

THE NAVAL ARCHITECT

SEPTEMBER/OCTOBER 2026 rina.org.uk



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A CHANCE CONVERSATION, A CAREER COURSE CHANGE

Welcome to the latest issue of *The Naval Architect* which has a focus on skills, education, development and careers.

I am writing this having very recently joined the RINA Council and been elected to the Board of Trustees, and what a privilege it is to introduce this issue of the magazine.

Like many of you reading this, my journey into naval architecture began early, not with a career plan, but from a love of being on the water, having spent summers growing up learning to sail and, later, teaching sailing.

Yet, when I was looking at university options and future careers, naval architecture wasn't something I ever considered because I wasn't aware it existed. It wasn't until a chance conversation with another sailing instructor, who mentioned he was studying 'ship science', that I discovered a profession that combined engineering with my passion for sailing and the ocean.

I went on to study naval architecture at the University of Southampton and joined RINA as a student member. Through local branch events and technical presentations, I gained further insight into the industry and the opportunities available, started to grow my professional network and began my involvement with RINA, which has remained an important part of my career.

In recent years, there has been a shift within RINA, with a growing focus on supporting its members at all stages of their professional journeys. This led to the creation of the Developing Careers Committee, focusing on a few key areas, including STEM outreach and engagement with universities and apprentices. There is further information on this in Chris McNair's article in the Members section.

Given my introduction to the profession was purely by chance, I have always been passionate about increasing the visibility of naval architecture as a career. I want to ensure that it is a profession that young people are aware of and can recognise as exciting and rewarding. This led me to join the STEM Working Group, where we are developing resources that make carrying out STEM



"I HAVE ALWAYS BEEN PASSIONATE ABOUT INCREASING THE VISIBILITY OF NAVAL ARCHITECTURE AS A CAREER"

outreach more accessible, helping members engage with schools and young people while reducing the time needed to prepare materials to do so. Resources are being developed with consideration for regional variations in education systems and courses available.

These efforts are particularly important as there are a wide range of opportunities available, at a time of innovation and growth in the industry. From advances in digitalisation, design for alternative fuels, the expansion of offshore renewables and increased shipbuilding programmes, our industry continues to evolve at a rate of knots.

As these opportunities grow, so too does the need for skilled professionals whose technical expertise will shape the future of the maritime sector, making it equally important that we attract new talent while retaining the experience that has already been developed within the industry. In recognition of this and with the help of its volunteers, the Institution is increasing its support for professionals throughout their careers.

If you are interested in getting involved in any of the initiatives mentioned or with your local branch activities, please contact branches@rina.org.uk.

CHARLOTTE DODGE is senior decommissioning engineer and operational support engineer at London-based energy and marine consultancy ABL. She is a RINA Trustee.

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Photograph: University of Plymouth

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INSIGHTS

NEWS AND VIEWS ON MARITIME INNOVATION



BIG PICTURE

HISTORY IN THE MAKING

Draken Harald Hårfagre is the world's largest Viking ship sailing in modern times, built in Haugesund, Norway, and launched in 2012 after construction began in 2010. The vessel measures 35m in length and 8m in width, with a 24m mast height, a draught of 2.5m, and 260m² of silk sail area, giving a gross tonnage of 75tonnes. Her hull is built in oak, the mast in Douglas fir, and the rigging in hemp, reflecting the traditional boatbuilding methods drawn from the Nordlandsbåt, a type of fishing boat, and the Gokstad, a longship. More than 10,000 nails were used in her construction, fastened plank by plank by a team of boatbuilders, historians, craftsmen and artists.



Operated by a crew of 30 to 35, with rowing capacity for up to 100 when required, *Draken* is capable of 14 knots under sail and 3 to 4 knots under oar, and carries modern engines and onboard systems for safety and manoeuvring. Since her launch, she has completed a series of major voyages, including the 2016 North Atlantic crossing to North America. Since 2018, she has also served as a research platform, collaborating with the Scripps Institution of Oceanography to collect microplastic samples for ocean science.

Draken featured in Christopher Nolan's film *The Odyssey*.

● Photograph: NYC, *Draken* Harald Hårfagre/Peder Jacobsson



Left: The Deep Blue Project USV gathers real-time maritime data in coastal and offshore environments



The CorPower C4

USV SUPPORTS MAPPING OF GLOBAL SEABED

An uncrewed surface vessel fitted with metocean sensors, feeding into a cloud-based analytics platform, is set to support one of the maritime sector's largest data gaps, the mapping of the world's ocean floor. The technology, developed under the Deep Blue Project and Deep platform, has been brought into the Seabed 2030 Project, which is now in partnership with the consultancy behind it, BMT.

The Deep Blue Project pairs autonomous vessels with metocean sensors and onboard analytics to collect maritime data continuously and in real time, without the vessel-time and crewing costs of conventional survey work. BMT Deep, the accompanying platform, processes that data into predictive insights, intended to support design, monitoring and operational decisions across offshore assets and coastal infrastructure. For naval architects, the shift is from periodic survey datasets towards a more continuous, decision-ready data stream.

Seabed 2030 is run jointly by The Nippon Foundation and General Bathymetric Chart of the Oceans (GEBCO), and is a Decade Action of the UN Ocean Decade. GEBCO has the sole mandate to map the entire seabed, yet large areas remain uncharted, restricting the ability of governments and operators to assess risk in the marine domain.

As part of its partnership agreement, BMT will work with Seabed 2030's regional centres and contributor network to identify where autonomous data collection can accelerate bathymetric surveying. All data gathered will feed into the freely available GEBCO global grid, for use by governments, industry and researchers worldwide.

Graeme Naylor, BMT's managing director, said better seabed information supports safer decision-making across the asset lifecycle, from design to decommissioning.

AYK ENERGY SHOWCASES CONTAINERISED BATTERY

Marine battery manufacturer AYK Energy has unveiled what it describes as the world's first swappable containerised marine battery system at SMM in Hamburg.

The Cosmos battery has completed the New Technology Qualification (TQ) stage, and the company said it is already receiving orders. TQ demonstrates that a new technology is mature enough to begin the class approval process.

According to AYK founder Chris Kruger, the containerised design changes how marine batteries are installed, deployed and operated, and it removes the need for a dedicated battery room, which he said can add significant engineering complexity and cost. He said that the system can be permanently installed for hybrid or fully electric vessels, or used as a swappable unit, with batteries charged onshore and exchanged between voyages. Kruger said this flexibility could support short sea electric operations in the EU, including compliance with ETS requirements, and could also provide hotel-load power for vessels in port.

The Cosmos battery features eight independent levels of safety, along with IP67 protection and an A60 fire rating. AYK is targeting the ferry, ro-pax and passenger vessel sectors initially, although the company said the technology also suits tugboats, feeder vessels and other workboats.





WAVE ENERGY CONVERTER SECURES WORLD-FIRST DNV CERTIFICATION

DNV has issued the world's first Prototype Certificate for a wave energy converter, awarded to Sweden-based CorPower Ocean for its C4 device, in a move the classification society says establishes a new benchmark for the wave energy sector.

The certificate, issued under DNV-SE-0120, the standard for certification of wave energy converters and arrays, followed a seven-year process during which DNV independently reviewed and approved the device's design, engineering, structural and fatigue analysis, manufacturing, testing, installation and performance in storm conditions with waves up to 18.5m. DNV's standards already underpin much of the offshore wind industry.

The CorPower C4 is a spherical composite hull, 9m in diameter and 18m tall, weighing around 100 tonnes, installed at a water depth of 45m off Aguçadoura in northern Portugal. It has operated at sea since 2023, including autonomous operation, grid power export, and surviving Storm Domingos in November 2023, a regional wave-height record according to the Hydrographic Institute of Portugal.

Certification is a critical step for wave energy technologies seeking project finance, insurance and institutional investment, since it independently verifies structural strength, reliability and safety against an established standard, reducing the technology risk associated with early-stage marine energy devices.

Claudio Bittencourt Ferreira, project manager at DNV Renewables Certification, said the certificate marked an important stepping stone towards commercial wave energy, adding that DNV would continue to support the sector's development.

Wave energy has remained largely untapped for more than half a century despite the scale of the resource, with developers and investors increasingly viewing certification as a prerequisite for the sector to move from prototype demonstration to commercial-scale deployment.



EcoPro on show at Seawork

ECOPRO TACKLES DIESEL COMBUSTION AT SOURCE

South Devon-based Ecomotus is urging vessel operators not to overlook a solution it says is already available and proven, as the industry continues to weigh up longer-term answers to marine emissions.

The company's EcoPro Catalytic Hydrogen Electrolyser System, an award winner at Seawork earlier this year, is a retrofit device designed to improve diesel combustion efficiency without engine modification, fuel replacement or hydrogen storage. It generates hydrogen on demand through catalytic electrolysis of a weak potassium hydroxide solution, drawing power from a vessel's existing supply, and feeds it continuously into the engine's air inlet. Because hydrogen ignites faster and more evenly than diesel, the company says the mechanism draws forward the diesel's own combustion, reaching fuel droplets that would otherwise burn late or incompletely, and cuts both particulate output and the localised high temperature zones in which NO_x forms. No hydrogen is stored at any point, and the only ongoing maintenance is a weekly top-up of de-ionised water.

Ecomotus cites 6-22% fuel saving, up to 74% NO_x reduction, and 84-90% plus reduction in black carbon, figures it says are drawn from operational data on working vessels, corroborated by independent engineering inspection and a bench testing programme carried out with the University of Strathclyde and City of Glasgow College.

STATS

72%

China took 72% of global shipbuilding orders by compensated gross tonnage in the first half of 2026, while South Korea accounted for 19%, according to Clarksons Research data.

TRINITY HOUSE ORDERS TWO HYBRID BUOY TENDERS FROM VARD

Trinity House, the General Lighthouse Authority and maritime charity responsible for aids to navigation around England, Wales, the Channel Islands and Gibraltar, has awarded a contract to VARD for the design and construction of two multifunctional vessels. This is a major milestone in the organisation's Future Afloat fleet renewal programme. The vessels will replace the ageing THV *Patricia* and THV *Galatea*, with delivery scheduled for the second and fourth quarters of 2029.

Based on an original VARD design, the new vessels will handle buoy maintenance, hydrographic surveying and emergency response to navigational hazards around the coasts of England, Wales, the Channel Islands and Gibraltar. They will be equipped with dynamic positioning technology, specialist deck equipment, workboats and a helideck.

Sustainability featured heavily in the design brief. Both vessels will have hybrid propulsion with substantial battery capacity and shore power connectivity, and are being designed with future conversion to methanol fuel in mind.

Damien Oliver, from the Future Afloat programme, said the contract would ensure Trinity House can continue to fulfil its statutory responsibilities for decades to come.

Iain Lower, Trinity House's deputy master and chief executive, called VARD "a world-class shipbuilder with



VARD 9 601
design

"THE VESSELS WILL HANDLE BUOY MAINTENANCE, HYDROGRAPHIC SURVEYING AND EMERGENCY RESPONSE TO HAZARDS"

an outstanding reputation for quality and innovation," following a highly competitive tender process. VARD Group chief executive Cathrine Kristiseter Marti said the contract would help develop maritime competence across borders.

The award includes UK supply-chain commitments through the build programme, and a training partnership between Trinity House, VARD and Vard Marine Canada, giving apprentices and students exchange opportunities to develop skills internationally.

The two vessels have been named *Princess Royal* and *Prince Philip*, in tribute to the late Duke of Edinburgh, whom The Princess Royal succeeded as master of Trinity House in 2011.

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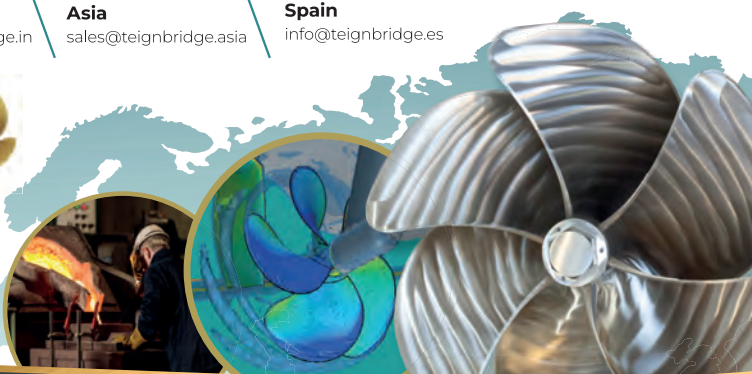
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Bollinger Shipyard and, below, celebrating the launch of its new training centre

RESHAPING INVESTMENT DECISIONS

Regulatory uncertainty is placing growing pressure on shipowners to make investment decisions robust enough to hold up across multiple possible futures, according to DNV's *Maritime Forecast to 2050*, published in August.

The report models four regulatory scenarios, ranging from adoption of the IMO's Net-Zero Framework in its current form to its outright rejection, a path that DNV warns could lead to prolonged regulatory gridlock. The difference between outcomes is stark: under strong global regulatory alignment, DNV projects the world fleet could consume 25% less energy by 2050 than under a future shaped mainly by regional rules.

One of the report's more practical findings concerns energy efficiency retrofits. A case study of a 5,000TEU containership fitted with hydrodynamic measures shows annual fuel savings of 16%, with payback ranging from 1.4 to 4.2 years, depending on prevailing carbon prices, reinforcing the case for efficiency measures that pay off regardless of the regulatory picture.

The report also sets out a widening gap between fuel demand and supply. DNV projects shipping's demand for low-GHG fuels could reach between 33 and 185Mtoe by 2050, against a maximum theoretical global supply of 270Mtoe across all industries, a volume likely to be lower in practice and one shipping will need to compete for. Abatement costs vary sharply by fuel pathway, ranging from around US\$180 to US\$1,290 per tonne of CO₂ avoided.

DNV recommends that owners accelerate energy efficiency measures, weigh up the full range of compliance options and use scenario-based fleet planning rather than committing to a single fuel or technology pathway.



BOLLINGER OPENS TALENT PIPELINE WITH MISSISSIPPI TRAINING CENTRE

Bollinger Shipyards has opened a new 7,200ft² workforce training centre at its Gulfport, Mississippi facility, developed in partnership with the Submarine Industrial Base Program Office and Mississippi Gulf Coast Community College.

The centre will deliver hands-on bootcamp training in marine electrical, electronics and sheet metal mechanics, with classes beginning this year. It builds on Bollinger's existing bootcamp programme, launched in 2024, which offers 14-week shipfitter, pipefitter and pipewelder apprenticeships.

Since its inception, the programme has attracted more than 4,000 applicants from 22 states, with applications rising by roughly 700% between the first and sixth cohorts. Graduation rates have climbed from 61% to 80% during the same period, and around 70% of graduates have remained at Bollinger.

Ben Bordelon, president and CEO of Bollinger Shipyards, said the centre reflects the company's commitment to building a direct talent pipeline for its Gulfport operations and the wider national shipbuilding workforce.

The opening comes amid growing pressure on the US maritime sector to expand shipbuilding capacity and strengthen the skilled labour pipeline supporting naval modernisation, with the Gulf Coast positioning itself as a key hub for defence manufacturing training.

Bollinger Shipyards has an 80-year history designing and building military and commercial vessels, from patrol boats to offshore support vessels and barges. It is the largest vessel repair company in the Gulf of America region.



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WINDCOOP ORDERS WORLD'S FIRST SAIL-POWERED CONTAINER SHIP

Cooperative shipping venture Windcoop has placed a binding order for what is being described as the world's first sail-powered containership, with construction due to begin at RMK Marine's shipyard in Türkiye in 2026.

The 91.3m vessel will carry 210TEU, including 40 reefer plugs, and will be propelled primarily by three rigid wing sails with a combined area of 1,050m². Windcoop projects an average service speed of 9knots and a 60% cut in carbon emissions compared with a conventional containership on the same route. Delivery is scheduled for May 2027, when the ship will open a new direct line between Marseille and Madagascar.

Windcoop, based in Lorient, was founded in 2022 by Zéphyr & Borée, Enercoop and Arcadie, and is structured as a Société Coopérative d'Intérêt Collectif, a French cooperative model in which profits are reinvested rather than distributed. It now has more than 1,600 members.

The €28.5 million build has been financed through a structured loan from Crédit Maritime Grand Ouest and Banque Populaire, backed by a Bpifrance guarantee, plus €6.8 million from private investors, shipper members and institutional backers. The confirmed order replaces an earlier 85m concept design and now specifies the larger, rigid-wing-sail-powered hull.

"THE 91.3M VESSEL WILL CARRY 210TEU AND WILL BE PROPELLED BY THREE RIGID WING SAILS"

WINDCOOP, ALAMY



Windcoop's containership is set to sail in May 2027

MAST REMOVAL ON WWII WRECK IN THAMES ESTUARY

Resolve Marine has started one of the UK's most sensitive wreck salvage operations – the removal of the three masts of the *SS Richard Montgomery*, a sight that has become iconic for residents around the Thames Estuary.

The £9.5 million project, confirmed by the UK government on 14 July, targets the WWII American Liberty ship that grounded on the Nore sandbank off Sheerness, Kent, in August 1944. The vessel's hull, cracked and split in two under the weight of its cargo, still holds an estimated 1,400 tonnes of wartime explosives in its forward holds. Only the three masts remain visible above the waterline, and it is their deteriorating condition that has driven the government to act, following years of monitoring and a 2022 plan that was delayed.

For naval architects, the wreck is a rare, long-running case study in structural failure. The Liberty ship class was notorious for brittle fracture in early welded hull construction, and this vessel's 82 years of continuous degradation under tidal loading and corrosion offer a data point with few parallels. The masts themselves are now judged structurally unsound, with concerns centred on the loss of section in their supporting steelwork and the risk that a collapse could transmit damaging loads directly on to the munitions below.

The engineering solution is to cut the masts down to below sea level rather than remove them, reducing top hamper and the associated fall risk. To do this, Resolve Marine will construct an underwater platform, allowing specialist engineers to carry out controlled cutting operations near live ordnance, under continuous safety oversight and within the wreck's existing exclusion zone.

Nolan Conway, project manager at Resolve Marine, said the firm was drawing on its experience in complex marine operations to deliver the work safely and in close collaboration with stakeholders, including local emergency services and harbour authorities.

Once cut, the masts will be transported to Chatham's Historic Dockyard for conservation, an engineering challenge in its own right.



SS Richard Montgomery

JAPAN PUTS SHIPBUILDING TO THE FORE AS A NATIONAL STRATEGIC PRIORITY

Hideaki Saito examines the rise and fall of the island nation's shipbuilding industry and how the country plans to revive its seafaring fortunes

Revitalising and strengthening Japan's shipbuilding industry has become an urgent national priority, not only for industrial policy but for economic security.

Japan led the world in shipbuilding for nearly half a century after overtaking the UK in 1956, at its peak building roughly half of the world's ships. The oil crisis, the yen's appreciation after the Plaza Accord, and two severe structural recessions forced Japan to close docks, cut employment and halve its shipbuilding capacity. Since around 2000, South Korea and then China have expanded rapidly, and today China accounts for more than half of global shipbuilding, South Korea around 30%, and Japan roughly 10%.

This decline in market share does not mean Japanese output has collapsed. Japanese yards have maintained annual production of about 9 to 10 million gross tonnes, but global demand has grown faster than Japan's capacity, and yards are already operating near their limits.

As a maritime nation with few natural resources, Japan depends on sea transport for 99.5% of its imports and exports, making its domestically built merchant fleet essential to national life, industry and economic security. Shipbuilding also sustains regional economies, particularly in western Japan, and a broad ecosystem of marine equipment manufacturers.

Once viewed domestically as a sunset industry, shipbuilding is now regarded globally as a growth sector. Demand is expected to rise as vessels built around the 2010 peak require replacement, and as shipping moves toward low- and zero-carbon fuels to meet the IMO's target of net-zero emissions around 2050, driving demand for

ships powered by ammonia, hydrogen, methanol and other next-generation fuels.

Japan faces four major challenges. Its shipyards are often small, dispersed and ageing, while Chinese and Korean rivals operate large, modern, integrated facilities with economies of scale. Labour shortages are severe, with shipbuilding workers falling from more than 90,000 in 2016 to about 76,000 in 2025, and the industry needs both skilled site workers and engineers. Years of intense price competition have limited investment in large-scale facilities, and rising costs for steel,

“JAPAN DEPENDS ON SEA TRANSPORT FOR 99.5% OF ITS IMPORTS AND EXPORTS, MAKING ITS DOMESTICALLY BUILT MERCHANT FLEET ESSENTIAL TO NATIONAL LIFE, INDUSTRY AND ECONOMIC SECURITY”



engines and equipment are pressuring profitability.

Even so, Japan retains real strengths, high technological capability, world-class shipowners and marine equipment makers, and a unique industrial cluster. Japanese-built ships are valued for fuel efficiency, quality, reliability and strong second-hand resale prices.

