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APRIL 2025

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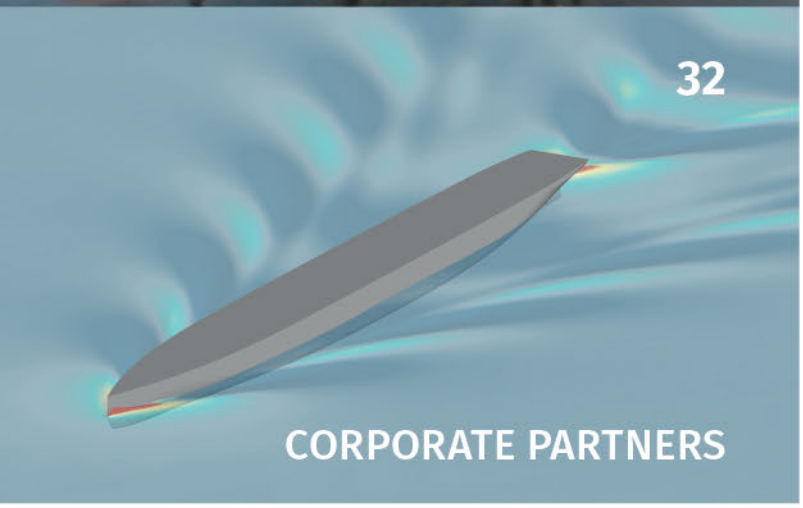
CONTENTS



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RECHARGE

NEW DIMENSIONS OF DESIGN

In the Editorial Comment in March, I looked at nuclear energy as a potential game-changer in the commercial shipping sector's quest to decarbonise, spurred by the development of small modular reactor technology.

Another technology that the maritime and offshore sectors may further exploit in the coming years is additive manufacturing (AM), or 3D printing. So far, this has mainly been used to manufacture onboard components, including, but not limited to, hatches and covers, cleats and hooks, vents and grilles, and even propellers. As well as granting users the ability to design parts tailored to exact specifications (particularly handy for one-off repair pieces) and the ability to create components lighter than their traditional counterparts (a win for smaller boats and racing vessels), 3D printing means reduced waste: unlike traditional build methods, using fibreglass or wood, 3D printing layers on only what's needed, removing the need to cut away excess material.

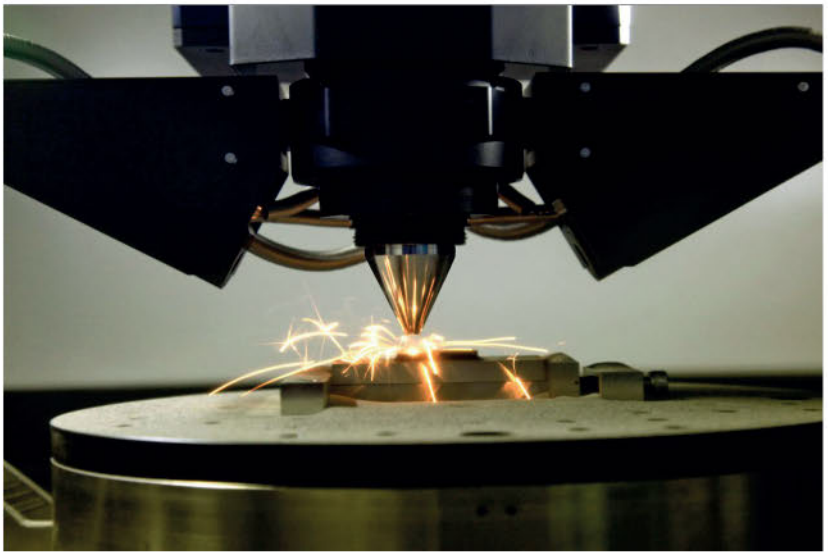
This methodology could benefit shipping companies that wish to print their own spare parts, rather than relying on dealer networks; simply print your own parts as and when you need them, either from a strategic port location, or even on board the ship itself.

Over the past few years, though, we've seen a handful of ambitious projects to develop 3D-printed boats – one of which, involving Caracol AM and V2 Group, is presented on pages 24-26. While the first version of the boat is described as near-functional, a fully functional second model should be under construction by the time you read this. Manufactured in less than a week, the 99% single-piece boat marks an important step forward for the concept.

Of course, there are safety and stability standards to consider: despite the aforementioned benefits, 3D-printed boats must be demonstrably robust to withstand high waves and harsh winds. It was interesting to see, then, the International Association of Class Societies (IACS) publish a new recommendation, Rec. 186, which has been developed to help advance a standardised approach to integrating AM into marine and offshore applications. Rec. 186 outlines several "key areas" for the "safe and effective adoption of AM in the marine sector, including AM processes (such as powder bed fusion, directed energy deposition and binder jetting), tiered testing levels, "rigorous qualification processes" for AM feedstocks, as well as maritime-specific qualifications for parts, which would also involve pre-build simulations.

As Alexandre Astruc, chair of IACS' expert group on materials and welding, puts it: "3D printing is increasingly becoming a valuable tool for the marine sector, offering a flexible, speedy and customisable solution for environments where the consequences for safety, sustainability or operational uptime can otherwise be significant." It will be interesting to observe how this technology develops within our industry – and, suffice to say, if any of our readers are working on 3D-related projects, whether manufacturing parts and components or whole boats, we would be delighted to hear from you. ■

Martin Conway,
Managing Editor



Reduced waste and customisation are two of the potential benefits of using additive manufacturing to build components and whole boats

GREEN PROPULSION

INTERFERRY CALLS FOR 'ROBUST' OPS

Shipping executives were recently informed that ferries need access to a reliable onshore power supply (OPS) for green propulsion to truly succeed. This key point was highlighted at a seminar called 'Shore Power Offers Promising Carbon Cuts – Are We on Track?', held on 19 March as a side event during the European Shipping Summit in Brussels. The seminar was jointly hosted by Interferry and the Cruise Lines International Association (CLIA).

Johan Roos, Interferry's director of regulatory events, told attendees: "Investment in OPS infrastructure is key to the energy transition of European and worldwide ferry operations, supporting the adoption of battery technology and reducing reliance on limited resources of alternative fuels. Focusing only on the vessel in port misses the bigger picture. We need robust power supply to charge the propulsion batteries on the ships, so that we can tap into the full technological potential of OPS.

"The energy infrastructure in many industrialised countries needs a more coherent view, and this includes the importance of electric transportation and shipping." Roos called for EU member states to allocate more funding to "upgrade the entire port infrastructure" and "set the benchmark for global development".

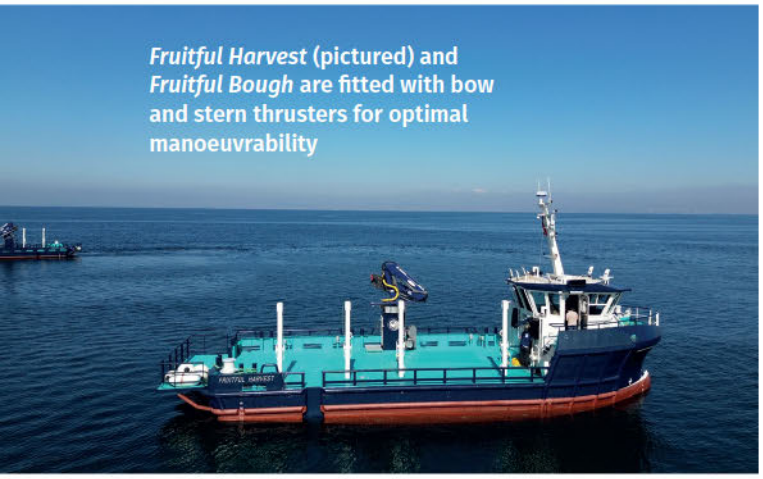
The seminar was also attended by Interferry CEO Mike Corrigan, who said: "The ferry industry is a driver in the development of sustainable propulsion solutions for the entire shipping industry, as we can see from the large number of projects and investments made by our member companies. Shore power is a cornerstone of our industry's decarbonisation efforts, and we must ensure that funding supports the full scope of infrastructure needs. We need a holistic approach to achieve meaningful carbon reductions."

Also in March, the Maltese government secured an agreement with Carnival UK and P&O Cruises to roll out fully electrified cruise berths at Valletta Cruise Port, enabling cruise ships to reduce their carbon footprint by sourcing power from the grid when in port. The cruise lines signed the agreement on behalf of Carnival Corporation & Plc, whose cruise brands include P&O Cruises, Cunard, AIDA, Costa, Holland America, Seabourn and Princess Cruises – all of which are regular callers at Malta, which takes nearly €40 million from cruise passengers during their visits each year. ■

FISHING VESSELS

DEBUT FOR *FRUITFUL* DUO

Scottish fishery Blueshell Mussels has taken delivery of two sister vessels, *Fruitful Harvest* and *Fruitful Bough*, ordered to service mussel farms around the Shetland Islands, in the north of Scotland. The vessels were designed by Macduff Ship Design and built by Turkish boatyard Etkin Marin, working under contract to Skagen Ship Consulting.

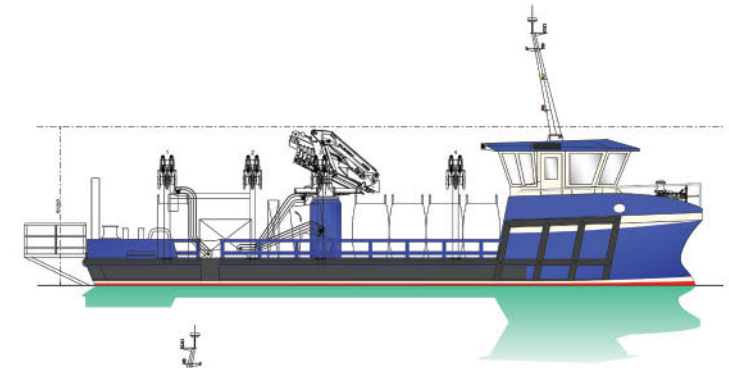


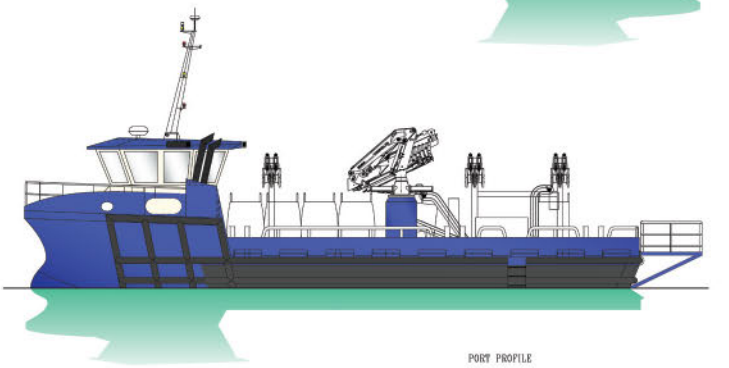
***Fruitful Harvest* (pictured) and *Fruitful Bough* are fitted with bow and stern thrusters for optimal manoeuvrability**

Each of the sisters features a length of 20m, a 7.2m beam and a depth of 2.3m. Design features include low water and air draughts, of 2m and 5.25m respectively, for seamless operations around the islands, plus the installation of bow and stern thrusters for enhanced manoeuvrability and accurate control at low speeds. Macduff Ship Design says: "Alongside their harvesting duties, the vessels can perform multi-role tasks such as mooring work, crane operations and towing."

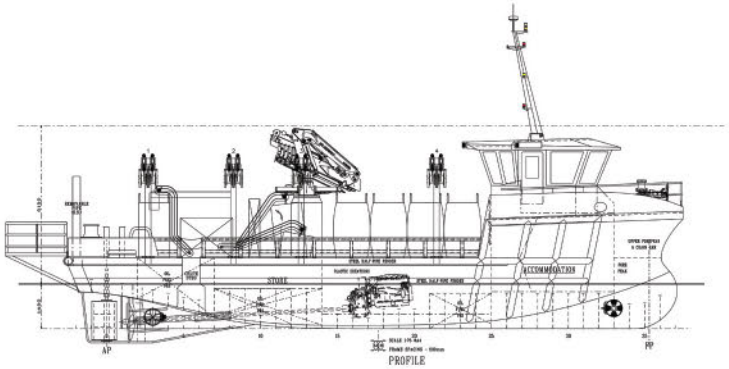
Fruitful Harvest and her sister each include bunks for four crew. The wheelhouse, mounted on the forecastle, is arranged with controls to starboard and a crew lounge to port. Each vessel is fitted with dual Doosan L125 TIH main engines, rated 268kW at 2,000rpm apiece, which drive fixed-pitch open Kort propellers through Dong-I gearboxes with 4.04:1 reduction ratio. Doosan also supplied each boat's AD136 TI auxiliary engine.

Thistle Group, meanwhile, supplied each sister with a Guerra M230.20A marine crane. The twins have been classed to the UK Maritime and Coastguard Agency (MCA) Workboat Code III, enabling them to operate in Category 3 waters up to 20 miles from a safe haven. ■





PORT PROFILE



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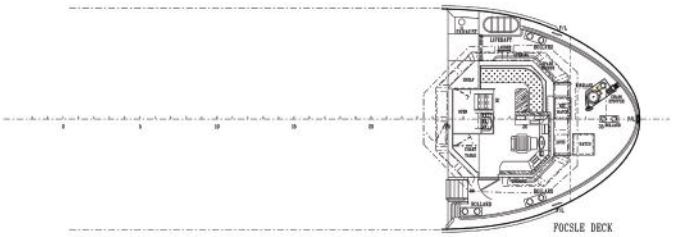
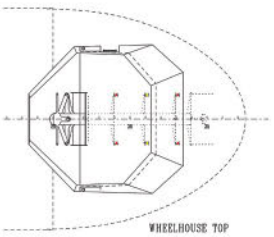
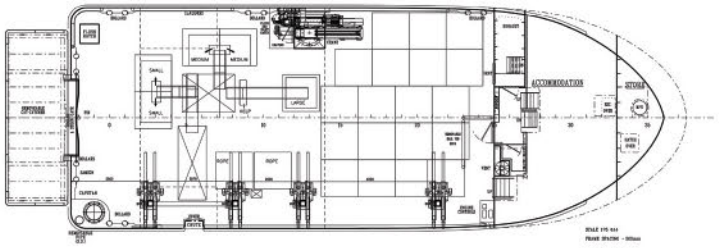


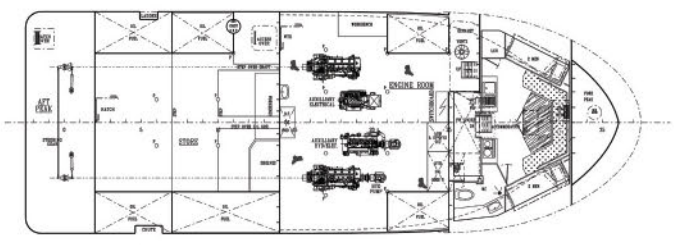
FOCSLE DECK



WHEELHOUSE TOP



MAIN DECK



BELOW DECK

The general arrangement for *Fruitful Harvest*/*Fruitful Bough*

OFFSHORE SUPPORT

UK EYES UP WIND BOOM BUILD OPPORTUNITIES

Shipbuilder APCL Cammell Laird has been tasked with performing an in-depth analysis of the potential market for UK-built ships in the offshore wind sector, commissioned by the Offshore Renewable Energy (ORE) Catapult, the National Shipbuilding Office and The Crown Estate.

Lauren Hadnum, clean maritime manager at ORE Catapult, says: "We know that for the UK to tap into the full potential offered by offshore wind, we're going to need to dramatically increase the number of vessels that are able to maintain the turbines of the future. It's vital, therefore, that we work to ensure as many of those vessels as possible can be manufactured in British shipyards."

Global offshore wind capacity is projected to exceed 850GW by 2050, driving demand for increased production of service operation vessels (SOVs) to support this growth. ORE Catapult has forecast that "hundreds" of SOVs are likely to be in operation around the world in the run-up to that date, with an associated global market value of "nearly £35 billion" between now and then.

Will Apps, offshore wind strategy director at The Crown Estate, which manages the UK seabed and leases sites to offshore wind farm developers, comments: "The UK is one of the world's leading offshore wind energy producers, second only to China. We expect a significant uplift in demand for SOVs in the coming years, with the potential to create jobs and economic growth within communities around the UK.

"One particularly interesting output from the study will be the feasibility assessment of low- or no-emission SOVs operating in the UK, acknowledging the importance of decarbonising the offshore wind sector itself and of the operation and maintenance of windfarms." ■

The global SOV sector could accrue a market value of "nearly £35 billion" between now and 2050, ORE Catapult predicts (image: Bibby Marine)

HEALTH AND SAFETY

FRESH IMCA GUIDANCE ON DIVER HEALTH

The International Marine Contractors Association (IMCA) has published new guidance on the use of deck decompression chambers (DDCs) to treat divers with decompression illnesses.

The document, referred to as *IMCA D085 guidance on DDC operations for the therapeutic treatment of divers*, stresses the importance of having DDCs at worksites and developing emergency response plans to ensure immediate treatment, to prevent long-term injury and death.

IMCA says the guidance was developed in response to diving industry concerns about "a decline in DDC operational competence". There have been cases where divers in need of treatment were not recompressed at the worksite, even though a DDC was available, IMCA notes.

The new IMCA guidance covers areas such as: project planning, including dive logs, dive rotas and the use of therapeutic recompression tables; the responsibilities of the diving contractor, diving supervisor, divers and clients; ensuring that third-party hyperbaric facilities are fit for purpose and accessible during emergencies; and the importance or regular training, drills and competence assessments. The guidance also includes minimum specifications for DDCs (including medical lock operation and gas management, for example) and medical equipment, as well as guidelines on informing next of kin and handling media inquiries in the event of an accident. ■

IMCA's guidance was developed to address concerns about a decline in deck decompression chamber operational competence

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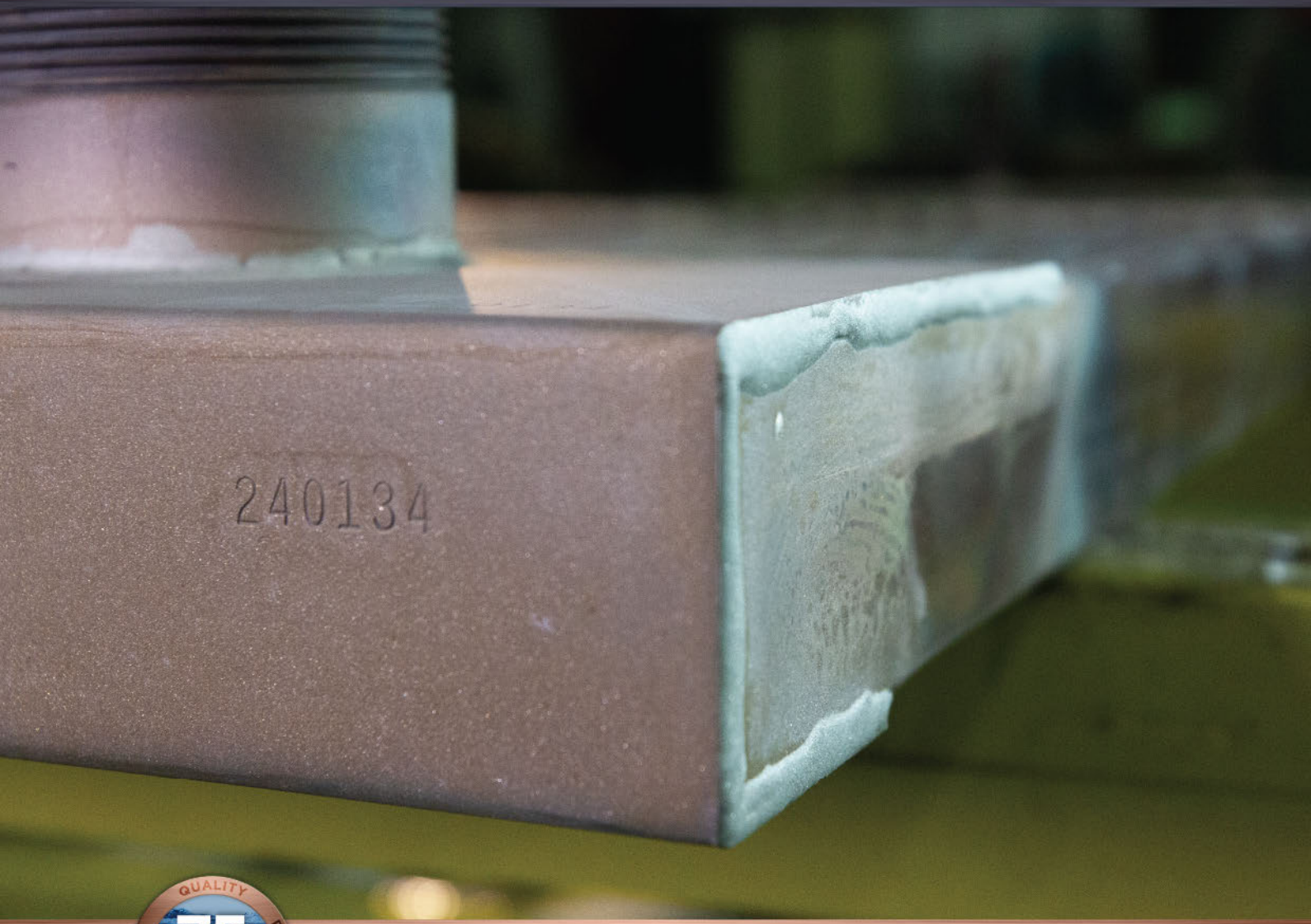

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CONTAINER FEEDER SHIPS

LANGH SHIP'S *INGRID* SAILS IN

Finnish shipping company Langh Ship has received the first of three new 1,200teu container feeder vessels from Chinese builder PaxOcean. Christened *Ingrid*, after the Langh Ship MD's daughter, the vessel will be chartered by UK-based Borchard Lines, as will her forthcoming sisters.

