ALTERNATIVE FUELS | SAFETY | HYDRODYNAMICS | DIGITALISATION

# THE NAVAL ARCHITECT

MARCH/APRIL 2026

**Safety first**
BMT on the technical challenges of low-carbon fuels (see pp34-36)


**TECH TONIC**
How AI will enable next-gen shipbuilding

**ENERGY SAVERS**
Is efficiency the real transitional fuel?

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*MPA Guardian*, a 35m hybrid-electric patrol and emergency response vessel, designed by BMT and built by Penguin International Limited for the Maritime and Port Authority of Singapore. It embodies the safety-first approach to alternative fuels championed by Dr Thomas Beard (BMT).
Photo: Maritime and Port Authority of Singapore

# THE NAVAL ARCHITECT

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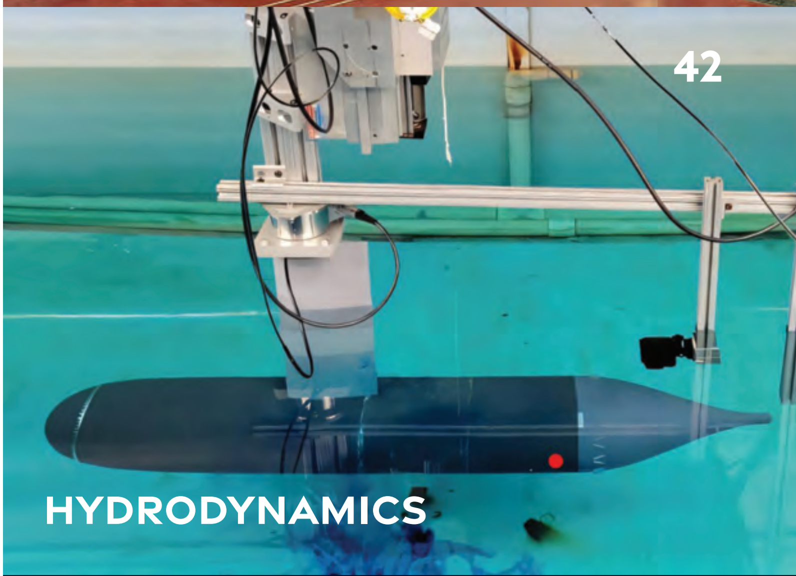

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# RINA ANNUAL DINNER 2026

## RINA Prestigious Annual Networking Dinner in the heart of Covent Garden

The RINA Annual Dinner returns on 28th May 2026, bringing together professionals from across the global maritime sector for an evening of conversation, connection, and celebration. Held at the historic De Vere Grand Connaught Rooms in Covent Garden, London, the event is a long-standing tradition in the Institution's calendar and a highlight for those working in naval architecture and maritime engineering.

With guests from industry, academia, defence, and beyond, the dinner offers a valuable opportunity to engage with colleagues in a relaxed and sociable setting. Whether renewing old contacts or making new ones, the evening is a chance to reflect on shared challenges, exchange ideas, and build relationships that continue long after the event.

For anyone in the maritime world, this is an evening not to be missed. Register your interest now and join us in celebrating the achievements, innovation, and people driving the industry forward.

28th May 2026
London, UK

THE ROYAL INSTITUTION OF NAVAL ARCHITECTS

# ADVANCING INNOVATION, COLLABORATION AND KNOWLEDGE-SHARING

Welcome to the latest edition of *The Naval Architect*. Eight months into my tenure as CEO, my initial focus has been on strengthening RINA's foundations and accelerating delivery of the strategic changes required for our next exciting phase, outlined below. I'm just the latest in a long line of custodians of RINA, building on what generations before us created, with a clear responsibility to ensure the Institution is stronger for our current members and those who follow.

At 166 years old, RINA is the longest-standing maritime engineering and naval architecture institution in the world. My ambition is to return RINA to its unique position as the global Learned Society, safeguarding the rightful place of the naval architects and maritime engineers at the very heart of critical global conversations on marine technology, innovation and development. We are also widening participation and inclusion across all associated professions to advance innovation. We recognise that the challenges facing our sector require collaboration across disciplines such as design, operations, regulation, finance and technology.