The international environment has shifted, too. China, the US, Europe, South Korea and India are all strengthening shipbuilding as a strategic industry tied to national and economic security. Japan has designated ship components, including hulls, as specified critical goods under its Economic Security Promotion Act, named shipbuilding among 17 strategic industry fields, and set a government roadmap to double capacity to 18 million gross tonnes by 2035, with a decade-long commitment to support the goal.

Meeting this target will require bold investment in cranes, docks, digitalisation, automation and smart factories, alongside better recruitment, improved working conditions and closer cooperation with universities. Japan already leads in ammonia and hydrogen marine engines, zero-emission vessels and autonomous ships, technologies that could prove a game changer for its competitiveness.

Japan's shipbuilding industry also builds and repairs vessels for the Self-Defense Forces and Coast Guard. It may lack public visibility, but for an island nation shipbuilding remains a foundation of trade, employment and national resilience.

AUTHOR PROFILE

Hideaki Saito is executive managing director of the Shipbuilders' Association of Japan, based in Tokyo.

'WE NEED MORE FOLK WHO KNOW HOW THINGS FLOAT'

Simon Benson looks at how to create the best talent pipeline to cater for the growing offshore renewables sector

This headline is how naval architect Hamish Adamson, founder and managing director of Harlyn Solutions and a Newcastle University alumnus, put it at a recent Port of Blyth breakfast briefing. He was talking about the talent pipeline we need for the growing offshore renewables sector in North East England – pipelines we are plumbing with industry initiatives such as Energy Central, the innovative learning hub where I now teach.

But how do we fulfil this diversifying need, one that also includes naval architects? Or, to use a maritime analogy: how do we onboard talent on to the good ship MV RINA as we chart a course forward for our profession?

We might wait for the job opportunity or career trajectory that transfers a practising engineer straight on to the upper decks of our ship. We have master's degrees, CPD and experiential pathways that support this route, enabling professionals to join RINA mid-voyage.

But we also need fresh cadets to join us onboard. Young sprogs who then climb ladders and companionways, sometimes all the way to the captain's table.

To join us, they first need to discover our ship even exists. Then they need to locate the dock, sign on at the shipping office, and cross a sometimes wobbly gangway before stepping onboard.

The first discovery is essential. STEM outreach plays a big part here, and I think we're already rather good at it. RINA members contribute to countless STEM activities in schools and with youth groups. RINA is developing deep support for these efforts.

For example, "Next Generation" is the first page on our institution website.

But what about that shaky gangplank? Outreach without pathways becomes entertainment. If a 14-year-old leaves a STEM masterclass buzzing about hydro-foiling yachts or floating wind, but cannot link this to a route into naval architecture, we risk wasting the moment.

"A PRACTISING NAVAL ARCHITECT RELIES ON INCREASINGLY DIVERSE SKILLS AND ATTRIBUTES. PATHWAYS NEED TO EMBRACE THESE QUALITIES TOO"

Furthermore, if the only obvious route comprises a narrow pathway of academic qualifications, we are closing the door to many who would thrive as naval architects but aren't motivated by the journey to reach us. A practising naval architect relies on increasingly diverse skills and attributes. Pathways need to embrace these qualities too.

To do this, enabling a secure walk-to-work access system to our RINA ship, I have three suggestions.

First, improve the clarity of entry routes into apprenticeships, HNDs and degrees that recognise vocational and non-traditional paths with equal terms and career prospects. This clarity of opportunity is needed before young people choose their school subject options, not after.

Second, offer wider and meaningful work placements that are accessible by those without prior industry connections. These should



capture those newly motivated youngsters in our STEM sessions, be developed alongside education professionals wherever possible, and focus on workplace behaviours and personal development as much as work activity contributions.

Third, develop more higher level vocational and degree-level apprenticeships with specific naval architecture-focused curricula. Degree apprenticeships are oversubscribed wherever they're offered because they work for students. If our industry isn't offering them, we're leaving the best talent for others.

None of this is RINA's job alone, but we can be the advocates to drive wider change in our industry. While we are at it, we can also keep delivering those showcase wow factors that our industry easily delivers.

AUTHOR PROFILE

Simon Benson is a teacher of engineering science at Bede Academy in Blyth, North East England, consultant naval architect for the Flipflop Project in Lamu, Kenya and an associate lecturer in naval architecture at Newcastle University. Formerly a senior lecturer at Newcastle, he switched to post-16 education in 2024 and now teaches part-time on a new T Level Engineering course hosted at the Energy Central Learning Hub, a specialist STEM education and training centre within the Port of Blyth. His consulting work for the Flipflop Project focuses on research and development using recycled plastics.

PRESIDENT'S INVITATION LECTURE 2026

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THE SKILL WE RARELY TEACH: ENGINEERING JUDGEMENT

While technology has opened up a world of possibilities, it cannot remove the need for sound judgement, argues James Gladman

I often imagine what the design process will look like 10 years from now. We are moving towards a world where digital engineering and AI can do in minutes what might previously have taken months or years. That is undoubtedly exciting, but what does it mean for the role of the engineer? What happens when we become too reliant on the technologies intended to help us?

As engineers, we spend years developing technical competence. We learn mathematics, engineering principles and, increasingly, how to work with digital engineering and AI. Yet one capability receives far less deliberate attention, despite sitting behind almost every significant engineering decision we make: engineering judgement.

Engineering judgement allows us to interpret imperfect information, balance competing priorities and make decisions when there isn't a single correct answer. It cannot be learnt solely from textbooks, captured within a design standard or generated by an AI model. It develops through experience, mentorship, reflection and exposure to real engineering problems.

AI and digital tools are here to stay, and that is a good thing. They enable us to explore complex problems, compare more options and develop designs in ways previously impractical. But they cannot remove the need for judgement. Models rely on assumptions. Simulations have boundaries. Data has limitations. A technically valid solution may still be impractical to build, difficult to maintain, unsuitable for the operator



“FOR ME, KNOWLEDGE TELLS US WHAT WE CAN DO; ENGINEERING JUDGEMENT TELLS US WHAT WE SHOULD DO”

or create risk elsewhere. Ultimately, someone still has to decide whether the answer actually makes engineering sense.

That decision is rarely straightforward because engineering is fundamentally about trade-offs. Every design is a balance; optimising one requirement will often come at the expense of another. Good engineering is not simply about finding the technically optimal answer; it is about finding the right answer for the capability, the customer and the environment in which it must operate.

Engineering judgement also goes beyond analysis. It shapes how we challenge assumptions, communicate uncertainty, decide when more evidence is needed and, occasionally,

when experience tells us to question the numbers. For me, knowledge tells us what we can do; engineering judgement tells us what we should do. That requires confidence to ask difficult questions, but also the humility to accept that we will not always have certainty.

Think about the engineers who have made the biggest impression on you. I suspect you rarely remember them simply because they were the most technically knowledgeable person in the room. You remember those whose judgement others trusted; who knew when to rely on analysis and when to challenge it; and who could take a complicated problem, understand what mattered and provide clarity on the way forward.

As our profession embraces digital engineering and AI, technical competence will remain fundamental. But I think judgement will become more important, not less. Combining knowledge and experience with critical thinking to make decisions when certainty does not exist remains an inherently human part of engineering.

This also presents a challenge for how we develop the next generation. If judgement is built through experience rather than instruction alone, what happens as digital tools take on more of the analytical work traditionally undertaken by junior engineers? We must ensure that, in making engineering more efficient, we do not inadvertently remove the experiences through which judgement is developed.

Engineering judgement, then, is not simply another skill. As technology becomes increasingly capable of telling us what can be done, one of our greatest responsibilities as engineers will be developing the judgement to decide what should be done.

AUTHOR PROFILE

James Gladman MRINA, chief engineer, naval architecture and platform design, Expleo UK.



CHALLENGING UNIVERSITIES

From defence and autonomy to alternative fuels and AI, naval architecture is being reshaped by rapid change across the maritime industry. Amy McLellan looks at how 20 leading universities are responding to the challenge

From active conflict zones in the Middle East and Black Sea to patrols of polar waters and strategic shipping channels around the world, the maritime industries are on the frontlines of rising geopolitical tensions. That is creating a pressing need to invest in naval assets, from autonomous patrol vehicles to Arctic icebreakers – and, alongside the vessels themselves, to ensure there is a ready pipeline of trained naval architects and marine engineers.

At the same time, the commercial maritime sector faces its own transformation. Pressure to reduce greenhouse gas emissions is driving demand for alternative fuels and

propulsion technologies, while digitalisation, autonomy and artificial intelligence are changing how vessels are designed and operated.

For universities teaching naval architecture and marine engineering, the challenge is therefore twofold: maintaining the fundamental engineering knowledge on which the

“IN THE UK, THE LAUNCH OF THE DUA HIGHLIGHTS THE INCREASINGLY IMPORTANT ROLE OF HIGHER EDUCATION IN NATIONAL SECURITY”

profession has always depended, while preparing students for technologies and operating environments that may look very different by the time they graduate.

A PROFESSION OF STRATEGIC IMPORTANCE

In the UK, the launch of the Defence Universities Alliance (DUA) highlights the increasingly important role of higher education in national security. Announced in July, the DUA brings together 35 UK universities with the Ministry of Defence to boost defence industry skills and support research into new defence technologies.

The University of Plymouth is among the institutions already



Students take part in a practical session using the wave flume in Plymouth University's Marine Building

working closely with the defence industry, with expertise including maritime cyber defence and marine autonomy.

Dr Jahir Rizvi, programme director and lecturer in Mechanical and Marine Engineering at Plymouth, says the university's membership of the DUA is helping it equip students with specialist technical skills for careers in defence, security and marine autonomy.

Plymouth is home to the largest naval base in Western Europe, while its campus sits close to Plymouth Sound, giving students an unusually direct connection with the maritime environment.

"Our campus is located a stone's throw from Plymouth Sound, giving our students the chance to hone their skills at the same time as seeing technological innovations in action on the ocean on a daily basis," says Rizvi. "They gain hands-on experiences from day one, meaning they learn by doing rather than simply being told what to do."

The university's Marine Engineering with Naval Architecture programme is

STATS: 20 LEADING ACADEMIC INSTITUTIONS

CHALMERS UNIVERSITY OF TECHNOLOGY (SWEDEN)

- Founded in 1829 in Gothenburg
- Maritime education delivered through the newly formed Chalmers School of Maritime Studies, established January 2026
- Head of the Marine Technology Division: Professor Jonas Ringsberg
- Facilities include the SSPA towing tank, cavitation tunnel, and seakeeping and manoeuvring basin
- Links: Swedish industry, such as Stena and Wallenius
- Innovation focus: energy-efficient and safe ship design, autonomous and remote vessel operation, and sustainable shipping research
- www.chalmers.se/en

DELFT UNIVERSITY OF TECHNOLOGY (NETHERLANDS)

- Founded in 1842 in Delft
- Head of the Department of Maritime and Transport Technology: Professor Bendiks Jan Boersma
- Facilities: towing tank, a hexapod motion simulator and a circulating water channel
- Innovation: autonomous shipping, wind-assisted propulsion, alternative fuels and 3D-printed ship models, alongside the PortCall.Zero project
- Links: shipbuilder Damen and research institute MARIN
- www.tudelft.nl/en

ÉCOLE CENTRALE DE NANTES (FRANCE)

- Founded in 1919 in Nantes
- Specialism: naval architecture and ocean engineering
- EMship is an Erasmus Mundus joint master's in advanced ship and offshore structure design, run by a seven-university European consortium led by École Centrale de Nantes
- Director of the Research Laboratory in Hydrodynamics, Energetics and Atmospheric Environment: Professor Pierre Ferrant

- Facilities: a 140m towing tank, a large ocean wave tank with a multiflap wave generator, and a circulating water channel
- Around 42% of the student population is international
- Innovation focus: sustainable ship design, offshore renewable energy, and advanced numerical hydrodynamics
- www.lheea.ec-nantes.fr

GDAŃSK UNIVERSITY OF TECHNOLOGY (POLAND)

- Founded in 1904
- Specialism: ocean engineering and ship technology
- Dean of the Faculty of Mechanical Engineering and Ship Technology: Professor Mariusz Deja
- Facilities: a 600m² construction, strength and technological research laboratory
- Recent partnership signed with Baltic Towers, a Polish offshore wind tower manufacturer
- Innovation focus: marine structures manufacturing technology, underwater robotics and offshore wind infrastructure
- www.pg.edu.pl/en

SHANGHAI JIAO TONG UNIVERSITY (CHINA)

- Founded in 1896 in Shanghai
- Dean of the School of Naval Architecture, Ocean and Civil Engineering: Professor Liao Shijun
- Facilities: the State Key Laboratory of Ocean Engineering and a research platform for deep-sea heavy-load operating equipment
- Alumni: the chief designers of China's first 10,000tonne cargo ship, first nuclear-powered submarine, and first 7,000m manned submersible
- Innovation focus: deep-sea exploration, autonomous underwater vehicles and large-scale offshore engineering
- Strong ties to China's state shipbuilding and offshore sectors
- www.en.sjtu.edu.cn

IIT KHARAGPUR (INDIA)

- Founded in 1951
- Specialism: naval architecture and ocean engineering
- Offers BTech, MTech, dual degree, master's and PhD programmes in the department
- Leadership of Ocean Engineering and Naval Architecture Department: Professor Ranadev Datta
- Facilities: Computational Marine Hydrodynamics Laboratory and teaching labs for ship design and marine structures
- Links: strong ties to the Indian Navy, Indian Coast Guard and India's major shipyards
- Innovation focus: marine structures, hydrodynamics, offshore technology and coastal engineering
- www.iitkgp.ac.in/departments/NA

NEWCASTLE UNIVERSITY (UK)

- Traces its origins to 1834, gaining full university status by royal charter in 1963
- Specialism: naval architecture and marine engineering, taught within the School of Engineering's Marine, Offshore and Subsea Technology (MOST) group
- Facilities: towing tank, a combined wind, wave and current tank, an Emerson cavitation tunnel, and the research vessel *Princess Royal*
- Head of MOST: Professor Zhiqiang Hu
- Innovation focus: zero-emission shipping, marine renewable energy and autonomous maritime systems
- Alumni work in naval architecture and offshore engineering globally
- www.ncl.ac.uk

NTNU TRONDHEIM (NORWAY)

- Traces roots back to 1870
- Specialism: marine technology, hydrodynamics, marine structures, offshore renewable energy and autonomous systems
- Department of Marine Technology has around 180 MSc and 25 PhD graduates annually
- Head of the Department of Marine Technology: Professor Sverre Steen

- Building the Norwegian Ocean Technology Centre, due for completion this year
- Close partnership with SINTEF Ocean, whose test facilities operate at above 85% capacity
- Innovation focus: offshore renewable energy, marine robotics, autonomous vessels and Arctic infrastructure
- Home to the Centre for Ships and Ocean Structures, hosting around 50 PhD students and researchers
- www.ntnu.edu/imt

OSAKA UNIVERSITY (JAPAN)

- Founded in 1931
- Specialism: naval architecture and ocean engineering
- Department of Naval Architecture and Ocean Engineering heads: Professors Munehiko Minoura, Kazuhiro Iijima and Masaaki Shibata
- New Open Collaboration Lab for Enabling Advanced Marine Systems established April 2025, with Imabari Shipbuilding, Japan Marine United, ClassNK and MTI
- Department has contributed to international maritime safety standards, working with Japanese shipbuilders and class societies
- Innovation focus: ship automation, offshore wind farm structures and alternative fuels
- Postgrad teaching delivered in English, with a dedicated maritime and urban engineering programme
- Close ties to major shipyards
- www.naoe.eng.osaka-u.ac.jp/eng

SEOUL NATIONAL UNIVERSITY (SOUTH KOREA)

- Founded in 1946
- Chair of the Department of Naval Architecture and Ocean Engineering: Professor Shin Hyung Rhee
- Facilities: a towing tank, structural and vibration testing equipment, and shipbuilding CAD suites
- Innovation focus: LNG carrier design, floating offshore structures, and large-scale marine vehicle engineering
- Graduates play leading roles in industry, government and academia
- www.naoe.snu.ac.kr

centred around the Babbage Building and Marine Building, which house facilities including an Autonomous Systems Test Laboratory, wind tunnel, UK Floating Offshore Wind Turbine Test facility and a facility for testing the cyber resilience of vessels and maritime infrastructure.

An Ocean Basin allows prototypes and devices to be tested in a controlled environment, while a Coastal Basin is used to study sediment transport and coastal structures at scale.

Such facilities are becoming increasingly important as the definition of the naval architect's role expands.

"There is a skills shortage globally in the naval architecture sector," says Rizvi, pointing to both demand from defence and the pressure on the wider maritime industry to develop new vessel designs and alternative propulsion solutions.

"ALTERNATIVE TECHNOLOGIES ARE PUTTING PRESSURE ON REGULATORY BODIES TO DEVELOP NEW RULES AND REGULATIONS"



For universities, that shortage is an opportunity as well as a challenge.

Contemporary vessel designs and alternative technologies are also putting pressure on regulatory bodies to develop new rules and regulations. But, says Rizvi, these challenges give naval architects the opportunity to reinvent themselves and redesign technologies that in some cases have remained largely unchanged for decades.

LEARNING BY DOING

The emphasis on practical experience is also evident at institutions outside the UK. The Webb Institute in New York has a long history of educating naval architects and marine engineers. The school was founded during the transition from wooden ships to steel, when the need emerged for more formal education in the field. That evolution has continued, but the pressures facing the industry have changed, from the demands of the energy transition to the increasing role for automation and autonomy in a sector facing a shortage of seafarers.

The Institute recently revised its curriculum to reflect these new pressures, says the dean, Matt Werner, who points out the commitment to the fundamentals



Dr Jahir Rizvi, Plymouth: “Students gain hands-on experiences from day one”

of traditional naval architecture, such as structures, stability and thermodynamics, has now been complemented by new elements on alternative fuels, automation and autonomy, and nuclear power.

The school places considerable emphasis on professional experience. Students go into a shipyard during their freshman year, initially working as labourers and observers and seeing how ships are constructed. In their second year they spend time on a ship, and in the following two years they move increasingly into design laboratories and the design of vessels and systems.

The aim, says Werner, is to give students an understanding not only of how an engineering decision works on paper, but of its consequences for the people who have to build, operate and maintain the resulting vessel.

This practical approach is particularly relevant as the US seeks to strengthen its domestic shipbuilding capability under the ambitious SHIPS for America policy, which is driving a real need to educate the next generation of naval architects.

BROADENING THE NAVAL ARCHITECTURE CURRICULUM

Across Europe, universities are similarly adapting their programmes to a changing maritime sector.

At Centrale Nantes in France, two MSc programmes in Marine Technology provide routes into specialist areas of ocean and naval engineering. The two-year programmes are taught in English. The MSc in Ocean Engineering provides advanced training in hydrodynamics for marine structures, including ships and floating offshore structures for marine renewable energy. The Atlantic Master on Ship Operation and Naval Engineering, organised by Centrale Nantes and Ecole Navale



Left: Plymouth’s Cyber-SHIP Lab, used for assessing the cyber resilience of maritime vessels and their systems. Above: a student at Plymouth takes the controls of USV Cetus, a university vessel used for environmental monitoring and data gathering



“TU DELFT IS CONTINUALLY ADAPTING ITS PROGRAMME ... INCREASING ATTENTION IS BEING GIVEN TO ALTERNATIVE FUELS, CIRCULARITY, BIG DATA AND WIND-ASSISTED PROPULSION”

near Brest, provides advanced training in naval engineering and includes training onboard French Navy vessels.

Both programmes include a six-month master's thesis in the second year, which can be undertaken in industry or an academic research laboratory. The approach appears to be highly effective in terms of graduate employment: according to Lionel Gentaz, associate professor in the Fluid Mechanics and Energetics Department, the programmes are popular and students typically find employment within three months. Around half join the company where they completed their master's thesis, while approximately 15% continue to PhD study.

The research infrastructure supporting the programmes is substantial. Centrale Nantes' Research

Laboratory in Hydrodynamics, Energetics and Atmospheric Environment includes a 140m towing tank, circulating channel, shallow wave tank and a large ocean wave tank with a segmented wavemaker. At Ecole Navale, the IRENav research laboratory includes a cavitation tunnel capable of operating at velocities of up to 15m/s and pressures between 0.1 and 3bar.

The Netherlands has another major centre of naval architecture expertise in TU Delft, described by Jeroen Pruyn, associate professor in Maritime Operations and Management, as one of the world's leading maritime engineering universities and the only one of its kind in the Benelux region.

The university's master's programme covers the traditional disciplines of hydrodynamics and structures, while allowing students to

specialise in areas including marine engineering, ship design, and ship and shipyard management. Its maritime research capability is similarly extensive, with around 120 researchers and facilities, including an autonomous vehicle laboratory, hydrodynamics laboratory with two towing tanks, a flume tank and advanced cavitation tunnel, alongside virtual reality practicals and workshops for welding and milling.

The connection to the Dutch maritime industry is particularly strong. “Many of the leaders and employees of these companies come from TU Delft,” says Pruyn, noting that graduates quickly find employment.