Ingrid's design, which was developed jointly by Langh Ship and the Shanghai Merchant Ship Design & Research Institute (SDARI), enables her to carry 45' containers both in the holds and on deck. Notable features include the vessel's hatch covers, which can be opened in three sections spanning the vessel's beam, for easier access to the cargo holds. Particulars for the three ships include a length of 150m, a breadth of 27m and a draught of 8.75m.

Ingrid is fitted with a two-stroke, slow-speed main engine and a hybrid scrubber, provided by Langh Ship's sister company, Langh Tech. Additionally, the ship's exhaust gas cleaning system has been prepared for the installation of Langh Tech's new onboard carbon capture system. Langh Ship states: "The system captures CO_2 from the exhaust gas flow, [reducing] CO_2 emissions by 20-50%. The captured CO_2 is then chemically bound into sodium carbonate, which can be utilised in a variety of other industrial applications. This helps to establish a circular economy across different sectors and accelerate decarbonisation." The vessel can attain and maintain a speed of 18knots. ■

Ingrid Langh, daughter of Langh Ship MD Laura Langh-Lagerlöf, pictured next to her 150m namesake at the delivery ceremony

FERRIES

HONG KONG GOING HYBRID

Hong Kong-based ferry operator Sun Ferry has taken delivery of a new 34.7m x 9.7m diesel-electric ferry, *Xin Ming Zhu 30*. The newbuild, which was built by AFAI Southern in Guangzhou, marks the third of seven vessels designed for the operator by Incat Crowther, and will connect the islands of Peng Chau, Mui Wo, Chi Ma Wan and Cheung Chau.

The alumunium ferry has a depth of 3.35m, a draught of 1.28m and overall capacity for 300 passengers and three crew. The main deck seats 171 passengers and includes wheelchair spaces and dedicated areas for pets, while the upper deck seats 129. Passengers can also take advantage of a centrally positioned, 6m² cargo space. The crew quarters are located on the main deck, aft. The ferry can also carry 4,800litres of fuel oil, 1,000litres of fresh water and 640litres of urea.

The powertrain includes four Volvo Penta D16 MG main engines, each rated 420kW at 1,500rpm, and two Ramme electric motors, rated 500kW at 1,200rpm apiece, granting the ferry a service speed of 14knots. A pair of 451kW Veth azimuthing thrusters were selected for enhanced manoeuvrability. The ferry is also fitted with 72 solar panels, which provide 7.5kW of additional clean power. Incat Crowther says that the final three vessels in the series, all measuring 45m in length, will be delivered by the end of 2025. ■

The diesel-electric *Xin Ming Zhu 30* has the capacity for 300 passengers

CRUISE SHIPS

FIRST PRIMA PLUS JOINS NCL FLEET

The Prima Plus-class *Norwegian Aqua* is 10% larger than its Prima-class predecessors

Mid-March saw Fincantieri's Marghera yard deliver the first in the Prima Plus class, *Norwegian Aqua*, to Norwegian Cruise Line (NCL).

Measuring approximately 322m in length and 44m in beam, the 156,300gt vessel is claimed to be 10% larger than the first pair of 293m x 41m Prima-class vessels that Fincantieri delivered to NCL, namely *Norwegian Prima* and *Norwegian Viva*. The handover of *Norwegian Aqua* was followed the next day by the launching ceremony for her sister cruiser, *Norwegian Luna*, which is scheduled for delivery in spring next year.

Fincantieri comments: "Over the past few months, more than 4,000 people, including Fincantieri staff and partner companies, have worked tirelessly on board this new ship." According to reports, *Norwegian Aqua* can accommodate more than 3,570 passengers at full occupancy, compared to the 3,099 passengers that *Norwegian Prima* and *Norwegian Viva* can carry. The vessel has been arranged for a 1,388-strong crew.

Norwegian Aqua's features include the 'Aqua Slidecoaster', described as a "hybrid rollercoaster and waterslide", plus the 'Glow Court', a digital sports complex with an interactive LED floor. The ship also hosts an 'Aqua Game Zone', featuring immersive and virtual reality-enhanced games. An outdoor promenade, dubbed 'Ocean Boulevard', is said to offer 360° views. ■

PATROL AND RESCUE BOATS

MARITIME PARTNER'S BIGGEST ORDER YET

Norwegian boatbuilder Maritime Partner says it has landed "the largest contract in the company's history" with an order for seven of its SJØBJØRN 71-class search and rescue (SAR) vessels. The order, which has been heralded as a win for both the builder and the local economy, was placed by the Danish Defence Acquisition and Logistics Organization (DALO), which previously took delivery of 20 boats from Maritime Partner.

Commander Steen Balslev, director for naval systems at DALO, says: "The addition of the new vessels is a fundamental element in the ongoing renewal of the existing fleet of rescue vessels. The renewal will give the coastal rescue service a significant boost...[and] the new vessels will ensure that the working environment and safety for the personnel are improved."

The seven aluminium vessels are based on Maritime Partner's A2000 hull design. Each will feature a length of 21.7m and a breadth of 5.9m, and will accommodate up to five persons. Each boat's powertrain will comprise dual 1,200kW engines and a waterjet, enabling speeds of more than 35knots and a towing capacity of more than 9tonnes. Range will exceed 350nm.

The DNV-approved SAR boats will also feature self-righting capability, even if the wheelhouse sustains damage, plus firefighting systems. All seven will be built at Maritime Partner's facility in Breivika, Ålesund. According to the company, the contract will "create jobs well into 2028". Maritime Partner tells *The Naval Architect* that the seven newbuilds will be delivered between mid-to-late 2026 and late 2028, though the contract contains an option for additional vessels. ■

The seven SJØBJØRN 71-class vessels comprise Maritime Partner's largest order to date

SMART SOLUTIONS

MONITORING TOOL SUCCESS FOR GNV

Italian ship operator Grandi Navi Veloci (GNV) reports that it has adopted class society RINA's SERTICA Performance tool aboard its newest fleet addition, the 218m *GNV Polaris*, kicking off with a trial during the ship's maiden voyage from China to Italy. This tool is designed to track operational data with the aim of enabling effective energy management and performance.

GNV says: "Thanks to the system, [we] identified two optimal operating scenarios allowing for the lowest specific fuel consumption, and a predictive model that serves as both a benchmark and a simulator for future operations." The trial saw the development of predictive models using machine learning techniques, to simulate scenarios where the vessel may undertake an alternative route or schedule, or to predict the effects of burning different fuel types. "A physical model of the ship, trained with the collected data, achieved remarkable accuracy," GNV says.

RINA's SERTICA Performance tool was used aboard *GNV Polaris* on her maiden voyage

SERTICA Performance uses a network of onboard sensors to gather real-time data related to parameters such as fuel consumption and generator/engine power performance, to help both the crew and shore-based management teams to calculate the ship's actual efficiency. This data is collected every five minutes.

During the *GNV Polaris* voyage, operational scenarios were simulated at different speeds and configurations, including alternating use of diesel generators and shaft generators to work out the most efficient solution regarding fuel consumption, GNV says. ■

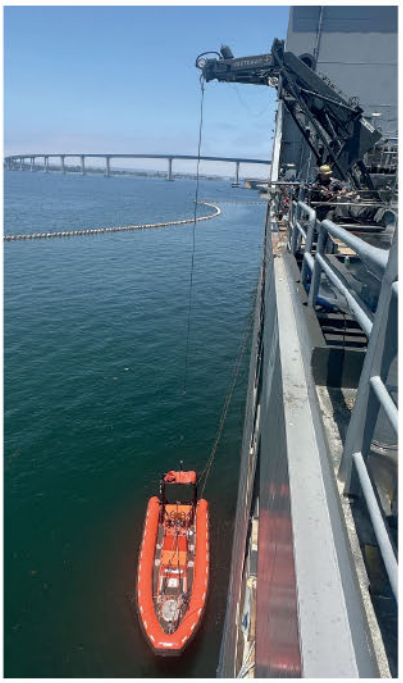
SAFETY AND SECURITY

T-AO OILER DAVITS COMPLETE SEA TRIALS

Norway's Vestdavit reports that an initial pair of rescue boat davits provided to the US Navy, intended for installation on a series of new fleet replenishment oilers (T-AOs), has successfully completed sea trials.

Vestdavit's PLRH-5000-branded davits were put through their paces aboard USNS *Robert F. Kennedy*, the fourth T-AO oiler to be delivered in the series of John Lewis-class vessels, under construction at San Diego-based General Dynamics NASSCO. The davits will be used to launch and recover 7m-long RIBS, which will support the oilers' refuelling operations for US Navy carrier strike group ships operating under the Military Sealift Command. Each of the 226m, 20knot-capable vessels will be capable of carrying 157,000 barrels of oil.

The PLRH-5000 davits are motion-compensated and incorporate shock absorbers, to remove peak loads, and constant tension, for safe and efficient recovery in rough sea conditions. They are designed with guiding arms, which effectively act as an anti-pendulation device, keeping each RIB steady during deployment/recovery.



The Vestdavit PLRH-5000 davits will be used by the US Navy's T-AO oilers to launch and recover 7m support RIBS

Vestdavit also reveals that it recently secured an additional purchase order from GD NASSCO for the davits. As a result, the company will supply the US builder with 14 PLRH-5000 davits in total, two for each of seven T-AO oilers. The shipyard has so far been contracted to build 10 T-AO oilers for the US Navy.

Magnus Oding, general manager of Vestdavit's US subsidiary, Vestdavit Inc, says that the PLRH-5000 units are supplied as self-contained, skid-mounted davits for easy installation. "All that is required is to weld it to the deck, fill oil and connect the power," he comments. ■

FUTURE OF CRUISE SHIP ON BOARD

Fincantieri is leader in high technological shipbuilding industry and the global leader in cruise sector.
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FUTURE ON BOARD

SAFETY AND SECURITY

ROLL-OUT FOR ANTI-JAMMER

AST Networks has been appointed an official reseller of SAL Navigation's SAL SPU-200 anti-jamming and anti-spoofing system, developed for both government and commercial maritime applications.

The SAL SPU-200 can maintain GNSS integrity even under military-grade jamming

According to the partners, the SAL SPU-200 can maintain GNSS integrity, even under high-power, military-grade jamming and/or if traditional onboard systems fail. The system offers uninterrupted positioning, speeds, heading and rate of turn, helping to prevent affected ships from veering off course, as well as real-time monitoring and alerts, giving crew members a chance to react to potential threats before they escalate.

The SAL SPU-200 is also compatible with any chart software or ECDIS system accepting NMEA 0183 data input, and WiFi-enabled to permit remote diagnostics and support. The system contains a built-in battery, offering more than 7.5 hours of uninterrupted operation in the event of a power outage.

AST Networks says: "The maritime industry is facing unprecedented threats from satellite navigation jamming and spoofing, particularly in high-risk regions like the Baltic Sea. Persistent GNSS disruptions have led to vessels losing course, increased collision risks and severe operational inefficiencies." The company adds that, as part of the reseller contract, it will offer tailor-made packages based around the system for specific vessels' and fleets' security needs. ■

FUEL MONITORING

CMT: BIOFUELS ADOPTION REQUIRES GREATER DILIGENCE

Shipowners and operators should exercise "greater diligence" and adopt "rigorous monitoring practices" when opting to use biodiesel blends to reduce their emissions, condition monitoring solutions specialist CMT has warned.

David Fuhlbrügge, co-MD at CMT, comments: "Operators must actively monitor fuel quality to prevent issues that could compromise engine efficiency, reliability and compliance."

"Rigorous monitoring" is necessary to protect engines against acidity and corrosion when adopting biofuel blends, CMT has warned

He cites research by classification society DNV, which found that "the solvent-like nature" of biofuels can dislodge tank residues, thereby clogging filters and separators. Similarly, the higher acidity in biofuels increases the risk of corrosion. "Higher base number [BN] lubricants will be required to neutralise acids and protect components from excessive wear," CMT states. "Biofuels also absorb more water, which fosters microbial growth and fuel degradation."

The company is consequently advising owners and operators to implement "strict testing protocols" for parameters such as viscosity, stability and water content, to avoid unexpected performance problems. Fuhlbrügge says: "With alternative fuels becoming mainstream, shipowners must adopt systematic fuel monitoring to safeguard engine reliability and regulatory compliance." ■

3D PRINTING

HMM TRIALS ONBOARD 3D PRINTING

South Korean containership operator HMM has conducted a pilot demonstration of a 3D-printing system on the 9,000teu *HMM Green*. The company aims to assess its operation in actual sailing conditions and evaluate its feasibility for procuring maintenance parts while at sea.

The installed '3D Printing Digital Workshop' uses metal powder to produce stainless steel components, and has the potential to reduce the lead times for components by enabling ships to rapidly produce essential parts on demand if adopted. This would reduce inventory costs while preventing downtime during vessel maintenance, HMM says. ■

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

RESEARCH AND SURVEY

FIRST DRIX O-16 SALE FOR EXAIL

USV developer Exail reports that it has sold its first DriX O-16 transoceanic USV to an unspecified commercial customer in the Indo-Pacific region. The sale was realised shortly after the launch of the monohull unit, which has been designed for the collection of hydrographic, geophysical and environmental data.

Olivier Cervantes, Exail VP, maritime autonomy solutions, says the USV "[secured] the customer's confidence just three months after its christening". Fashioned from infusion epoxy and a combination of e-glass and PVC, the DRiX O-16 measures 15.75m In length and 1.83 in breadth, and draws 2.55m. The USV utilises a dual-hybrid diesel-electric powertrain, including a 120kW diesel engine and a 20kW electric Azipod.

The 15.8m DRiX O-16 has a range of 3,500nm (image: Martin Raget)

The DRiX O-16 weighs 10.5tonnes and has a fuel capacity of 2,300litres, enabling a range of 3,500nm, Exail says. The payload includes a sub-bottom profiler, a USBL and single and multibeam echosounders, to undertake fish and biomass monitoring, for example. The USV can also be fitted with a launch and recovery system (LARS) for the deployment and recovery of smaller ROVs and AUVs, thus permitting multi-vehicle operations. The DriX O-16 is also equipped with a forward-looking sonar, to detect potential obstacles in the water, as well as the CortiX obstacle avoidance system. ■

RESEARCH AND SURVEY

ADVANCED TECH FOR WASSP-EQUIPPED DRONE

HydroSurv has delivered a REAV-28 USV to Foyle Marine & Dredging, which will use the drone to conduct bathymetric surveys for marine construction and dredging operations.

For this order, the 2.85m catamaran USV was equipped with a WASSP multibeam echosounder system, supplied by Furuno. The WASSP's reported features include "survey-specific tracking algorithms", plus 120° swath width (the width of the seafloor that a sonar beam can map in a single pass), thanks to advanced signal processing, HydroSurv says.

"We've seen growing demand from marine service operators for a solution that addresses the gap between single-beam echosounder and high-end multibeam solutions," adds David Hull, HydroSurv CEO and founder. "Partnering with WASSP, we've been able to put a powerful tool into the hands of the team at Foyle Marine & Dredging that will drastically reduce the costs of repeated resurveys in their construction and dredging projects."

The REAV-28 is powered by 915W Torqeedo lithium-ion batteries; two of these batteries grant the USV a range of 4.5 hours, and four a range of nine hours, when travelling at 3knots. The USV has a top speed of 5.5knots and a lightship displacement of 200kg.

HydroSurv has reported an increase in orders of late, including a recent contract to supply a REAV-28 package to offshore engineering firm Engitec Systems International (ESI), which intends to deploy the USV for environmental monitoring and research – and, in particular, to support ESI's participation in the EU's Restoration of Deep-Sea Habitats to Rebuild European Seas (REDRESS) project. The USV supplied to ESI, named *ERV 1*, is equipped with a sensor array to monitor water quality parameters linked to temperature, salinity, dissolved oxygen and turbidity. Further orders from ESI are anticipated, HydroSurv hints. ■

The REAV-28 USV delivered to Foyle Marine & Dredging features Furuno's WASSP multibeam echosounder system

NAVAL APPLICATIONS

UMS MILESTONE FOR RNMB *HYDRA*

RNMB *Hydra* is the first mine countermeasures vessel to receive LR's UMS certification

An uncrewed mine countermeasures vessel developed by Atlas Elektronik UK (AEUK) for the UK Royal Navy has become the first of its type to receive class society Lloyd's Register's (LR's) Unmanned Marine Systems (UMS) certification.

Designed for minesweeping and mine-hunting operations, the 11m x 2m RNMB *Hydra* received Grey Boat Code certification from LR last year, following mid-2023 sea trials conducted with the 97m, VARD-built RFA *Stirling Castle* and sister USVs RNMB *Apollo* and RNMB *Hazard*.

The USV is part of the Atlas Remote Combined Influence Minesweeping System (ARCIMS) family, ordered to support the Royal Navy's Mine Hunting Capability Project. Wesley Galliver, head of AEUK's surface ship systems division, comments: "Working with LR to achieve this certification means that our users can operate these technologically advanced systems safely and with confidence in their capabilities. The benefits of unmanned systems – such as force multiplication, safety of operators and value – in comparison to traditional assets mean that this will be the first of many steps towards an autonomous future."

LR introduced the UMS Code in 2017, to complement IMO and flag state regulations by providing a framework for the certification of "novel technologies", scaled to each system's size, risk assessment and autonomy level. "The Code is adaptable and applicable to vessels ranging from very small to large, complex ones," LR states. The Grey Boat Code, meanwhile, was released by LR in 2019, to cover government service vessels under 24m in length. ■

SITUATIONAL AWARENESS

NAVTECH LAUNCHES USV-READY RADAR

Navtech Radar has launched a new maritime radar, the MAS10, which is primarily aimed at autonomous and uncrewed vessels requiring high-precision radar capability when navigating high-traffic waterways, or when operating in low- vis conditions and rough weather.

The MAS10 is a 77GHz frequency-modulated continuous wave (FMCW) radar. Whereas older radars send out short bursts of signals, FMCW radars send a continuous signal that changes frequency over time, to measure both the distance and speed of objects accurately. Navtech says that the MAS10 delivers "centimetre-level precision" within a 1km range, with the ability to detect and classify very small objects in cluttered environments.

Navtech adds: "Unlike optical and infrared sensors, its W-band radar technology cuts through fog, heavy rain and snow. It [functions] seamlessly in darkness, bright sunlight and shadowed areas, where cameras and LIDAR often fail."

The MAS10 is also designed to withstand sea spray, mist and wind turbulence, and features an open architecture design, to facilitate integration into existing and emerging autonomous systems.

The MAS10 was developed with assistance from Marine AI (see *The Naval Architect* March 2025, pages 54-58), Seadronix, Singapore Technologies Engineering and Zero USV – the latter the producer of the Oceanus12 USV. Zero USV founder and MD Matthew Ratsey says: "When you are totally reliant on your sensor pack for your autonomous navigation, ensuring you have the complete picture is vital. The definition and quality to pick up even the smallest of targets in cluttered environments is vital for the autonomous industry to continue seeking the goal of 'jetty to jetty' navigation where busy harbours still represent a significant challenge." ■

The MAS10 radar was developed with autonomous and uncrewed vessels in mind

ROCK STEADY GUIDANCE

Martin Conway speaks to Beckett Rankine about the publication of the UK's first-ever guidance for static floating ship stability

While the classification of operational ships can be a challenging task, the compliance required to ensure safe navigation is at least well-known, in most cases.

However, when it comes to static floating ships, the regulations become much more ambiguous. As John Monasta, associate director at maritime engineering firm Beckett Rankine, explains, the first key question to ask may be: "When does a ship stop being a ship and become a floating building?"

Data shared by National Historic Ships UK suggests that there are more than 2,000 historic ships around the UK, either moored, under restoration or no longer afloat. As Monasta points out, there is a misconception that, once a retired or historic ship has been moored – and now functions as a tourist attraction, a floating museum or a bar or restaurant – the need to conduct regular stability assessments is diminished.

