VIII had ordered for the Navy: the first time I am aware of that a dry dock received a significant extension in length to convert if for a new class of vessel. So, it seems an apt time to look at the early history of docks.

The current Portsmouth Dockyard site is claimed to have started between 1492 and 1495, and certainly work started on a dry dock there that year for the King's Navy. But it is also clear that this dock was not new then, but was a repaired or redeveloped earlier feature, though who owned it previously is unknown, and whether it had been abandoned for a while is impossible to ascertain [1]. A Tudor map shows the new dock on a greenfield site outside the city walls. It was also at least the third location of a naval base in what is now Portsmouth.

With much increased capability from that initial dock construction, Portsmouth was certainly in use as a naval dockyard by 1509, concentrated around what is now called King's Stairs, as Henry VIII commissioned ship repairs there. The extension mentioned earlier occurred in 1523, and in 1527 Henry bought a further nine acres of adjacent land at 20 shillings an acre to expand the dockyard.

A map of forts on the Saxon shore

Dispersed production

The earliest naval base in Portsmouth was at the top of the harbour in what's now called Porchester. When it was built, it was probably called Portus Adurni, and it was one of the ports of the Roman fleet called Classis Britannia. The name is partially deduced in that there are four known sites and four known names and that is the only one where the name was not found. However, it makes etymological sense as *adurni* means 'thorns' and nearby is Thorny Island. This is where the Romans operated from, but we do not know where the ships were built. That possible dislocation of shipbuilding and naval base is not the same for all the classical navies. Rome had its own port, Portus, which was its industrial heartland for building and maintaining its ships. The Greeks maintained a base at Piraeus and the Carthaginians had a complex at Carthage, among other classical behemoth dockyards.

Back to Britain, the Saxons established a network of coastal forts to protect Britain from Viking raids. But there is no mention of naval bases, although the four Classis Britannica naval operating bases are among the list of forts [2], so presumably some supported vessels. We have no idea where the supposed 3,600 vessels that gathered for King Edgar's exercise in the 860s [3] were built or maintained. However, the scale means that they cannot have been built just for the exercise and with no major dockyard structure in Britain from the era; they must have been assembled from numerous dispersed sites.

That, however, was not the method used by the Normans to build their invasion fleet for 1066. The Bayeux Tapestry shows it being built on the beach in Normandy, specifically for the event, bringing all necessary resources to the site. We also know the seamen for these ships largely came from Flanders. It is most likely these ships were disposed of after the invasion, as there is no evidence of them subsequently being kept anywhere. With the dispersed nature of the sources for Edgar's fleet, it seems likely Britain continued to do the opposite to the Normans and dispersed its production, constructing ships all over the country, in mud docks. This was the method applied in 1294 when Edward I ordered selected towns to build 20 x 120-oar (or larger) galleys between them. Mud docks were temporary and meant you built the vessel where your main resource, wood, was. Thus, you would set up on the site, build the ship, sail it away and let the site return to nature.

Naval base

There are some known sites. One is at Small Hythe Place, now a museum, near Tenterden. This was part of the Cinque Ports and elements of medieval shipbuilding materials have been found. It is

known to have been where *Jesus*, a 1,000-tonne vessel, was built for Henry V, despite now having no access to a river. There are indications it may have been used for shipbuilding in the Roman era. It remained in use until the 19th century [5].

By the medieval period, the port and naval base at Portsmouth had moved from the Roman port to a small harbour behind the city walls, in what would now be old Portsmouth. At this time in Britain, there was no clear delineation between a merchant and a naval vessel. The King took merchant vessels into his service when he needed them and even the King's ships were used for merchant service to bring money in for the King when not needed for campaigns.

There, the naval base was used to support fleets for Richard I, King John [6] and Henry III [7] with the earliest mention in 1194 saying it consisted of "*our dock at Portsmouth with a good and strong wall…for the preservation of our ships and galleys and likewise penthouses to be made to the same wall…in which all our ships' tackle may be safely kept*" [8]. The facilities were probably temporary in nature although in use until 1228. But this was for maintenance rather than construction and, while we know where some were built, it appears shipbuilding remained dispersed around the country, though shipbuilding centres were emerging.

While other countries had built significant ship industrial complexes, in Britain this only seemingly started to change in the early 15th century due to the need to fortify naval bases. It is believed the Round Tower at Portsmouth was built in 1418 and a chain boom then installed between Portsmouth and Gosport. Further fortifications were added over the remainder of the century, enabling Portsmouth to become a permanent naval base once the Tudor dynasty came to power.

Specialist dockyards

Although Henry VIII is credited with being the 'Father of the English Navy', it was his father, Henry VII (1485-1509), who created the first purpose-built fleet of heavy gun-armed, three-masted warships capable of defending the country against invasion. Increasingly, the focus of naval strength shifted from the tidal creeks of the Kent and Sussex coast to specialist dockyards at Deptford and Portsmouth, although it appears they built the docks after the ships requiring them. Greenwich was already operating, but Woolwich is believed to have been established in 1512 and Deptford in 1513. The Tudor period, saw the home fleet based in Kent and London, with forward operating bases at Portsmouth and Plymouth [9]. However, ships were built for the crown at any suitable port, with the work spread around in what was in effect an industrial strategy supporting independent suppliers.