Most remain in the maritime sector, primarily in the Netherlands, although around 10% spend some part of their careers abroad or return to their home countries if they are international students.

Their destinations extend well beyond traditional shipyards and naval architecture offices. Graduates work for shipping companies, banks, governments, classification



Left: Centrale Nantes students work with test maquettes

Above: The Webb Institute where the fundamentals of traditional naval architecture are taught alongside new elements, such as automation

societies and research institutes, taking on roles ranging from project management and surveying to concept design, research and innovation, data analysis and engineering.

SHIP DESIGN TO SYSTEMS THINKING

The breadth of those careers reflects a wider change in what industry expects from its engineers. TU Delft is continually adapting its programme alongside developments in the maritime sector. Traditional disciplines remain at its core – hydrodynamics, structures, marine engineering, design and operations – but increasing attention is being given to alternative fuels, including nuclear, circularity, operational efficiency, big data, digital twins, wind-assisted propulsion and underwater adaptations.

Yet Pruyn identifies a further challenge: greater integration.

“In many cases more integration is needed and a broader approach, including business and macroeconomics,” he says.

That tension between specialisation and breadth runs through naval architecture education worldwide.

At University College London’s (UCL) Department of Mechanical

TECHNICAL UNIVERSITY OF DENMARK, DTU (DENMARK)

- Founded in 1829
- Specialism: naval architecture and maritime engineering, offered through a BEng programme
- Head of Maritime DTU: Mette Sanne Hansen
- Students contribute to the design and construction of DTU’s new research vessel, *DANA V*
- Member of the Nordic Five Tech alliance alongside Chalmers, KTH, NTNU and Aalto
- Innovation focus: offshore wind turbines, wave energy converters and aquaculture structures
- Close ties to Danish industry, reflecting Denmark’s position as home to Maersk and a major global shipping hub
- www.maritime.dtu.dk/english

TECHNISCHE UNIVERSITÄT HAMBURG, TUHH (GERMANY)

- Founded in 1978
- Head of the Institute of Fluid Dynamics and Ship Theory: Professor Moustafa Abdel-Maksoud
- Offers a joint MSc in Ship and Offshore Technology with the University of Strathclyde
- Dual-study programme combines full university study with paid work at 50+ partner companies
- Innovation focus: propulsion systems, ship auxiliary machinery and climate-neutral shipping
- Based in Hamburg, one of Europe’s largest ports
- www.tuhh.de/fds

UNIVERSITY COLLEGE LONDON, UCL (UK)

- Founded in 1826
- Specialism: naval architecture and marine engineering, taught in the Department of Mechanical Engineering
- Head of Mechanical Engineering: Professor Richard Bucknall; chair in Marine Technology: Professor Jeom-Kee Paik
- Facilities include a new towing

tank for ship models, engine test cells and Advanced Propulsion Lab

- Links: with BMT, Babcock, Rolls-Royce, and a Memorandum of Understanding with BAE Systems
- Innovation focus: AI-enabled ship design, digital twins, hydrogen and alternative fuels, and autonomous maritime systems
- Notable academic leadership includes Professor David Andrews
- www.ucl.ac.uk

UNIVERSITÀ DI GENOVA (ITALY)

- Naval architecture teaching in Genoa traces back to 1870
- Specialism: naval architecture and marine engineering, plus a master’s degree in Yacht Design
- Coordinator of the Naval Architecture and Marine Engineering programme: Professor Cesare Rizzo
- Facilities: a towing tank and cavitation tunnel, and a Marine Structures Testing Lab
- Founding member of WEGEMT, a network of around 30 European universities in naval architecture
- Innovation focus: ship propulsion environmental impact and low-pollution marine power plants
- www.diten.unige.it/en/naval_unit

UNIVERSITY OF MICHIGAN (USA)

- Roots traced back to 1879
- Specialism: naval architecture and marine engineering to PhD
- Chair of the Department of Naval Architecture and Marine Engineering: Professor David Dowling, ABS Professor of Marine and Offshore Design Performance
- Facilities: the Aaron Friedman Marine Hydrodynamics Laboratory
- New dual master’s degree in Naval Architecture and Marine Engineering and Sustainable Systems launching this autumn
- Innovation focus: marine renewable energy, robotics and autonomy, yacht design, and structural and hydro-acoustics
- Notable alumni include Kari Wilkinson, president of Newport News Shipbuilding
- www.name.engin.umich.edu

UNIVERSITY OF PLYMOUTH (UK)

- Traces roots back to 1862
- Director of the COAST laboratory and academic lead for ocean and marine engineering: Professor Deborah Greaves
- Facilities centre on the Coastal, Ocean and Sediment Transport (COAST) laboratory, including an ocean basin, coastal basin and the UK's first floating offshore wind turbine test facility
- Links include Eaton and Babcock
- Innovation focus: marine autonomy, maritime cyber security, and floating offshore wind
- www.plymouth.ac.uk

UNIVERSITY OF SOUTHAMPTON (UK)

- Roots date back to 1862
- Specialism: naval architecture, uniquely branded 'Ship Science', taught within the Maritime Engineering research group
- Head of the Maritime Engineering Group: Professor Alan Murphy
- Facilities: the UK's largest university towing tank, a 138m facility at the Boldrewood Innovation Campus
- Maritime consultancy delivered through the Wolfson Unit, working with yacht, ship and powerboat manufacturers
- Home to the Centre for Green Maritime Innovation, a national facility leading shipping decarbonisation
- Innovation focus: maritime decarbonisation, offshore geotechnics and autonomous marine systems
- Notable alumni include Grahaeme Henderson OBE, former senior vice president for Shipping and Maritime at Shell
- www.southampton.ac.uk

UNIVERSITY OF STRATHCLYDE (UK)

- Founded in 1796
- Ranked first in the UK and top 10 in the world for marine/ocean engineering
- Head of the Department of Naval Architecture, Ocean and Marine

- Engineering: Professor Evangelos Boulougouris
- Facilities centre on the Kelvin Hydrodynamics Lab, the largest fully operational ship-model experiment tank in a UK university
- New Research Centre for Sustainable Shipping recently launched in Glasgow
- Innovation focus: floating wind turbines, carbon emission reduction from shipping and fluid load modelling
- Builds on Glasgow's historic shipbuilding heritage on the Clyde
- www.strath.ac.uk

UNSW CANBERRA (AUSTRALIA)

- Roots traced back to 1962
- 'Grey-ship' focused, sponsored by the Royal Australian Navy
- Naval architecture coordinator: Associate Professor Warren Smith
- Innovation focus: hydrodynamics of high-speed craft, ship structures, and design for naval shipbuilding
- Unique student cohort mixing uniformed ADFA officer trainees with Defence-sponsored and fee-paying civilian students
- Supports Australia's continuous naval shipbuilding programme
- www.unsw.edu.au

WEBB INSTITUTE (USA)

- Founded in 1889 in New York
- Around 100 to 106 students total, roughly 28 per year group
- Dean: Matthew R Werner, who is ABS chair of Naval Architecture and Marine Engineering, and is NAVSEA professor
- Facilities: Robinson Model Basin, a 93ft ship model towing tank; the Haeberle Laboratory; the Livingston Library
- Links: works with the US Coast Guard Academy and ABS on a NIST-funded course on standards for emerging marine technologies
- Notable alumni: yacht designer and America's Cup navigator Halsey Chase Herreshoff, and Alana Duerr, president of Offshore Wind US
- www.webb.edu



Nantes leads an Erasmus master's programme in advanced ship and offshore structure design

Engineering, Professor Ema Muk-Pavic says naval architecture can be a niche subject, but that students can become highly passionate about it once they understand what the discipline offers.

UCL, which became a centre for naval architecture studies in 1967 when Royal School of Naval Architecture and the MoD's Combined Staff College moved from Greenwich to the university, attracts significant numbers of international students, from both naval and commercial backgrounds. Its central London location is another asset.

"The city is home to the International Maritime Organization and a concentration of shipping companies, insurers, classification societies, associations and other maritime organisations," says Muk-Pavic, "and this means our students have a sense of being part of a maritime community that is simultaneously local and global."

Students have opportunities to go on trips, participate in research projects, present at conferences and contribute to journal publications. Graduates go into the naval sector worldwide as well as into shipyards, consultancy, banking and finance, and classification societies.

And here too, the boundaries between disciplines are becoming



“THE AIM IS TO ENSURE THAT STUDENTS HAVE THE ‘COURAGE AND STAMINA’ TO TAKE ON CHALLENGES THAT CANNOT YET BE SEEN”

less rigid. “Employers do not like the traditional boundary between naval architecture and marine engineering,” says Muk-Pavic, pointing to increasing integration between the two.

PREPARING ENGINEERS FOR AN UNCERTAIN FUTURE

Perhaps the greatest challenge for universities is not knowing exactly what technologies their graduates will encounter during their careers.

That is particularly apparent in the discussion around AI.

For the Webb Institute, AI is both a challenge and a tool for students and engineers. Rather than simply teaching students to use a new technology, the question is how it can help engineers perform their roles more quickly and make better-informed decisions while still relying on their own knowledge, judgement and understanding of the trade-offs within complex systems. That distinction is important. The

universities developing today’s naval architects cannot predict precisely which fuels, propulsion systems, autonomous technologies or digital tools will dominate in 10 or 20 years.

The answer, therefore, is not to train students for a single technological future. Instead, the emphasis is increasingly on giving them strong engineering fundamentals, practical experience and the ability to understand complex systems – while exposing them to enough emerging technology to be able to adapt.

As Werner puts it, Webb is technology-agnostic because nobody knows what will happen in 10 years. The aim is to ensure that students have the “courage and stamina” to take on challenges that cannot yet be seen.

That may ultimately be the most important evolution in naval architecture education.

The profession still depends on the fundamentals of science, engineering, structures, stability, thermodynamics and hydrodynamics. However, today’s graduates also need to understand autonomy, alternative propulsion, digitalisation, cyber resilience, sustainability and the increasingly complex regulatory and commercial environment in which ships operate.

The naval architect of the future may therefore look rather different from the traditional image of the ship designer. But the underlying purpose remains much the same: to bring together engineering knowledge, practical judgement and an understanding of how a complex vessel or marine system must work in the real world.

With demand rising across both defence and commercial shipping, universities have a significant role to play in ensuring that the profession has the people it needs – not just to design the ships of today, but to determine what comes next.



Plymouth students in a practical session in the Babbage Building's Autonomous Systems Test Laboratory



Incat Crowther delivers Azam Marine's newest catamaran, bringing aviation-inspired styling and a 679-passenger capacity to East Africa's busiest ferry corridor, says Bruno Cianci

REVERSE BOW, FORWARD THINKING

The entry into service of *Kilimanjaro IX*, the latest 53m high-speed catamaran passenger ferry designed by Incat Crowther, marks a significant milestone for East African maritime transit. Built by Afai Southern Shipyard in Guangzhou, China, *Kilimanjaro IX* joins her twin, *Kilimanjaro VIII*, built by RDM Construction in Tasmania and delivered in 2023, to reinforce crucial connectivity between Dar es Salaam and Tanga on the Tanzanian mainland, the port of Stone Town (Zanzibar) and the island of Pemba.

While *Kilimanjaro VIII* initially heralded the operator's shift towards a larger 53m hull platform, the arrival of *Kilimanjaro IX*, earlier this year, consolidates this high-capacity fleet transformation. The vessel is the 12th high-speed ferry designed for Azam Marine. Earlier models in the

current fleet range from 35m to 45m in overall length.

To ensure strict quality control, Incat Crowther, whose engineers provide design, build and consulting services for specialist ships, deployed a team throughout the build phase at the Guangzhou facility, where, says Linda Liu, sales manager at Afai, aluminium high-speed catamarans like *Kilimanjaro IX* are a core product.

Brett Crowther, CEO of Incat Crowther, says: "In addition to providing bespoke design support, Incat Crowther's team worked closely with Afai to provide project and quality management services."

"THE INFLUENCE OF COMMERCIAL AVIATION EXTENDS BEYOND AESTHETICS TO THE FUNCTIONAL LOGISTICS"

Having an Incat Crowther expert regularly on hand during the build phase of the project streamlined communication between all stakeholders and helped to ensure *Kilimanjaro IX* was delivered to plan and on budget.

BIG IT UP

Constructed entirely from marine-grade aluminium, the platform has an overall length of 53m, a waterline length of 51m, a beam of 12.5m, a hull draught of 1.5m, and a maximum depth of 3.65m. Afai's staff were unable to disclose figures on building time, staff-hours or outsourcing.

A key structural feature of the hull form is its distinctive reverse bow. Explaining the hydrodynamic rationale behind this configuration, Incat Crowther's project assurance director, Glenn Young, says: "Following a thorough analysis of the routes and operational environment of these

vessels, it made sense to recommend a reverse bow when designing the 53m platform. Ultimately, this feature has offered improved stability and seakeeping, and increased the vessel's operational efficiency in the unique environments in which it operates."

The high-performance propulsion system is the same as that installed on the 45m *Kilimanjaro VII*, but the larger vessels offer increased horsepower, higher speeds and enhanced stability. The power plant comprises twin Cummins QSK95-M main engines delivering 2 x 2,983kW at 1,800rpm, paired with ZF 24060 NR2 gearboxes and two Kongsberg S80-4 waterjets. This mechanical configuration yields a service speed of 34knots and a maximum of 37knots.

Despite the substantial power output, the design maximises overall yield. As Young explains, operational efficiency was a critical element of Azam Marine's brief, and the team delivered a vessel that is not only faster than the smaller vessels in the fleet but also more fuel efficient on a per-passenger basis.

PLANE SAILING

The vessel's aesthetic profile draws inspiration from modern commercial aircraft engineering. Project manager Paul Humphris says: "*Kilimanjaro IX* represents a modern progression of the fleet's style, with the vessel's long, sleek profile and aesthetics taking some inspiration from the aviation industry."

However, he notes, the team's task was to deliver a vessel tailored to the unique operational conditions Azam Marine faces in Tanzania, and one that would provide an efficient, reliable and safe high-speed passenger service.

The influence of commercial aviation extends beyond external aesthetics to the ship's functional logistics and boarding architecture. According to Humphris, parallel boarding has been a feature of Azam Marine's Kilimanjaro fleet since *Kilimanjaro IV* was delivered in 2011. The parallel boarding system, which mimics that of the aviation sector, allows for segregated passenger and cargo flows, helping to increase operational efficiency and safety by ensuring passenger classes and luggage trolleys remain separated

during boarding. This operational separation speeds up turnaround times at port facilities by isolating passenger boarding lanes from heavy luggage handling.

CAPACITY ENHANCEMENTS

The spatial configuration of the 53m platform optimises internal volume relative to its predecessors. The Incat Crowther team worked closely with Azam Marine to redesign the internal layout of the 53m vessels. This resulted in a 679-passenger capacity across two spacious decks, compared with a 500-passenger capacity across three decks on its 45m predecessor.

The air-conditioned main deck provides indoor seating for 334 passengers, complemented by 40

exterior seats on the foredeck, standing space for 11 passengers on the aft deck, extensive luggage storage areas, a refreshment kiosk and five bathrooms, including a wheelchair-accessible facility. The upper deck accommodates 200 passengers in covered outdoor seating, a second kiosk, four bathrooms, the wheelhouse and an air-conditioned VIP cabin for 72 passengers split across two tiers (56 VIP class seats and 16 Royal class seats).

Certified under DNV/NSCV 1C regulations and operated by a crew of eight, the *Kilimanjaro IX*, alongside the broader Azam fleet, sets a modern standard for high-capacity passenger transit across the country's coastal network and East Africa as a whole.



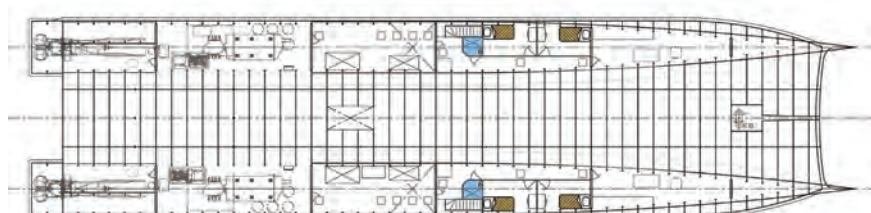
Kilimanjaro IX can carry 679 passengers and is operated by a crew of eight



The upper deck can accommodate 200 passengers



The main deck has indoor seating for 334 passengers and plenty of luggage storage



The reverse bow hull was chosen to improve stability and operational efficiency



CHILE'S NAVY: BUILDING MORE THAN SHIPS

LA ARMADA DE CHILE



The launch of *Magallanes* in 2026

Naval shipbuilding in Chile is no longer just about replacing ageing fleets, writes Luis Ovalle Leyton, it is a long-term national endeavour that demands sustained collaboration between government, industry and academia to build lasting engineering, industrial and technological capability

The Chilean Navy has launched the Escotillón IV programme, aimed at renewing its ageing amphibious and military sealift capacity through the national construction of four common-platform, multi-role vessels.

The launch of the first platform, LPD-93 *Magallanes*, in June marked an important milestone, its significance extending far beyond the operational capability the ships themselves will deliver. This progress continued in August with the keel laying of LPD-94 *Rapa Nui*, reinforcing the continuity of the programme and its planned construction sequence.

The programme is set to strengthen Chile's engineering expertise, systems integration, industrial processes and the involvement of national suppliers, gradually expanding the base of the national shipbuilding industry.

THE PROGRAMME

Escotillón IV comprises four amphibious and military sea transport vessels built around a common-platform concept and is structured in three construction phases. Phase I includes LPD-93 *Magallanes* and LPD-94 *Rapa Nui*, while Phases II and III will deliver one additional platform each. With *Magallanes* already afloat and *Rapa Nui* under construction, the programme has moved from the design phase into construction and systems integration.

The initiative will gradually renew the Chilean Navy's amphibious and military sealift capacity by replacing its existing amphibious support fleet. Rather than replacing individual ships on a one-for-one basis, Escotillón IV consolidates complementary capabilities into a single multi-role platform capable of supporting amphibious operations, military sealift, humanitarian assistance and disaster relief, and logistic support to Chile's remote territories, including the Antarctic region.

The common-platform philosophy allows the baseline design to be adapted through limited modifications for different operational roles, while preserving a high degree of commonality in construction, onboard systems and lifecycle support. This gives the Navy the

“CHILE’S VAST COASTLINE DEMANDS SIGNIFICANT LOGISTICAL AND OPERATIONAL CAPACITY FROM THE NAVY”

Magallanes is the lead ship of four multi-purpose LPD ships for the Chilean Navy



CHILE'S COASTLINE

Chile is a tricontinental and insular country with more than 84,000km of coastline. Its geography gives the country significant maritime interests, providing access to the resources and trade routes of the Pacific Ocean, connections between the Pacific and Atlantic oceans, and a strategic projection towards Antarctica.

Chile's southern maritime geography includes the Strait of Magellan, the Beagle Channel and Cape Horn, where strong winds, large waves and rapidly changing weather create demanding operating conditions

The coast's location on the tectonically active Peru-Chile Trench makes seismic loading critical for port design.

flexibility to meet both military and peacetime demands without maintaining several specialised ship classes. Although conceived primarily for amphibious operations, the platform also incorporates a versatile roll-on/roll-off cargo deck for military vehicles, containers and general cargo, validated against a broad range of vehicle configurations to ensure operational flexibility without compromising its amphibious role.

BETTER BY DESIGN

The design process was driven by the Requirements and the Concept of Operations (CONOPS) developed by the Chilean Navy during the programme capacity definition phase. As is usual in major Chilean defence acquisition programmes, the project followed a structured investment process developed by the Dirección de Programas de Investigación y Desarrollo de la Armada (DIPRIDA), in which a complete concept and basic design were developed before construction approval.



ASMAR's Talcahuano yard

Chile's vast coastline demands significant logistical and operational capacity from the Navy. Rather than optimise the platform for a single mission, the design philosophy prioritised adaptability, resulting in a flexible multi-role platform able to meet many requirements while balancing operational capability, engineering complexity and acquisition cost.

A fundamental design principle set at the beginning of the process was that the platform should

adapt to the Chilean Navy's operational requirements, rather than forcing the operator to adjust its CONOPS to an existing design. Instead of modifying an existing vessel, the designers developed a tailored solution through an iterative engineering process. The resulting VARD 7 411 configuration was refined through design iterations involving Canadian naval architecture and marine engineering firm VARD Marine and ship builder ASMAR, and the Chilean Navy (DIPRIDA), ensuring that the final design remained aligned with the defined requirements.