With members in more than 140 countries, RINA has extraordinary global reach and expertise. Our task now is to connect that expertise more effectively through the technical excellence of our conferences, publications and other structured collaboration. The following is just some of what we are doing.

Our digital library is being rebuilt, making the entire 166-year archive of journals, articles, conference proceedings, magazines, papers and other materials accessible for free to all members. Later this year, we will introduce an AI-powered search function.

We have introduced a 'Find a Member' capability, enabling members and employers to identify expertise, verify credentials and connect directly for collaboration, projects and professional engagement. It's coming very shortly for our corporate partners too.

We have added new newsletters to our portfolio, which members can subscribe to in MyRINA.

In April, we are launching an innovative mentoring scheme, with every mentor and mentee individually matched. More than 10% of RINA members have indicated that they want to be involved, which demonstrates the depth of commitment within our membership. If you have put your name forward, you will be hearing from us very soon. If you haven't done so yet, and would like to, this is available in your MyRINA area.

We are establishing structured digital forums for branches and committees, enabling international discussion without barriers of time or geography. Follow us on LinkedIn for forum announcements and updates over the coming weeks.

New technical working groups will address the defining issues of our industry, with findings made available to members via our digital library.

And every event, wherever it takes place in the world, will be recorded and made available to all members to watch in their own time. We are here to advance innovation, promote collaboration and make all the knowledge generated within RINA accessible to the entire membership.

These initiatives are being delivered by a strengthened executive team focused on operational excellence and effective communication.

RINA's strength is its members. I encourage every member to engage actively with our resources, forums and events. Follow us on LinkedIn to join the conversation. Sign up to our newsletters to stay informed. Get involved in a working group. Be active in our forums. Come forward to mentor or be mentored. Attend an event. And if you know someone who belongs in this community, bring them in. A stronger, more connected Institution depends on the participation of its members.

This edition of *The Naval Architect* is looking at alternative fuels and vital decarbonisation work taking place. We have included content from our sold-out Wind Propulsion Conference 2026. If you are interested in more detail, proceedings and recordings are available in your MyRINA area. This magazine also features a professional profile of Edwin Pang, RINA trustee and chair of our IMO Committee.

We will continue to evolve *The Naval Architect* to anticipate the technical needs of our members and feature top talent. The next issue will benefit from a redesign and the introduction of a Technical Panel to support the editorial team. Please get in touch via publications@rina.org.uk to share your news and insights. I hope you find this edition informative and thought-provoking. ■

**Paul Jobson**, CEO

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ENERGY TRANSITION

# CHINA MOVES FAST WITH GREEN FUEL AMBITIONS

China is moving with unusual institutional weight to position itself at the centre of the global maritime energy transition. A blueprint backed by 10 central government ministries has set Shanghai on course to become a leading green bunkering hub by 2030. It is targeting one million cubic metres of bonded LNG capacity and one million tonnes of methanol and biofuel bunkering, a 'double-million' ambition that signals Beijing views this not as a commercial experiment but as strategic infrastructure.

The scale of state coordination is interesting. It is rare for 10 central agencies to jointly back a single city's initiative, and the involvement of the National Development and Reform Commission alongside the Ministry of Transport suggests that this is being treated as industrial policy in the same register as semiconductors or electric vehicles.

Shanghai already leads Singapore in green methanol bunkering and recorded a 54% increase in bonded LNG bunkering volumes in 2025, but trails the city-state in overall LNG supply, a gap this plan is specifically designed to close.

Infrastructure investment will concentrate on Yangshan Port, Hengsha Island, the Yangtze River estuary and the Shanghai Chemical Industry Park, covering the full supply chain from production and storage through to bunkering vessels and onshore power equipment.

Operationally, Shanghai already offers a 50% discount on berthing fees for vessels using alternative fuels, piloting night-time bunkering at Yangshan, and promoting simultaneous cargo and bunkering operations to reduce turnaround times, the kind of practical competitive measures that erode Singapore's incumbency advantage gradually rather than dramatically.