"There have been instances where historic vessels have capsized and sunk," Monasta tells *The Naval Architect*. He references the sinkings of the 1864-launched naval training ship *City of Adelaide*, in Glasgow, in 1991; the 1888-launched fishing boat *Esther*, in Hull, in 2012; the King's ship HMS *Bronington*, in Birkenhead, in 2016; and a 110-year-old floating restaurant, on the River Thames, in 2024 as just four examples.

"It isn't uncommon, especially when the vessel is neglected or not properly maintained, for it to sink when a pump trips out or a hull fitting springs a leak," Monasta continues. As well as the commercial loss of the ship, this poses an obvious health and safety-related risk to any sightseers or guests who may be aboard at the time. "In reality, from a regulatory perspective, the only people interested in monitoring floating restaurants and pubs are food hygiene inspectors and the fire brigade," he says.

Skills gap

Maintaining historic ships has become increasingly challenging due to a shortage of individuals with the necessary skills, Monasta adds. "Until very recently, we had ex-mariners, ex-naval architects and retired admirals maintaining these vessels," he says, "but, as the industry changes and these people retire, museum curators have taken over this role.

Stability tests are still crucial for static floating ships (image: Dan Jones @LightWithALens)

***LV21*, a 1963-launched lightship transformed into a floating art space and performance facility, is an example of the vessel types Beckett Rankine's guidance addresses (image: Tom Duff)**

"However, these curators often don't have the necessary legacy knowledge. We've noted that historic floating ships owned by societies where the key personnel are naval architects tend to be more aware of the risks; even if they haven't conducted an inclining test in 30 years, they've done stability checks and analysed the risks. On the other hand, many museum staff haven't seen a stability booklet and don't know what GM is." The same can be said for many shore-based owners of floating pubs and restaurants.

This lack of experience has led to some risky ship modifications – for example: overloading the top deck with additional balconies, seats or bar areas; removing heavy items such as engines; decommissioning bilge pumps to create additional space; and cutting through the bulwarks to make

John Monasta, Beckett Rankine: "There isn't enough understanding of the potential risks for static floating vessels"

the interiors more accessible to disabled visitors – all typically done "without a naval architect in sight", and with no follow-up stability testing, Monasta says. He cites the case of one static floating vessel, currently degrading at the waterline, which the vessel owner has addressed by repeatedly removing ballast from the keel to keep the vessel above water to reduce the risk of flooding – while significantly increasing the risk of the vessel toppling over.

"Having no pumps on board is one thing, but many curators don't know that they should have a back-up pump plan – they wouldn't know who to call to supply a pump if flooding did occur," he says. "A lot of these vessels are in waterways where there's some traffic – so, once you've removed the bulkheads, you're in trouble if the ship suffers a leak or impact damage."

In the grey zone

As a naval architect and engineer by trade, Monasta was keen to raise awareness of the need for proper stability checks for floating static vessels. However, he soon found he was dealing with a regulatory "grey zone".

For example, operational ships comply with the standards set by IMO, their local maritime authority (such as the MCA in the UK) and the classification societies. Structures technically classed as 'buildings' in the UK, meanwhile, come under the Construction (Design and Management) 2015 (CDM 2015) regs, introduced 10 years ago to ensure that structures are safe to build and use. Static floating ships, though, tend to fall uncomfortably between both stools.

"There's a whole shade of grey in the middle and an absence of industry standards for these vessels," Monasta notes. "Even shipyards are considered 'factories', and so are not covered by CDM 2015, under UK law. Static floating ships are currently in a vacuum – and it will stay that way until either a serious accident occurs, or someone takes a political interest in this."

"There isn't enough understanding of the potential risks for static floating vessels," Monasta continues. Consequently, a study was developed to clarify what steps the maritime heritage sector could pragmatically take towards safer ship management, while accounting for its already significant operational pressures. Introducing new rules and regulations could place unexpected financial burdens upon museums and curating bodies.

"If a set of new regulations for static floating ships came in tomorrow, and required the vessel owners to have X number of watertight bulkheads and install X amount of pumps on board, and to conduct inclining experiments, most of them would struggle to remain financially viable," Monasta explains. "Some museums don't have the budget to undertake structural maintenance, let alone full maintenance of onboard systems and engines. High-prestige historical vessels like the Royal Yacht *Britannia* would be OK, but most of the smaller vessels couldn't afford to close down for a period to put these changes in place."

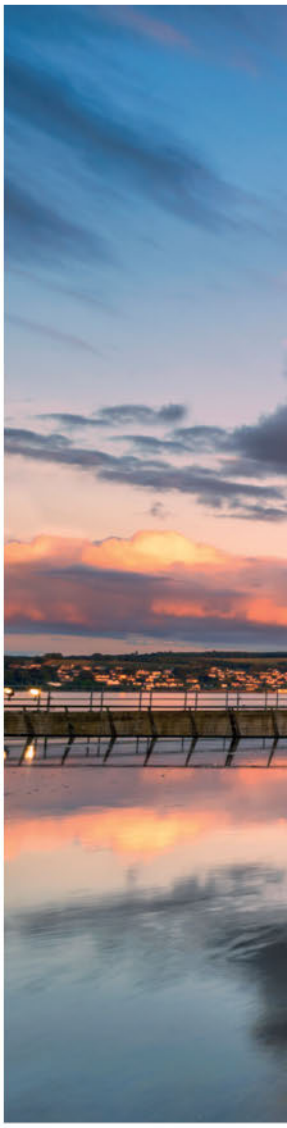
But there can be advantages to this lack of distinct regulation in the UK. Without a regulatory body dictating a strict set of assessment rules for static floating vessels, the maritime heritage sector can take a risk-based approach to its asset management. In turn, "this offers the freedom to put the historic fabric of the vessels at the core of their conservation", Monasta says.

Industry first

So, in collaboration with National Historic Ships UK and supported by funding from Lloyd's Register Foundation, Monasta and Beckett Rankine have co-launched the 'Don't Rock the Boat' project, focusing on static floating ship stability and related risk mitigation.

This initiative has culminated in the publication of the UK's first-ever set of guidelines specifically tailored towards these ship types. Tim Beckett, director of Beckett Rankine, comments: "This new document provides long-overdue and much-needed guidance on best practices for all those who are responsible for the care and maintenance of static floating vessels." The newly released stability guidance also offers practical solutions without compromising each individual vessel's heritage.

Monasta adds that the plan is to use this guidance "as a foundation for conversations with our clients", and as a useful resource for contractors and service providers, particularly in addressing the often-confusing



overlaps between maritime and offshore regulations, UK Common Law requirements and other grey areas related to liability and insurance.

The guidance begins with an introduction to ship stability, including topics such as downflooding and stability assessments, and goes on to provide an overview of existing IMO, MCA and UK health and safety legislation. The document also provides real-life case studies of related incidents, including info on the vessels' public accessibility (or lack of), location and cause of loss of stability.

The guidance then advises on how to best assess these risks, providing a checklist of recommended actions (such as hiring a qualified naval architect and accurately measuring the vessel's heel angle).

Interestingly, National Historic Ships UK comments, the guidance could be extended beyond historic vessels and applied to any static floating structure. Hannah Cunliffe, director of National Historic Ships UK, remarks: "Drawing on research from vessel case studies around the UK, the guidance offers practical advice as well as reviewing existing legislation and its applicability to our sector.

"I look forward to seeing it put to good use and am grateful for the support we received from Lloyd's Register Foundation's small grants scheme, which made this project possible."

As an attempt to counter complex and confusing regulatory uncertainties, Don't Rock The Boat would definitely appear to be a step in the right direction. ■

The new guidance on static floating ships can be accessed free of charge at: www.nationalhistoricships.org.uk/technical-papers/stability-guidance-floating-static-vessels

For more information on Beckett Rankine's maritime heritage expertise: www.beckettrankine.com/maritime-heritage

The guidance aims to provide owners with the tools to reduce the risks to the vessel, staff and public, while accounting for the unique conservation needs of historic ships, such as RRS *Discovery*, pictured (image: John Pow)

PRINT ON DEMAND

A collaborative effort between V2 Group and Caracol AM has seen the production of the 6m loa AM Cat, produced as a 99% single-piece, near-functional boat. **Martin Conway** reports

A collaboration between Spanish engineering start-up V2 Group and Italy-headquartered 3D-printing specialist Caracol Additive Manufacturing (AM) has resulted in the production of a part-functional, 6m-long monolithic catamaran for open waters, produced entirely via robotic 3D-printing technology.

While whole 3D-printed boats are not entirely new, the models produced to date – including a 9m ferry unit built by Holland Shipyards Group, and the University of Maine's 7.6m 3Dirigo – these have tended to serve as prototypes or single-use demonstrators, lacking the capability to operate at sea for real. The AM Cat developed by V2 Group and Caracol, however, is intended to not only sail offshore but to commercially compete with conventionally built leisure and recreational craft in the same size class.

While V2 Group has experimented with its own 1.5m x 0.5m printing bed for small parts, it has turned to Caracol, which specialises in large-format 3D-printing systems, for larger end-user parts (such as on-deck yacht furniture and hard tops) and this catamaran. As Caracol puts it: "The boat is a tangible example of how advanced 3D-printing processes can accelerate production times, minimise material waste and enable the creation of high-quality floating structures and boats tailored to meet the growing demands of a global market."

The 6m x 2.26m AM Cat runs on batteries feeding an 11kW electric motor

A reduced environmental impact is another obvious strong draw for AM vessel production. And now, with a second, fully functional version of the AM Cat due for imminent launch, the project could mark a milestone for this radical but nascent boatbuilding technology.

Moving into maritime

Founded in Milan in 2017, Caracol has come to specialise in developing large-scale AM technology, integrating hardware, software and robotic arms to serve industries including aerospace, energy, railways and marine.

Caracol employs over 80 specialists across several facilities, including an R&D centre north of Milan, where the company develops polymer tech and software, a small facility in Austin, Texas and a commercial office in Dubai.

"We started exploring the marine industry in 2021," Violetta Nespolo, Caracol CMO, tells *The Naval Architect*. This has included collaborations with luxury superyacht manufacturers, mainly focusing on the production of components, as well as involvement in sectors such as offshore wind turbine blade manufacture, automative and aerospace. In that year, the plan arose for a whole 3D-printed vessel, initially based on a 3m skiff. This project would take further form when the company teamed up with V2 Group.

Caracol describes its strategy as providing a turnkey solution for 3D printing, offering a package that includes robots, its own patented extrusion heads (used to melt and deposit the pellet material to create a 3D object, layer by layer), the material-feeding system and the software, as well as the systems required for control and automation.

"Maritime was an unknown area to us when we started off, but it is also the area that has grown the most," Nespolo says, adding that one of Caracol's owners having a maritime background also pushed the company to consider this sector. "Maritime has now become one of the main sectors we work with, especially on the finished parts side," she says.

Single-piece production

The AM Cat was manufactured at Caracol's facility over the course of 160 hours, "so in less than a week", explains Marco Caso, software development manager at Caracol. During critical stages of the print, the process involved hourly checks in the daytime, he adds, enabling Caracol's personnel to keep an eye on parameters such as temperature and ensure there

were no critical mistakes. "Seventy-six hours in was a critical point in the print, where we wanted to be sure to monitor what was happening live with an operator," he says.

The vessel was printed on Caracol's Heron AM large-format additive manufacturing platform, which comprises: a high-throughput extrusion head; a 10m-long printing bed; and a robotic arm with over six-axis manoeuvrability, which travelled on the rail. The company used its own software to 'slice' the 3D model of the cat, supplied as a digital file, into horizontal layers. This data was then relayed to the printer, which used the info to build the boat layer by layer.

The boat was 3D-printed using recycled polypropylene with glass fibre. "About 99% of the boat was produced in one single piece, including internal structure and supports of the hull, but we kept some of the smaller elements out," says Caso. "Polypropylene was the material we chose as it fit with the mechanical and chemical requirements, together with the client's need for an economical material given the scale of the project. We know this material very well – we understand its parameters, and that's important when you're building something this big and complex."

Nespolo adds: "We go through a qualification process for any material we use on our machines, to understand its properties and the chemical compatibilities for post-processing methods, like applying gel coats. We wanted to make sure the material was the right fit: economical but also recyclable." As a recyclable plastic, polypropylene is usually fed into the Heron AM in pellet form.

Material selection

Raúl Gonzalo, a naval architect for 25 years and head of engineering at V2 Group, describes polypropylene as a "good, cost-efficient material", and says: "We originally looked at fibreglass but agreed it was too early for this material, which is currently better suited to mass-production boats." While fibreglass may create a more rigid finish than polypropylene, the latter material is still tough enough to withstand bad weather and harsh waves.

However, Nespolo explains: "The material costs will decrease as we learn more about the process and how we can make it more efficient, and as the number of suppliers interested in this technology increases." She mentions that Caracol is looking at combining acrylonitrile styrene acrylate (ASA), a durable thermoplastic polymer with notable weather and UV resistance, with strands of fibreglass: a mix that should result in enhanced mechanical properties. Acrylonitrile butadiene styrene (ABS) is another material Caracol has used to create end-user parts for the marine sector.

The AM Cat is engineered for pure-electric propulsion, featuring an 11kW drive motor from Dutch e-motor manufacturer Rim Drive Technology. It's designed to be powered by four 200Ah, 48V batteries, delivering a total capacity of 40kWh. However, during testing, the AM Cat was fitted with smaller batteries, providing a combined 10kWh.

Performance evaluations by V2 Group and Caracol revealed that, with this 10kWh battery pack, a 10.3kW power input, and three people on board, the AM Cat reached a top speed of 6.3knots and was capable of a range of four to five hours. "With the full 40kWh battery pack, the range is expected to increase fourfold," says Gonzalo.

TECHNICAL PARTICULARS
AM CAT

Length, oa	6m
Length, hull	5m
Beam, oa	2.26m
Beam, wl	0.58m per hull
Draught	0.38m
Weight	1.22tonnes
Persons on board	7-8

Production of the boat, using Caracol's Heron AM set-up, took approximately 160 hours

Newbuild challenges

Reflecting on the process, Caso says: "Printing a boat in one piece is not easy: it requires a lot of effort to create the geometry, and, if you rely too heavily on this approach, you end up with a solution tailored to just one specific design. If the geometry changes, you're forced to start over.

"Our goal wasn't just to build this one boat but to develop a reasonable simple process that will allow us to create more boats, even different ones. This raised the question for each component: should we use 3D printing for this? It doesn't make sense to include some components in a one-piece print; instead, we can produce them separately using other methods. Ultimately, it's all about finding the right balance."

About 99% of the polypropylene boat was produced in a single piece, minus some smaller components

Gonzalo adds: "Normally, when we build a boat using traditional materials, we follow ISO standards, which provide a clear framework. However, if you switch to 3D-printed boats and apply scantling rules, it's not as straightforward.

"The challenge arises when you start working with unfamiliar materials. Without optimised data for these materials, we have to rely on existing rules, which tend to be very conservative in defining load scenarios. This becomes an issue when dealing with 3D-printed materials, which often aren't isotropic." This is because, as opposed to building a vessel in steel or wood, the 3D-printing process builds the material layer by layer, which can lead to differences in strength and stiffness. "As a result, we're basing our calculations on data that isn't always reliable," says Gonzalo.

MkII imminent

To evolve the design, a second boat is now in development, and, at the time of writing, was scheduled to begin production by the end of March 2025. For this follow-up project, the partners attempted to delve into the new boat's mechanical properties in more detail, concentrating on "more realistic loaded scenarios", Gonzalo explains, adding: "Although [the first boat] is not yet 100% fully functional, [it] represents an innovation marking a decisive step toward sustainability, efficiency and industrialisation of the marine industry. We expect that boat number two will meet that standard, being fully operative, with the design remaining 99% unchanged."

Like the first model, the second AM Cat will be built in polypropylene. Gonzalo concedes that this material makes the boat approximately "25-30% heavier, compared to traditional materials", but he explains: "Using very sophisticated plastics with fibreglass additives makes the equation much easier in terms of weight, but these are 4x in price."

For now, V2 Group's target markets are leisure boating and yachting, though Gonzalo says that AM may also be a good solution for "small professional boats that don't require a lot of units – maybe runs of three to five, or up to 10". He adds: "We're not looking to compete with those builders who mass-produce fibreglass vessels on spec, in large volumes."

As such, Gonzalo envisages high demand for 3D-printed boats from sources such as hotel chains and tour operators (which can also take advantage of the ability to create boats with unique and interesting geometries, perhaps incorporating the owners' brands) as well as the developers of uncrewed vessels. V2 Group is now hoping to secure funding to push development of the AM Cat concept into unchartered territory.

Reduced inefficiencies

Meanwhile, Caracol is continuing to make inroads into the maritime sector, having recently used its Heron AM system to 3D-print the side air grilles and above-windshield-visor for the Pershing GTX116, a 35m superyacht produced by Pershing, a brand of Ferretti Group. For this project, the Heron AM was equipped with a high-accuracy extruder and a 3mm nozzle. Caracol elaborates: "The grilles were printed using ASA reinforced with 20% glass fibre. The 3D-printing process took 72 hours to complete, producing an air grille measuring 4200mm x 400mm x 400mm and weighing 40kg."

Caracol estimates that this process not only halved the lead time but resulted in 60% less material waste, plus 15% less component weight, compared to using traditional manufacturing methods. Each grille was finished with a gel coat to protect it against the elements. "The implementation of AM for such large-scale yacht components showcases the potential of this technology to revolutionise production, offering greater flexibility and performance while significantly cutting down on inefficiencies," Caracol states. ■

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ICEBREAKER DUO BOOST FOR CANADA

The Canadian Coast Guard is anticipating the delivery of two polar icebreakers, to ensure a continuous, year-round presence in the Arctic, writes **David Foxwell**

In March 2025, the Canadian government awarded contracts to Seaspan's Vancouver Shipyards and Chantier Davie Canada to build two polar icebreakers for the Canadian Coast Guard. The contracts, awarded as part of the country's National Shipbuilding Strategy, should see the vessels delivered by the early 2030s.

The programme to replace Canada's existing icebreaking vessels has a long history. It was first mooted in 2008 and formally launched in 2012, but has faced many delays and undergone numerous changes. The programme was also put on hold for the better part of a decade, before being relaunched in 2021. The aim is to replace the Canadian Coast Guard's fleet of heavy icebreakers with a new class of icebreakers built to modern specifications.

The Government of Canada has contracted Seaspan and Chantier Davie to build one ship apiece. According to a late-2024 report from the Office of the Parliamentary Budget Officer, acquisition of the polar icebreakers is estimated to cost C$8.5 billion (US$5.9 billion), including the development and acquisition phases of the project.

Design refresh

Although the vessels will have slightly different capabilities, working together, they will be able to fulfil all of the Arctic missions Canada requires of them and ensure a continuous, year-round presence in the region.

They will be larger and more powerful than earlier polar icebreakers operated by the Canadian Coast Guard, and will enable the Coast Guard to operate at high latitudes for longer periods, strengthening Arctic security, advancing high Arctic science and responding to emergencies.

The new vessels have different hullforms, but both have high ice class – Polar Class 2 – and both make use of Aker Arctic's Hybrid DAS propulsion concept, employing two azimuthing propulsion units flanking a fixed shaft line. This set-up combines a high level of manoeuvrability, provided by the azimuthing propulsors, and the flexibility and robustness of a fixed shaft line. Having gained popularity in recent years, the twin-azimuth hybrid configuration has largely replaced the classic triple-shaft configuration prevalent in polar icebreakers for decades.

The polar icebreaker to be built by Seaspan – which is the first heavy icebreaker scheduled for construction in Canada in 60 years – is based on a design developed for the Government of Canada under a 2012 contract awarded to STX Canada Marine, with Aker Arctic as part of the design team. As the original design was developed over a decade ago, and technology has since taken significant steps forward – particularly in terms of propulsion and hull construction – 2021 saw Seaspan team up with Aker Arctic and another Finnish firm, Elomatic, to review the design. Other

Seaspan will build its icebreaker - the first heavy icebreaker to be built in Canada in 60 years – at Vancouver Shipyards

A starboard-profile render of Seapan's forthcoming, 158m polar icebreaker

companies to have joined the design refresh effort include Canal Marine & Industrial, Barrier Marine Services and Genoa Design International.

Propulsion options

The overall aim of the design review was to build a modern and effective icebreaker and investigate possible improvements in the design, while identifying potential technical risks. Over the course of the programme, the regulatory landscape had also evolved significantly. This meant that, given the timeline leading up to the vessel's delivery, the design and engineering team had to take steps to plan for potential regulatory changes.

However, due to the uncertainty of future regulations, a certain degree of adaptability and flexibility has been necessary, to ensure that the icebreaker remains compliant as it approaches its completion date, and into the future.