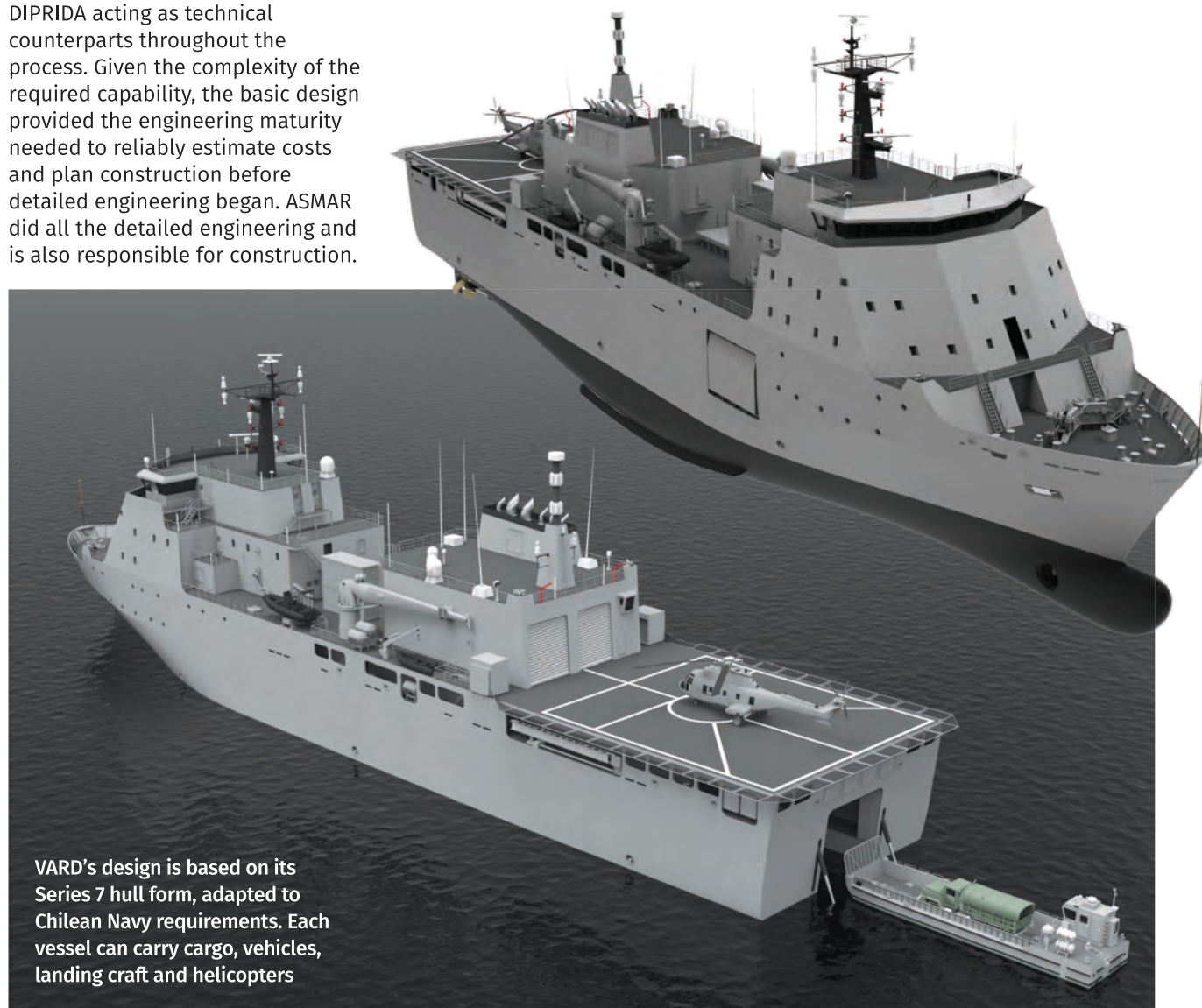
The engineering phase was structured in two stages. Concept and basic design were developed by VARD through successive technical reviews and design refinements, with ASMAR and DIPRIDA acting as technical counterparts throughout the process. Given the complexity of the required capability, the basic design provided the engineering maturity needed to reliably estimate costs and plan construction before detailed engineering began. ASMAR did all the detailed engineering and is also responsible for construction.

These teams included naval architects, marine engineers and specialists from several engineering disciplines, who verified that the design met the requirements and the applicable classification and statutory standards. ASMAR's design department has been responsible for managing, reviewing and complementing the external basic design; supporting the technical and logistical definition of equipment and materials; developing the detailed engineering required for production; controlling weight and centre of gravity; and contributing to production planning and the construction strategy. Throughout

this process, the Chilean Navy has continued to act as the technical counterpart through DIPRIDA's Technical Inspection Office (Inspección Técnica de Obras – ITO), which provides on-site oversight of the construction process and verifies that the vessels are built and delivered in accordance with the approved design and the programme's requirements.

From the beginning, the programme adopted a design philosophy based on recognised international classification and statutory standards, to minimise technical uncertainty during design and construction while ensuring a

“THE DESIGNERS DEVELOPED A TAILORED SOLUTION THROUGH AN ITERATIVE ENGINEERING PROCESS”



VARD's design is based on its Series 7 hull form, adapted to Chilean Navy requirements. Each vessel can carry cargo, vehicles, landing craft and helicopters

VARD, LA ARMADA DE CHILE

CHILE FOCUS

high level of operational availability throughout the vessel's service life. The use of commercial off-the-shelf equipment, together with compliance with DNV rules and applicable IMO statutory requirements, established a robust engineering baseline that reduced technical risk while simplifying systems integration, maintenance, lifecycle support and future upgrades.

Although the vessels are naval platforms, compliance with classification and statutory requirements was verified throughout the design process. DIPRIDA, acting as the end-user technical authority, worked closely with ASMAR to confirm that the chosen solutions met both maritime regulations and the Navy's operational requirements. Where naval-specific requirements exceeded statutory standards, these were incorporated based on the Chilean Navy's technical directives, without compromising the overall design philosophy. The resulting design complies with the applicable DNV Rules and relevant IMO statutory requirements while satisfying the Chilean Navy's operational needs.

BUILDING CAPABILITY

The main outcome of the programme is not just the delivery of four vessels, but the capabilities developed during their design and construction. Escotillón IV has strengthened

national expertise in engineering, integration, manufacturing and project execution, while creating opportunities for Chilean companies to develop technologies and products that will remain available for future shipbuilding projects. Rather than representing the end of a single shipbuilding project, these capabilities constitute a long-term industrial asset.

One example of this industrial development is the Integrated Platform Management System (IPMS), developed by SISDEF in close

collaboration with DIPRIDA and ASMAR. Its development represents a national investment in naval software and systems-integration capabilities that could support future shipbuilding programmes.

SISDEF is also developing digital solutions to support damage-control management, translating the Navy's operational experience into technology tailored to naval requirements.

KNOCK-ON EFFECTS

Industrial capability has also expanded across the national supply chain. Another example is Induelectro, a Chilean manufacturer supplying electrical distribution equipment for the vessels and contributing to its integration with the platform's power-management systems.

The building process has also fostered the development of locally engineered solutions, such as recyclable polymer-based decking materials manufactured in Chile for the well dock area. Besides satisfying operational demand and durability requirements, these developments demonstrate how naval programmes can stimulate innovation beyond traditional shipbuilding disciplines.

The Escotillón IV programme has strengthened Chile's engineering and industrial base for future naval projects. New engineering



Magallanes is undergoing systems integration and outfitting. Sea trials will follow, with delivery to the Chilean Navy planned for 2027



*Lt Cdr Luis Ovalle
Leyton alongside Block
51 of LPD-94 Rapa Nui
at ASMAR Talcahuano*



capabilities, local hardware and software development, and stronger national suppliers will continue to support the vessels throughout their service life, while providing a stronger industrial foundation for future national shipbuilding programmes.

NATIONAL STRATEGY

As naval platforms become more sophisticated, building national shipbuilding capability takes far more than constructing individual vessels. Successive shipbuilding projects provide the continuity necessary to accumulate engineering expertise, stimulate innovation, sustain highly skilled employment and strengthen industrial foundations. The challenge goes further than hull construction, to the integration of complex digital, electrical and mechanical systems. Expanding these capabilities requires sustained investment in engineering, systems integration and industrial coordination, rather than isolated procurement projects.

At the launch ceremony of *Magallanes*, the programme was presented as an important step towards Chile's National Shipbuilding Strategy, whose goal is the progressive development of the technological and industrial base to support the future development of more complex naval platforms. The achievement of this goal requires

close collaboration between state, industry and academia, using a well-known model of innovation called the Triple Helix. Within this model, the state sets long-term strategic direction, academia builds knowledge and specialised human capital, and industry turns both into engineering capability and industrial solutions. The effectiveness of a national shipbuilding strategy relies not only on individual projects, but on the coordinated contribution of all three actors.

A practical example and first test of this collaborative approach came when ASMAR awarded ASENAV the contract to build two landing craft mechanised vessels for the Escotillón IV platforms. Beyond increasing national industrial participation, this initiative demonstrated how public and private shipyards can collaborate within a common naval programme, strengthening the national shipbuilding ecosystem while expanding engineering experience and industrial capability.

“BUILDING NATIONAL SHIPBUILDING CAPABILITY TAKES FAR MORE THAN CONSTRUCTING INDIVIDUAL VESSELS”

COLLECTIVE AMBITION

The Escotillón IV programme does not simply deliver four multi-purpose platforms, it allows each new hull to learn the lessons of the last, turning design maturity into construction efficiency and reducing risk with every step. What began on CAD software is now taking shape in steel, generating real, measurable benefits for Chile, such as skilled jobs, domestic technology and industrial capacity. Sustaining that benefit, however, will depend on the continuity of a national shipbuilding strategy that carries this momentum into future projects.

The construction of more complex naval vessels does not begin with the vessel itself, but with the progressive development of the engineering,

industrial and organisational capabilities needed to design, integrate and build it. Escotillón IV shows that these capabilities are created through continuity, collaboration between government, industry and academia, and a sustained commitment to shipbuilding.

Luis Ovalle Leyton is a Lieutenant Commander and naval mechanical engineer in the Chilean Navy. He holds a master's degree in maritime technology management from the Australian Maritime College. He has worked on the Escotillón IV programme since 2020, initially as deputy project manager during the basic design phase, and is currently project manager for LPD-94 *Rapa Nui*.

THE CHILEAN NAVY: A SNAPSHOT

The Armada de Chile comprises more than 25,000 personnel and has its headquarters in Valparaíso.

Its principal surface combatants comprise eight frigates across four classes: one Type 22, three Type 23s, two Adelaide-class and two M-class frigates, plus two Scorpène-class and two Type 209 submarines, all based in Talcahuano. It also operates a range of patrol and auxiliary vessels.

Chile is advancing its National Continuous Shipbuilding Plan. It seeks to strengthen the nation's engineering, technological and industrial capacity through sustained collaboration between the state, public and private shipyards, industry and academia. For more, see www.bit.ly/3UF0Nvr

Chile's naval strategy is shaped by its geography, a long Pacific coastline, a vast Exclusive Economic Zone, and responsibilities in Antarctica, where the Navy provides logistics, search and rescue, and scientific support.

Adopting solar panels is one small way of accelerating decarbonisation in the shipping industry.

However, while it's easy to install panels on a flat roof, getting the best out of them onboard vessels with varying geometries is another matter.

On land, you can bolt a solar panel to a roof at a fixed angle or rotate it to follow the sun. On most vessels, the panel is permanently attached to a flat deck or vertical hull. Because the ship is constantly turning, rolling and manoeuvring, the panel's orientation relative to the sun is at the mercy of the ship's heading. On-deck container stacks or nearby offshore structures can further block direct sunlight, limiting clean onboard power generation.

"We were looking at applications where solar panels cannot be installed at optimal tilt angle, such as vertical integration on electric vehicles or vessels," explains Dr Katie Shanks, a researcher at the University of Exeter, UK, who headed up a three-year EPSRC Fellowship project, 'Invisible' Solar Technologies from Bio-inspired Optics. "We wanted to evaluate how much energy could be captured to offset onboard auxiliary power demands."

Running from January 2022 to July 2025 and supported by UK Research and Innovation, the project turned to biomimicry for the solution. The concept originated during Dr Shanks' PhD research into the cabbage white butterfly, which in turn sparked a deeper exploration into insect optics, leading her to study the glasswing butterfly's wide-angle anti-reflectance properties.

Partnering with industry and academia, the team pursued two goals: bio-inspired coatings to trap off-centre sunlight at awkward angles; and eco-friendly cover glass made from recycled solar panels, with ReSolar and the Upcycled Glass Company.

"CHANGING THE ARRAY SURFACE AREA DOES NOT DEGRADE THE INTRINSIC CELL EFFICIENCY"

WING-WIN SITUATION

Inspired by the anti-reflection properties of glasswing butterfly wings, a research team plans to roll out a series of enhanced prototype solar panels by 2029. Martin Conway reports



Glasswing butterflies

"When light hits standard flat cover glass at an oblique angle, much of it bounces off as reflection or glare," Shanks says. "Glasswing butterfly wings are naturally transparent thanks to an array of sub-wavelength nanostructures resembling microscopic tripods, measuring 50-150 nanometres across. Because these features are smaller than the wavelengths of visible light, incoming rays do not perceive a solid barrier. Instead, the tripods create a graded refractive index, blending air to solid glass."

Applied as a surface coating or etched into fused silica, this bio-inspired structure cuts down glare and reflection, even when sunlight

strikes the panel from extreme side angles. Modelling and lab testing show the nanostructure boosts annual energy gains by 5-8% at awkward angles, and up to 20% over uncoated bare glass. "On the open ocean, where vertical hull panels harvest both diffuse sunlight and low-angle reflections bouncing off the waves, energy generation could be boosted by up to 30%," Shanks says.

SCALABLE SOLUTION

The current lab scale for the nanostructures is 10mm x 10mm to 20mm x 20mm, although Shanks adds: "One advantage of photovoltaics is scalability; changing the array surface area does not degrade the intrinsic cell efficiency. The core manufacturing challenge is controlling nanometre-scale features continuously over square metres of surface area."

GRAPHIC: DR KATIE SHANKS

Some manufacturing bottlenecks remain: “We can precisely fabricate nanostructures over a small area [eg, 20mm x 30mm] very accurately, but using electron-beam or nanoimprint lithography over metre-scale surfaces currently takes too long,” she says. “We need high-throughput processes that maintain structural fidelity across the entire surface.” There’s also a question of weight. “Early maritime prototypes will likely be thicker and ruggedised for harsh marine environments. Weight savings will be tackled in subsequent design iterations.”

Crucially, the nanostructured configuration creates a super-hydrophobic surface to prevent saltwater droplets from evaporating on the glass, reducing salt crusting and fouling.

The first phase of the research has attracted interest from various maritime parties, including Grafmarine, a UK developer of modular solar tile systems. Shanks is also keen to collaborate with naval architects and boatbuilders.

“Naval architects use specific ratios for vessel design – length, beam, draught and freeboard,” she says. “Their input will help us to accurately model array placement, structural integration and net energy yield for scaled commercial vessels.”

Naval architects could also help address regulatory unknowns. Shanks points out that permanent vertical side mountings may require regulatory review regarding port operations, docking clearance and impact resistance.

She estimates that the nanostructured anti-reflective coating alone, if scaled to mass manufacturing, could compete with current anti-reflective coatings on cost. However, incorporating recycled glass may increase initial costs because the supply chain and recycling logistics are not quite there yet. “Co-locating recycled glass processing with cell assembly will be key to cost efficiency,” she suggests.

The goal now is to build a working prototype panel. “We are applying for further research grants while continuing work under the Meta Hub



UK solar panel tech specialist Grafmarine has expressed an interest in the project



A 10mm x 10mm solar cell, developed in the first phase of the project



and UK Metamaterials Network,” Shanks says. “We are also moving beyond flat coatings to design 3D meta-optics that accept light from wide angles and direct it to a fixed focus point, maximising light capture and solar concentration. The current Meta Hub project runs until August 2030 and targets the fabrication challenges mentioned. Testable physical prototypes are planned by 2029, and further industry collaborations are welcome.”

“[NAVAL ARCHITECTS’] INPUT WILL HELP US TO ACCURATELY MODEL ARRAY PLACEMENT, STRUCTURAL INTEGRATION AND NET ENERGY YIELD FOR COMMERCIAL VESSELS”



Babcock is investing heavily in apprenticeship and graduate courses

WANTED: SKILLS FOR THE 21ST CENTURY

Rising orders, retiring staff and a fast-changing design toolkit are testing naval architecture's skills base. How the profession trains its next generation, and where it looks for new talent, will shape who designs and builds the world's fleet for decades to come, says Nick Savvides

The numbers are stark and illustrate the scale of the challenge facing naval architecture today. The global order book stands at a 17-year high, at 191 million compensated gross tonnage, equivalent to 17% of the existing fleet, while it is estimated that 40% of the current naval architecture workforce is expected to retire by 2030.

Against that backdrop, worldwide demand is being driven by substantial investment on both sides of the

Atlantic and beyond. A US\$150 billion programme is under way in the US, while India has committed to a US\$100 billion, 25-year investment programme. Both offer job opportunities for newbuilding and repair yards, along with other professionals in the maritime sector including class and maritime consultancies.

THE NEXT GENERATION

Babcock's skills director Debbie Joce agrees that there is a shortage of graduates entering the field. The

UK-based global defence design and engineering group said the lack of vessel design graduates is intensifying the demand for those who do obtain their degrees.

In a bid to encourage new recruits, Babcock is investing heavily in what it calls "emerging talent programmes", through its apprenticeship and graduate courses. In addition, the company has taken engineers from other disciplines, such as physics and mathematics, and developed them as naval architects.

STATS

40%

It is estimated that 40% of the current naval architecture workforce will retire by 2030.

“We use their base mathematical and analytical knowledge with the passion they have for ships or sailing, and provide structured training on the specific naval architect principles,” explains Joce.

Traditionally, naval architects are educated at university, followed by several years’ development in a design role, leading on to a full career in the field, says Joce. “Naval architects are provided with general [ship design] knowledge by academic study, and it’s generally not until they enter their first roles that they start to develop specialist skills.”

Typically, naval architects specialise within market sectors such as military, commercial or recreational and, within sectors, may specialise further in structures, stability, mooring, production or management, among other possibilities.

Maritime design specialist BMT is also grappling with similar issues over training, including the shortage of new recruits, although it is difficult to assess the numbers in training, either nationally, regionally or globally. Estimates for training universities and colleges range from 100 to 150 institutions worldwide, but as naval architecture is often combined with ocean or marine engineering programmes, the exact number changes depending on how the courses are classified.

Jake Rigby, head of innovation and research at BMT, says the sector needs more apprenticeships alongside existing educational programmes, because people learn in varying ways and an exam-centred system does not suit everyone. BMT runs a combined graduate and



Top: SeaRegs Training offers marine apprenticeships

Middle: Babcock apprentices help the Vine Trust convert vessels into clinics
Below: BMT's Digital Innovation and Simulation Centre (DISC), used for problem solving, immersive engineering and digital experimentation





BMT's DISC helps train naval architects, providing a virtual environment for testing designs



Tapio Seppälä, NAPA: "When it comes to the fundamental know-how of ship design, there is a real skills shortage"

"THE COMBINED BMT SCHEME STARTS MUCH EARLIER THAN MOST EXPECT, MAKING ENGINEERING VISIBLE AT PRIMARY SCHOOL AGE"

apprenticeship development programme, and its apprentices have been recognised externally.

Rigby believes that the profession has a visibility problem, not a talent problem. "Maritime careers are largely invisible to young people; the sector needs more routes in, including apprenticeships, not just more graduates," he says.

As such, the combined BMT scheme starts much earlier than most expect, making engineering visible at primary school age, followed by schools outreach and work experience, and then an accredited graduate programme with structured mentoring and a skills-based capability framework that plans development against customers' future needs.

IMO and EU regulation are driving change in maritime design, but Rigby argues that "the core discipline has not moved, but training has shifted

from a single-discipline model to one in which the fundamentals are wrapped in whole-system thinking, operational effectiveness, emissions, buildability and through-life cost considered together".

In Rigby's opinion, digital design tools help designers understand the operational impact of their vessel, while digital twins support efficient operation.

"A naval architect starting out now needs to understand the design consequences of alternative fuels, and how digital tools are an enabler both through design and through-life support," he explains.

LOOKING ABROAD

Tapio Seppälä, services director for design solutions at Finnish design house NAPA, believes training matters more than ever because, "when it comes to the fundamental know-how of ship

design, there is a real and increasing skills shortage”.

Whereas UK firms have favoured home-grown apprenticeships, Finland’s NAPA has looked abroad, partnering with the University of Michigan’s Naval Architecture and Marine Engineering Department and Texas A&M University’s Ocean Engineering Department to plug its own skills gap.

NAPA’s focus on shipbuilding growth drove that collaboration. “These ambitions are backed by policy and investment, with the Maritime Action Plan announced earlier this year described as the most ambitious commitment to revitalising the US maritime industry since the 1930s,” says Seppälä.

The US\$150 billion investment programme behind that ambition has also attracted South Korean expertise, says Seppälä, with NAPA sharing digital shipbuilding best practice with US naval architects and engineers in training, and bringing US students into a global community of fellow designers and shipbuilders.