HAROPA PORT is set to be part of a green corridor (Image: ©HAROPA PORT/Samuel Salamagnon)

The trading ambition is equally significant. Shanghai intends to establish a green fuel spot market, introduce futures trading and financial derivatives, and develop internationally recognised price indices for green marine fuels. If successful, that would shift pricing power over the emerging alternative fuels market eastward in a way that has implications well beyond port competition.

It is against this backdrop that a new agreement has been signed to develop a green shipping corridor between French HAROPA PORT Seine Axis and Ningbo Zhoushan, China, the world's largest port by cargo tonnage. With MSC, CMA CGM, Terminal Investment Limited and Bureau Veritas among the signatories, the corridor commits carriers on one of the world's highest-volume container routes to developing alternative fuel supply chains spanning LNG, bio-LNG, green ammonia and green hydrogen. China accounts for 30% of HAROPA PORT's container throughput, making this a route with the frequency and commercial density to actually stress-test infrastructure at scale.

The green corridor is a credible mechanism to address the chronic chicken-and-egg problem that has stalled maritime decarbonisation – shipowners unwilling to order alternative-fuel vessels without bunkering certainty, port operators unwilling to invest without confirmed demand.

Formalising mutual commitment across the supply chain simultaneously is more likely to break that impasse than waiting for either side to move first.

Ammonia and hydrogen feature in the corridor's ambitions but remain pilot territory rather than near-term operational commitments. LNG and methanol will carry the early years. But taken together, Shanghai's state-backed hub plan and this first intercontinental green corridor represent the most coherent and commercially grounded push yet to move maritime decarbonisation from aspiration to infrastructure.

These infrastructure commitments carry instant design consequences. Every fuel on the approved list demands fundamentally different tank arrangements, containment materials and safety zone configurations.

The corridor also sharpens the case for genuine multi-fuel capability rather than dual-fuel compromises. If LNG and methanol infrastructure consolidates on this route within the decade, designers will face pressure to specify vessels capable of both without significant payload or stability penalties, a tougher engineering problem than it sounds. ■

APPOINTMENTS

# UK NAMES NEW MARINE ACCIDENTS CHIEF

The UK's Marine Accident Investigation Branch (MAIB) has appointed Rob Loder as its new chief inspector of marine accidents, succeeding Andrew Moll OBE, who retired earlier this month after 21 years at the organisation.

Loder's career began at sea: after training in heavy engineering ashore, he joined the Merchant Navy, completed a rating to officer conversion course, and rose to chief engineer across a varied fleet, including oil tankers, cable ships, ferries and superyachts. He subsequently moved into fleet management, ship repair, ship build supervision and project management before a period of industry consultancy.

His experience spans design-adjacent disciplines such as ship-build supervision and project management alongside deep operational knowledge. Loder joined MAIB in 2020 as an inspector, progressing to principal inspector and then deputy chief inspector before his current appointment. He is a chartered engineer, marine engineer and Fellow of IMarEST.

Headquartered in Southampton, MAIB was established in 1989 following a recommendation from the public inquiry into the *Herald of Free Enterprise* disaster in 1987, when a ro-ro passenger ferry capsized off Zeebrugge with the loss of 193 lives. It is authorised to investigate all maritime accidents in UK waters and accidents involving UK-registered ships worldwide.

In 2024, MAIB recorded 1,631 reports of accidents involving UK vessels worldwide or vessels within UK coastal waters, with 1,753 vessels involved.

Loder said: "Working alongside the outstanding MAIB team, I am committed to ensuring our work continues to drive meaningful improvements in safety across the maritime sector." ■

LNG BUNKERING

# WÄRTSILÄ WINS LNG CONTRACT FROM CHINESE SHIPBUILDER

Wärtsilä Gas Solutions has been awarded a contract to supply cargo handling and fuel gas supply systems for two new LNG bunkering vessels currently under construction at Zhejiang Xinle Shipbuilding in China.