The design team also evaluated three propulsion options for the icebreaker, including the hybrid propulsion configuration incorporating two azimuthing propulsion units for optimal manoeuvrability and a centre shaft line for efficiency during long transits in heavy ice.

Extensive model tests in ice and open water were completed to verify seakeeping and manoeuvrability

Chantier Davie will build its 139m icebreaker in Lévis, Quebec, working closely with Helsinki Shipyard in Finland

and to enhance performance. Careful attention was also paid to the design of the vessel's primary structures, to provide a better understanding of safety margins. The hull of the icebreaker has been optimised, resulting in a lighter ship with benefits such as reduced steel weight, reduced construction costs and an efficient steel structure.

In advance of construction, Seaspan built a prototype block to test new processes and tools required to work with the ship's specialised steel. The prototype block was designed to include the most complex steel structures and welding requirements involved in building the polar icebreaker, and this part of the process was completed in February 2024.

Seaspan newbuild

The Seaspan polar icebreaker will be able to operate for several months at sea without needing to return to port, and will be equipped with a flight deck to land Arctic-capable helicopters. It will be 158m in length, and will be optimised for performance in heavy ice.

With a breadth of 28m and design displacement of 26,036tonnes, the new vessel will have more than 40MW of installed power and 36MW of propulsion power; a moonpool, to enable safe deployment of equipment from within the vessel; a helicopter flight deck and hangar; and a vehicle garage for unmanned aerial systems.

The new design will also feature extensive over-the-side science handling capability; a flexible forward working deck, with a cargo hold below; an aft deck with multiple cranes and flexible load-out; and towing capability.

In a March 2025 presentation at the Aker Arctic 'Arctic Passion' seminar in Helsinki, Seaspan Shipyards COO Jari Antilla added that the vessel will have an open-water speed of 18knots, a speed of 3knots in 2.5m ice and a range of 20,000nm at 12knots. The icebreaker will bear the class notation ✠100A1 Icebreaker(+), Ice Class PC 2, LA, Winterization H(-50) D(-50) ✠LMC, NAV 1, IBS, DP(AM), UMS, CCS, ICC, PSMR.

The contract for the construction of the Seaspan icebreaker is valued at C$3.15 billion, and the ship is due to be delivered by 2032. The official start of construction is scheduled for April 2025. In addition to the construction contract, the Government of Canada previously awarded three contracts to Seaspan for ancillary, construction engineering and long lead items for the new icebreaker with a combined total value of C$1.12 billion.

Finnish collaboration

Chantier Davie will build its polar icebreaker in Lévis, Quebec. To accelerate construction, the company will work closely with Helsinki Shipyard in Finland, which it owns. Through a work-sharing programme, Canadians will work alongside their Finnish counterparts to build a portion of the ship in Finland. This will allow Canadian workers to learn from the Finnish yard, which has extensive experience building icebreakers.

The skills and knowledge Chantier Davie workers will acquire will be applied to future icebreakers, improving the shipyard's capacity to build this kind of vessel. This dual approach will also enable Chantier Davie to continue infrastructure upgrade work at its yard in Lévis while simultaneously building part of the polar icebreaker in Finland.

Less information has been released about this design, but it is known that it will be based on Davie's Polar Max-type icebreaker, the design of which was developed at Helsinki Shipyard, based on Aker Arctic's Aker ARC 148 hullform. The Polar Max is the first newbuild project at the Helsinki Shipyard under Davie's ownership. In addition to conventional Canadian Coast Guard operations, it will also function as a research vessel and be capable of undertaking year-round oil spill response and emergency towing operations.

The Davie-built icebreaker will be 139m in length. The Polar Class 2 rating means it can break ice in the high Arctic and deliver ocean science missions all year round. The contract for the construction of the Chantier Davie polar icebreaker is valued at C$3.25 billion and the ship is expected to be delivered by 2030. ■

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A NEW TAKE ON HULL ANALYSIS

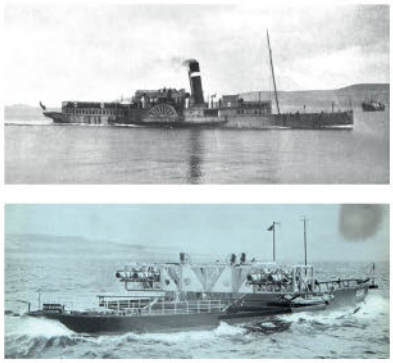
Dr Shona Cunningham, principal CFD engineer at BMT, talks about the recent success of the JoRes project and its implications for naval architecture

The Joint Research on Ship Design Evaluation (JoRes) project is a global research initiative aimed at revolutionising the way hulls are tested for performance and efficiency.

Traditionally, hullform designs are validated through model-scale testing in tow tanks, which involves building scaled-down versions of the hull and testing them under controlled conditions. However, this approach has inherent challenges in scaling results to full-scale due to the use of Froude number scaling as opposed to Reynolds number scaling. BMT took part in the JoRes project as, for us and our clients, one of the most important components of vessel design is understanding the total resistance of a hullform.

Dmitriy Ponkratov of JoRes and Rui Lopes of the Chalmers University of Technology brought together industry leaders to explore the feasibility of using computational fluid dynamics (CFD) for full-scale ship validation by asking participants to analyse a hull where the details of the hull were initially undisclosed until all participants had submitted their results. The purpose of the JoRes work was to carry out a 'blind' comparison between the unknown hull which was tested extensively at both full scale and model scale against CFD to compare the uncertainties between model scale and full scale analyses of the hullform, and discuss whether CFD calculations are viable within the cost and time-scale constraints of a commercial project.

However, it transpired we were replicating tests conducted in the 1950s by the British Ship Research Association (BSRA) on *Lucy Ashton* (Figure 1 and Figure 2, with Rolls-Royce jet engines attached for calm water resistance testing), a Clyde-built paddle steamer that carried passengers on the Clyde between 1888 and 1949, including through WWI and WWII. A significant historical connection exists, as the BSRA is one of the founding companies of what is BMT today. This historical link highlights the pioneering role of British naval research in ship design validation and underscores how we, through JoRes, continue to build on the legacy of rigorous ship performance analysis.



Figures 1 and 2: The paddle steamer *Lucy Ashton*, before (Fig 1) and after (Fig 2) modifications (Denny M. BSRA resistance experiments on *Lucy Ashton*. Part 1. Full-scale measurements, 1951)

Form factor

The results from BMT (see Figure 3) and many of the other participants matched the historical data, demonstrating the accuracy of CFD for full-scale assessments. The results of JoRes reaffirm the accuracy of historical BSRA testing while showing how modern CFD approaches can enhance and potentially replace traditional model-scale methodologies. This approach could allow ship designers to assess vessels at real-world scale using advanced simulations.

Whilst the aim of this study was to provide resistance results at full scale and at six model scales, BMT went further into the analysis and used the experimental data to interrogate the scaling process, with a focus on the form factor.

Using the International Towing Tank Conference (ITTC) guidelines, the model scale results obtained from both the physical model tests and CFD simulations

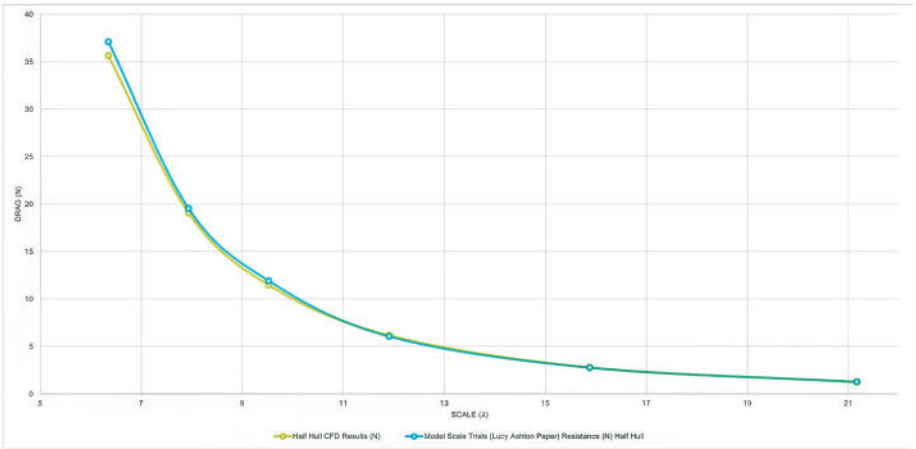


Figure 3: Comparison of half of the total resistance recorded for a symmetric hull from the model basin test and the CFD model scale analysis (BMT)

were scaled up. The physical model test data was scaled using the ITTC 78 (ITTC, 1978) frictional line. The form factor was calculated from the physical model tests at Froude numbers 0.1<Fr<0.2 using Prohaska's method carried out at each scale assessed. Two ways of applying form factors were calculated for the physical model scaling process: the form factor calculated at each scale, and then one constant form factor taken from the original list. The CFD analysis calculated an individual form factor per scale using the CFD frictional line and then chose one constant form factor representative as the average to be used for all six model scale-ups.

When scaled up, the CFD results have less variability than the physical model test data. Variability is a characteristic in the experimental process with factors such as environmental effects, temperature, water quality/changes in the tank, equipment/ sensors used and personnel contributing to this variability. The variability in the CFD simulation results is noticeably less as many of these factors can be controlled for. Factors affecting variability in CFD results such as the hardware, software and mesh were constant in the analysis. This contributes to a more consistent trend which is corroborated by the low coefficient of variation in the CFD results.

Model scale

The results highlight the importance of the Reynolds number in the scaling process. Often when choosing the scale of model to be used in tow tank testing, the model scale used is driven by the size of the tank and thus it is often the largest beam size of the hull which is the predominant factor. The beam size must be chosen to minimise boundary effects or reflections from the tank walls. This analysis demonstrates the need for further consideration of the model scale even if it meets the beam dimension constraint.

To calculate form factor experimentally, Prohaska's method is employed. Typically, a high scale factor corresponds to a high uncertainty. Another important scaling effect is the Reynolds number, which will cause the boundary layer of a hull to change thickness. This thickness does not change linearly with the scale factor. Therefore, the displacement thickness, pressure, and velocity profile within the boundary layer changes at varying scales. The low Reynolds number will affect the effective blockage due to the thicker boundary layer.

With improvements in technology and high-performance computing (HPC), running full-scale CFD offers an alternative solution to deriving full scale resistance results. Previously mesh, HPC and user uncertainties were primary failures of conducting full-scale CFD trials for calm resistance studies. Due to improving technology, the consistency offered by full-scale CFD arguably outweighs the uncertainties. Designs can be assessed as intended, with no unit conversions or queries on Reynolds number similarity, and now, with the conclusion of the JoRes project, validated against high-fidelity data sets. ■

Dr Shona Cunningham is a principal engineer with 12 years' experience in a consultancy role with technical responsibilities for a range of CFD projects in the fields of oil and gas, maritime, environment, civil construction and defence. Shona is a chartered engineer as well as a fellow of the Institution of Mechanical Engineers. She joined BMT as a project engineer in 2014 after receiving her PhD in Mechanical Engineering from the Cork Institute of Technology (Republic of Ireland) and her technical expertise includes CAD, data analysis, hydrodynamic analyses, gas dispersion modelling, explosion modelling, dynamic simulation models, fire and gas mapping and technical reporting.

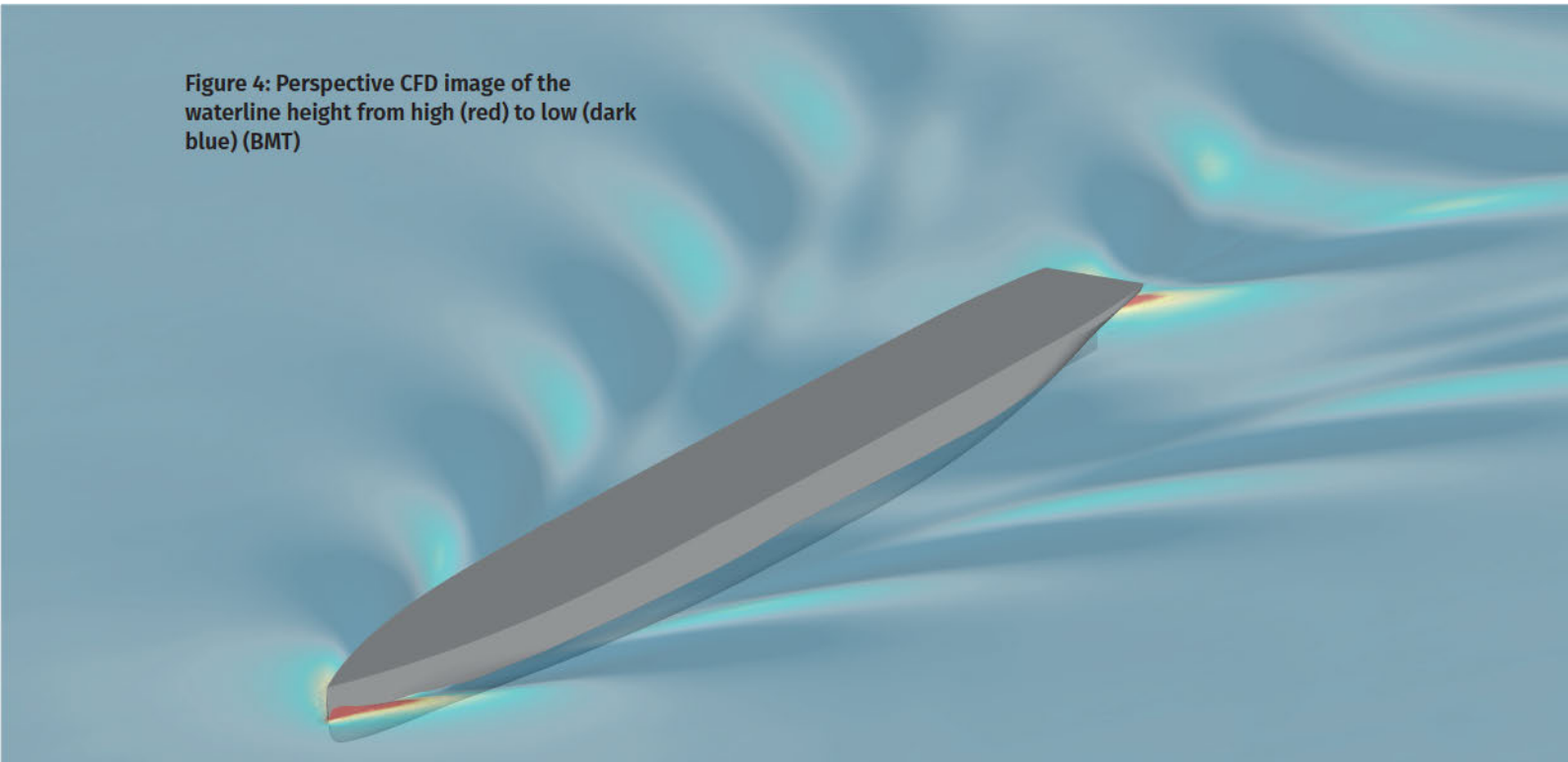


Figure 4: Perspective CFD image of the waterline height from high (red) to low (dark blue) (BMT)

OPPORTUNITY FOR EUROPEAN CO-OPERATION

Richard Barwick BSc (Hons), C Eng, MRINA provides a brief overview of the work undertaken by the Confederation of European Maritime Technology Societies to foster participation and co-operation within the European marine sector

The West European Confederation of Maritime Technological Societies (WEMT) was formed in 1971 to provide a forum for the exchange of information and co-operation between professional institutions (those involved in education and professional development) and learned societies (those facilitating the exchange of information) in the field of maritime technology. In 2003, the Council of WEMT, recognising that the impending enlargement of the EU would present further opportunity for exchange and co-operation, decided to adopt a new constitution and change the name of the organisation to the Confederation of European Maritime Technology Societies (CEMT).

Today, CEMT is an independent confederation of national professional societies from the UK, France, Spain, Italy, Serbia, Finland, Poland, Denmark, Greece, Turkey and Portugal. Collectively, CEMT represents over 60,000 professional maritime engineers in Europe who are involved in all sectors of the maritime industry – from design and construction to maintenance and operations – in universities, industry and maritime organisations. It is therefore uniquely placed to contribute to the success of the European maritime industry.

Information exchange

CEMT provides a link between the member societies of CEMT and organisations such as the EU, where it contributes its collective knowledge and experience to such issues as the EU's maritime policy. CEMT is also an NGO member of the Central Commission for the Navigation of the Rhine and the UN Economic Commission for Europe.

CEMT also provides a forum for the exchange of information on matters relating to the education and professional development of naval architects, marine engineers and others in the field of maritime technology. Such information, posted on the CEMT website at www.cemt.eu, includes the requirements for recognition as a professional engineer in other European countries, details of member societies' events to which members of other societies are invited to attend, societies' publications, reports from the organisations where CEMT is a member or represented and careers in the maritime industry. All member societies subscribe to an Agreement of Co-operation and a common Code of Professional Conduct.

The 2024 CEMT Award was presented to Nuno Antunes dos Santos, MD of Lisnave Shipbuilding Group (far left) by CEMT chairman Trevor Blakeley (second right)

The governing body of CEMT is its Council of representatives of each of the member societies. The current chairman of the CEMT Council is Trevor Blakeley FRINA, past CEO of RINA, and its secretary is Richard Barwick MRINA. The Council meets twice a year, its meetings being hosted by its member societies in turn. Such meetings include an update by member societies on the state of the maritime industry in their countries, and may include a technical visit.

Annual conference

CEMT organises the annual International Conference on Postgraduate Research in Maritime Technology (PostGradMarTec). This conference

is aimed at young maritime engineers, who are usually recent postgraduates, and it provides an opportunity for them to present and discuss their work, both complete and in progress, and to meet with other maritime professionals from universities and industry worldwide in an international conference environment.

The online conference is unique in that it allows young engineers in the maritime field to present their work without having to arrange the finance to attend an in-person conference, which is usually difficult for these young people. Presentations from engineers based outside Europe are accepted. Papers that are presented at conferences are subsequently posted on the CEMT website.

Awards

As with its member societies, CEMT aims to promote the highest professional standards throughout the European maritime community, both by organisations and individuals. It believes that such high standards are encouraged by the recognition of their achievement.

"CEMT provides a forum for the exchange of information on matters relating to the education and professional development of naval architects, marine engineers and others in the field of maritime technology"

Visit: www.cemt.eu

The CEMT Award is presented annually in recognition of the outstanding achievement in the field of maritime technology by an individual, company or organisation from one of the member countries of CEMT. For example, the 2024 CEMT Award was presented to Nuno Antunes dos Santos, MD of Lisnave Shipbuilding Group. The award was presented by CEMT chairman Trevor Blakeley, and also in attendance were Fernando de Almeida Santos, president of the Portuguese Engineers Association, and Dina Paz Dimas, president of the Portuguese College of Naval Architecture and Oceanic Engineering. ■

TURKISH TUGS ON A ROLL

Turkey's tug output is showing no signs of a let-up, whether for domestic or overseas customers – and with Robert Allan Limited's designs very much at the forefront for the steady stream of newbuilds

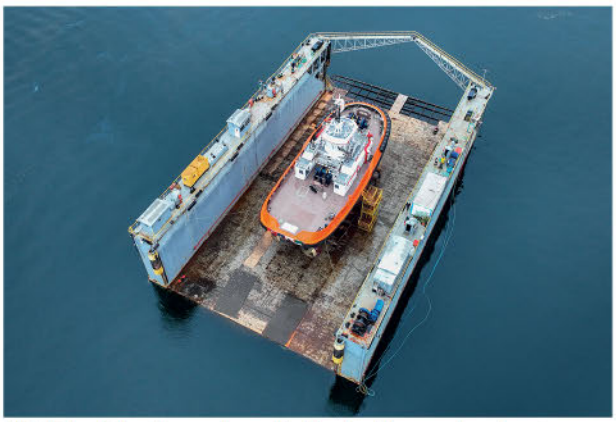
Over the course of the past 15 years, Turkey has carved out an enviable niche for itself as a national tug factory. A report published on Statista, titled *Export value of tugs and pusher craft from Turkey between 2012 and 2023*, claims that Turkey exported new tugs and pushers to the value of just over US$416 million in 2023, representing an increase of nearly 36% on the previous year.

The country has also pioneered a number of eco-friendly tug firsts, designing vessels capable of running on alternative fuels. Examples include the 2014 launch of the twin tugs *Borgøy* and *Bokn*, hailed as the first two pure-LNG-fuelled tugs in the world, and the 2020 delivery of the 18.7m 'zero emissions electric tug' (ZEETUG) by Navtek: a vessel powered by lithium-ion batteries.

One major Turkish player is Uzmar, originally founded in 1972 as a pilotage and towage services firm, before coming to build tugboats for its own requirements from 1993. In February this year, the builder delivered the 32m x 13.2m tug *TIGER* to Italy-headquartered tug and barge operator Ocean SRL. This vessel will be used for operations including towing, pushing, firefighting, vessel escort, ship rescue and stand-by duties. Uzmar says that it managed to complete *TIGER* just eight months after the contract with Ocean SRL was signed.