INDIA’S GROWTH STORY

Modern shipbuilding has shifted centres before, from Europe and



Vivek Merchant, SDHI

“THE [INDIAN] GOVERNMENT SEES THIS [INVESTMENT IN SHIPBUILDING] AS A FIX TO PLUG THE FOREIGN EXCHANGE OUTFLOW”

America to Asia after the 1970s, as economies there recognised the industrial and foreign-currency benefits of shipyards.

India is now following that path, positioning itself as a maritime centre of excellence after China, South Korea and Japan.

Swan Defence and Heavy Industries (SDHI) director Vivek Merchant tells *The Naval Architect*: “We spend about US\$80 to US\$85 billion on foreign exchange because of foreign tonnage, and the government sees this [investment in shipbuilding] as a fix to plug that Forex outflow.”

Naval architects and marine engineers are key to that transition, and India must train vessel designers even as it builds its industry.

New Delhi’s flagship response is the US\$100 billion, 25-year Amrit Kaal Vision 2047, aimed at self-reliant development by the country’s centenary, within which the Maritime India Vision 2030 recognises shipping and logistics as a critical element of future growth.

“In the present scenario, the maritime education and research ecosystem in the country operates on a standalone basis,” noted India’s maritime ministry in laying out its proposals for the ‘Blue Economy’.

Shipyards are looking to collaborate, however, not just with other yards and naval architects but with vessel operators, such as CMA CGM, which has ordered six 1,700TEU LNG dual-fuel container ships from Cochin Shipyard Ltd.



Aerial view of SDHI’s shipyard in Gujarat



SDHI has invested US\$280 million in modernisation, including training its workforce

SDHI has moved fast to become a fully developed repair and construction yard, drawing on Amrit Kaal funding. It is a comparatively new business within Swan Corporation, a family-run conglomerate that acquired the Gujarati shipyard in January 2024 and began ship-repair activities that October.

According to Merchant, the company has invested US\$280 million in modernising the yard, with training its 1,000-strong workforce, particularly its naval architects and marine engineers, central to that effort.

To meet its 2047 targets, Merchant says SDHI is collaborating with the established South Korean shipbuilding company Samsung Heavy Industries, and has developed close links with 13 educational

institutions across India, including in its home state of Gujarat.

Merchant describes a centre of excellence combining in-class syllabus training, simulators and on-the-job training with a licensing certification programme, before graduates are inducted on to the shop floor and into project teams.

BUILDING SKILLS

SDHI is also partnering with maritime technology specialists such as Kongsberg and DNV to build the skills needed for complex vessels.

“Last year we onboarded about 45 [naval architects]. This year we have 76 and we’ve retained all

but three of them. So the attrition rate has been relatively low. And going forward we expect to have about 5,500 people, across all disciplines, on our team by 2028, 2029,” says Merchant.

SDHI has also won orders for six 18,000dwt dual-fuel chemical tankers from Norwegian operator Stenersen, with six further options, and four 92,500dwt dual-fuel bulk carriers for a UK customer, all due for delivery in 2028-2029.

These complex vessels will need the experience of SDHI’s collaborators to ensure successful delivery, with naval architects gaining experience across design and build.

“SDHI HAS DEVELOPED CLOSE LINKS WITH 13 EDUCATIONAL INSTITUTIONS ACROSS INDIA, INCLUDING IN ITS HOME STATE OF GUJARAT”

UK companies such as Babcock and BMT have decades of experience training new designers that could benefit the emerging Indian industry, although no formal UK-India training partnership yet exists to put it to use.

THE AI RESPONSE

NAPA sees growing demand and a declining workforce as an opportunity for digitalisation, an “AI revolution in ship design” in which AI-generated efficiencies help address both pressures, Seppälä notes. Ship design software has traditionally had a steep learning curve, he adds, but AI-based productivity tools are breaking down that barrier.

Such tools are still at an early stage, with full integration expected to bring more powerful optimisation and unlock design potential not yet seen.

“The complexity of shipbuilding is at new heights, largely driven by designs that push the boundaries of engineering, evolving regulations, and the inherently multidisciplinary nature of ship design,” says Seppälä.

“BAE SYSTEMS HAS COMMITTED TO AROUND 2,700 APPRENTICES AND GRADUATES ACROSS THE UK TO ADDRESS A NATIONAL SKILLS GAP”

NAPA’s own AI tool, NAPA Navigator, is already built into naval architects’ daily workflow, helping staff navigate design software, interpret model data and perform model checks. “It also supports building custom workflows tailored to specific project needs, and can automate parts of the design process that would otherwise require manual effort,” Seppälä adds.

Rapid change across the maritime industry is reshaping vessel design, with new naval architects needing to master alternative fuels and digitalisation alongside the basics of ship design. Apprenticeships, academic partnerships, offshore collaboration and now artificial intelligence are all part of the industry’s answer to a workforce retiring faster than it is replaced. And for those entering the profession today, the opportunities are increasingly international.

UK SKILLS GAP

The UK faces a persistent shortage of qualified naval architects, set against a wider shipbuilding and maritime engineering skills crisis. UCL, one of only four RINA-accredited providers alongside Newcastle, Southampton and Strathclyde, describes a global shortage of well-qualified naval architects on its own MSc programme, and graduate numbers remain small, with Newcastle admitting around 40 undergraduates a year and Strathclyde’s two naval architecture degrees together attracting roughly 30 to 45.

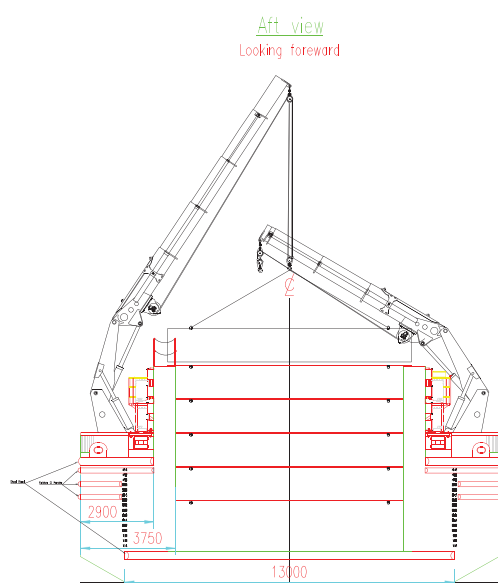
The pressure is most visible in defence shipbuilding. The 2025 Strategic Defence Review pointed to a workforce crisis across the naval sector, linked to recruitment and retention problems. At yard level, firms in Portsmouth have reported a nationwide skills shortage, particularly in traditional shipbuilding and repair trades, while BAE Systems has committed to around 2,700 apprentices and graduates across the UK to address what it calls a national skills gap. Analysts also point to Britain’s long-term decline in heavy industry as having thinned the pipeline of young people entering technical marine disciplines.



BMT

TECHNICAL

THE LATEST DEVELOPMENTS IN MARITIME TECHNOLOGY



TERRA MARIQUE PONTON

Damen Shipyard's plans for the multi-purpose heavy-lift barge, a specialist 80m-long vessel designed to carry abnormal indivisible loads

Terra Marique, built in 2004 by Damen Shipyard in a yard in Ukraine for Robert Wynn & Sons (established 1863), has handled some of the UK's most demanding heavy-lift cargoes.

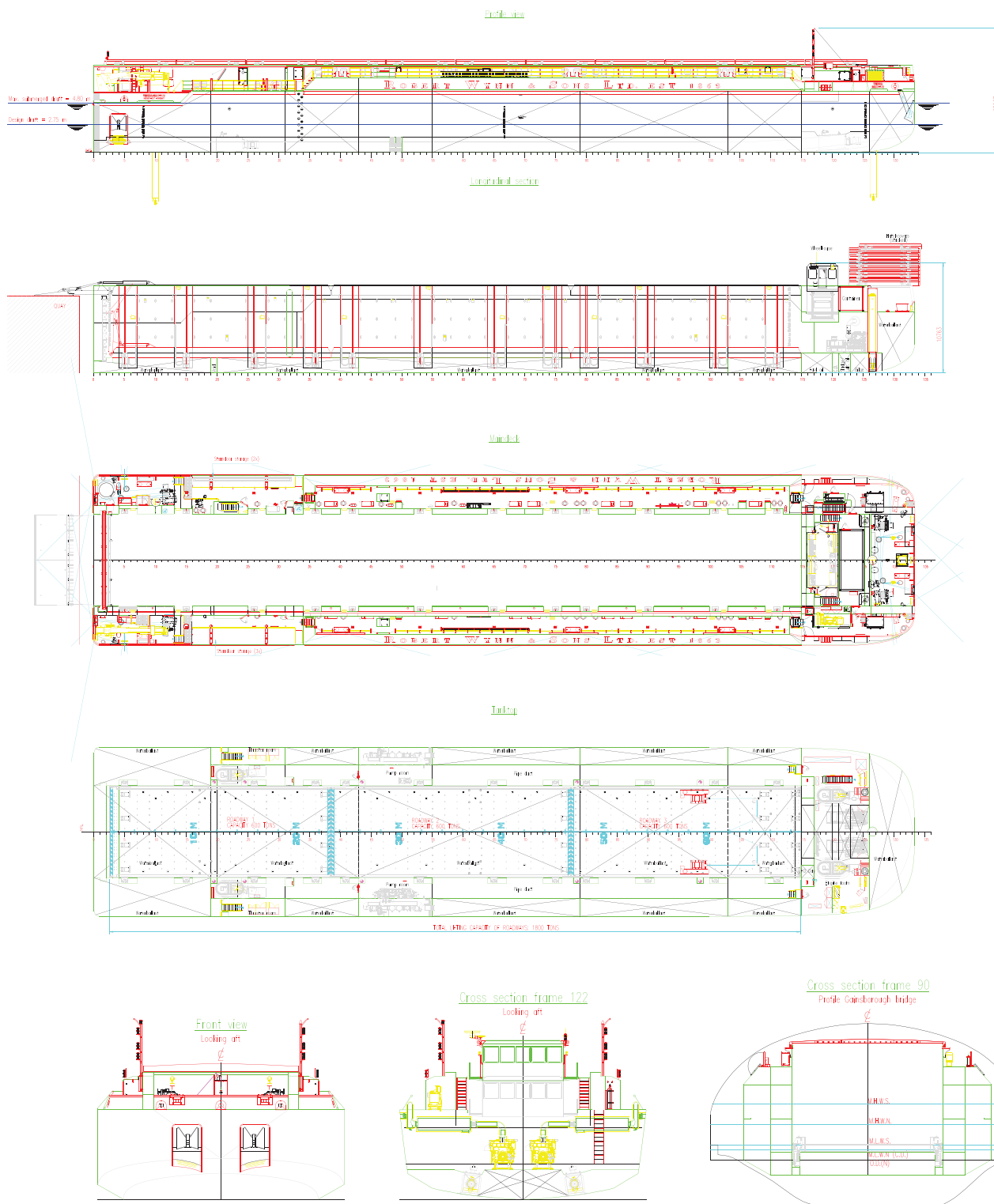
She completed two shipments from Foynes to Tarbert in August, for SSE plc's Tarbert Next Generation Power Station, delivering a 335tonne gas turbine and a 318tonne generator stator directly to the site. Each operation involved the vessel safely taking the ground at Tarbert, with a bespoke ramp arrangement enabling safe roll-on/roll-off transfer of the loaded self-propelled modular transporter from vessel to shore.

Tim West, a director at Robert Wynn & Sons, says the work places Terra Marique "at the vanguard of delivering projects that will help deliver the UK and Ireland's net-zero commitments".

On its debut, the vessel carried a Concorde plane down the Thames past the Houses of Parliament, drawing national headlines. She has since supported the construction of Flamanville and Hinkley Point C nuclear power stations, and in 2023 became the first vessel in more than 60 years to deliver cargo via the River Forth to Alloa. Other projects include deliveries to Preston and Guernsey, and beach landings at Sellafield, Black Rock Sands, Lee-on-the-Solent and Sinclair's Bay.

FACTS AND FIGURES

1. Dimensions and deadweight: 80m LOA, 16.5m beam, 8.5m depth to coaming, with a design draught varying from 1.6m to 3.4m depending on cargo, and 2,211t deadweight.
2. Classification: Lloyd's Register 100AT Barge with LMC, plus an ES notation for +20% on all shell and deck plating, and UK MCA Class IX (A), reflecting the reinforced structure needed for grounding and heavy cargo work.
3. Elevating roadway system: A three-section roadway with a safe working load of 600t per section (1,350t total capacity), lifted by 24 hydraulic jacks through a full 6.5m of travel.
4. Ballast performance: 2,800m³ of seawater ballast capacity, with pumps moving 680m³/hr each (4 pumps, 2,720m³/hr combined), enabling fine trim control against tidal range during ro-ro operations.
5. Propulsion arrangement (for inland navigation and manoeuvring in ports and onto beaches): Diesel-electric-style pumpjet propulsion, 4 x pumpjets at 200kW each, driven off 2 x Caterpillar 3508B main engines rated 670kW, giving 2 x 630ekW at 1,500rpm.
6. Station-keeping: Two spud poles (7.5m) for positioning during beach landing and river work, plus 4 x 360° water thrusters for independent manoeuvring without tug assistance.
7. Modest service speed: 4-4.5knots forward, 1.5knots transverse, reflecting its role as a heavy-lift work barge rather than a transit vessel, with 5t bollard pull.
8. Hold dimensions: 67m length x 9m width hold, floodable for float-in/float-out operations, allowing the barge to submerge and refloat smaller vessels (used operationally for RNLI lifeboat and rescue launch transport).
9. Auxiliary deck equipment: 2 x knuckle-boom deck cranes rated 10t at 14m outreach, supplementing the roadway/ramp system for lift-on/lift-off work.
10. Auxiliary/extension equipment: A dedicated harbour generator set (Caterpillar 3304 NA, 50ekW), and a set of extra extension ramps (9 x 1m x 16.8m and 5 x 1m x 14m) for reaching quays with insufficient bearing capacity.



VESSEL PARTICULARS

Length overall	80m
Beam mld	16.50m
Depth to maindeck	6m
Depth to top of coaming	8.52m
Draught	2.75m
Draught submerged	4.80m

MORE

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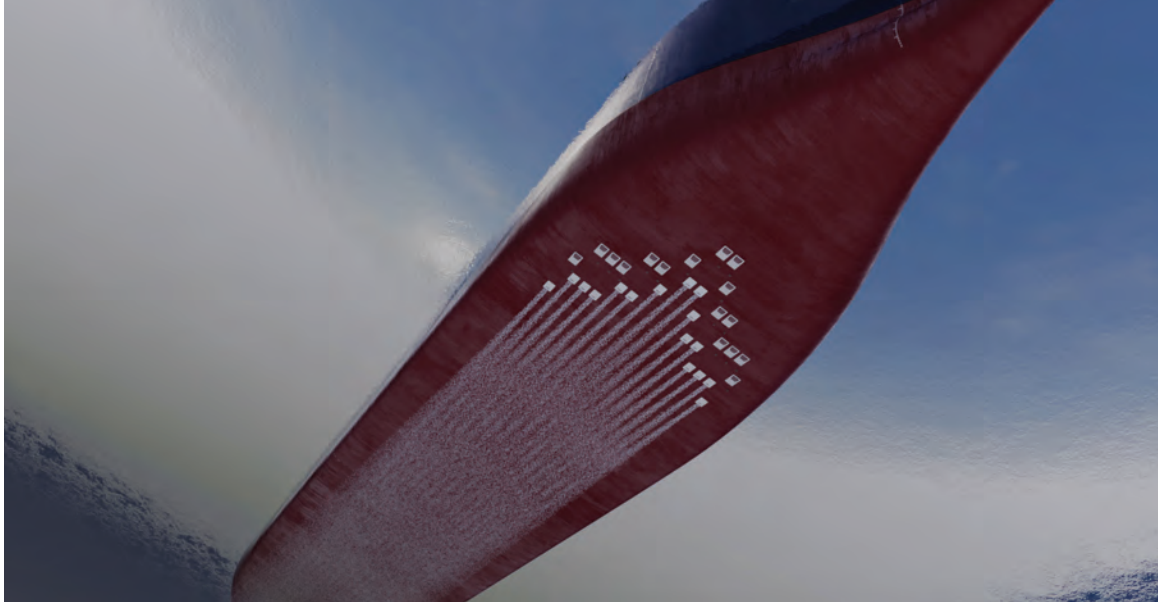


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RETHINKING HULL LUBRICATION FOR REAL OPERATING CONDITIONS

Passive lubrication and full-scale operating data are extending net performance across the vessel operating profile, says Alex Routledge

Air lubrication uses a well-established hydrodynamic principle, introducing air into the boundary layer between a vessel's hull and the surrounding water to reduce frictional resistance and propulsion power.

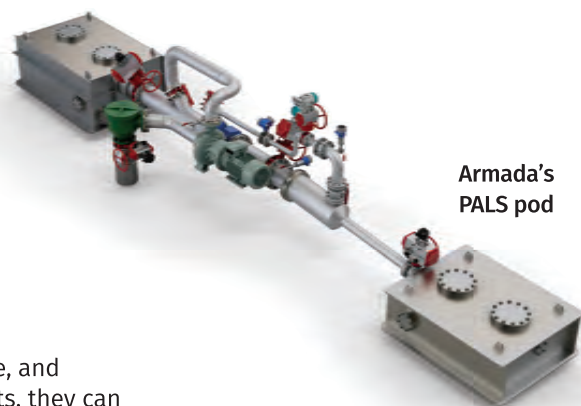
First-generation systems brought that principle into commercial shipping. Operational experience has since provided a better understanding of the factors influencing performance. Vessel design, speed, draught, loading condition and sea state all matter, as does system energy demand. The challenge has evolved from proving air lubrication works to delivering consistent net efficiency across a vessel's actual operating profile.

That experience has been particularly valuable at lower speeds. In many first-generation systems, relative movement between water and a static air pocket creates shear at the air-water interface, helping break air into bubbles and distribute them within the boundary layer, explained in part by Kelvin-Helmholtz theory. As speed falls, relative water movement

and shear stresses decrease, and below approximately 12knots, they can become insufficient to draw and distribute air.

Operating experience has also reinforced the distinction between gross drag reduction and net vessel power saving. Where compressors or other powered equipment deliver air beneath the hull, their energy demand must be considered when determining overall vessel saving. These lessons informed the development of subsequent approaches, such as Armada Technologies' Passive Air Lubrication System (PALS). Rather than using powered machinery to force air beneath the hull, PALS uses the forward motion of the vessel to drive water through purpose-designed venturi ejectors. Accelerating water creates suction, drawing air from deck level and generating a targeted air-water mixture introduced into the boundary layer. With no compressor-powered air delivery, operating power demand is minimal.

PALS is in full-scale deployment aboard *Kool Husky*, a 160,000cbm LNG carrier operated by CoolCo. Its unusually low-speed data reflects actual operation rather than ideal testing conditions, since modern LNG carriers with sub-cooling or reliquefaction can reduce propulsion speed when trading conditions allow, and changing LNG trading patterns



Armada's PALS pod

have also contributed to lower and more variable voyage speeds.

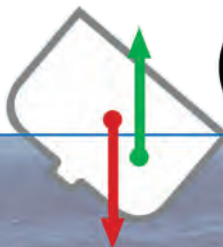
Independent analysis of PALS on *Kool Husky* has demonstrated average power savings of 5.6% laden below 12.5knots and 4.5% in ballast below 6.5knots. These establish a lower-speed benchmark for PALS rather than an expected optimum, and higher-speed data shows a strong performance trend as speed increases.

More than 500,000 operating data points have been assessed across datasets independently analysed by METIS Cyberspace Technology and Zizo Analytics. DNV-RP-0695 filtering reduces these to approximately 162,000 qualifying points, and Armada requires tens of thousands within individual speed and draught ranges before publishing results. Data are transmitted directly from the vessel to the independent assessor via API, without Armada selection or screening.

The *Kool Husky* programme extends beyond savings at a particular speed or loading condition. It provides full-scale evidence of air lubrication without the high-powered air-delivery machinery traditionally associated with the technology, and demonstrates measurable net power savings at speeds where effective air lubrication becomes increasingly difficult.

Alex Routledge, CEO of Armada Technologies, is a naval architect (Newcastle), formerly with Shell and Qatar Gas.





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STAYING IN CONTROL OF MULTI-CAD

Shipyards working with third-party data need the means to integrate and keep track of data of increasing complexity, writes Simon Crook

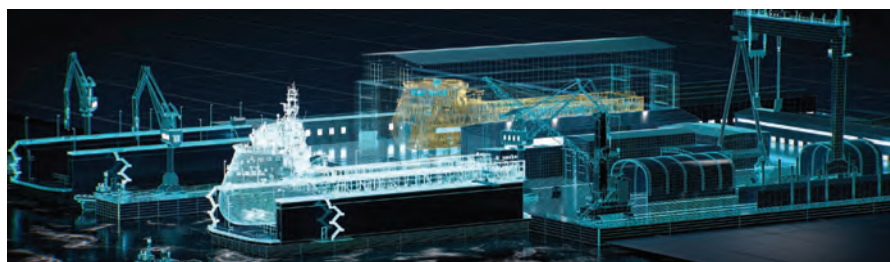
Shipbuilding programmes are under constant pressure to move faster. Shipyards are expected to evaluate opportunities quickly, reuse proven designs, adapt existing information to local production methods, and begin planning long before every design detail has been finalised.