The vessels, each with a capacity of 20,000m$^3$, will be owned by a Hong Kong-based shipowner. The order was booked in Q4 2025 and reinforces Wärtsilä Gas Solutions' position as a leading systems integrator for small-scale LNG applications.

The contract covers a comprehensive systems package including LNG cargo handling and fuel gas supply equipment, full system engineering and design, and integrated control and monitoring of all cargo handling operations. This level of systems integration is critical in bunkering vessel design, where operational reliability and safety margins are paramount.

"The use of LNG is key in enabling a green shipping future," said Barry Yang, general manager of sales China at Wärtsilä Gas Solutions, adding that the systems offer a flexible and proven solution supporting operational efficiency for vessels bunkering LNG-fuelled ships.

The vessels will fill an increasingly important role in the marine energy transition. LNG continues to be adopted as a bridging fuel between conventional diesel and future zero-carbon alternatives, driving demand for purpose-built bunkering infrastructure.

**Zhejiang Xinle shipyard in Ningbo, Zhejiang, China**

Equipment delivery to the Zhejiang Xinle yard is scheduled to commence in Q4 2026, with both vessels expected to enter service during the latter half of 2027.

The number of LNG-fuelled ships in operation doubled between 2021 and 2024, with a record number of deliveries (169) in 2024, according to DNV, a Norway-based independent assurance and risk management provider. By the end of last year, 641 LNG-powered ships were in operation. According to the orderbook, this number is expected to double by the end of the decade.

While the bunkering infrastructure for some alternative fuels remains underdeveloped, DNV said LNG bunkering is maturing, adding that the significant gap between LNG bunkering supply and demand is expected to widen over the next five years based on the orderbook. ■


The AirWing unit onboard *Vectis Progress* has worked well in various conditions

WIND PROPULSION

# LLOYD'S REGISTER VALIDATES GT WINGS' WIND PROPULSION SEA TRIALS PERFORMANCE ASSESSMENT METHODOLOGY

Lloyd's Register has verified the sea trials performance assessment methodology used by GT Wings for its AirWing Jet Sail system. This provides an independent stamp of approval for the way the company measures fuel and emissions savings from its wind-assisted propulsion technology.

Announced at RINA's Wind Propulsion Conference, the verification follows nearly 10 months of commercial operation of a 20m AirWing unit onboard *Vectis Progress*, a general cargo vessel operated by Carisbrooke Shipping. Installed in March 2025, the system has accumulated service experience across various routes and conditions, including North Atlantic winter passages, Great Lakes transits and Caribbean voyages.

Lloyd's Register confirmed that GT Wings' methodology aligns with recognised industry standards, including ISO 19030, and ITTC performance analysis practices, and that the approach used to isolate and quantify wind propulsion benefits is technically sound for in-service evaluation.

Andrew Hurford, senior specialist at Lloyd's Register, said that independent verification of such methodologies is essential to building confidence in emerging maritime technologies.

As wind-assisted propulsion moves towards broader commercial adoption, the ability to demonstrate performance through independently verified, standardised methods is increasingly important for shipowners, charterers and project financiers weighing the business case for such systems. GT Wings said that data collection and analysis from *Vectis Progress* will continue as part of its ongoing validation programme.

Liam Campbell, chief commercial officer at GT Wings, said: "From the start, our vision has been to drive the transition through measurable, data-driven performance. Lloyd's Register's verification confirms our alignment with international standards and validates that our performance predictions are grounded in real-world evidence. It is an important step toward scaling wind-assisted propulsion across global shipping and strengthening confidence in this technology as a viable pathway to reducing carbon emissions."

# WARSHIP 2026 SUBMARINES

## Accelerating Underwater Capability through Collaboration

Warship 2026 Submarines brings together international experts in naval design, engineering, and innovation. The conference will focus on accelerating underwater capability through collaboration, exploring technical developments, fleet management strategies, and advanced systems shaping the future of submarines.

The event attracts defence professionals, industry specialists, academics, and technology experts. Delegates will hear from leading speakers, join technical discussions, and connect with fellow professionals from around the world.