RAL designs

TIGER was built to the specs of the RAstar 3200 class, provided by Canadian naval architect Robert Allan Limited (RAL). RAL's tug designs – including the RAstar, RAmparts and VectRA series (and their offshoots) – have proven popular with Turkish shipbuilders such as Uzmar, Sanmar and Med Marine, and these designs cover a range of tug applications, from harbour towing to offshore support.



***TIGER*, built by Uzmar, has a bollard pull capacity of 80tonnes**

TIGER features a depth of 5.5m and has the capacity to store 199m³ of fuel and 40m³ of fresh water. The tug is powered by twin Caterpillar 3516E main engines, each rated 2,350bkW at 1,800rpm and featuring IMO Tier III-certified aftertreatment systems.

Propulsion-wise, the vessel is fitted with two Kongsberg US255 Z-drives with 2.8m fixed-pitch propellers, while deck equipment includes an Ibercisa split drum escort forward winch, an aft towing winch and a towing pin, supplied by Data Hidrolik, to support vessel escorting and towing operations. Uzmar reports that *TIGER* has a bollard pull capacity of 80tonnes, and carries the class notations Escort Tug, Recovered Oil Second Line (FP>60°C) and Firefighting 1.

Uzmar is now working on a battery-methanol tug for port and terminal services supplier Svitzer, scheduled for handover in the second half of 2025. The tug will incorporate a 6MWh battery, manufactured by AYK Energy, to assist it in providing zero-emissions escort tug duties in the Port of Gothenburg, the operator says.

The battery-methanol tug is based on Svitzer's TRAnsverse tug design – which, as the name implies, features additional design input from RAL. AYK Energy explains: "The battery

Sanmar has completed sea trials for the third fully electric tugboat it has constructed for SAAM Towage

Med Marine's latest MED-A2500 tug was delivered to SVS Maritime in February

will be supported by dual-fuel methanol engines for back-up and range extension. The escort duty tug is expected to conduct more than 90% of its operations using its battery-electric powertrain."

AYK Energy continues: "The vessel's design will also allow the battery-powered tug to operate more efficiently than internal combustion engine [ICE]-powered tugs of a traditional design."

The 806gt vessel will feature an overall length of 34.9m, a bollard pull ahead of 85tonnes and the capability to reach speeds up to 14knots. It will also utilise escort steering and braking forces, rated 150tonnes and 200tonnes respectively, measured at 10knots.

Electric for LatAm

On the subject of electric tugs, Turkish builder Sanmar Shipyards recently completed the sea trials for the third fully electric tugboat constructed for SAAM Towage. Sanmar has stated that the newbuild effectively constitutes "the first fully electric tugboat to operate in Latin America", as well as marking the eighth all-electric newbuild produced by Sanmar.

The builder adds that it has another six fully electric tugboats under construction at its facility in Tuzla. The newcomer follows the ElectRA 2300-class tugs *SAAM Volta* and *Chief Dan George*, which Sanmar delivered to SAAM Canada in Q4 2023, for operations in the Port of Vancouver.

This latest launch is based on RAL's ElectRA 2500SX design, provided to Sanmar on an exclusive basis. The boat feaures an overall length of 25.4m, a 12.86m beam and a draught of 5.6m, and has a maximum battery capacity of 3,616kWh.

Rüçhan Çıvgın, commercial director of Sanmar Shipyards, says: "It was extremely important, when we were developing the ElectRA series with our partners RAL and [battery manufacturer] Corvus Energy, that the move to electricity and other alternative fuels should not come with any loss of power or performance."

According to the partners, the ElectRA 2500SX exhibits a bollard pull of at least 70tonnes and a speed of 12.5knots – which certainly seems to have pleased the operator. Pablo Cáceres, sustainability and development director at SAAM Towage, comments: "Electric-powered tugs represent the way to advance towards more sustainable operations and move our business into the future."

Sanmar has also been keeping busy supplying tugs to domestic companies, such as compatriot operator Marin Tug. In February, the yard announced that it had delivered one of its selling Boğaçay MKII-model tugs (based on RAL's RAmparts 2400SX-MKII design: another exclusive arrangement for Sanmar) to Marin Tug. The completion of this newest handover builds on a relationship stemming back to 2006, when Sanmar delivered a pair of 45bp twin-screw tugs to Marin Tug.

This latest tug, christened *İNCEBURUN*, measures 24.4m x 12m and has a depth of 4.5m and a draught of 5.45m. Classed for FiFi-1 firefighting capability, the new tug can also achieve a bollard pull of at least 70tonnes and a free running speed of 12.5knots, Sanmar says, adding: "The design enables optimal efficiency in shiphandling duties for seagoing ships and emphasises low-manning operation with advanced machinery automation. A wider beam compared to similar-sized tugs enables greater performance and stability."

Multiple roles

February also saw Med Marine's 180,000m² Ereğli Shipyard facility launch a new tug in its MED-A2500 series, for Greek operator SVS Maritime. This class is part of RAL's RAmparts 2500-W range, designed to handle a variety of operations including shiphandling, towing, pushing, mooring and emergency response. Med Marine adds: "The addition of an aft towing hook and capstan further enhances its operational versatility."

The new tug measures 25.2m in length and 12m in breadth, has a depth of 4.6m and draws 5.75m. The powertrain combines two main diesel engines feeding Z-drive units, for enhanced manoeuvrability, through dedicated shaft lines. The vessel has a bollard pull of 75tonnes and a speed of 12knots, and can accommodate an eight-person crew.

This launch came on the heels of the delivery of a MED-A3200-class escort tug (the RAstar 3200-W) to P&O Maritime Logistics. Named *P&O Africa*, the 31.8m unit has a depth of 5.57m, a draught of 6.05m and the capacity for 10 crew, and exhibits a bollard pull of 80tonnes and a speed of 12.5knots. *P&O Africa* is equipped with advanced firefighting systems, gas detection sensors and emergency shutdown protocols, as well as a forward escort winch, an aft winch and an aft towing hook. ■

COMPLETELY CARBON FIBRE

Keeping the weight down while ensuring rigidity are two of the benefits of carbon fibre – assets that could make superyacht sailings far more environmentally friendly. **Stevie Knight** speaks to SAY Carbon Yachts

It's possible to cut the kilos though carbon-fibre construction, according to Karl Wagner, SAY Carbon Yachts CTO. However, this process demands rigour – and you can't make assumptions based on other composite builds.

After a fairly difficult 2024, SAY has returned to the table with new designs. But the company and Wagner himself are both still capitalising on what they know best: how to create extremely lightweight, efficient boats.

In fact, these motoryachts really are impressively light: the SAY42, with its 12.96m length and 3.99m beam, comes in at around 4.5tonnes when fully equipped, right down to the twin engines yielding 860hp (641kW) and stern drive. The company favours this configuration partly because it suits the boat's centre of gravity and internal volume, and these drives can be tilted to accommodate shallow waters. Wagner adds: "It's also not that complicated to convert to outboard power and, for the US market, you need to have that option."

The same weight consideration applies to the largest, top-of-the-range and completely new SAY52: this is 15.75m-long and 4.4m-wide, but has a dry weight of just 7.5tonnes, and only 10tonnes at maximum load.

However, that "wasn't so easy" to realise, admits Wagner, because the SAY52 is a good deal larger than its sisters. "A new boat that is 25-30% longer than your existing designs is clearly a big challenge," he tells *The Naval Architect*. "Added to which, it has a far higher demand for luxury. There's a master bedroom with bathroom and all the extras that go with it...everything needs to feel completely premium, but it still needs to be light."

Tougher option

However, the very first SAY52 has hit the mark. Just out of production, it is fitted with Volvo Penta engines delivering 880hp (656kW) and, despite all the trimmings, a top speed of around 45knots.

Underpinning each design is carbon fibre's rigidity. Carbon fibre is much lighter than aluminium, and the construction comprises a layer each side of high-density foam core, which itself adds stiffness by resisting sheer and compression forces. These fibres and cores are vacuum-infused together with epoxy resin – itself a tougher option than the usual polymers.

It's also worth noting the major joints aren't just bonded, but completely laminated – the point is to avoid sudden load steps between the various

"Our boats are around half the weight of the competition," says Karl Wagner, SAY CTO (image: SAY)

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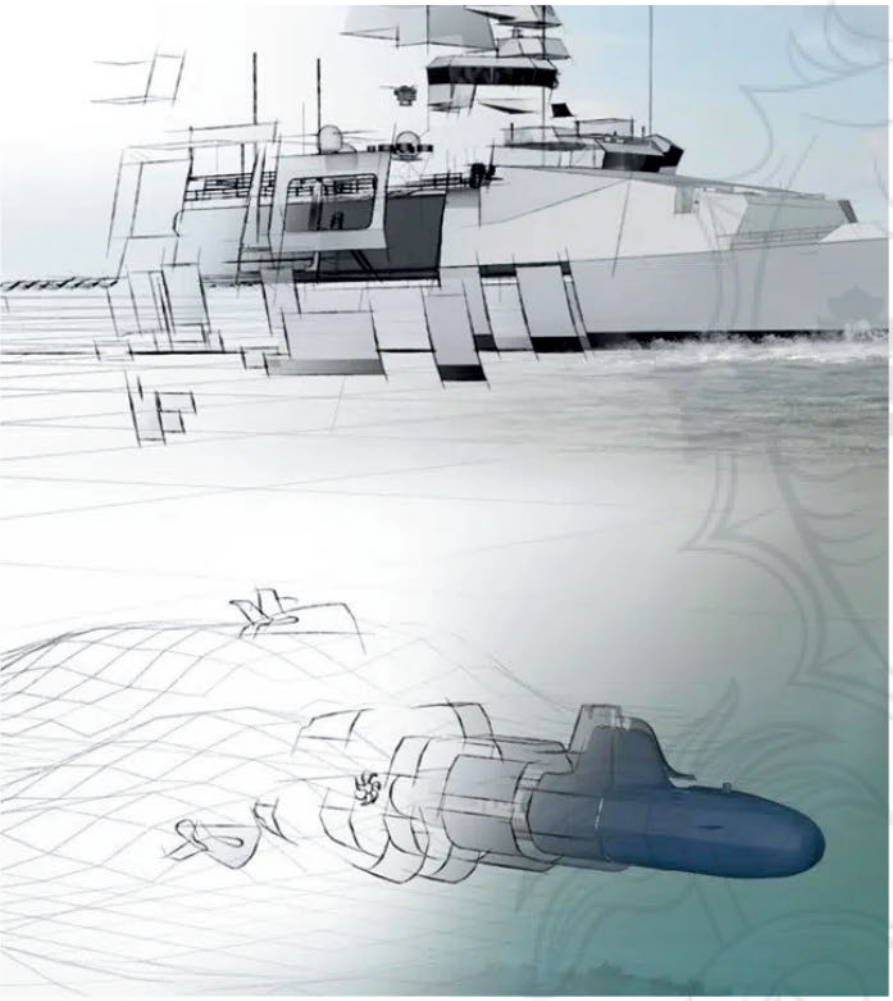

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Trials showed that modifying the hull to the Petestep design resulted in an extra 3knots and an efficiency boost of about 10% (image: SAY)

elements. "The way we do it makes a very stiff structure," says Wagner. "In fact, the whole thing works like a monocoque."

So, while these boats have been subject to the kind of rigorous structural analysis that, on other vessels, would have resulted in more stringers and internal bulkheads, here there are fewer. In turn, this opens up the internal spaces and can also mean a smaller engine, which again reduces weight and therefore drag.

In short, these motor yachts take advantage of a positive efficiency spiral: "Our boats are around half the weight of the competition and consume about 30-40% less energy," Wagner explains. Further, while this makes for generally better handling, he also admits it's their ability to step up the pace that really give the new SAY models their punch: "It's in the acceleration you really feel it... and we really like acceleration."

All-electric variant

The super-light construction opens the door for another fully electric variant of the coming SAY32, which should be released in time for boot Dusseldorf 2026. This variant will feature an Evoy drive and a 126kWh Kreisel battery. While hammering the maximum speed – which may match the old 29 model's 50knot+ top – obviously stands to drain the battery in just a few minutes, a more sedate pace should provide roughly 50nm of range.

On the other hand, Wagner explains, the big SAY52 can be kitted out as a hybrid which lifts the lid on endurance. The idea here is that relatively small combustion engines will provide just the cruising power, while the 100kWh battery gives

The fully carbon fibre-built SAY42 weighs 4.5tonnes when fully equipped (image: SAY)

the boat silent, clean running around harbour and eco-sensitive areas. This arrangement would also give an extra kick to boost that all-important acceleration, pushing the top speed up to 50knots.

Hull considerations

Despite carbon fibre's pivotal role, you can't just use it and trust everything will suddenly become possible. As Wagner underlines, there's no point in simply taking a GRP design and trying to execute it in carbon fibre – you'd gain a hefty bill and lose the advantage.

Firstly, there's the hull itself. Sweden-based Petestep has taken charge of the form below the waterline, says Wagner, adding: "These boats have a very sleek deep-V and relatively small volume in the bow, which, together, gives a perfect, soft ride through waves."

Further, it's shaped to avoid spray generation, which can account for a significant proportion of the hull's hydrodynamic resistance. The idea is lateral 'steps' (Wagner underlines these aren't conventional chines) that deflect the water and turn it aft, decreasing the wetted surface area and friction while also putting some of the otherwise lost energy to use.

So, does it work? "On the 42 we modified the hull from an un-stepped form to the Petestep design," says Wagner. "We gained 3knots and about 10% efficiency."

However, there are further areas where the carbon fibre helps out: for example, the SAY52's stability requirements are actually met by a Seakeeper 3 gyrostabiliser, a feature usually reserved for a boat that's 20-30% shorter.

Bringing all this together is a rigorous job, admits Wagner. "We have a close look at every single component – cables, hatches, everything," he says. "It's always a fight – everything needs room, and especially in the cabin." However, where weight is concerned, a line in the sand needs to be drawn at the start, and an accurate one at that. Wagner explains: "At a very early point, you need to decide how heavy the boat will be, because that clearly has a big influence on the whole design."

The downsides

Are there definite downsides to a carbon fibre construction? Certainly: the rigidity leads to more noise compared to a glass fibre build, admits Wagner. "You don't really care about it when you're underway," he says, "but we had to work on noise insulation for when the boat's at anchor."

There's also a slightly trickier issue: electrical conductivity. "That's something you really need to handle carefully," says Wagner. He explains that, electrochemically, carbon fibre is close to titanium and stainless steel, so there is no galvanic corrosion between these materials and the hull. However, he adds: "If you don't add proper counter measures, aluminium always gets eaten up very quickly."

Finally, this kind of boat is also going to cost a lot more than a GRP build: although carbon fibre is coming down in cost, it is, after all, more than 10 times the price of its cheaper counterparts. And, even if carbon fibre builds permit smaller engines, to give you more bang for your buck, there's something extra that is at least as important as the material itself: the yard still needs the skills and experience to make it all work together. ■

The 15.75m SAY52 is the biggest so far from the builder (image: SAY)

SETTLING THE SKAW

Skaw Sailing's new monohull scow yacht concept, the SKAW (A), is set to incorporate a foiling system to grant it the performance typical of a larger catamaran

The SKAW (A), due to hit the water in December this year, has been described as the first scow yacht to incorporate a foiling system

Scow yachts are typically characterised by their distinctive wide, flat-bottomed hulls. As such, these boat types have gained popularity among family-oriented cruisers and performance sailors, who value their stability and ability to navigate shallow waters.

Now, as something of a groundbreaking development for this vessel segment, Skaw Sailing's forthcoming SKAW (A) scow yacht is set to add foiling capabilities to the equation. The 12m SKAW (A) will boast an interior volume comparable to a 15m monohull, Skaw Sailing says, offering optimal space for guests with a full-beam roof. Equipped with C foils and twin rudder blades, the intended result is a safe, stable and fast monohull that won't capsize, yet will still be able to navigate shallow waters with ease.

The SKAW (A) has been co-designed by French ocean racer Benoît Marie, winner of the 2013 Mini Transat, and Clément Bercault, founder of naval architecture firm Berco. The duo began work on the SKAW (A) project approximately three years ago, with the aim of producing a faster, more efficient cruising yacht than those that were available at the time.

The final hullform was signed off last year, and French boatbuilder and composite specialist SHORETEAM received the hull mould in December 2024. Arnaud Lample, SHORETEAM CEO, explains that his team was "checking the longitudinal reinforcements" of the first SKAW (A) model in late March, with the expectation that the yacht "should touch the water by the end of 2025", prior to delivery to the boat's anonymous owner. The designers have estimated that the vessel will have an average cruising speed of 15knots, increasing to more than 20knots, under favourable conditions, with a gennaker.

Foils and resins

Lample tells *The Naval Architect*: "The foiling system is designed to enhance the performance of the SKAW (A), with the foils lifting the hull and reducing drag. The yacht is planned to cruise at the same speed as a 60' [18.3m] catamaran."

The two C-shaped foils lift the hull, dampen any pitching motion and minimise the heeling effect – said to be limited to 16° – as the foils allow the yacht to sail fast and flat, "like a catamaran, but without the risk of capsize, due to the lift from the foils", Lample adds. The foils are retracted inside the yacht's dimensions when not required.

Skaw Sailing and SHORETEAM turned to Sicomin, a specialist in bio-based epoxy systems, to deliver its GreenPoxy resins for the yacht's construction. SHORETEAM previously used Sicomin's infusion resins to build three Ocean Eagle 43-class counter-piracy trimarans for the Mozambican government, the first of which was delivered in 2014.

TECHNICAL PARTICULARS

SKAW (A)	
Length, hull	11.95m
Breadth	4.85m
Draught	1.2-3.5m
Air draught	19m
Weight	5tonnes (light)
Sails	
- Main	64m²
- Jib	42m²
- Gennaker	100m²
- Asymmetric spinnaker	155m²
Engine power	38hp (28kW)
Fuel capacity	80litres
Fresh water capacity	150litres

Tom Kerriou, project manager at Sicomin, tells *The Naval Architect*: "One of the key issues was to manage production costs for the new yacht. Typically, foiling race yachts use lightweight carbon prepreg construction, but this can mean higher material costs and expensive mould tooling.

"Switching to resin systems allowed the team to control the tooling and material costs while still delivering great mechanical performance."

Sicomin's SR InfuGreen 171 resin was used to laminate the fibreglass and foam cores of the yacht. "This is a very low-viscosity system and can procure long working times, which is key when infusing large-scale hulls and decks," says Kerriou. He continues: "For the resin itself, the requirements are to be able to respond to the high mechanical properties requested, especially interlaminar shear strength, elongation and slamming."

Another important element, Kerriou says, is the resin's "processability" and its ability to guarantee "infusability and wettability, [for] a perfect impregnation of technical fabrics and adhesion to the core materials, to ensure a high-quality assembly, able to meet the mechanical requirements".

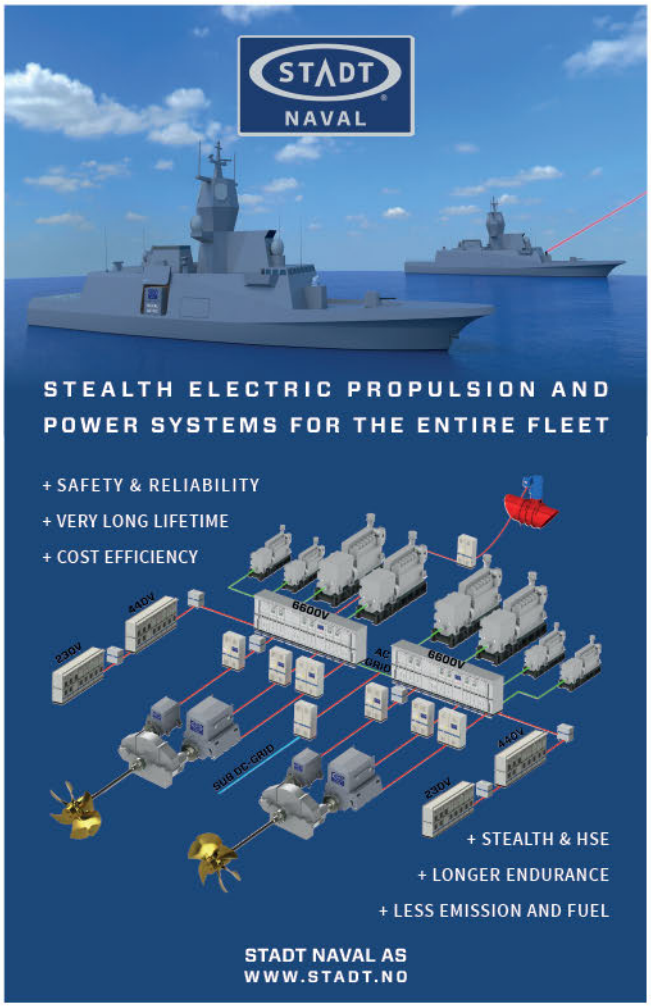
Eco-friendly bonus

The SKAW (A) also incorporated Sicomin's SR Greenpoxy 170 resin, "formulated for the hand laminating/vacuum process where working times can be shorter, or where you have to work quickly with adapted viscosity and sensitivity in the assembly stages once all the parts have been infused", says Kerriou.