This is especially true when a programme starts with an existing design package, which is becoming more common in naval programmes. In these cases, the shipyard rarely starts with a digital twin built using its own systems and practices. Instead, information arrives in mixed forms: native CAD models, neutral exports, drawings, spreadsheets, equipment lists, supplier documents, classification comments and legacy files, some well-structured, some incomplete or inconsistent.

The main challenge is not the use of disparate CAD systems. A single authoring environment may be desirable for long-running programmes, but it is rarely realistic at the outset. The more immediate need is a way to govern incoming information without forcing a full redesign from day one.

Interoperability and information control are not the same problem. Interoperability concerns whether geometry and model data can be exchanged, viewed or converted across systems. Information control concerns whether that information can be identified, structured, trusted, configured, changed, released, and reused. Provided the necessary data is available, the originating CAD platform should not matter to downstream functions such as planning, procurement or documentation.

The risk in a multi-CAD environment is loss of control. As information



SSI software can help keep on top of constantly evolving data from multiple sources

moves between authoring systems, spreadsheets and production tools, the shipyard can lose track of product structure, identifiers, revisions and approvals. This shows up in three common pitfalls. Information fragmentation occurs when data needed to execute the vessel is spread across systems with no clear governed source – for example, weight may sit in a CAD object, a spreadsheet and a supplier document, each telling a different story. Product model mismatch arises when incoming CAD structures reflect the design partner's logic rather than the shipyard's own engineering, process and manufacturing bill-of-materials needs. Conflicting revisions and baselines occur when no single source confirms which combination of model, drawing and document represents the approved state of the vessel.

Two current programmes illustrate the stakes. Australia has selected Damen's Landing Ship Transport 100 as the basis for eight Landing Craft Heavy vessels, to be built by Austal at

Henderson, while the US Navy has adopted the same design for its Landing Ship Medium programme, with construction split across Bollinger Shipyards and Fincantieri Marinette Marine.

In each case, the receiving yard must take on an external design package, govern it, selectively convert what is needed and maintain traceability across sister ships, often while a change on one hull must be evaluated against others at different build stages. Austal's use of SSI's ShipbuildingPLM is one example of a shipbuilding-specific PLM layer being used to sit between the third-party design and the yard's own execution environment, preserving traceability while allowing local requirements and production methods to be applied.

Multi-CAD is now a normal feature of naval shipbuilding. The question is not whether data can move between CAD systems, but whether the shipyard can retain control of structure and identity, and change history as it does so.

Simon Crook CEng FRINA is senior solution specialist at SSI, the British Columbia-based software company behind ShipConstructor and ShipbuildingPLM



Why we need to rethink methods of predicting real-life rudder performance, taking sea margin, turning and WASP into account

RUDDER PERFORMANCE: HOW TO SEE THE FULL PICTURE

Standard rudder performance assessments, including towing tank tests and straight-sailing CFD simulations, evaluate the rudder at its neutral steering angle. This gives a reasonable reading of rudder drag in calm, straight-sailing conditions. What it does not capture is rudder drag or steering performance in typical service conditions, where the rudder is actively working. For that, the neutral angle tells you very little.

This means that the real-world performance difference between a conventional rudder and a twin-foil configuration is structurally invisible to the methods most commonly used to evaluate it. The gap shows up in operation. It does not show up in the tank or simulation.

IN SERVICE CONDITIONS

A sea margin of around 15% extra power is standard practice. It accounts for waves, wind, course corrections and autopilot activity in service. It absorbs the drag cost of rudder use, but it is almost never examined in detail.

Wärtsilä has run full-scale CFD simulations modelling vessel response to rudder steering angles of $\pm 2.5^\circ$, representative of normal autopilot operation. When hull, propeller and rudder interaction effects are modelled together rather than in isolation, the picture changes. A conventional rudder vessel operating in these conditions may need the full 15% sea margin. A Gate Rudder vessel may need closer to 5%, with shipowners consistently recording double-digit fuel savings.

The IMO turning circle is evaluated on advance distance and tactical diameter. Vessel speed during the manoeuvre receives considerably less attention. That is worth revisiting.

During an IMO turning circle at 35° of rudder and 85% power, a vessel with a conventional rudder typically loses 65% to 75% of its initial speed. Gate Rudder vessels have consistently lost around 50% of initial speed through the same manoeuvre across multiple sea trials.

A vessel that loses less speed through a turn requires less power to recover it afterwards. Speed retention during steering actions is not just a handling metric. It is an indirect but measurable indicator of improved fuel consumption in service.

At smaller angles the same pattern holds. Autopilot course corrections at 2.5° to 5° show less speed lost and less power required to recover it.

As wind-assisted ship propulsion (WASP) becomes more common, a specific opportunity is emerging. Sails generate side forces that the rudder must compensate to hold course. But

as propeller loading falls, exactly when WASP is contributing most, conventional rudder effectiveness falls with it. The wash the conventional rudder depends on weakens, steering angles increase and drag rises. Some of the efficiency gain from wind assistance is therefore negated.

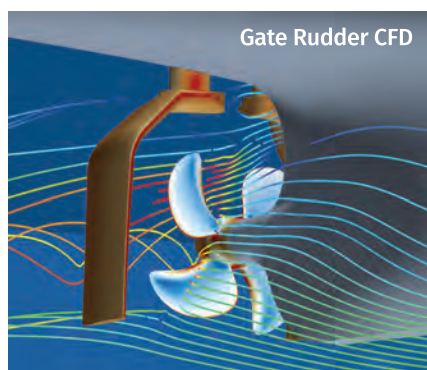
Gate Rudder sway force generation is largely independent of propeller wash, driven primarily by vessel speed. With significant wind contribution, the foils maintain course authority at smaller steering angles. In short, a Gate Rudder vessel with WASP should expect an extra boost in fuel consumption compared with a WASP vessel with a classic rudder. For designers evaluating WASP integration at concept stage, that interaction is worth including in the model early.

WHERE THIS LEADS

The common thread is that the methods used to predict rudder performance in operation leave a significant portion of in-service efficiency headroom unexamined.

Addressing it requires evaluating hull, propeller and steering together, and that needs to happen at concept stage. Once the propulsion layout is fixed, the opportunity largely goes with it. The rudder steering system is part of that decision and should be treated as such from the start.

Norbert Bulten is senior product performance manager at Wärtsilä.



WÄRTSILÄ

PROACTIVE HULL CLEANING

How a year of biocide-free robotic hull cleaning on a trading LPG carrier held performance close to dry-dock levels, despite high fouling pressure and imperfect execution

The dominant model for managing hull fouling in shipping has always been reactive. Antifouling coatings are applied at dry dock, the vessel trades, performance degrades and cleaning is eventually scheduled once the penalty becomes visible enough to act on. The cleaning that follows is often aggressive, the coating loses film thickness and the cycle repeats.

A paper titled *Proactive Hull Management with Biocide-Free Hard Foul-Release Coatings*, presented at HullPIC 2026 by Ryan Ingham, Michael Jacot and Philippos Sfris from GIT Coatings, documents an attempt to replace that model, and presents one year of operational evidence from a 120m LPG carrier to support the case.

The vessel's historical trading profile placed it firmly in the high-to-extreme fouling exposure range: approximately 40% activity at sea, around 225 idle days in warm, nutrient-rich waters and frequent calls at ports with high biofouling productivity. Before the vessel's dry docking, GIT Coatings conducted a biofouling risk assessment using AIS data combined with local ocean condition data, including sea water temperature, salinity and biofouling productivity proxies, to simulate how quickly microfouling would accumulate on the hull under its expected trade. From this, it developed a ship-specific cleaning plan, targeting inspection every 30 days and a clean every 90 days on the vertical sides, with inspection every 60 days and cleaning every 180 days on the flat bottom.

The coating applied was XGIT-Fuel, GIT's biocide-free graphene-based hard foul-release system, selected for its low-friction surface properties and compatibility with repeated light mechanical cleaning. The cleaning method used was a semi-autonomous magnetic crawler with soft brushes, operated by the vessel's crew and capable of full vertical hull coverage in

six to eight hours per side. A port feasibility assessment identified which ports and anchorages on the vessel's typical routes would allow cleaning within the planned intervals, and mapped approved in-port cleaning contractors as contingency options.

THE COATING IN ACTION

Over the first 12 months, the vessel had seven underwater inspections and three cleans. Commercial reality intervened throughout: tight port schedules, cargo operations competing for crew time, and occasional robot reliability issues meant that some cleanings were partial, covering one vertical side only, and some were delayed relative to the planned FR20 threshold (FR is the fouling rating scale). Grass growth appeared locally on one side when cleaning was late, but was removed at the next cleaning without visible damage to the coating. No hard fouling was recorded on the underwater hull at any point, and no coating detachment, blistering or roughening was observed after multiple cleaning cycles.

The performance results, derived from high-quality noon report data normalised to 12knots at Beaufort force four or below, showed a 6%

power gain out of dock compared with the vessel's previous high-tier self-polishing copolymer antifouling under comparable trading conditions, attributable primarily to the lower surface roughness of the new coating.

Over the year, added power accumulated to less than 2% despite approximately 180 idle days in high fouling exposure waters, a result the authors describe as relatively stable. Each clean recovered an average of around 4% of fuel efficiency, within a measured range of 3%-5%.

The authors compare the actual performance trajectory with two reference curves: an ideal proactive cleaning model assuming full-hull on-time cleaning at every FR20 threshold, and a theoretical high-tier SPC baseline with no in-water cleaning in year one. The actual results sit between the two but considerably closer to the ideal model. Even with partial and delayed cleanings, the vessel outperformed the SPC baseline by around 2% over the year. The modelling suggests a further 6% annual efficiency gain is attainable if cleaning can be brought closer to the ideal schedule.

The paper is candid about the challenges. Spot charter trade proved poorly suited to proactive hull management because future port calls are unknown, making cleaning scheduling difficult. Several ports refused robot deployment. The authors identify port authority education as a significant outstanding requirement for broader adoption.

"EVEN WITH PARTIAL AND DELAYED CLEANINGS, THE VESSEL OUTPERFORMED THE SPC BASELINE BY AROUND 2%"

XXGIT-Fuel is a biocide-free hull coating



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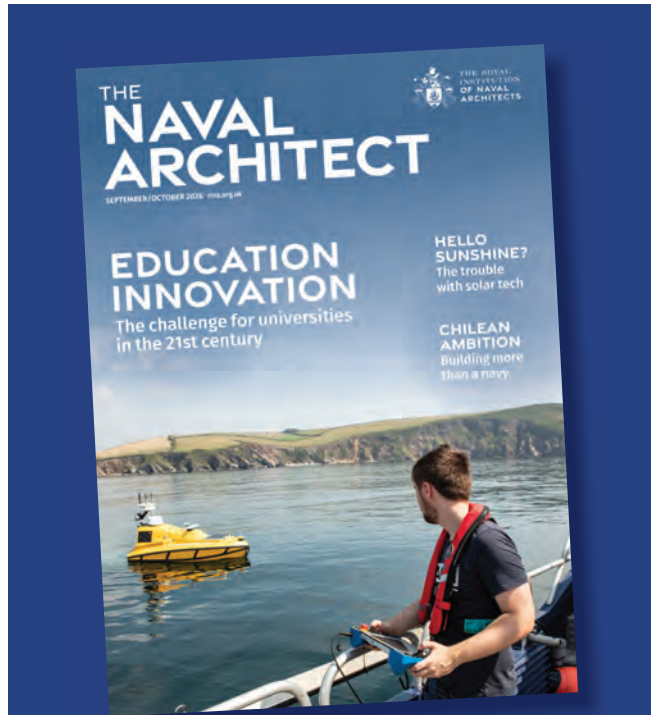
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HYBRID THINKING ON WAVE RESISTANCE

How a new model from Bureau Veritas attempts to predict wave-added resistance at close to CFD accuracy but at a fraction of the computational cost

Accurately predicting how much extra resistance a ship encounters in waves remains a challenge. Added resistance in waves forms a substantial component of total ship resistance in real operating conditions, and errors in its estimation feed directly into inaccurate performance predictions, flawed sea trial corrections and poorly calibrated voyage optimisation tools.

Théo Descamps presented a paper at HullPIC 2026 examining the available methods for calculating wave-added resistance, and proposing a hybrid approach, developed by Bureau Veritas Solutions Marine & Offshore (BVS M&O), that seeks a practical compromise between computational cost and accuracy.

The three main methods in use each occupy a different position on the cost-accuracy spectrum. Semi-empirical models, of which the SHOPERA-NTUA-NTU-MARIC (SNNM) method is considered the most capable, require only basic geometric parameters and deliver fast results. They are useful for early-stage design, but limited in accuracy where linear wave theory breaks down, such as steep waves or short-crested seas. Potential flow solvers, including BV's Hydrostar and MARIN's SEACAL, both

of which model wave diffraction and radiation around the hull, offer a middle ground: more precise, and a fraction of the cost of CFD, but with inaccuracies at certain headings and speeds. Reynolds-Averaged Navier-Stokes (RANS) CFD simulations are the most accurate, but are too costly and complex for routine industrial use.

BEST OF ALL WORLDS?

BVS M&O's hybrid model combines elements of all three:

1. Potential flow calculations are run first across a range of headings, using Hydrostar and SEACAL to improve robustness.
2. These are calibrated against a small number of CFD simulations – just three RANS runs, conducted in head seas at selected wave periods.
3. A least-squares regression step simplifies the calibrated transfer functions into a compact parametric form.
4. The SNNM model then extrapolates results across the full range of speeds, draughts and headings not covered by the CFD runs.

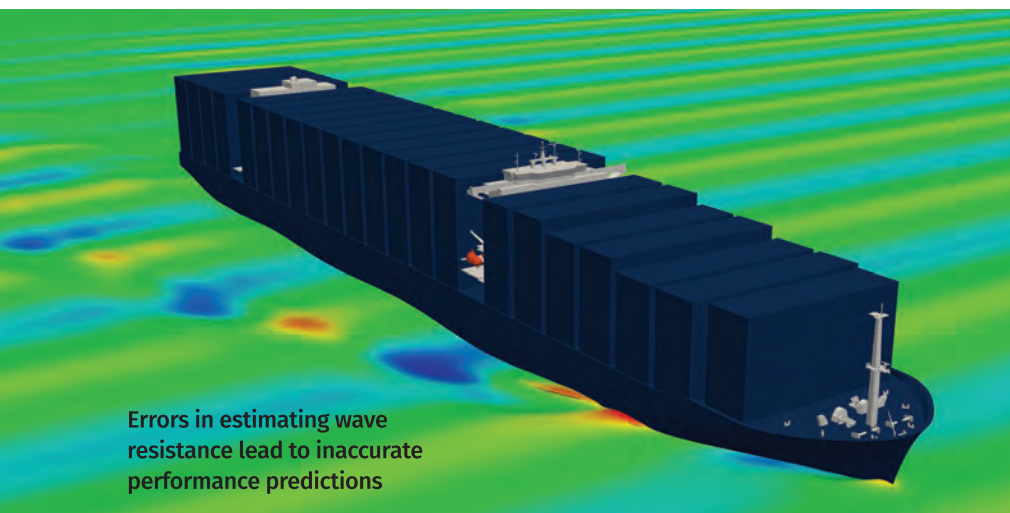
The aim is to capture most of the accuracy benefit of CFD while keeping the computational overhead close to that of the potential flow approach. To evaluate performance, Descamps

applied the model to voyage data from a series of sister ships, representing 3,815 days of at-sea operation. After filtering for data quality, physical validity and navigation phase, 1,128 days of usable data remained. A statistical model was then fitted independently to both the measured shaft power and the hybrid model's predictions, allowing direct comparison against real-world behaviour.

The results were revealing. For several key parameters, including the dependence of added resistance on significant wave height, the hybrid model aligned closely with the statistical model derived from measured data. However, a consistent overestimation of added power was identified, most pronounced at wave headings approaching 90° and peak wave periods around 10 seconds, attributed partly to calibrating the potential flow results using CFD data from head seas only. With oblique and beam sea CFD runs absent, extrapolation to those headings introduced error that the calibration step could not correct. In practice, this makes predictions conservative for ships that regularly operate in beam or oblique seas, overstating rather than understating fuel and power requirements, a safer failure mode, but one that could still distort voyage optimisation and performance benchmarking on routes where beam seas are common.

Descamps is clear about this limitation. Three CFD simulations in head waves, the paper concludes, is too restrictive for ships where beam sea conditions are operationally significant. Future iterations will add CFD runs at oblique headings, guided by the statistical procedure developed in this work. The broader significance is what the model demonstrates in principle: that CFD-level accuracy in wave-resistance prediction may be achievable at a cost much closer to potential flow methods, bringing high-fidelity resistance estimation within reach of routine industrial work, rather than just specialist research.

Théo Descamps is a hydrodynamic engineer with BVS M&O. His paper is titled *Ship Performance Prediction with a Hybrid Model for the Estimation of a Ship's Added Resistance in Waves*.



Errors in estimating wave resistance lead to inaccurate performance predictions

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MAKING SPACE FOR WASTE

Martin Shutler on the design challenges created by modern water and waste treatment requirements

In the past 15 to 20 years, onboard wastewater treatment has shifted from an auxiliary service to a core ship system. More stringent discharge requirements and treatment of multiple wastewater streams have increased process volumes, making structural tanks, machinery space and system integration significant design considerations.

The influence begins early, often during concept and general arrangement development. Biological treatment processes depend on substantial treatment, buffering and storage volumes, so tank allocation and location must be established while there is flexibility in the vessel design.

Sufficient upstream capacity is needed for black and grey water collection, as well as downstream capacity for treated effluent and sewage sludge. Large structural tanks may be subdivided into process compartments, or multiple tanks hydraulically linked through balance connections. Such arrangements must satisfy stability requirements while minimising free surface effects, as process tanks are often partially filled.

A BALANCING ACT

Designers must balance treatment capacity, redundancy and operational flexibility against available machinery space. Redundant treatment arrangements, increasingly specified by owners, can add significant piping complexity and valve counts.

With environmental requirements likely to evolve over a vessel's life,

flexibility in space allocation, tank arrangements and utility capacity can make future equipment upgrades or additional treatment capacity easier to accommodate.

Interfaces must also be defined early. Connection points, access routes and service requirements need identifying before pipe routing and structural arrangements become fixed. Equipment may remain in service for decades, so maintenance access is equally important. Modules requiring access from one side only can be positioned closer to bulkheads, preserving space without compromising serviceability.

Requirements differ significantly between vessel types. Cruise ships have the highest hydraulic and organic loads and need large, highly integrated treatment systems. Merchant vessels generally have lower accommodation loads and simpler arrangements. Naval vessels

“DESIGNERS MUST BALANCE TREATMENT CAPACITY, REDUNDANCY AND OPERATIONAL FLEXIBILITY AGAINST AVAILABLE SPACE”

must operate efficiently with wide variations in persons onboard, while ferries have sharply fluctuating wastewater generation rates.

Waste system type also affects vessel layout. Advanced membrane bioreactor (MBR) systems depend heavily on structural tank

arrangements and process volume allocation. Dry and wet waste systems may rely on gravity transfer between shredders, storage silos, centrifuges, dryers and incinerators, requiring vertical arrangement across several decks. Incinerators also consume significant air and generate heat, which must be allowed for in compartment HVAC design.

THE DEVIL IS IN THE DETAILS

System performance throughout the life of the vessel can be undermined by early design decisions. Poorly designed MBR vent lines can become flooded and restrict airflow, adversely affecting biological treatment.

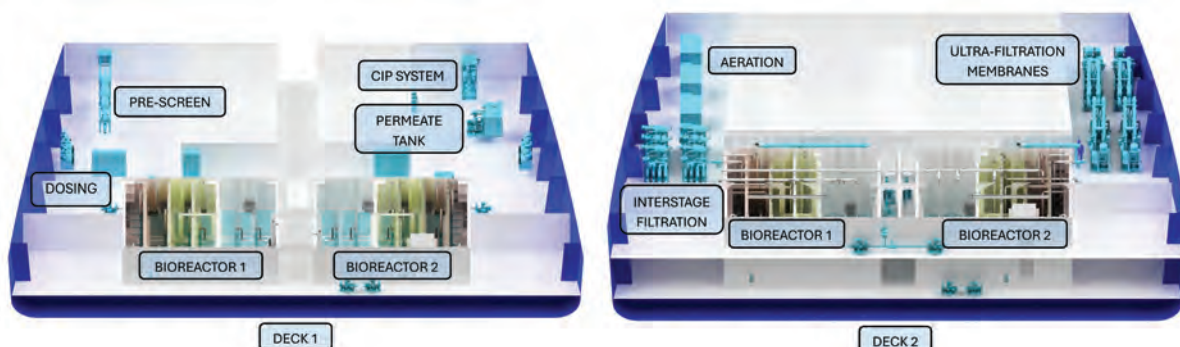
Inadequate buffering can cause shock loading, while insufficient sludge storage can limit effective sludge management. Misconfigured vacuum or gravity collection systems can also overload inlet screening equipment.