The challenge of building large, capable dock sites closer to ship operations to reduce transit time has long been a dilemma. The Royal Navy would ever after maintain major naval bases but also add significant dispersed docks to that capacity, including many contractors establishing docks for naval shipbuilding during the Napoleonic Wars. The 1865 Colonial Dock Loans Act, which established docks in countries such as Canada and Australia to enable them to provide a global support network, made use of temporary floating docks in various places, which could either then be used as the basis for the creation of permanent dockyards, such as AFD 9 at Singapore and AFD 60 at Faslane to get them started, or AFD 20, based in Kames Bay, Scotland. which was a temporary base to enable the X craft to operate and which allowed the site to return to nature after the war. ■

REFERENCES

1. OPPENHEIM, M., *Naval accounts and inventories of the reign of Henry VII* (London, Naval Records Society Vol 8, 1896)
2. Saxon forts map created by Constantine Plakidas, 4 October 2007 and released for public use. This has similar assumptions in translation as the earlier list of Classis Britannica and is based on the *Notitia Dignitatum XXVIII* (Extract) held by Bodleian Library, accessed 29 May 2023 at http://www.favonius.com/romans/saxon_shore_forts.htm.
3. HILL, P., *The Anglo-Saxons at War, 800–1066* (Barnsley, Pen and Sword, 2012), p67. Although with the nature of records at that time the number could easily be an exaggeration.
4. This was due to William's seizing of Matilda, daughter of the count of Flanders to make her his bride. VAN LOO, B., *The Burgundians, A Vanished Empire, A History of 1111 years and a day* (Great Britain, Zeus Books, 2019), p58.
5. GILLINGHAM, J., *Richard I Galley Warfare and Portsmouth* (Thirteenth Century History Durham Conference 1995 - ed by Britnell VI pp1-15), p11.
6. GILLINGHAM, J., *Richard I Galley Warfare and Portsmouth* (Thirteenth Century History Durham Conference 1995 – ed by Britnell VI pp1-15), p11.
7. ROSE, A., *Kings in the North, the house of Percy in British History* (London, Weidenfeld & Nicholson, 2002), p120 and p184.
8. ROSE, S., "A re-appraisal of the King's Ships in the Reigns of Richard I and John 1189-1216" *The Mariner's Mirror* Vol 106: 1 February 2020, pp6-17, p14.
9. ROSE, S., *England's Medieval Navy 1066-1509* (Barnsley, Seaforth, 2013), p93.

LOOKING GOOD

Dear Sir,

I read with interest Mr Maurice Napier's feature on *Ship Aesthetics: An Endangered Art?* in the June issue of *The Naval Architect*.

In the author's feature, he highlights British India's *Bulimba* as being a cargo ship combining aesthetics and functionality. It is the opinion of the writer that the mid-to-late-1960s was the zenith of break-bulk cargo vessel design, as well as its wane. This was also the rise of the 'box-boat' containership and its rapid trend. Other cargo ships that incorporated aesthetics were Shaw Savill's *Medic*, *Megantic*, *Laurentic* and *Zealandic*, also Union-Castle's *Good Hope* and *Southampton Castles*. All now consigned to history.

The author also mentioned 'sheer'. This can readily be appreciated if one looked down the long accommodation passageways of the *Queen Elizabeth 2* seeing the curvature of the sheer as it dipped down and rose so the end of the passage was out of sight. This compared with the *Queen Victoria* and *Queen Elizabeth*, where one could look along similar long passageways and see the doors at the far ends with no sheer.

In 2019, the writer was privileged to take a cruise on the old liner *Marco Polo*, originally built in 1965. The cabin [stateroom] was forward of the accommodation beneath the bridge overlooking the foredeck. It extended from near amidships to the starboard extremity, a really 'posh' choice.

The ship was originally the Soviet liner *Alexandr Pushkin,* so the bathroom/WC was retrofitted from its early days. Now this cabin was situated where the sheer of the deck intersected with the camber of the deck! When one entered the cabin from aft, one had to walk 'uphill' to the forward ports and 'downhill' to the starboard ports, and reverse in the opposite direction. The shape was in effect a distorted cuboid and reminded the writer of a mild form of the Crazy House at Blackgang Chine.

In answer to Maurice Napier's question about aesthetics: most certainly! ■

Richard de Kerbrech
MRINA

Shaw Savill's *Medic*: an example of a cargo ship incorporating strong design aesthetics

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4-7 NOVEMBER, 2025
EUROPORT 2025
International exhibition
Rotterdam, Netherlands
https://www.europort.nl/

18-20 NOVEMBER, 2025
METSTRADE 2025
International exhibition
Rotterdam, Netherlands
https://www.metstrade.com/

12-16 JULY, 2026
NINTH SYMPOSIUM ON MARINE PROPULSORS - SMP '26
International symposium
St John's, NL, Canada
https://www.smp26.ca/

11-14 NOVEMBER, 2025
DRY DOCK TRAINING 2025 (ONLINE)
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