There's an environmental advantage too: as well as offering a lightweight solution, Kerriou reveals that "33-35% of the carbon content of the two resins is from sustainable bio-sources, providing a lower-impact solution than traditional petroleum-based resins".

The boat has been engineered to meet the CE Category A – Ocean classification under the EU's Recreational Craft Directive (RCD). Intended primarily for large yachts or superyachts undertaking transoceanic crossings, this category acknowledges the boat's ability to withstand significant wave heights above 4m.

The SKAW (A) will be made available in two configurations, SHORETEAM's Lample adds: a four-cabin version for a maximum of eight guests, or a 10-guest version with the cockpit converted to sleep an extra two. ■



MED YARDS EXPAND CAPACITY

Some significant developments have recently taken place in the Mediterranean superyacht repair sector, writes **Clive Woodbridge**

MB92 Group is operating a new superyacht refit facility at Golfe-Juan

For obvious reasons, the Mediterranean is a key hub for superyacht repair and refit work. Strong demand levels are triggering continued investment to expand and enhance facilities and capabilities in the region.

MB92 Group is one of the major players, and its new MB92 Golfe-Juan facility commenced operations earlier this year, continuing the company's steady expansion of its portfolio of refit yards. Following the certification of its new 240tonne travelift, the site can now service 16 yachts of up to 43m in length simultaneously.

Located between Monaco and St Tropez on a 9,000m² site, MB92 Golfe-Juan can accommodate a wide range of projects, from short stops to complex refits. To bring the shipyard in line with its quality standards, MB92 Group is investing over €5 million in modernising the site. Key developments include the renovation of buildings, restoration of the hard-standing area and the installation of new infrastructure to prevent pollution and improve environmental performance.

MB92 Group also offers superyacht refit facilities at La Ciotat and Barcelona in the Mediterranean, plus facilities in the Red Sea region. In another development, MB92 Group recently acquired GYG Ltd, the parent of superyacht painter Pinmar.

Focus on yachts

Meanwhile, Gibraltar's Gibdock has announced the launch of Gibdock Yachting as a separate, dedicated division focusing on maintaining and refitting superyachts, working in a strategic partnership with BWA Yachting. Gibdock Yachting will offer services including: routine maintenance and certification dockings; large-scale refits; covering topsides and underwater coatings; shaft, rudder and propeller works; propulsion system maintenance works; and main engine overhauls. The company also has a network of subcontractors available to undertake interior refurbishment, electrical and communications systems work.

Meanwhile, in Turkey, KRM Yacht Refit & Rebuild has installed a 900tonne-capacity shiplift at its facility in Tuzla, Istanbul. As the largest lift of its kind in Turkey, the shiplift has the certified ability to accommodate yachts up to 70m in length, having undergone testing with a 1,100tonne load.

North Europe

While there is much going in the Mediterranean, the North European market is also relatively buoyant at present. Damen Yachting recently announced the relaunch of the 79.2m Delta Marine superyacht *Albatross*, following an extensive refit at its facility in Vlissingen, the Netherlands.

Albatross arrived in the Netherlands in January 2023 and underwent a full refit and layout transformation with Amels Refit over a 26-month period. Originally measuring 72m, the work saw the vessel extended by a total of 7m, with 10m removed and 17m added. During the refit, the biggest challenge was the extension of the yacht's hull, which also had to maintain stability, while the exhaust systems were upgraded due to the increased weight and various other systems were re-engineered. *Albatross* was also given an almost entirely new interior, designed by HarrisonEidsgaard. ■

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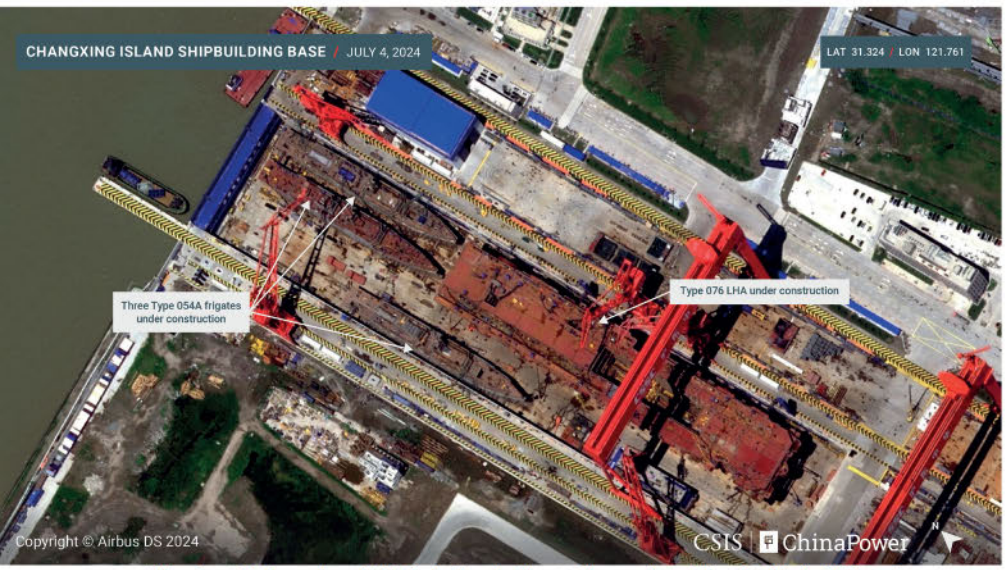
RAPID PROGRESS ON CHINA LHA SHIP

The world's largest amphibious assault ship to date, the Yulan-class landing helicopter assault ship, is currently nearing completion in China

As China's naval and amphibious forces continue to expand, analysis by experts at the Center for Strategic and International Studies (CSIS)* has shed new light on the design of a vessel it describes as a 'substantial step' in the People's Liberation Army's (PLA's) ability to project power.

The Chinese defence industrial base continues to build larger and more capable warships at a stunning pace, and satellite imagery of the Changxing Island Shipbuilding Base shows rapid progress on the construction of the first Yulan-class landing helicopter assault (LHA) ship.

Dubbed the Type 076, the vessel represents a substantial step forward in the ability of the PLA to project power farther from China's shores. Once completed, the Type 076 will be the world's largest amphibious assault ship.



The first Yulan-class LHA is being built at Changxing Island Shipbuilding Base (image: CSIS/ChinaPower/Airbus 2025)

Satellite imagery from 2024 shows that its flight deck is approximately 260m x 52m – that is, more than 13,500m², considerably larger than the US Navy's America-class LHA and Japanese Maritime Self Defense Force's Izumo-class helicopter carriers (CVHM/DDH). The Type 076 will also be much larger than its Chinese predecessor, the Type 075.

Catapult and trench

Like other amphibious assault ships, the Type 076 will be capable of carrying dozens of aircraft and drones, amphibious landing craft and a complement of over 1,000 marines. Yet, the vessel's larger size gives it even greater capacity to carry more aircraft within its internal hangar and provides additional space for launching aircraft on its expansive flight deck.

Size is only one of the Type 076's advantages. The vessel will have significant technological upgrades that place it in a class above its peers. Most notably, it will have a catapult for launching fixed-wing aircraft, making it unique among all other amphibious assault ships.

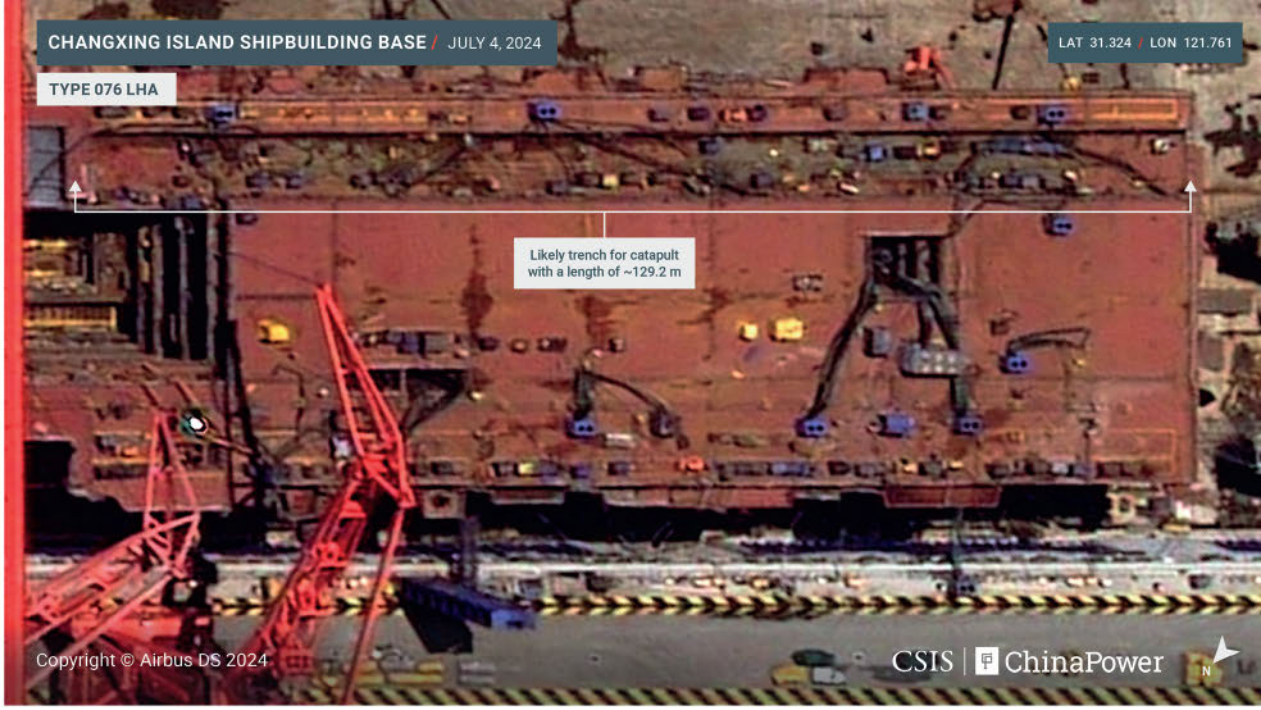
Historically, only 'flat top' aircraft carriers have been outfitted with catapults, while amphibious assault ships have only been able to launch helicopters and vertical/short take-off and landing (V/STOL) aircraft such as the F-35B. China has not yet fielded manned aircraft with V/STOL capabilities.

The Type 076's catapult will likely be similar to the electromagnetic aircraft launch system (EMALS) pioneered by the US Navy's Ford-class aircraft carriers, an advanced technology that only the US and China have successfully deployed. It provides more power than conventional steam-powered catapults installed on older classes of carriers, allowing for larger aircraft with heavier payloads to be launched.

China outfitted its third aircraft carrier, the Type 003 Fujian, with three EMALS-style catapults, and the expected installation of a similar catapult on the Type 076 suggests that China has confidence in the design. At present, the Type 076's catapult trench is nearly 130m long, which is significantly longer than the 108m catapults seen on the Fujian carrier. However, more time is needed before the exact length and capabilities of the Type 076's catapult can be determined.

Aircraft options

Satellite imagery also shows that the Type 076 will have an aircraft elevator on each side of the vessel, for lifting aircraft from the internal hangar to the flight deck. This new configuration is better optimised for aircraft take-offs and landings compared to the Type 075's design, which has one larger aft elevator and a smaller internal forward elevator that obstructs the flight deck when in use.



Uniquely, the Type 076 will have a catapult to launch fixed-wing aircraft (image: CSIS/ ChinaPower/ Airbus 2025)

These and other features enable the Type 076 to launch fixed-wing aircraft, which generally have greater range, speed and payload capacity than helicopters. At a minimum, the ship should be capable of launching fixed-wing unmanned (combat) aerial vehicles (UAVs/UCAVs), which are lighter and easier to launch and land than manned systems.

However, the vessel's catapult, wider flight deck and lack of elevators obstructing the runway suggest it may be capable of launching manned aircraft. That would put the Type 076 in a class of its own, somewhere between an LHA-class ship and a full-fledged aircraft carrier. Yet, it would require the PLA to overcome a number of new technical and operational challenges.

Even if it is limited to unmanned systems, the Type 076's air wing will be highly capable. China has an advanced and growing arsenal of UAVs, including the GJ-11 stealth combat drone, the WZ-7 reconnaissance drone and the CASC Rainbow strike UCAV, among others. Analysts have noted that in 2017, Chinese UAVs were photographed conducting test launches from a catapult test track at a naval air base near the northern Chinese city of Huludao, suggesting that the PLA is experimenting with ways to adapt them for carrier-based operations.

In satellite imagery of the Changxing Island Shipbuilding Base, what appear to be mock-ups of GJ-11 drones are visible in a testing facility. They are likely there in anticipation of trials on the Type 003 aircraft carrier and potentially for the Type 076 once it is completed.

Anticipated timeline

The ability to bring considerable air power to bear will make the Type 076 a formidable platform at sea, but it is also designed to be capable of amphibious assault. The vessel is expected to feature a floodable well deck on its stern, allowing for launching amphibious vehicles like the Type 726 air-cushion landing craft to conduct ship-to-shore operations.

Once operational, the Type 076 will serve as a multifunctional combat platform, capable of conducting air operations, launching amphibious landings and providing joint command and control for broader amphibious forces.

The exact timeline of the Type 076's construction is unknown but, even for China's prolific shipyards, the pace of the ship's progress has been extraordinary. Extrapolating from the construction timeline of China's Fujian carrier and its Type 075s, the Type 076 could be launched into the water in the first half of 2025. It will then take another several months or even years before the ship is commissioned.

It is notable that the vessel is being built at a massive new dry dock in a section of Changxing Island that was only completed in September 2023. Visible in the dry dock beside the Type 076 are three Type 054A guided-missile frigates simultaneously under construction, demonstrating the shipbuilding capacity unfolding at Changxing Island.

While it will not fundamentally tip the military balance in the Indo-Pacific, the introduction of the Type 076 will give the PLA even greater options in bringing combat power to bear, whether in the Western Pacific, the South China Sea, or beyond.

**This analysis of Yulan-class LHS was first published by CSIS and is printed here with permission. It was authored by Matthew Funaiole, vice president of the iDeas Lab; Andreas Dracopoulos, chair in innovation, and senior fellow of the China Power Project at the Center for Strategic and International Studies (CSIS) in Washington, DC; Brian Hart, a fellow with the China Power Project at CSIS; Aidan Powers-Riggs, a research associate for China analysis with the iDeas Lab at CSIS; and Joseph Bermudez Jr, senior fellow for Imagery Analysis at CSIS.* ■

The Royal Netherlands Navy's LPDs *Rotterdam* and *Johann de Witt* will reach the end of their service lives in 2028 and 2032 respectively (image: Damen)

AMPHIBIOUS SHIP OVERHAUL

A flexible design will replace ageing LPDs and four OPVs, though it will be smaller than LPDs they replace, writes **David Foxwell**

The Netherlands state secretary for defence, Gijs Tuinman, has unveiled an innovative (and potentially challenging) plan to build a new class of amphibious transport vessels that will not only replace the Royal Netherlands Navy's landing platform dock (LPD) ships *Rotterdam* and *Johann de Witt*, but also replace four Holland-class ocean-going patrol ships.

In what is known in The Netherlands as an 'A-Letter,' sent in early March 2025 to the House of Representatives, one of two chambers in the Dutch Parliament, the state secretary detailed plans for the new class of vessel.

The state secretary highlighted the fact that the Royal Netherlands Navy's LPDs *Rotterdam* and *Johan de Witt* will reach the end of their service lives in 2028 and 2032, respectively. He also noted that the Holland-class offshore patrol vessels (OPVs) – which are very different vessels from the LPDs, with very different roles – will reach the end of their service lives between 2035 and 2038.

Replacing both vessel types with a single class of new ships will not be an easy task, and will not be made any easier by the fact that, for the new programme to succeed, the Royal Netherlands Navy would need to commission the first of the new amphibious transport ships in 2032, with the sixth and final vessel to enter service in 2037 and be operationally deployable in 2038. Consequently, the Ministry of Defence is investigating whether *Rotterdam* could be maintained in service for longer than originally anticipated.

'Station ship'

The design process for the new class of amphibious transport ships is only now getting going, but some details have become clear. Given that the new LPDs need to replace two classes of very different vessels, they will need to have a very flexible design.

The amphibious transport vessels are intended to operate in a high-threat environment; whereas the OPVs that will be replaced currently fulfil low-level patrol, security and intervention tasks against lightly armed opponents, and participate in operations that fall short of outright war.

The solution the state secretary seems to envisage is using one or more of the new amphibious

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The Holland-class OPVs, one of the ship types the new amphibious ships will replace, are lightly armed (image: Damen)

transport ships as a 'station ship' for the constabulary roles usually assigned to the OPVs, such as the role the OPVs play in the Caribbean and elsewhere. Such a solution would mean that the OPVs are replaced with a much larger, more capable design, but not one designed to operate cost-effectively as a patrol boat.

However, Tuinman said that if six ships are built and if the design is sufficiently flexible, they will be able to carry out the widely differing roles required of them. "The replacement of two existing ship classes by one new class provides the Royal Netherlands Navy with more flexibility and economies of scale in the deployment of the ships," he explained, "and in, among other things, training and maintenance."

As with another key programme for the Royal Netherlands Navy, the 'Replacement LC Frigates' project, the Department of Defence wants to involve industry at an early stage of the development and construction of the new designs, as part of a new form or "industry-enhanced procurement".

Dispersed operation

Dutch and British amphibious forces have operated together over many decades in the UK/NL Amphibious Force and, in 2023, the two countries signed a ministerial-level statement of intent to collaborate in the replacement of large amphibious ships. The Netherlands and the UK are not expected to build identical ships, but to ensure the interoperability of their equipment, and that co-operation is possible with regard to multiple systems on the new vessels, although the A-Letter notes that there is a risk that the desired level of interoperability with vessels operated by other countries such as those of the UK Royal Navy – and Belgium and Germany – could lead to higher costs.

In the A-Letter, the secretary of state said Dutch marines would use the new amphibious transport ships to go ashore using landing craft and helicopters. "Just like the current LPDs, the new vessels will take multiple landing craft in their internal dock," he said. "Helicopters and unmanned systems will operate from a helicopter deck." Amphibious operations are changing, he said, and, compared with the LPDs they will replace, the new vessels will deploy landing craft further from shore, from more widely dispersed locations, where they will be less vulnerable.

"In this dispersed operation, each amphibious transport ship will carry smaller detachments of marines than the current LPDs usually carry," Tuinman said. "This means that the new ships will be smaller in size but that more of them are needed to deploy the same number of marines."

Automation

The A-Letter says it remains an open question whether the hulls of the amphibious transport ships will be built in the Netherlands, or elsewhere in Europe. "Building the hulls in the Netherlands has not been excluded," it says, "but this also depends on the available target budget and on the developments surrounding the 'Shipyard of the Future' project."

The new vessels will make use of a high level of automation in order to limit the size of the crew, but it is not yet clear how many personnel will be needed to man the new amphibious transport ships. "This partly depends on the size of the new ships and on the chosen automation concept," said the state secretary.

Input from 'knowledge institutes' such as TNO, NLR and MARIN is also expected to be key to the design of the amphibious transport ships, which, the state secretary said, will be able to operate on biofuels, but not on an alternative fuel such as methanol, which is not yet operationally possible, partly due to its vulnerability in combat conditions and the large volume of fuel that the ship would have to carry.

The target project budget for the acquisition of the amphibious transport ships is in the range of €1 billion to €2.5 billion.

A new series of littoral assault craft are also planned that will operate from the new amphibious vessels. Two types are planned: a littoral assault craft (LAC) for personnel; and littoral craft mobility (LCM) for personnel and material. Both types are due to be delivered in the period 2026 to 2030. ■

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UK-JAPAN UNITY FOR CAIMEN EVOLUTION

A collaboration between BMT and JMU will see the creation of next-gen, high-speed landing craft based on an established BMT model. **David Foxwell** reports

The Japanese Self Defense Force is to become one of the first forces in the world to operate new-generation, high-speed landing craft, having selected a design developed by BMT in the UK.

The contract for the vessel, based on the fast landing craft version of BMT's Caimen concept, was unveiled in February 2025.

Under the terms of the deal, Japanese commercial and naval shipbuilder Japan Marine United (JMU) and BMT have been contracted by the Acquisition, Technology & Logistics Agency (ATLA) to design and build the next-generation vessels. Production, design and construction of the vessels – based on the Caimen-100 version of the British company's range of high-speed landing craft – will be carried out at JMU's facilities in Japan.