Temperature is another consideration. Control panels close to heat sources such as heated HFO tanks can face elevated ambient temperatures, while aeration compressors can impose a substantial heat load in compact machinery spaces.

Requirements vary by system and vessel type, so water and waste treatment needs to be considered as part of the vessel architecture from the outset. Effective performance depends on getting tank capacity and arrangement, pipework, ventilation, heat loads, access and structural integration right. In practice, this means decisions throughout the ship design process ultimately determine how well water and waste systems perform across decades of service.

Martin Shutler CEng MEng MIMechE is principal engineer at Hamworthy.

Waste systems may rely on gravity transfer requiring vertical arrangement across decks



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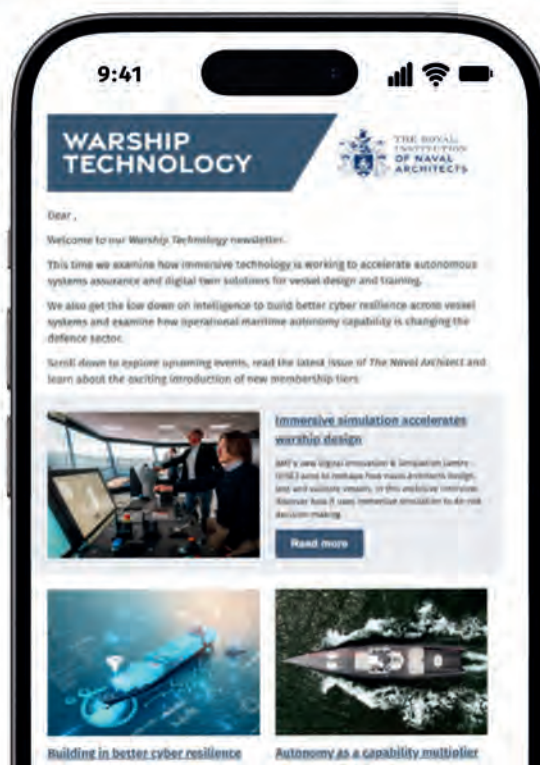
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PHYSICS MEETS MACHINE LEARNING IN SHAFT POWER PREDICTION

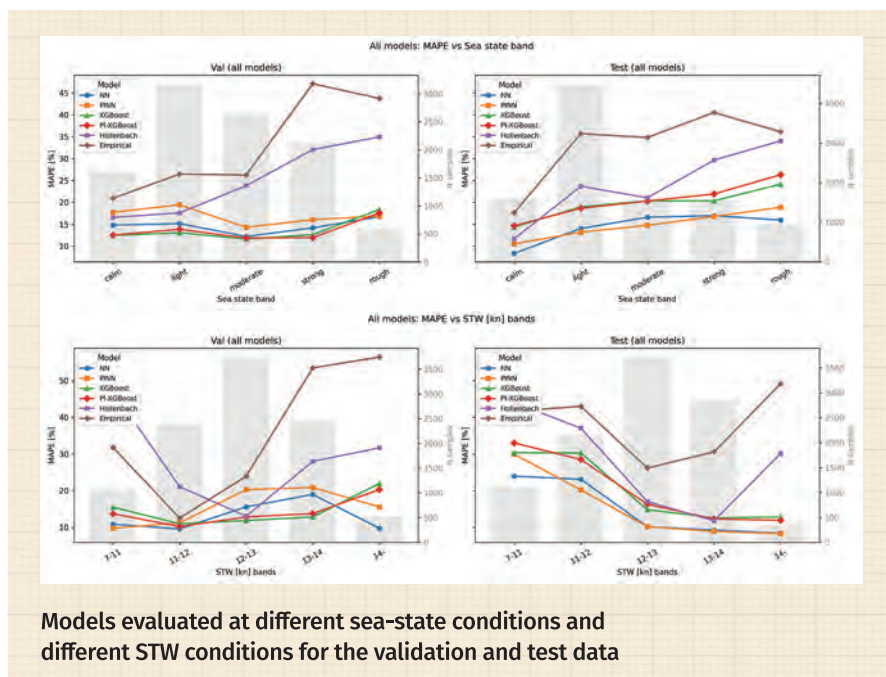
Norwegian researchers find machine learning consistently beats a purely empirical benchmark for shaft power, though combining the two brings no clear gain

Accurate shaft power prediction is central to voyage optimisation, energy efficiency assessment and IMO's target of a 30% emissions reduction from the global fleet by 2030. Environmental effects, hull fouling, loading variations and the transient behaviour of large vessels such as bulk carriers all introduce complexities that neither hydrodynamic nor machine learning models handle well alone.

A paper presented at HullPIC 2026, *Comparing AI and Ship Hydrodynamics for Ship Performance Estimation*, addresses this directly, using five years of full-scale operational data from a 200m deep-sea bulk carrier, logged at 15-minute intervals from 2020 to 2025. The team evaluated five approaches: a standard neural network, a physics-informed neural network (PINN), XGBoost, a physics-informed XGBoost, and a purely empirical method combining the Hollenbach calm-water resistance formulation with the SNNM wave-added-resistance method.

Both physics-informed models share the same mechanism, calm-water resistance from the Hollenbach method fed in as an extra input feature. Described by the authors as sequential integration, it needs only principal ship and propeller dimensions, making it accessible where fuller data is unavailable.

The results are clear in one respect: data-driven and hybrid models all outperform the empirical method by a wide margin, recording a test-period Mean Absolute Percentage Error (MAPE) of about 33%, against roughly 14% for the two neural networks and around 19% for the tree-based models. Less clear-cut is the benefit of adding physics, since the PINN and the plain neural network perform almost identically, at around 14% MAPE, though the plain network has the stronger overall fit, with an R^2 of roughly 0.56 against 0.33. On this



“THE RESULTS ARE CLEAR IN ONE RESPECT: DATA-DRIVEN AND HYBRID MODELS ALL OUTPERFORM THE EMPIRICAL METHOD BY A WIDE MARGIN”

dataset, informing the network with calm-water resistance neither clearly helps nor clearly hurts.

A complication arose in the shaft-power record, where values proved inconsistent with speed and fuel consumption in ways weather or hull cleaning could not explain. Investigation traced this to a change in onboard data transfer hardware, and the authors reconstructed the affected period from fuel consumption using an operator-verified SFOC curve, then retrained all models, a candid handling of an issue familiar to anyone working with real vessel data.

Analysis across operating regimes reveals further nuances. All data-driven models perform poorly at low shaft power, below 5,000kW, an underrepresented regime in the training data, while the empirical model struggles below 13knots, reflecting its calibration on higher-

speed model tests. The empirical model also cannot account for hull fouling, whereas the data-driven models capture some fouling effects implicitly, through dry docking and propeller polishing events used as input features.

The authors are measured in their conclusions. Beyond the single-vessel caveat, future work includes testing on multiple vessels, examining how performance depends on training data volume, and exploring hybrid architectures better suited to low-speed and rough-weather regimes.

This study was funded by the research project KSP FUSE, supported by the Research Council of Norway, project number 352781. The paper was authored by Pauline Røstum Bellingmo and Endre Sandvik of SINTEF Ocean, Trondheim, Thor Albrektsen of SINTEF Ocean, Oslo, David Odd Erik Fürst Standal of NTNU, Trondheim, and Severin Sadjina of SINTEF Nordvest, Ålesund.



GENERATIVE AI DESIGN CUTS FUEL USE AND EMISSIONS

AI-designed crew transfer vessel

A seven-month feasibility study has produced a crew transfer vessel with 11% lower fuel use and 9% lower CO₂ than a diesel baseline. It's a working test of whether generative design can move from concept to class approval

Designers make the decisions that will determine around 90% of a vessel's eventual performance at the concept stage, before a hull form is even fixed. Naval architects have traditionally tackled this with the design spiral, refining a shape through repeated cycles of assessment and adjustment, a process that delivers thoroughness but sacrifices speed, and tends to favour conservative outcomes. Generative AI is showing it can propose hull forms that go far beyond what that process would typically surface. The harder question is whether engineers can trust the unconventional designs, simulate them with enough confidence to predict real performance, and build them without the costly rework that so often follows an ambitious concept into the design office.

ORIGINS OF THE PROJECT

Compute Maritime, a London-based deep tech company, built its NeuralShipper tool to tackle this problem directly, using generative AI to produce novel hull forms as native CAD geometry rather than abstract concepts

requiring translation. GenDSOM (short for generative design, simulation, optimisation and manufacturing) set out to prove that NeuralShipper's outputs could be trusted, simulated to a validated standard and carried through to a buildable vessel, replacing the traditional design spiral with a single, intelligence-led loop.

It ran as a seven-month, roughly £700,000 feasibility study under Round 6 of the Clean Maritime Demonstration Competition, part of the Department for Transport's UK SHORE programme, delivered by Innovate UK. From September 2025, the consortium took BYD Naval Architects' B-WIND crew transfer vessel (CTV) from brief to validated design. The result is a 32.5m twin-hull aluminium CTV, carrying 24 technicians and four crew at 25knots. Compared with a like-for-like diesel baseline, it saves 101,671litres of fuel and 258.7tonnes of CO₂ per vessel, per year.

For the engineering, it had to be performant, predictable and producible. Lose any one, and the output is a rendering, not a vessel.

NeuralShipper generates hulls as high-fidelity NURBS surfaces rather than mesh, since surface irregularities distort predictions, and design offices need precise, editable geometry. The search worked within everything that makes a CTV fit for purpose, including seakeeping, operability, deck layout, structure, classification rules and aluminium fabrication. It was steered by physics-informed geometric operators, which read hydrodynamic character from geometry alone, reserving CFD for validation.

The hull itself was treated as an energy system, not a resistance problem. Power reductions of 6.3% at service speed, rising to 11.6% elsewhere in the range, turned the baseline's 34kWh end-of-day deficit into a 106kWh surplus, annualised over 285 operating days.

OBSTACLES ALONG THE WAY

Data came first. There is no large public corpus of ship geometry, so a dedicated work package drew on Compute Maritime's proprietary database. Manufacturability was the recurring risk, since geometry that performs in simulation cannot always be built. That was addressed by embedding production constraints into the loop itself, rather than checking for them afterwards. The final obstacle was human: a sector wary of black boxes,

STATS

-11.1%

Annual fuel saving
101,671l/yr avoided
vs baseline diesel

258.7_{T/YR}

Annual CO₂ saving -8.9% vs
baseline diesel over 285
operating days

25_{KNOTS}

Service speed Met with
42kW headroom and
0.56C burst (within limit)

100%

Zero-emission harbour
Full battery departure,
approach & manoeuvring

and five partners working to a tight clock, met through disciplined delivery.

WHAT THE AI CHANGED

The mission profile was fixed, so the optimiser could not buy performance by shrinking the ship. The result remains a recognisable catamaran. Where a parametric study spreads small, conservative adjustments evenly, NeuralShipper made larger, local moves, concentrating change in the regions that drive required power. Gains that grow with speed point to wave-making and demihull interaction, rather than wetted surface alone. The lines themselves remain proprietary while build discussions continue.

Human factors came in too. On a CTV these are principally motions, so seakeeping and operability constraints were expressed as human limits, covering the accelerations crew tolerate in transit and the motions within which push-on transfer stays safe. Detailed ergonomics sat outside this loop, though relevant objectives already exist within NeuralShipper for future work.

Compute Maritime is clear there is no separate approval path for an AI-generated hull, since classification societies approve evidence, not tools. Compliance was designed in from the outset: rules embedded as constraints, conventional aluminium construction

keeping the vessel inside the existing yard and survey ecosystem, and design data flowing straight into standard plan approval. Performance was proven against the offshore duty cycle rather than calm water, with operability filtering candidates before the shortlist. The printed hydrofoil is an added capability the vessel does not depend on, so its qualification proceeds separately as additive manufacturing class frameworks mature.

On verification, a question raised previously with RINA's Maritime Innovation Committee, the company's position rests on architecture: nothing the AI predicts is load-bearing. Every published figure comes from the solver of record, Siemens' Simcenter STAR-CCM+, run at full scale and independently validated by the University of Southampton. The campaign was comparative against a proven vessel, so the deltas that matter are more robust than any single prediction. Final closure, as with any verification chain, is the instrumented sea trial.

WHAT COMES NEXT?

The decisive next step is commercial: an operator and funding, currently the focus of route-to-build conversations with BYD. Detail design, class approval and sea trials follow the standard

newbuild sequence. An offshore fast-charging inlet, specified at build, lets the design absorb rather than wait on the infrastructure behind its roadmap to roughly 95% lower lifetime emissions. NeuralShipper is already in use with customers across vessel types, so the CTV demonstrates a repeatable process. The company expects the approach to expand from workboats into energy-saving devices and, as evidence accumulates, ocean-going tonnage.

Compute Maritime CEO Shahroz Khan says AI does not change what a good ship is, or who is responsible for one. "It changes the economics of exploration, making the naval architect's judgement more valuable, not less," he says. "First, hull form is a system enabler. Optimising the vessel against its duty cycle, rather than the hull against calm water, decided whether the electric propulsion system had enough energy margin to work at all. Second, the naval architect remains the multiplier: tools that sharpen human judgement go further than those that try to replace it."

Shahroz Khan has a PhD in Naval Architecture, Ocean and Marine Engineering from the University of Strathclyde.



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MEMBERS

A SPOTLIGHT ON MEMBERS AROUND THE WORLD

DR BATUHAN AKTAS WINS RINA-QINETIQ 2026 MARITIME INNOVATION AWARD

Prize for vessel-specific propeller retrofit
presented at the RINA Annual Dinner

Dr Batuhan Aktas MRINA has won the 2026 RINA-QinetiQ Maritime Innovation Award. The award recognises his invention and the first commercial deployment of the Eco Boss Cap, a vessel-specific, CFD-optimised propeller boss cap retrofit designed to suppress hub vortex formation and improve propulsive efficiency. The device is now in service on four vessels, with owner-reported fuel savings of 3.1 to 4.0%. The award, presented annually by RINA in association with QinetiQ, was given at the RINA Annual Dinner in May 2026. Aktas is the chancellor's fellow in future proof ship design at the University of Strathclyde and founder and chief executive of EcoNavis Solutions.

The rotating propeller hub sheds a concentrated vortex into the low-pressure region downstream of the boss, a rotational energy loss that is also a common source of

**The Eco Boss Cap,
designed to improve
propulsive efficiency**

cavitation and rudder drag. Conventional fin-based boss caps are typically optimised for a narrow operating point. Aktas took a different approach, developing a full-scale RANS CFD optimisation workflow that accounts for hull-propeller-rudder interaction and each vessel's real operating range. No two units delivered to date share the same geometry.

Installation is a passive mechanical exchange, requiring no class approval, ship systems integration or crew retraining on the installations done so far. The most recent fitting was completed in around five hours in drydock, and an in-water installation is now in the order book, decoupling the investment decision from the docking window.

In-service data comes from four vessels: a 177m timber carrier, two Handysize bulk carriers and a 32,000dwt general cargo vessel. Fuel savings ranged from 3.1 to 4.0%, a spread Aktas attributes to the vessel-specific design basis. The most recent figure, a 4% reduction on an Oshima-type Handysize bulk carrier, was produced independently by the owner's fleet performance team, comparing the fitted vessel against sister ships drydocked to the same hull coating specification. Aktas

stresses that measurement and verification are ongoing, with predicted and measured values reported separately throughout.

Commercially, Aktas led the first retrofit for an Asia-based ship management company and secured £300,000 in Innovate UK ICURE funding. EcoNavis has since received a multi-vessel order from an international liner operator covering up to 20 vessels, plus repeat orders placed on the strength of owners' own performance data. The order book also includes a first controllable pitch propeller application and a first in-water installation, with active technical engagement across owners in Europe, Türkiye and Asia. A UK patent filing is underway, with further families in preparation as the company extends its approach into upstream flow devices and rudder-related energy-saving solutions.

"The award recognises a position we took at the outset: that an energy-saving device should be designed for the ship it is fitted to, not selected from a catalogue," says Aktas. "What has changed commercially is who is producing the numbers. Owners are reporting savings from their own performance teams, using their own sister vessels as the control, and placing repeat orders on that basis."



Dr Batuhan Aktas (centre)

ECONAVIS

CAREERS

HELPING DEVELOP YOUR CAREERS

Chris McNair reflects on how times are changing for skills, development and how RINA can support you

When I joined RINA in 2009, the CEO presented to my class, and back then we still used paper forms. The website was dated, the library ran by mail order and only a handful of resources were available digitally. My welcome to the Scottish Branch came as a printed events pamphlet through the post.

Now, RINA is far more digital, and combined with an ambition to improve support for early careers and professional registrations, we wanted a more purposeful offering. So, after bringing the right people together, we proposed an initiative, which we called Developing Careers.

It covers support for those starting a naval architecture career or making a career change. It looks to develop resources for school engagement and improve our support for those in university, apprenticeship or other training routes – bringing all paths into our profession under one banner.

So, how does RINA support our members' career ambitions? Professional registration is what many strive for, as it is proof of professionalism and creates opportunities. Traditionally, members went for CEng: master's graduates applied once they had covered enough competencies, bachelor's graduates took longer, completing extra education first, and apprenticeshipwrights followed the experience route, applying later. Today, RINA offers Engineering Technician, Incorporated Engineer and Chartered Engineer awards, and members can research the pathway most appropriate for them via the membership menu on the website.

“MENTORING CAN HELP BUILD THE CONFIDENCE TO ASK THE RIGHT QUESTIONS, AND IT CAN SUPPORT DEVELOPMENT IN OTHER AREAS”

‘Skills’ is the current buzzword. The world is changing with the development of AI, yet the fundamentals of engineering still apply. With that in mind, RINA has changed how it makes content accessible for continuing professional development. Branch and conference recordings are now available on demand, accessed via the On-Demand Learning page, while conference proceedings sit in the Event Session Library, where Wind Propulsion 2026 and The Naval Architect 2025 are currently hosted. Our AMRINA working group is also developing material and events to create more focused sessions.

Branches are great for the developing engineer. Local committees create opportunities to get together for a technical talk, giving everyone the chance to start building a network, which can help develop ambitions and career plans, while building bonds and strong friendships. Since 2020, many branches have adopted a hybrid digital model and, as Scottish Branch chair, I am grateful that we have members joining us in spirit from around the world. Even so, branches still need members attending in

person, to help develop and maintain the relationships that make the branch a great place to socialise.

Lastly, mentoring. Most graduate programmes offer a mentor to support you in your early career, and some offer peer support for your transition to working life, giving perspective on first placements. But mentoring isn't limited to a business. RINA has launched a mentoring programme focused on our sector-wide membership, and you'll find details of registration and the principles on the Career Development menu of the website. Mentoring can help build the confidence to ask the right questions, and it can also support development in other areas, such as further RINA registration or leadership accreditation.

Our profession has a visibility issue, but with our STEM offering, as mentioned by Charlotte Dodge on page 3, I'm sure we'll address this and create something great with RINA Developing Careers.

AUTHOR PROFILE

Chris McNair AMRINA is a naval architect in the defence industry. He is chair of RINA's Scottish Branch and chairs RINA's Developing Careers Committee.

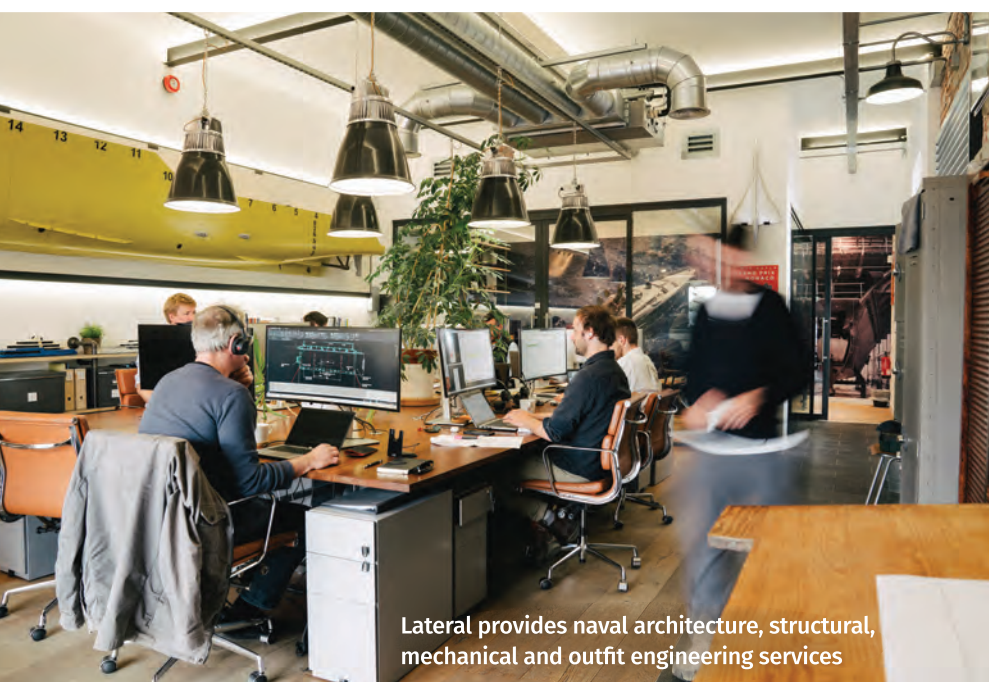


Chris McNair at London International Shipping Week

INTERNSHIPS

HANDS-ON EXPERIENCE AND A FRESH PERSPECTIVE

Southampton-based superyacht engineering firm Lateral Naval Architects had taken summer placement interns for many years. Ten years ago, it changed the strategy and now offers two 12-month internships a year. We hear from two interns and get the view of its chief naval architect about the positive benefits of the programme



Lateral provides naval architecture, structural, mechanical and outfit engineering services

JAMES BAINES, AN MENG SHIP SCIENCE STUDENT AT THE UNIVERSITY OF SOUTHAMPTON, HAS DONE A ONE-YEAR INTERNSHIP

What has been your greatest challenge on the internship?