**Why Attend**

Warship 2026 Submarines offers a unique opportunity to engage with the forefront of naval innovation:

- Discover the latest technologies and strategies for submarines and underwater capability
- Join expert-led discussions on fleet development, collaboration, and innovation
- Connect with defence, industry, and academic leaders worldwide
- Gain insights into trends shaping the future of naval capability

**Topics (including but not limited to):**

- Technology Insertion
- International fleet management
- Collaborative procurement
- Application of Intelligent Systems / Lean Crewing Considerations
- Design for Availability
- Digitalisation in Submarines
- Driving down through life cost
- Human-Autonomy Teaming and Human Factors Considerations in Design
- Innovative power systems and energy storage
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- Streamlining build processes. Reduction of time and cost
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- Sustainability
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CAR AND TRUCK CARRIER

# GRIMALDI ADDS *GRANDE MICHIGAN* TO AMMONIA-READY CARRIER FLEET


***Grande Michigan*** **can carry 9,000 car equivalent units**

The Grimaldi Group has taken delivery of *Grande Michigan*, the eighth ammonia-ready pure car and truck carrier (PCTC) in its fleet, from China Merchants Heavy Industries Jiangsu. Built to 220m in length with a beam of 38m, a gross tonnage of 93,145 and a service speed of 18knots, the vessel continues a fleet renewal programme that has established Grimaldi as one of the more technically progressive operators in the automotive shipping sector.

Across its 14 decks, *Grande Michigan* has a maximum capacity of 9,000 car equivalent units, with stowage arrangements capable of accommodating battery electric vehicles alongside those running on conventional fuels, a flexibility that has become a commercial requirement as the automotive sector's transition to electrification continues at uneven pace across different markets.

The vessel is fitted with a gate rudder, a configuration first introduced to the PCTC sector on *Grande Shanghai*, the lead vessel of this series, delivered in July 2025, and now standard across the class. Developed originally by Kuribayashi Steamship in Japan and licensed globally by Wärtsilä, the arrangement positions two foil-shaped blades symmetrically either side of the propeller centreline. It functions simultaneously as a post-swirl energy recovery device, capturing rotational energy from the propeller slipstream that would otherwise be lost, and as a conventional steering system, with the claimed benefit of improved low-speed manoeuvrability at the automotive terminals at which the vessel will regularly call.

Grimaldi claims a 50% reduction in fuel consumption compared with earlier-generation car carriers, attributing the figure to a package of efficiency measures. These include an air lubrication system reducing frictional resistance at the hull-water interface, a silicone-based foul-release hull coating, and 2,500m$^2$ of solar panels across the upper decks. Smart building management systems govern ventilation and air conditioning loads to reduce hotel power demand. The 50% figure is presented without a defined baseline vessel or operational condition and should be read as a comparative design estimate rather than a demonstrated in-service figure.

The main engine is electronically controlled and fitted with an exhaust gas cleaning system to limit sulphur oxide and particulate matter output. Selective catalytic reduction maintains nitrogen oxide emissions below IMO Tier III limits.

A lithium-ion battery energy storage system with a combined capacity of 5MWh supports onboard power management. The vessel is also fitted for cold ironing, enabling zero-emission port operations wherever shore power infrastructure is available, a capability of growing relevance as EU regulations extend onshore power supply obligations at European terminals.

*Grande Michigan* has received the Ammonia Ready notation from Italian classification society RINA, confirming that her structural arrangements, piping routing, ventilation provisions, and safety systems have been designed to facilitate future conversion to ammonia-fuelled propulsion without major structural intervention. The notation reflects the industry's broader effort to preserve conversion optionality on newbuilds, given the current immaturity of ammonia bunkering infrastructure and the unresolved challenges surrounding the fuel's toxicity in a shipboard environment.

Additional RINA notations include Green Plus, Green Star 3, Comfort Vibration, and Comfort Noise Port. The Comfort notations address habitability standards, a consideration of some weight on a vessel that will operate on a continuous deep-sea rotation.

*Grande Michigan* departed on her maiden voyage from Taicang, China, the commercial loading port proximate to the CMHI Jiangsu yard, carrying more than 7,000 cars and vans alongside more than 100 rolling units including heavy vehicles, MAFI trailers, and project cargo, bound for Mediterranean ports on Grimaldi's Asia–Europe service.