First developed more than a decade ago, the Caimen series of landing craft is BMT's response to the need to reduce the vulnerability of amphibious vessels and the landing craft they deploy by launching landing craft further from shore. Doing so results in a need for increased speed on the part of landing craft, hence the need for a new generation of vessels, of which the Caimen-100 is an example.

Tri-bow hullform

The new design for Japan makes use of the 'tri-bow' hullform at the heart of high-speed versions of the landing craft. The hullform was developed to provide enhanced seakeeping, performance and beaching capability: adopting it will mean that, compared to older, conventional landing craft – which typically operate at much lower speeds – the new units for Japan will be capable of speeds in excess of 20knots. This high-speed capability is coupled with extensive vehicle- and troop-carrying capability, significantly enhancing operational flexibility and efficiency.

The high-speed landing craft selected by ATLA in Japan is based on the Caimen-100 design

The Caimen-100 design on which the Japanese landing craft are based has a length overall of 33m, a waterline length of 30.3m, a moulded beam of 8.2m, a design draught of 1.5m and a maximum deadweight of 100tonnes. It has a speed of more than 30knots and a range of 200nm, and is propelled by a trio of MTU 16V2000 M96L engines, each rated 1,939kW, driving MJP 850 waterjets.

New capabilities

Typically, a landing craft is used to transport vehicles, stores and personnel from the host vessel, such as a landing platform dock (LPD) or a landing helicopter dock (LHD). They have long been an essential part of the capability required to deliver amphibious forces, vehicles, equipment and supplies to a beachhead, but the threat levels they now face are much higher than that those military forces encountered for much of the post-war period. This has forced major navies to rethink concepts of operations and the design of the vessels they employ.

Seemingly relatively simple vessels, modern landing craft – with the requirement for greater speed, increased payload-carrying capacity, survivability and the ability to beach far simpler ships – are actually complicated to design, and pose unique challenges to naval architects and engineers. BMT's response to these challenges was a design to deliver heavier types of rolling and cargo payloads directly to a beach, hard standing or port, with the capability for international voyages or open-sea conditions.

Arranged with a large open or enclosed cargo deck, the vessels are configured for the delivery of amphibious operations, tactical movement of military vehicles, general logistics, resupply and humanitarian operations. In the Caimen-100 design for Japan, an open vehicle deck has been adopted.

Design advantages

Apart from the ability to deliver high speeds, the tribow hullform confers a number of other advantages. These include superior seakeeping

The Caimen series ranges from the Caimen-60 (pictured), with 60tonne capacity for payload and fuel, to the somewhat larger Caimen-150

and stability when operating in high sea states, and at high speed with a heavy payload, offering enhanced motions for crew comfort and payload lashing and minimal speed reduction in waves.

Other benefits include the ability to operate in shallow water in the littoral environment and in inland waterways; a high level of manoeuvrability at all speeds, including at slow speed and in close-quarters operations; and stability when engaging with a beach, floating causeway, motherships and piers for payload transfer.

The Caimen hullform also enables the use of a triple-waterjet arrangement, providing protected propulsion for shallow-water operations and manoeuvrability, coupled with significant propulsion redundancy and enhanced capability for beach extraction where, due to a raised central waterjet, a minimum of one waterjet is available for use even in fully beached scenarios, ensuring that the vessels have a self-extraction capability from a beach.

Prepared for beaching

As BMT notes, one of the most unique aspects of landing craft is the requirement to ground the vessel repeatedly on unprepared and frequently uneven and rough beach surfaces. Designing for controlled beaching of a landing craft requires careful analysis of the ship's loading condition, its draught and trim relative to the beach and its gradient, the forces associated with the initial impact, the loading of the hull when beached and the forces to extract the vessel when unloaded.

Beaching must also be achieved such that the vehicle or other loads can be safely moved, based on the ramp geometry and a safe fording depth for the vehicle at the end of the ramp. At the same time, the consequences of accelerated wastage and abrasion of the hull bottom must also be remembered. This is a complex set of assessments, needed for all the various loading conditions in which the vessel may operate.

In the Caimen design, BMT has considered the interaction with the beach to be a fundamental element of the vessel, and in addition to the bow ramp design, this interaction flows down into a range of other aspects of the design. The company used bespoke tools to understand the balance of friction when beached, hydrodynamic loads, approach speed and extraction capability to ensure that landing craft can be beached and recovered to sea under its own power.

From a structural perspective, BMT says the design provides a compromise between a structure that is robust but also lightweight, a key requirement for high-speed Caimen variants. The design can be provided in aluminium or steel, and in both cases achieves a class-approved structure.

Ramp design

While conceptually a straightforward piece of equipment, says BMT, the ramp design is highly sophisticated, while also maintaining a philosophy of robustness. The geometry allows for suitable vehicle fording depths on a range of beach gradients, and suitable clearances when landing on floating causeway systems or mothership stern gates. The structure is critical for acceptance of high vehicle wheel and track loads, as well as significant torsional requirements when landing on an uneven beach or a moving floating causeway.

The ramp performs as the bow of the boat when stowed, both hydrodynamically (which greatly influences the position of the hinge point in association with the hull) and structurally, and does not interfere with sight-lines when stowed. Deployment times, and the supporting control system, allow for rapid deployment and recovery.

Speaking at the time the Japanese contract was awarded, Akinori Takeno, JMU director and senior managing officer, said: "This collaboration presents a valuable opportunity for us to work together to build cutting-edge, high-speed landing craft with advanced aluminium hulls. By combining BMT's innovative design concepts with our technologies and facilities, we hope to deliver landing craft that exceed expectations."

Sarah Kenny, BMT CEO, said the company was proud to have been selected by ATLA and JMU as design partner. "The collaboration between our teams in the UK and Japan has been exemplary from the very beginning of our relationship," she said. Martin Bissuel, BMT head of sales, commercial maritime, said the next-generation high-speed landing craft "stands out as a pivotal investment for the Japan Self Defense Force" and that the Caimen-100 would provide Japan with an advanced, reliable and highly functional platform that enhances its capabilities significantly. ■

SHAPE OF THINGS TO COME

Coatings manufacturer Hempel is further developing its SHAPE digital platform, which is intended to help ship operators to maintain a clean hull, save fuel, reduce greenhouse gas emissions and protect biodiversity, writes **Clive Woodbridge**

Until a few years ago, antifouling coatings were mainly recognised for their ability to prevent biofouling. Today, however, the emergence of regulations such as CII and EU ETS means that coatings are increasingly now also being evaluated based on their impact on operational and fuel efficiency.

Coatings manufacturer Hempel has in recent months responded to this trend with further upgrades to its Hempaguard range, which has been used in more than 4,500 applications, the company claims. According to Mads Bertelsen, Hempel director for data and technology: "Advanced hull coatings are widely recognised as a low-hanging fruit, being one of the single most impactful ways to improve the energy efficiency of a vessel with a return on investment of less than a year."

Hempel says it has seen a significant trend towards silicone-based coatings over the past year

An industry-wide shift toward silicone technologies contributed to Hempel experiencing a record year in terms of sales volume for its Hempaguard solutions in 2024, despite a slight drop in revenues overall for its marine coatings business, attributed primarily to delays to drydockings caused by the disruption to shipping in the Red Sea.

New coating line

Last year, responding to market requirements, Hempel launched an extension to the Hempaguard series, called Hempaguard Ultima. According to Bertelsen: "The new product combines the tried-and-tested performance of Hempaguard X7 with our new biocide-free silicone topcoat, Hempaguard XL. The unique two-layer system delivers up to 21% fuel savings."

Ongoing R&D work is expected to lead to another important new addition to the Hempaguard range later this year. Bertelsen explains: "Given the challenges applying silicone hull coatings to newbuilds, ship operators have tended to choose to receive new tonnage with conventional antifouling and then re-dock again to apply Hempaguard to get the benefits of an advanced silicone hull coating. But, later in 2025, we will be launching an extension to the Hempaguard series that will make it possible to apply a silicone coating during the structural erection stage of newbuild projects."

In the field

The benefits of applying an advanced coating like Hempaguard have been demonstrated by experience in the field, closely monitored by Hempel's technical teams. An example of this is provided by Tailwind Shipping Lines, a subsidiary of Lidl, which reached out to Hempel in 2022 after acquiring the 276m container vessel *Panda 001*, requesting a solution that would reduce both fuel consumption and emissions.

Bertelsen says: "We recommended our hull coating Hempaguard X8 and the digital platform Systems for Hull and Propeller Efficiency [SHAPE]. This powerful combination has since delivered remarkable results, including a 25% reduction in fuel consumption and a 12% boost in the vessel's EEXI reference speed." With these proven fuel savings and a rapid return on investment, Tailwind has since decided to upgrade all of its in-charter vessels to the same solution, Hempel points out.

GETTING INTO SHAPE

Hempel's SHAPE platform is designed to enhance hull and propeller efficiency through a combination of high-quality data collection, expert analysis and advanced hull coatings. The platform is built on the ISO 19030 framework, an international standard for measuring hull and propeller performance, and collects precise performance data from vessels, focusing on factors like hull fouling and mechanical damage, which can significantly increase a ship's required engine power.

Sensors and performance-monitoring systems on the ship collect high-resolution data on hull and propeller efficiency, including speed loss due to hull fouling, water resistance and engine power output. SHAPE integrates this raw data with operational parameters like voyage duration, weather conditions and the vessel's trading patterns. Hempel then analyses the collected data to provide actionable insights tailored to a vessel's specific type, age, size and operating patterns.

For example, the data may indicate that the amount of hull fouling has increased drag, resulting in a 12% increase in required engine power. The analysis may show that the current antifouling coating, applied three years ago, is nearing the end of its effective lifespan and is no longer suitable for the vessel's operations (especially if the vessel is operating in warm waters, where marine growth is more common). SHAPE is then used to generate a detailed report with tailored recommendations for the operator – potentially including coating upgrades, a scheduled drydock and/or an in-water propeller polish to restore smoothness.

Another example of a positive outcome is provided by Hempel's partnership with the Brazilian metals and minerals company Vale, which has also utilised the Hempaguard coatings as part of its efforts to deliver efficiency gains and carbon emission reductions. In 2022, the 360m x 65m ore carrier *Liwa Max*, which is owned and operated by Asyad Shipping and chartered by Vale, became the largest ship to date to be coated with Hempaguard. Over an 18-month period after the application, monitoring showed that the vessel achieved an estimated reduction of 6,700tonnes of CO_2 emissions.

SHAPE platform

As well as enhancing its coatings range, Hempel is using its experience, combined with AI-enhanced models, to further develop SHAPE, an innovative digital platform which helps ship operators to maintain a clean hull, save fuel, reduce greenhouse gas emissions and protect biodiversity. SHAPE includes hull performance monitoring models and the option to get fuel performance guarantees tied to Hempel's premium coatings.

SHAPE also maps trading patterns and biofouling pressure on a live basis, proactively identifying vessel risk levels for biofouling growth and notifying the ship's operators when to act to address such issues. The live data feeds generated by SHAPE are combined with expert in-house advisory services.

While customers are increasingly specifying coatings to meet efficiency and environmental goals, and to put them in a better position regarding regulatory compliance, the original biofouling objective is still high on the agenda, and is in itself likely to drive further new product development.

As Bertelsen points out: "IMO is now placing a focus not only on the prevention of biofouling, but also its control and removal to mitigate environmental impacts, with the aim of reducing the transfer of invasive aquatic species. Manufacturers of antifouling coatings, including Hempel, are collaborating closely with the growing number of in-water cleaning suppliers to conduct compatibility testing and ensure optimal coating performance." ■

Hempel says the Tailwind vessel *Panda 001* has benefited from a combination of coating with Hempaguard and utilisation of the SHAPE digital platform

GRAPHENE GUARDIANS

A major order from a tanker operator has demonstrated growing interest in graphene as an ingredient for coatings, writes **Clive Woodbridge**

Tanker shipping company Overseas Shipholding Group (OSG) has decided to extend its adoption of GIT Coatings' graphene-based propeller coating, XGIT-PROP, across seven additional crude oil tankers.

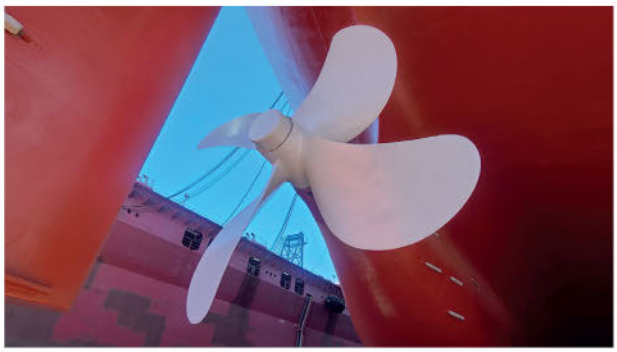
OSG had applied the coating to one of its crude oil tanker vessels in October 2023, and this initial application reportedly generated performance gains and fuel savings, which were further validated by a third party, with the vessel being tracked along its Pacific trade route.

As a biocide-free hard foul release coating, XGIT-PROP is designed to withstand the particularly rigorous conditions faced by propellers. According to GIT Coatings, the coating overcomes the shortcomings of conventional antifoulings or soft foul release coatings. Combining a strong adhesive primer with a hard foul release topcoat, XGIT-PROP ensures the propeller's surface stays smooth, the company claims.

Hull grooming services

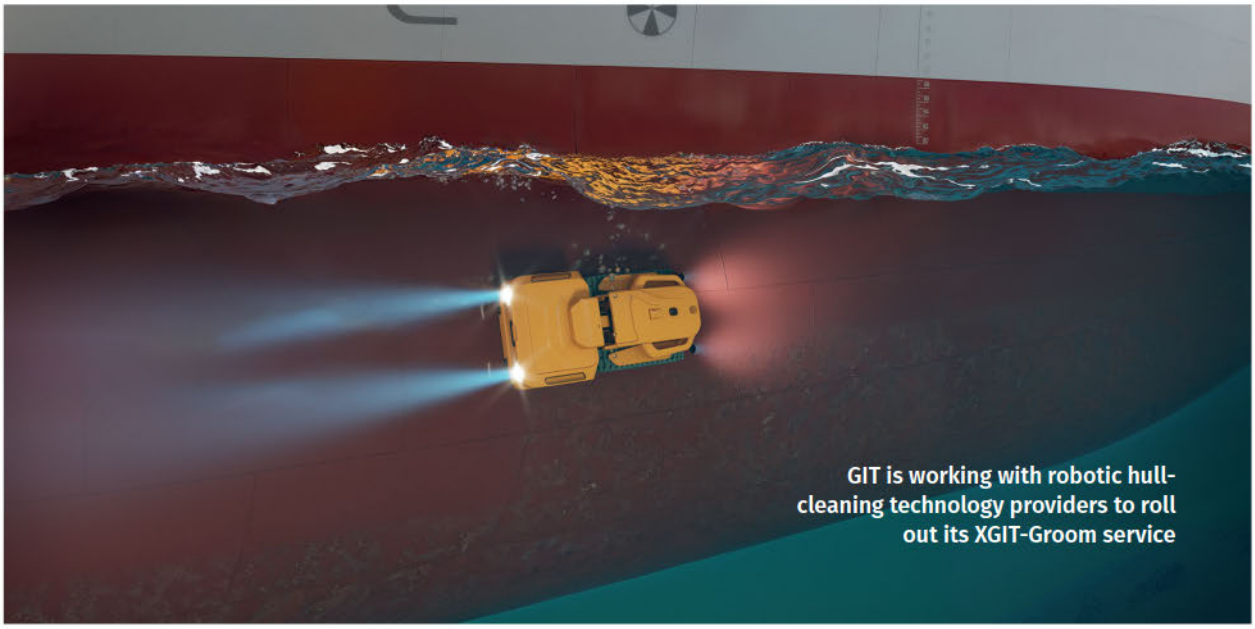
GIT Coatings is also working to develop the use of its graphene-based hull coating XGIT-Fuel, pairing it with robotic hull grooming services from a number of approved third-party providers, in a bundle called XGIT-GROOM. GIT Coatings has recently received Lloyd's Register (LR) enhanced type approval for XGIT-Fuel, which demonstrates that the coating will not degrade with repeated grooming events and the brushes will not damage the coating's surface.

Philippos Sfiris, head of market strategy and vessel performance at GIT Coatings, comments: "We are seeing a shift in the industry away from reactive cleanings, with more owners adopting the proactive cleaning or 'grooming' approach to maintain a clean hull. As the adoption of proactive cleaning increases, so will the need for antifouling coatings that can withstand repeated cleanings, as well as robotic technologies that can perform these cleanings on vessels both in port and in-transit."



OSG is applying GIT's graphene-based propeller coating to seven more of its tankers

GIT's vessel performance department offers a pre-screening service, which includes running biofouling risk assessments and grooming feasibility analyses on vessels to determine if they are good candidates for the XGIT-GROOM program. Once coated, GIT's team will work with the owner or technical manager to implement the grooming plan, provide insights on port restrictions and give feedback on in-water cleaning footage to ensure the vessel maintains optimal fuel performance. ■



GIT is working with robotic hull-cleaning technology providers to roll out its XGIT-Groom service

INTO NEW TERRITORIES

Nippon Paint Marine has seen its Aquaterras coating being used in China and for a Japanese client for the first time, writes **Clive Woodbridge**

Over the past six months or so, Nippon Paint Marine has carried out some interesting projects applying coatings for new customers and in different markets.

For example, the company applied its biocide-free antifouling, Aquaterras, to a Wan Hai vessel at a shipyard in China for the first time last year. The container ship, *Wan Hai 613*, entered Zhou Shan Chang Hong Shipyard for a scheduled ship repair and maintenance drydocking, during which Nippon Paint Marine applied a full coating of the low-VOC Aquaterras coating, which was first released in 2021. Other notable recent projects include the application of its Fastar coating to 10 vessels in the Wan Hai fleet, continuing the company's close working relationship with the Taiwanese container carrier.

In the second half of 2024, Nippon Paint Marine applied Aquaterras to the Mitsui OSK Lines (MOL) car carrier *Courageous Ace*, the first time the Japanese shipping company had used this coating for its fleet. The vessel was coated with Aquaterras on its flat bottom, vertical bottom and boot top while in for a scheduled drydocking.

According to Gladys Goh, Nippon Paint Marine CEO: "The car carrier operates on multiple different routes in changing and challenging conditions, making Aquaterras the ideal hull coating to help maintain vessel efficiency. We were able to provide a long-standing customer with a coating that protects the marine environment and delivers significant energy and fuel savings in line with their own objectives for sustainable operations."

Goh adds: "Our customers are coming to us to ask for hull coatings that reduce the harm their operations do to the environment, driven by regulation but also by their focus on conducting sustainable operations. While hull coatings are an often-overlooked clean technology, they can provide significant fuel savings, of up to 14.7% in the case of our Aquaterras range, that help vessel owners to meet sustainability goals across their fleets."

Shipyard facilities

Nippon Paint Marine is also being called upon to meet the requirements of shipyard facilities. The company's division in China recently supplied its epoxy anti-corrosive coating NOA 60HS to two of the largest floating docks in the world, a project that required over 2.5 million litres of coatings. The floating docks are currently under construction, with one delivery scheduled for June 2025 and the other for December 2025.

NOA 60HS is designed primarily for use in ballast tanks, cargo oil tanks and voids. It includes Nippon Paint Marine's Self-Indicating Technology, which allows sprayers to judge coating thickness by colour in real time, helping to ensure accurate application even in low-light environments.

Nippon Paint Marine is now offering clients a consulting service to support the ongoing effectiveness of their hull coatings. Goh says: "Our consulting teams can help to tailor hull coatings to a vessel's operational profile, supporting the optimisation of performance and providing an immediate and cost-competitive coatings solution to support compliance with decarbonisation regulations aimed at delivering net zero in or around 2050."

Meanwhile, Nippon Paint Marine's R&D team continues to develop technologies that build on the effectiveness of its coatings. Later this year, the company expects to release a further extension to its established Fastar range, which combines nano domain technology with hydrogel, with the aim of delivering low environmental impact and significant fuel-saving performance. The hydrogel acts to trap a layer of water against the hull surface increasing smoothness, reducing friction between the hull and the water, and delivering significant fuel savings with a claimed average speed loss of just 1.2% in the first 60 months of operation. Fastar has been applied to over 1,000 vessels worldwide since its introduction in 2021. ■

Aquaterras was applied to the MOL-owned car carrier *Courageous Ace* in 2024

PPG CHASES SUSTAINABILITY

The coatings supplier has shown a willingness to explore more environmentally friendly application technologies, writes **Clive Woodbridge**

In response to evolving trends within the shipping industry, coatings supplier PPG has recently significantly expanded its product portfolio with what it describes as "sustainably advantaged solutions". In 2024, 41% of the company's sales were from such products.