Familiarising myself with new software (or improving my existing skills). My naval architecture degree prepared me well in terms of engineering theory, but the software skills taught, particularly in 2D and 3D draughting, were not up to industry standards, so I had a lot to learn.

What was the most satisfying project?

The highlight of the year was being able to support a weight survey for an inbuild 80m motor yacht, which included preparing the survey documents, carrying out the survey

itself, and post-processing to determine any weight changes from the expected values. It was an amazing opportunity to gain some practical experience, look around a ship still fitting out and physically see the results of the company's work.

What was the most surprising aspect?

The opportunities available, such as being able to work on a huge range of projects from CFD to AIS research to a study on using machine learning to predict scantlings. I also visited MARIN and Oceanco, which I didn't expect from a year-long placement, and these were absolute highlights of my time at Lateral.

What skill do you now have that you didn't know you'd need?

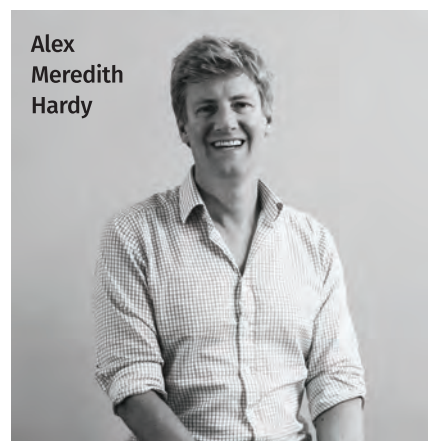
Dealing with legacy code was a far

greater challenge than I expected, especially if it was poorly documented and integrated with other tools and processes. Writing your own code is far easier than picking up the pieces from someone else, and I spent much time deciphering various Python, VBA and Grasshopper scripts to update or improve existing tools.

What's your advice to other students?

Try to absorb as much knowledge as possible. Listen out for office chatter, speak to teams outside your own, learn what typically 'bottlenecks' deliverables and familiarise yourself with the company's old projects. Also, stay proactive and always enquire about anything that interests you. You may end up creating new opportunities for yourself that your manager or company had not thought of.

ALEX MEREDITH HARDY IS LATERAL'S CHIEF NAVAL ARCHITECT



What does Lateral get from running the programme?

The hope is always that you select interns with enthusiasm, fresh perspective and an open mind, who can bring new ideas to the table. Ideally, they know just enough theory to understand our company design processes but are not set in their ways and so can help shape and optimise our design tools and processes. This is where we focus their efforts – not in doing our day-to-day work, but more on how to make our day-to-day work better and more efficient.

What should an intern be capable of by the end of the year?

Typically after a good one-year internship, saying goodbye can be



Nuala chose Lateral because of its reputation as a leader in the superyacht industry

quite painful. The candidates have become integral, valuable employees churning out valuable outcomes in research and development. Through their exposure to the design process, the contacts they made across our company disciplines, and the opportunities to visit shipyards and testing facilities, they are capable of seeing how the industry really works. This allows them to return to university with a fresh, realistic and up-to-date perspective, and hopefully a clearer view of where they may wish to join it after they graduate.

How has the skillset you look for changed?

We have always looked for self-starting, enthusiastic and communicative intern candidates. Not being at the top of the day's priority list can be a difficult reality to navigate if you don't have the right skills to get what you need out of the situation. More recently we have seen candidates coming with more advanced knowledge of programming skills and AI opportunities. Both of these areas are very relevant for improving Lateral's workflow, which is the primary focus of our internship programme.

What could government do to support companies like Lateral?

Our internship programme is closely aligned to the company's priorities and ethos. We recognise the value employing interns brings to our business while giving them meaningful experience and an opportunity to build their careers.

We see this as a mutually beneficial investment, with the additional potential for interns to return as employees and continue contributing to the company. We do see a constraint in the typical naval architecture course configuration, which requires students to take a gap year and can see merit in supporting the year in industry approach which is encouraged in other engineering disciplines.

What's your advice to other companies considering an intern programme?

Try it! As with most ventures it will need to evolve, and the more you invest in it, the more you will get out. Allocating enough time to select the right intern, support them in their role and create successful outcomes isn't easy. The business needs to have enough 'headroom' to support these activities but, once developed, the outcomes can be very positive.

NUALA SELLWOOD IS A NEW INTERN WITH LATERAL WHILE STUDYING MARINE ENGINEERING AT THE UNIVERSITY OF SOUTHAMPTON

Why did you choose Lateral?

Because of its reputation as one of the leaders in the superyacht industry, particularly in innovative and technically challenging projects. At university, most of my experience has focused on more conventional commercial ship design, so this placement gives me the opportunity to explore a part of naval architecture

that I would otherwise have relatively little exposure to.

What do you see as the greatest challenge ahead?

Learning to see the vessel as a complete system. At university, subjects such as structures, hydrodynamics and stability are often taught separately, whereas in a real design a decision in one area can have consequences across the whole yacht. Developing an understanding of those interactions, particularly at an early design stage, is something I am looking forward to.

Where do you see yourself in five years from now?

I would like to be working as a naval architect on technically interesting projects. I am particularly interested in performance, hydrodynamics and developing more efficient vessels, so I would like to build experience in those areas. I'm also hoping this placement helps me work out what aspects of naval architecture I enjoy.

What would count as success by the end of the year?

I would like to return to university with a much stronger understanding of how the theory I have learned is applied in practice. If I finish the placement more confident in my engineering judgement, with improved technical skills and a clearer idea of the naval architect I would like to become, I would consider the year a success.



James Baines and Nuala Sellwood

PROFESSIONAL DEVELOPMENT

ADVANCE YOUR SKILLS WITH RINA RESOURCES

Broaden your horizons with a broad range of activities designed to keep your career on track

RINA supports members' continuing professional development (CPD) through a range of resources, including branch lectures, on-demand webinar recordings, conference session recordings and papers, specialist technical newsletters and *The Naval Architect* magazine. Together, these help members keep pace with developments across naval architecture and maritime engineering, while also providing the evidence members need to record and demonstrate their ongoing professional development.

RINA also provides a wider library of eLearning courses, covering the practical business, safety and personal development skills that complement day-to-day naval architecture and maritime engineering work.

Spanning more than 100 courses across four broad areas: health and safety, business skills, people and inclusion, and mental health and wellbeing, this eLearning offer gives maritime professionals a flexible way to build capability outside their core technical expertise, whether that

means managing a team, adapting to new technology or supporting colleagues' wellbeing.

As with RINA's other learning activities, time spent on these courses can be recorded as part of CPD, supporting the systematic maintenance and broadening of skills expected of all fellows, members and associate members throughout their careers.



HEALTH AND SAFETY

Courses in this area build practical workplace knowledge, covering core topics such as fire safety, working at height and manual handling, alongside more specialist areas including asbestos awareness, legionella management and lone worker safety. Cyber security and environmental awareness also feature, from introductory overviews through to more advanced topics, alongside site-specific courses such as CSCS Green Card preparation.



SKILLS FOR BUSINESS

This strand builds capability in leadership, management and communication, from front-line

manager skills and project management through to negotiation and presentation skills. A growing number of courses address artificial intelligence, covering everything from the basics to prompt engineering and ethical considerations, alongside digital marketing and governance topics such as GDPR and anti-bribery and corruption.



PEOPLE, INCLUSION AND DEVELOPMENT

Courses here explore workplace conduct and inclusion, including equality and diversity, disability and neurodiversity awareness, and anti-harassment training, alongside broader people-management topics, such as conflict resolution, employee relations and personal development. Together, these support members working in supervisory roles as well as those building more inclusive teams.



MENTAL HEALTH AND WELLBEING

This area builds awareness and confidence around mental health, from first aid and stress management through to guidance for managers on implementing workplace wellbeing policies and supporting occupational health. Courses also cover emotional intelligence and approaches to supervising mental health at work, reflecting a growing emphasis on wellbeing alongside more traditional workplace skills.

These courses sit alongside RINA's existing knowledge-sharing activities, from branch lectures and on-demand recordings to the technical content in *The Naval Architect*, as part of members' wider professional development. This combination of resources is designed to reflect members' different roles, goals and areas of interest as they progress through their careers. The eLearning courses are available to logged-in members at preferential rates.

Explore the full course offering at rina.org.uk/Learning, or visit rina.org.uk/CPD for further guidance on what counts towards CPD and how to record your learning activities as part of your ongoing professional development.



Stay on course with
RINA resources

HOW IT'S CHANGED

FIFTY NOT OUT

Dr Robin Loscombe has been a RINA member for 50 years, moving between shipyards, consultancy, classification and academia. Here, he reflects on what's changed

It was always going to be aero or naval engineering, and naval won.

My A-level physics project involved a home-made towing tank, and I bought my first ever textbook, Barnaby's *Basic Naval Architecture*. I still have it. I was hooked, and in 1973 I headed north to Newcastle to read for my BSc.

My first job, at Richards Shipbuilders in Lowestoft, was the right decision. Universities do a great job, but it's only when theory meets practice that you really start to get to grips with naval architecture as a discipline. There was a lot less retiring to the design office to spend three hours on a calculation, and more back-of-an-envelope work done on the spot. The inclining experiment that had worked so brilliantly in the lab threw up all sorts of challenges when I did it for real.

In 1976, plenty of small yards were happy to take a chance on a fresh graduate, and there were fewer graduates chasing that kind of work. Things aren't so easy now, and I think the biggest challenge for a recent graduate is that a remote design office, where you design it here and build it 500 miles away, can look a little too similar to the computing lab at university. My suggestion is to draw it, see it for real if you possibly can and maybe rethink it for next time.

That early spread across yard, consultancy and classification society, at Keel Marine consultants and then Lloyd's Register of Shipping, set the pattern for a career that kept moving between practice and theory. I joined RINA as a junior member in 1976, became a full member and Chartered Engineer in 1981, and a Fellow in 1999. Membership has given my career a framework – milestones might be the better word – and I can't imagine my career without it. I'd also mention the transactions archive, which is brilliant. I've been researching Victorian-era

ships, work that would have been almost impossible without access to papers from the 1860s. It's fascinating, and humbling, to read the actual words of the great names of the past.

Thirty years teaching naval architecture and small craft design at Southampton Institute and Solent University, from 1983 to 2014, gave me a front-row seat on how the discipline has changed, at least for a typical small design office of five to ten staff. In 1983, a complex problem meant a choice between relatively simple formulae or model testing, and getting an answer meant knowing the underlying theory as well as having a bit of practical experience.

In 2026, even very small offices can analyse almost anything with user-friendly FEA and CFD. That's good in one sense, and bad in another, because these packages are black boxes to most of us, and only practical because they're getting increasingly easy to use. I've seen FEA run by people without the faintest idea of

“DRAW IT, SEE IT FOR REAL IF YOU POSSIBLY CAN AND RETHINK IT FOR NEXT TIME”



Robin checking the armour plate thickness of HMS Warrior (1860) at Portsmouth dockyard as part of a study of Victorian-era warships

beam theory. Someone once told me the biggest bug in the system is the one sitting in front of the screen. Whether AI helps or hinders that, I'm glad it's not my problem.

I did my MSc and PhD part-time while working, taking two years and nearly six years respectively, and I'd tell anyone considering the same to ask themselves whether they can really manage 17 to 20 hours a week, on average, for six to eight years, whether there's a subject they care about enough to sustain that, and whether it's genuinely about the subject or just the idea of the title.

Teaching and consulting especially developing ISO-12215 and working with a RCD-Notified Body (the RYA), gave me something neither role alone would have. Teaching keeps fundamental theory at the front of your mind, and consultancy fine-tunes those methods into real-world answers to real-world problems.

I've also served on RINA's SJB and PAC committees, the latter taking part in IEng and CEng accreditation panels, work I found genuinely interesting. No committees means no RINA, or at least a very different RINA. I felt I owed the Institution my time. My advice to others is: give it a go.

JOURNEY OF A LIFETIME

The scope of the maritime industry is vast with a wide range of career paths to follow. Let RINA help you chart the best course for you

CAREER PATHS	 TECHNICAL DESIGN & ENGINEERING	 PROJECT MANAGEMENT	 OFFSHORE INFRASTRUCTURE
			
 EXECUTIVE SHAPE THE FUTURE	Chief engineer/CTO Design authority and technical strategy	Programme director Portfolio leadership and strategic oversight	Asset director Offshore assets and infrastructure leadership
 SENIOR CAREER LEAD & INFLUENCE	Lead designer Lead complex designs and provide technical assurance	Project manager Manage major projects and teams	Project manager Offshore projects and execution leadership
 MID CAREER DELIVER & IMPACT	Engineer Develop designs and solve complex technical problems	Project engineer/planner Plan, coordinate and control projects	Project engineer Support project delivery and site execution
 EARLY CAREER DEVELOP & GROW	Graduate engineer Apply engineering knowledge and support projects	Assistant engineer/coordinator Support planning and coordination	Site engineer Support site activities and data collection
 ENTRY ROLES START YOUR JOURNEY	Engineer trainee Learn, assist and build technical competence	Project support assistant Provide admin and project support	Site support assistant Support logistics and field activities
 ENTRY ROUTES DISCOVER YOUR PATH	<ul style="list-style-type: none">• Naval architecture• Marine engineering• Mechanical engineering• Ocean engineering	<ul style="list-style-type: none">• Engineering• Management• Construction• Project management	<ul style="list-style-type: none">• Offshore engineering• Civil engineering• Geoscience• Environmental science

Our members' careers are as varied as the maritime world itself. From those taking their first steps into the profession to those shaping its future, our ambition is for RINA to be where every member can find the support, connections and opportunities they need to thrive.

This career map is helping us bring that ambition to life. It provides a framework for connecting our growing range of learning and development/CPD, mentoring, technical knowledge, professional recognition, events and career opportunities, making it easier for members to discover

what is relevant to them and what might come next. Behind each pathway and career stage sits the skills, knowledge and experience needed to develop and progress. We are working on how to connect these requirements to practical support, recognising that careers are rarely straight lines.

As members mature, we then want to create more opportunities to share their experience, mentor others and contribute to the profession, helping each generation support the next and recognise their impact.

PAUL JOBSON, CEO, RINA; PJOBSON@RINA.ORG.UK

 TECHNOLOGY & INNOVATION	 OPERATIONS	 REGULATION & POLICY	 ACADEMIC & RESEARCH
			
Chief innovation/technology officer Drive innovation and digital transformation	Operations director Fleet and operations leadership	Policy director Shape global standards and regulation	Research director Lead research strategy and impact
Senior engineer/specialist Lead advanced technology solutions	Fleet/operations manager Manage vessels, crews and performance	Senior surveyor/specialist Lead compliance and technical assessments	Principal researcher Lead research programmes and collaborations
Engineer/analyst Develop digital tools, systems and innovation	Operations officer Oversee operations and ensure safe, efficient delivery	Surveyor Carry out surveys and ensure compliance	Research engineer Conduct studies and analyse data
Junior engineer Support R&D, testing and modelling	Junior officer Support vessel operations and administration	Junior surveyor Assist with surveys and certification	Research assistant Support experiments, testing and data analysis
Technical assistant Support labs, testing and data	Cadet/trainee officer Learn operations and seamanship	Surveyor trainee Learn survey processes and standards	Lab/research assistant Support lab work and experiments
<ul style="list-style-type: none"> • Engineering • Computer science • Data science • Innovation and design 	<ul style="list-style-type: none"> • Nautical science • Marine engineering • Logistics • Operations 	<ul style="list-style-type: none"> • Engineering • Maritime law • Policy • Environmental science 	<ul style="list-style-type: none"> • Engineering • Science • Mathematics • Research methods



THE BIG QUESTIONS

Poole Harbour

BOB CRIPPS



With a degree in Ship Science from the University of Southampton, Bob Cripps FRINA has worked at Lloyd's Register, the RNLI, VT Halmatic, BAE Systems and Longitude Engineering. He is now a director at RMC Projects, Manor Marine and a non-exec director at Chartwell Marine. He was vice chair and Trustee on the RINA Board and currently chairs the RINA Maritime Innovation Committee

Why did you choose naval architecture?

My grandparents lived in Portsmouth, and I stayed with them during the holidays, watching liners such as the *Queen Mary*, *Queen Elizabeth* and the *United States* sail up the Solent to Southampton. I also went to Navy Days in Portsmouth Dockyard with my grandfather, who had worked there, and that is where my fascination with ships and boats began. A degree in Ship Science at Southampton felt like a logical step, and a year in a small boat consultancy proved invaluable.

What did 11 years at Lloyd's Register teach you?

The importance of a classification society, and the need to check the detail and safety implications of a design, in plan approval, surveys and new design work.

What kept you at the RNLI for 18 years?

It was probably the best job a naval architect could have. I had a unique opportunity to transform the RNLI fleet for the 21st century. When I joined, they were building 8knot wooden lifeboats, and 18 years later, 25knot lifeboats in advanced composites. We also developed the A85 rigid inflatable, the D class inflatable lifeboat, the hovercraft, and launch and recovery equipment. Developing these from scratch meant building an engineering

team around a systems-based philosophy. I remember early on being asked what I did, and when I said "naval architect", the reply was, "Oh, you draw pretty pictures". Hopefully the engineering we produced dispelled that, and trying to achieve it is what kept me there so long.

What carried over into naval and commercial work?

Safety features, particularly self-righting design, nerve-racking to trial when you did the calculations, and an in-depth knowledge of advanced composite structures.

What does the industry get right (or wrong) in training naval architects?

It gives good technical exposure and real-world pressure, but often lacks structured development, mentorship and broader systems thinking, since most programmes are specific to one organisation. Training should not stop after the initial programme – it should be a lifelong continuum.

What did you learn chairing Poole Harbour Commissioners?

A greater understanding of the wider issues facing the port sector, especially chairing through the COVID pandemic, when restrictions hit hard with no ferry passengers and few ships calling. It showed the resilience of the port and its staff, and broadened my

appreciation of the opportunities for naval architects in the sector.

Which job changed the way you think about ships most?

The RNLI, designing boats for crews who go to sea when everyone else is in port. I've learned something in every role, though, and I'm still learning.

What excites you most about your current roles?

Though formally retired, I remain involved with a shipyard, a design company and RINA. What excites me most is talking with and supporting young naval architects and engineers and, as chair of the RINA Maritime Innovation Committee, working on new technology.

LEARNING POINTS

MY NAVAL ARCHITECT MOTTO

Never forget the past and learn from your mistakes.

ADVICE FOR A GRADUATE

Be true to yourself and do what you enjoy. Being a naval architect provides the opportunity to have a varied and enjoyable career.

BOTTOM LINE

Try to get practical experience as well as a qualification.

YOUR CAREER IN MARITIME

STARTS BEFORE YOUR FIRST JOB

STUDENT

MEMBERSHIP

Open to undergraduate students preparing for a career in the maritime sector. vocational routes..

FREE THROUGHOUT YOUR STUDIES

GRADUATE

MEMBERSHIP

Open to recent graduates, whether or not you were previously a RINA Student Member.

FREE FOR UP TO TWO YEARS AFTER GRADUATION



THE ROYAL
INSTITUTION
OF NAVAL
ARCHITECTS

RINA offers **free membership** for students and recent graduates, giving you early access to the professional community, technical knowledge, mentoring and networks that can support your next steps.

Join RINA from the start

rina.org.uk/Become-a-Member



Save 1-3% propulsion power*

Looking for more efficiency gains?
Neuver steering gears are a fuel saver
across your fleet. We deliver steering
gears and rudders for safe and efficient
maneuvering at sea.

*Read the article to learn more about dependencies.

The illustration above visualizes deadband:
Neuver Rotary Vane (blue) versus other steering gears (red).

neuver.com



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