The delivery extends a newbuild programme that has seen Grimaldi take eight ammonia-ready PCTCs in relatively quick succession. Whether the efficiency package's cumulative gains can be validated under operational conditions across varied load factors and seasonal routing will be of material interest to competitors and the wider automotive logistics market. ■

A packed audience at Convene 133 Houndsditch

# WIND PROPULSION 2026: MOMENTUM MEETS METHOD

RINA's conference brought together industry leaders to examine how wind propulsion technologies are moving from concept to fleet-level implementation. **Tom Barlow-Brown** reports

"Wind propulsion technologies are the only solution that actually pay for themselves," said Gavin Allwright, secretary general of the International Windship Association (IWSA), during his keynote speech at Wind Propulsion 2026. The statement captured the commercial logic increasingly underpinning wind propulsion technologies.

Held on 17–18 February at Convene 133 Houndsditch in London, the conference opened to a sold-out audience, a clear sign of the growing centrality of wind propulsion within maritime decarbonisation strategy.

Hosted by RINA in association with the IWSA, the event continues to serve as an important early-year marker in the decarbonisation calendar, setting context ahead of further debate at gatherings such as RINA's Ship Energy Efficiency Conference in Athens.

Gold sponsorship came from DNV, with silver sponsors including Lloyd's Register and Vaisala, underscoring the degree to which wind propulsion is now embedded within mainstream classification, verification and risk management frameworks. Bronze sponsorship was provide by Mitsui O.S.K. Lines.

## Still optimistic

An underlying theme on the first day of the conference was the industry's response to the recent impasse at the latest IMO MEPC meeting. Conference attendees remain optimistic that it would not prevent wind-propulsion technology from developing apace, despite a hoped-for consensus on mid-term greenhouse gas measures not being reached in 2025.

In one of the conference's opening speeches, Aakash Dua, regional business development director at DNV, framed the broader challenge that new fuels and technologies are introducing uncertainty into the system, but that also provides new opportunities to evolve. Decarbonisation, he argued, is not a "chicken and egg" dilemma but a full-system transformation requiring early dialogue rather than competition between sectors. The pathway must be "safe, scalable and irreversible".


IMO's David Osborn gives the keynote speech


Above: Audience questions to the legal panel; and, right, music from John Taukave


That framing set the stage for the keynote from David Osborn, director, Marine Environment Division, IMO, whose remarks carried particular weight given the recent regulatory turbulence (see page 38 for more).

In the technical streams, presentations examined verification methodologies, digital twins and performance modelling, all essential for translating projected savings into bankable outcomes. The integration of wind systems into hull design, manoeuvring standards and structural assessments featured prominently. Post-presentation panel discussions agreed that as installations scale, wind devices must be treated as part of vessel architecture rather than appendages.

The Policy and Regulation roundtable that followed also revealed a more candid assessment of the current moment. Chaired by Stefano Scarpa, director of maritime decarbonisation, ABL Group, the discussion began with what he described as the "big shock" of the most recent MEPC meeting. Regulations had not been approved; consensus had fractured. Yet, he argued, work on practical implementation must continue regardless.

Decarbonisation is a matter of "when, not if," argued David Connolly, head of operations, UMAS, who also suggested the outcome of the previous MEPC meeting was less surprising than some perceived. Connolly stated that while the regulatory trajectory may be uneven, directionally it remains clear.

John Taukave, policy advisor, Micronesian Center for Sustainable Transport, provided a stark reminder of the stakes: "Every delay is an existential delay for the communities of the Pacific." He made it clear that for small island developing states, wind propulsion is not merely a commercial efficiency tool but part of a broader zero-carbon transition framework, and one that also reconnects with long maritime traditions of wind-powered navigation.

The concept of a just and equitable transition surfaced repeatedly. How does wind propulsion contribute not only to emissions reduction but also to inclusive decarbonisation pathways? The Marshall Islands' historic and cultural relationship with wind-powered vessels was cited as a powerful symbolic and practical reference point.