Ariana Psomas, PPG global segment director for new build and dry dock, explains: "While many of our products have sustainable attributes in their end use that promote longevity of customer assets, we consider products to be sustainably advantaged when they contribute to improved environmental outcomes or provide relative improvements over industry benchmarks. Our product diversification focuses heavily on meeting the growing customer demand for these more sustainable marine coatings."

As an example, the PPG Sigmaglide 2390 biocide-free fouling release coating, introduced in 2023, offers claimed benefits of up to 35% reduction in greenhouse gas emissions and up to 20% power savings compared to traditional antifoulings.

Last year, PPG also launched PPG Nexeon 810, a copper-free antifouling coating. Of that coating, Psomas claims: "Its unique formula can enable a total emissions reduction of up to 25% compared to traditional antifouling coatings, and supports resistance to idle times of up to 60 days with minimal speed loss."

PPG is developing products suitable for electrostatic application

Ariana Psomas, PPG: "Selection of the right energy-efficiency solutions is of utmost importance"

Electrostatic applications

In addition to these new coatings, PPG has stepped up efforts to introduce electrostatic coating applications in the shipping industry. This technology is claimed to significantly improve transfer efficiency compared to traditional airless spraying, which results in reduced overspray, less waste and a cleaner working environment for applicators.

The electrostatic process uses charged paint droplets that are attracted to the vessel surface with high levels of precision, lowering environmental impact and VOC emissions.

According to Psomas: "We have seen an increase in demand for the PPG Sigmaglide 2390 fouling release coating and PPG Nexeon 810 antifouling which are ideal for electrostatic application. We have experienced real success with this advanced method, particularly in reducing environmental impact and improving application efficiency for our customers."

As an example, the EDR Antwerp shipyard recently achieved a 40% reduction in overspray with the electrostatic application of PPG's Sigmaglide 2390 coating. This was the second such electrostatic application project PPG had completed with EDR and was carried out on the underwater hull of the 212m ro-pax vessel *Stena Transporter*. Another recent electrostatic application was carried out on the VLCC *Sidr*, operated by Bahri Ship Management, at the Asyad Drydock in Oman, on this occasion using the PPG Nexeon 810 antifouling.

In addition, PPG has recently undertaken the first PPG Sigmaglide fouling release coating drydocking for Cosco Shipping Energy Transportation, again using electrostatic application. This was carried out on the *Yuan Chun Hu*, a 333m crude oil tanker, at the Liuhengdao shipyard in Zhoushan, China. PPG Sigmaglide 2390 coating was applied to the underwater hull, while PPG Nexeon 810 was used on the boot top.

Psomas says: "Our investment in promoting the use of electrostatic application aims to encourage a shift towards a more sustainable operation in shipyards,

with less coating overspray and waste providing an improved working environment for applicators. We believe we are the first in the shipping industry to introduce this type of application, having developed coatings specifically suited for it."

"Radical improvements"

IMO's greenhouse gas reduction strategy, constructed in the short term around the CII and EEXI measures, and with more measures under development for the medium and long term, calls for a drastic reduction in emissions by at least 20% compared to 2008 levels by 2030, and by 70% by 2040, as well as reducing total emissions to net zero by 2050.

Psomas says: "For shipowners and operators, the ability to achieve savings of this magnitude requires radical improvements in design and in operating efficiency, and the selection of the right energy-efficiency solutions is of utmost importance. It is this realisation that is prompting leading shipowners and operators to adopt low-friction coatings that can directly shift the speed-power curve, reducing fuel consumption and, consequently, greenhouse gas emissions while improving operational efficiency."

She continues: "By investing heavily in innovation and coatings R&D, we are developing products that deliver superior performance while meeting stringent environmental standards. Through ongoing collaboration with regulatory bodies, shipowners, shipyards and industry stakeholders, we are shaping a future where marine coatings are integral to achieving more sustainable shipping." ■

LASER QUEST

A group of Japanese firms is developing laser technology to facilitate the removal of rust and coatings during ship repair work

Four Japanese companies – Mitsui OSK Lines (MOL), MOL Drybulk, Furukawa Electric and Tsuneishi Shipbuilding – recently tested a new surface treatment system, called the InfraLaser, on the outer hull of a vessel, successfully stripping down rust and coatings with industrial laser technology.

Furukawa Electric, with the assistance of MOL and MOL Drybulk, has been developing a rust and coating removal system for onboard maintenance since 2021, while Furukawa Electric and Tsuneishi Shipbuilding have been conducting demonstration experiments aimed at the development of the same system for ship repairs since 2022.

Through the development of the InfraLaser system, the partners aim to reduce the environmental impact of rust and coating removal, as well as to improve working conditions, in ship repair yards. In the future, they also plan to automate this process.

MOL ship trial

During ship repairs, rust and coatings are removed for hull inspection and repainting. However, the frequently used sandblasting method, which removes rust and coatings by blasting abrasive materials against the hull surface, scatters waste materials and removed paint as debris, adversely impacting the environment and necessitating extra work to recover the materials.

By replacing this process with a laser-blasting method that generates relatively little waste, dust and noise, the partners expect to reduce environmental impact and improve occupational health. Similarly, by applying metal-processing technology, covering welding, cutting and surface treatment, the partners aim to develop a much-improved alternative system.

A field trial was conducted in December 2024 on a ship operated by MOL, which reportedly confirmed the effectiveness of the laser application of the system under development. The partners say they will now accelerate the development of the laser application system, and will also continue to study the automation of the system by taking advantage of the laser's zero reaction force, aiming to achieve significant labour savings, among other benefits. ■

A field trial of the InfraLaser was conducted on a ship operated by MOL in December 2024

COLOUR SELECTION WITHIN SECONDS

A new digital colour configurator is intended to speed up the selection of colours for yacht newbuilds, offering more than 1.7 million colour combinations

Germany's Alexseal Yacht Coatings has launched a 'digital colour configurator' tool, to help yacht owners to decide the paint finish details for their forthcoming newbuilds. The tool enables owners to superimpose up to 121 different solid and metallic colours onto a 3D yacht model, giving them a photorealistic preview of how their yachts' hulls, superstructures and stripes will look when finished.

The tool is intended to provide a time-efficient alternative to using colour sample cards during the colour selection process. A spokesperson for Alexseal tells *The Naval Architect*: "The configurator offers the possibility to compare several shades on a yacht type within seconds. For example, if you have a customer in South America who wants to make a colour decision for a yacht newbuild and you have to send a colour sample card from Europe, that can take days or maybe more than a week."

The Alexseal colour configurator provides a photorealistic preview of how clients' yachts' hulls, superstructures and stripes will look when completed

The configurator is available for five yacht types, the spokesperson adds, including sailing yachts, motor yachts, superyachts, sport fishing boats and open-deck picnic boats.

3D overview

The colours available via the configurator range from yacht sector "classics", like 'snow white' or 'super jet black', to more obscure hues, including 'Venetian red', 'dolphin blue' and 'Lambo orange', Alexseal says. In all, more than 1.7 million colour combinations are possible through the configurator.

Once the user has settled on the colour(s) they like, selected designs are saved as PDFs and can be sent by email. The configurator is compatible with both desktop PCs and smart devices, enabling the customer and builder to communicate while on the move. ■

JOTUN RAISES BIOFOULING WARNING

Biodiversity, biofouling and emissions issues are inextricably linked, the coatings manufacturer has warned. **Clive Woodbridge** reports

UAE-based Sallaum Lines has invested in Jotun's Hull Performance Solution (HPS), in combination with HullKeeper, for its four pure car and truck carrier (PCTC) newbuildings under construction at Nanjing Jinling Shipyard, China. HullKeeper uses a proprietary algorithm to evaluate fouling risk and recommends the best course of action.

"In the near term, optimising hull performance will contribute positively towards regulatory requirements, such as IMO's CII and potential carbon tax implications, as well as potential exposure to regional regulatory requirements like EU ETS and FuelEU," comments Mohamed Ehab, key accounts manager for shipping, Jotun UAE.

"Major concern"

From Jotun's perspective, biodiversity, biofouling and emissions issues are inextricably linked.

"Considering that shipping accounts for about 3% of global emissions, this is a major concern," said Dr Christer Øpstad, Jotun global R&D director of fouling protection, at the COP 29 conference in Baku in November 2024. "By keeping hulls clean, we can largely avoid these additional emissions and biosecurity risks."

According to a Jotun study, two-thirds of industry stakeholders lack awareness about the real-world impacts of biofouling.

"It just shows that in addition to developing technologies and solutions, we also need to work together in raising the awareness, ensuring stakeholders understand the consequences and how they fit into the bigger picture," said Øpstad. "We cannot solve this with one technology or one single solution." ■

ANNUAL DINNER 2025

ROYAL INSTITUTION OF NAVAL ARCHITECTS
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The Annual Dinner is a major event in the Institution's diary and is well supported by the maritime industry, as well as members of the Institution. Members and guests represent designers, builders and operators across the entire spectrum of the global maritime industry. For the third time, the event will be held at the gorgeous De Vere Grand Connaught Rooms in the heart of Central London – Covent Garden, with great transport links and easy access for you and your guests. RINA Annual Dinner 2024 was attended by more than 130 companies and 370+ industry professionals. The event will be a great opportunity for you to catch up with your colleagues, clients, guests and friends in the maritime industry!

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COMMANDER MIKE FORRESTER MBE,
ROYAL NAVY

A Marine Engineer Submariner with 18 years of service, Mike took on the 'World's Toughest Row' in 2023 - an unsupported Atlantic crossing with his fellow submariners - emerging victorious in an incredible test of resilience, teamwork, and leadership. We can't wait to hear his inspiring story!

22ND MAY 2025
LONDON, UK

THE ROYAL INSTITUTION OF NAVAL ARCHITECTS

100 YEARS SINCE 'THE GREAT BETRAYAL'

A review of the relationships between warship officers and engineers within the Royal Navy reveals a history of interpersonal tension and financial challenges, writes **Mark Barton**

We frequently see concerns across society about the lack of engineers and how they are needed to help companies succeed and for good products to be developed. These concerns often focus on pay and status and, several times, there have been calls for 'engineer' to become a protected title.

This year sees the centenary of what was then known as 'The Great Betrayal', when the status of engineers in the UK's Royal Navy (RN) took a significant step backwards. Therefore, on this anniversary, it might be illuminative to see how the RN approached the employment status of its engineers, from the formation of the Branch in 1837 and how that changed over time.

The challenges in this article were not unique to the RN and apply to many other countries' navies, as well as to commercial firms. Indeed, when engineering was still all related to wood and sail in 1755, the French Navy struggled to get its fleet to sea at all, simply because of a lack of skilled artisan workers available for the requisite work in the dockyards [1].

An image of the first uniform adopted by Royal Navy engineers, which was the same as the uniform for gunners, boatswains and carpenters (image: Royal Museums Greenwich)

A distinct role

Prior to the RN's formation of the 'Engineering Branch Afloat' in 1837, ships' engineers (or, as termed at the time, enginemen) were an anomaly. They belonged neither to the existing groups of officers – who were then divided into the military branch commissioned by the Admiralty, who would fight and command the ship – and the civil branches – appointed by warrant from the Navy Board and including all those with broader skills, such as surgeons, masters (navigators), secretaries and pursers (now, both groups are commissioned and that former group is known as executive officers, although they have absorbed the master into their group).

However, rather than being appointed by the RN through either the Admiralty or Navy Board, enginemen came with the engine. The problem was that, without a commission or warrant, they often left just as and when they pleased. The impact of the introduction of engines, and thus the need for engineers, even in the early days of the RN, was profound. However, after generations of having had the ability to impose harsh discipline and unbending tradition, the RN was suddenly confronted with a breed of men lacking both, but having their own robustness.

The RN was not sure how to deal with them; nor was it able to effectively apply any of its usual 'remedies', because nobody else could handle the engines and the engineers could walk away. This state of affairs could not be allowed to continue if the 'steam navy' was to expand, as the Admiralty and government desperately wished it to do.

Appointment by warrant

Over the first 20 years of using engines at sea, the RN settled on two main suppliers – Maudsley and Penn, whose companies later merged. Because of this commonality in equipment, engineers could be moved from vessel to vessel if needed. This was especially pertinent as steamships were often based a long way from the UK on operations, rather than in support roles at home. This was because the paddle wheels on early steamers meant they could operate in shallow waters, and this capability was critical for the RN's anti-slavery operations that characterised the post-Napoleonic War period.

Admiral Fisher attempted to plug the engineer shortage within the Royal Navy with the 1902 publication of the Selborne Memorandum

Therefore, on 19 July 1837, an Order in Council regularised the position of engineers in the RN, appointing them by warrant. However, within 12 months, a second order had to be issued awarding a 30% pay rise because of competition from the external marketplace – engineers were needed, and so could take their skills elsewhere. Thus, the never-ending challenge began, with the RN trying to attract skilled technical individuals who could earn high pay elsewhere, though not wanting to pay them higher than the executive officers, while being overall budget-constrained.

Outside war, the RN has been consistently under financial constraint. More than 89% of lieutenants were unemployed in 1817 following the ending of the Napoleonic Wars and the 1812-15 War with America [2], at the same time that the first enginemen were finding employment. So, in some ways, it is understandable these officers would be upset when others found employment and they could not. The first steamship hired by the RN was in 1814 in the Great Lakes campaign and, by 1822, it had its own steam vessel, *Comet*. Without the ability to significantly increase pay for engineers, the RN's answer to attracting and retaining them was initially to try and make them feel appreciated through uniforms, rank and a medal.

As part of giving them the status of warrant officers, the engineers gained a uniform. Early efforts to improve retention involved changes to this uniform to help distinguish engineers. In 1841, engineers would get their own special button on their uniforms to distinguish them from the other warrant officers. The purple between the stripes was not introduced until later, with the adoption of the 1856 RN uniform. In 1842, it was decided to introduce a medal just for engineers, for their ability and good conduct. These were awarded either for outstanding work on operations, as an MBE would receive now, or for an invention, as a Herbert Lott award would be made now. These perks clearly were not enough, and the Navy had to return to the question of renumeration, as it would have to do again and again.

A question of pay

As part of the bid to solve the shortage of naval engineers in 1847, just a decade after gaining status as warrant officers, it was deemed necessary to raise the pay of RN engineers 1st Class from £16 to £18 per month, with similar pay rises to other levels. But it was known this was still less than industry typically paid, including the merchant navy. That year, the steam vessels *Monarch* and *Neptune* were being refitted in the UK as warships for the Spanish [3]. Even though the company building them was offering the chief engineer £24 per month, engineers £20, third engineers £16 and stokers £8, they still struggled to fill the posts.

It is clear that some of the attempts by the Admiralty to solve the engineer recruitment challenge during the Victorian era did not go down well. In the 1860s, the RN felt that, to improve their status and help them become more equal to existing commissioned officers – a step that had by then already been taken by pursers and surgeons – engineers should become more managerial and less hands-on. To enable this, the RN moved the boundary between the individual fixing the engine and the officer who managed that fixing. They introduced, in 1868, a level in between: the engine room artificer.

This was met with considerable disgruntlement by the engineers because it was seen as removing many of their posts, even though they were short of people and struggling to recruit, and so all it did in effect was remove gapping. The next 30 years saw the RN attempt to solve the problem by creating its own naval engineering college, so that it developed their own trained engineers rather than take from society.

Fisher's plan

In 1902, as Admiral Fisher became first sea lord, there were about 1,500 RN engineers. However, the shortage was such that, in the same year, the RN raised the retirement age for engineers to 55 [4] compared to 50 for all other officers.

Fisher was determined to solve the problem, publishing, in December that year, the Selborne Memorandum. This announced there would be: "One system of supply, entry and training with homogenous training of executive, engineer and marine officers." All were to enter the service as naval cadets between the ages of 12 and 13, and their specialisation, when selected, would be definite and final.

In other words, once it was determined that they were a navigation (N), gunnery (G), torpedo (T) or engineer (E) specialist, they would remain so for their whole career. You would become a naval officer first, and then become an engineer. This also declared that, from the next year, engineering ranks would move to traditional RN ranks, albeit with the addition of the word engineer. For example, the engineer in chief became an engineer rear admiral.

Admiral Fisher, prior to his reforms, had commented on how executive officers were contemptuous of engineers, and that when officers of a warship were invited to a function ashore, it was tacitly understood to exclude the engineers [5]. He also noted many executive officers seemed to have a very poor understanding of technology, using as an example that one captain, having been told by his engineer the ship was going as fast as she could, replied that he should just put more oil on [6]. Despite Fisher's attempt to rectify the situation, there remained a tension between engineers and executive officers, with it being felt that the latter looked down on the former.

Tension and division

This feeling received unexpected confirmation in 1925, when an Order in Council effectively reversed Fisher's reforms. This played on many executive officers' desire to blame Fisher's change in engineers' training for their lack of success in WWI [7], despite those engineers trained through the Fisher scheme still being very junior at the time.

This order became known as 'The Great Betrayal' in engineering circles, both within and outside the RN, and attracted considerable press coverage. The five branches established by Fisher were abolished and replaced by 12 categories: executive officers; engineer officers; medical, dental and accountant officers; instructor officers; chaplains; shipwright, ordnance and electrical officers; and schoolmasters and wardmasters. Writing later, following his rise to engineer vice admiral, Sir Louis Le Bailly summarised it as follows:

By employing the word 'categories' the Admiralty hoped to avoid the stigma attached to those who were not executive (and therefore by tradition not military; and if not military then civilian). Gunners and gunners (T) and boatswains, although still warrant officers, were included in the executive category. Within this rather fraudulent device were several concealed caveats which gave the game away. Although for many years there had been an executive branch, this order, for the first time, gave legality to the term executive officer. Secondly, the order made it clear that only executive officers were to be considered in the chain of command...

Pictured: the buttons added to the engineer's uniform in 1841 to make them distinctive (image: Royal Museums Greenwich)

and, importantly, command over ratings of all branches was to be reserved only for those in executive command.

Admiral Le Bailly was not the only senior engineer who clearly felt this very strongly. He also wrote: *These actions, taken in all sincerity as being good for the Navy, were founded on the mistaken belief that Fisher's legacy of some community of knowledge and a lifelong community of spirit between engineers and seaman officers had somehow been responsible for a large part of the naval failure in World War I [and]...as a result, advancing naval technology withered.* [8]

Post-WWI

Post-WWI, the problem was not only about engineer retention but also technicians. This was despite the massive reduction in personnel due to the end of the war, and came about because the expansion of the artificer cadre had been achieved using hostilities-only personnel. These were, of course, the first to demobilise and return to their pre-war professions. The war had seen many stokers advance very quickly to petty officer, but they did not have the same technical engineering experience as they would have done prior to the war, noting that a marine engineer's job in war only really changes significantly once the ship is hit; otherwise, peacetime or war, the kit has to be kept running.

The RN established a scheme for mechanicians, to enable stokers to move into the artificer branch rather than remaining as a completely separate pipeline as they had done previously [9]. So, while the RN improved the status and promotion opportunities for stokers, it reduced them for engineers – and then wondered why engineers got upset and they struggled to recruit.

This change continued all the way through the 1930s and WWII; even in the mid-1950s, the crewing plans for ships and establishments still showed chief and petty officers listed in the chain of command above all non-executive officers such as engineers [10].

AFO 1/56

However, by the end of WWII, three quarters of the senior engineers in the RN were Fisher-trained, and their value was belatedly recognised [11]. Therefore, another change to the overall officer structure took place and Admiralty Fleet Order (or AFO) 1/56 was issued.

This established the General List which, for all purposes except command at sea, meant engineers and non-engineers should once again have equal status and opportunities. This removed the purple between their stripes that engineers had had to wear, and which was the public mark of the difference in status of officers of the same rank. The branch colour only remained in the RN for doctors, dentists and members of the Royal Corps of Constructors and Royal Fleet Auxiliary (RFA), the latter two being technically members of the RCNC and RFA rather than the RN, although their recruitment and retention problems are equally challenging and their service is critical to the successful operation of the RN.

While it is arguable as to whether all the old perceptions of executive officers had disappeared, naval author John Winton commented in 1980:

Vestigial traces of that snobbery still remain. For example, membership of the Royal Navy Club of 1765 and 1785 (United 1889) is still restricted to 'Seaman officers of the Royal Navy . . .who are, or were eligible to be appointed to command one of H.M. ships-of-war at sea. . .' The rules were firmly amended in January 1957, to take care of the new situation created by AFO 1/56, lest anybody get ideas above their station. [12]

Never again would engineers not be allowed to give orders to those junior to them of whatever branch.

Future challenges

While ensuring that engineers are rewarded sufficiently to retain them remains at the forefront as an issue for a technical service, it will be interesting as economic hard times continue for the government. At the same time, there is potentially significant growth for those involved in developing the products needed for defence, meaning that demand for maritime engineers is likely to grow.

How the balance will develop will be interesting, especially as drones and autonomous vessels mean that more and more vessels can be operated from remote locations by those who are in the traditional executive role – but these drones still need to be maintained and repaired on site often from an operationally forward position. ■

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