Connolly argued that a "fundamental reset" may be necessary: newbuilds should be prepared for wind in the same way they are increasingly designed to accommodate alternative fuels. Wind should not remain an afterthought retrofit, but a design consideration from the outset.

Parallel presentation streams throughout the first day demonstrated that scaling wind propulsion requires more than aerodynamic efficiency.

## The letter of the law

Elsewhere, legal and contractual risk was scrutinised. Professor Orestis Schinas, specialist in ship finance, HHX.blue, chaired a roundtable on how construction contracts, charterparty arrangements and insurance frameworks must evolve.

Dr Pia Rebelo, legal analyst at Stephenson & Harwood, noted that contractual obligations will require reshuffling as wind propulsion becomes embedded in design and regulatory compliance. New areas of risk, performance guarantees, downtime exposure, repair and logistics must be allocated clearly.

The complexity of maritime contractual relationships, voyage

**Attendees were optimistic about wind propulsion technology**

charters, time charters, sale contracts and bills of lading remain "incredibly antagonistic" in places. Introducing new propulsion technologies adds further friction.

François Luigi, client director, Filhet Allard, observed that insurers do not fear risk; they fear uncertainty. The challenge lies in limited repair infrastructure, sparse spare parts networks and geographically dispersed manufacturing. Data, therefore, becomes central to risk assessment and premium stability.

## Wind takes off

Gavin Allwright's keynote on the morning of the second day placed wind propulsion within a pragmatic commercial frame. Ninety-three large vessels are now operating with wind systems, representing around 5 million dwt, with a further 120 installations in the pipeline, the majority expected in 2026. The sector, he suggested, is "rapidly approaching an inflection point," where operational data, production capacity and commercial familiarity begin reinforcing one another.

Framing wind not as a novelty but as continuity, he observed, "we are coming back to an energy source that has been there forever – we're just doing it better." At the same time, he was clear that integration matters: "If we take energy efficiency, voyage optimisation and wind together, cumulatively, we're getting close" to longer-term decarbonisation targets.

"If the shipping industry doesn't see a way to make money, these will fail," he cautioned. But, wind propulsion's distinguishing feature is its ability to deliver measurable savings now, he stated, layered alongside CII compliance, FuelEU Maritime incentives and EU ETS exposure.

The Shipowners' Debate, overseen by Dimitris Monioudis, Technical Committee chair, INTERCARGO, reinforced that this is no longer theoretical.

"It's quite complex to really put the two lines under the answer of how much you're saving," observed Jan Opedal, project manager, Odjfell Tankers, who described a decarbonisation journey rooted in fuel efficiency long before regulatory compulsion intensified. With incremental measures largely exhausted, suction sails were introduced as a next step. Yet quantifying savings precisely was noted as still being complex.

Union Maritime's commercial performance manager, Jesse Bryce, described a portfolio approach across vessel classes, embedding flexibility into newbuild foundations. "If things look good, the price looks good, the performance looks good, and we can get it on the ship, why not?," he stated.

## Sights set on safety

Concluding the conference, the roundtable on safety and hazards reinforced that scaling must not outpace safeguards.

The panellists explained that crew require understanding of wind dynamics; and simulator training and updated company procedures must align with regulatory development. Again, focus was placed on the IMO, which faces a deadline to produce a dedicated safety code for wind-assisted propulsion, and has acknowledged gaps in expertise. Collaboration between class, insurers and owners was also emphasised as essential.

Redundancy, including retention of conventional propulsion systems, was framed as reasonable and necessary. Commercial realities, cargo considerations and operational risk must be balanced carefully.

Wind Propulsion 2026 demonstrated the scale and industrial growth of the segment within the maritime sector, technically, commercially and institutionally. While regulatory uncertainty remains, deployment across the global fleet continues.

The narrative has shifted from "if" to "how".

As Osborn cautioned, maintaining course matters. But as Allwright argued, commercial logic must underpin ambition. ■


**Gavin Allwright: wind propulsion is "rapidly approaching an inflection point"**

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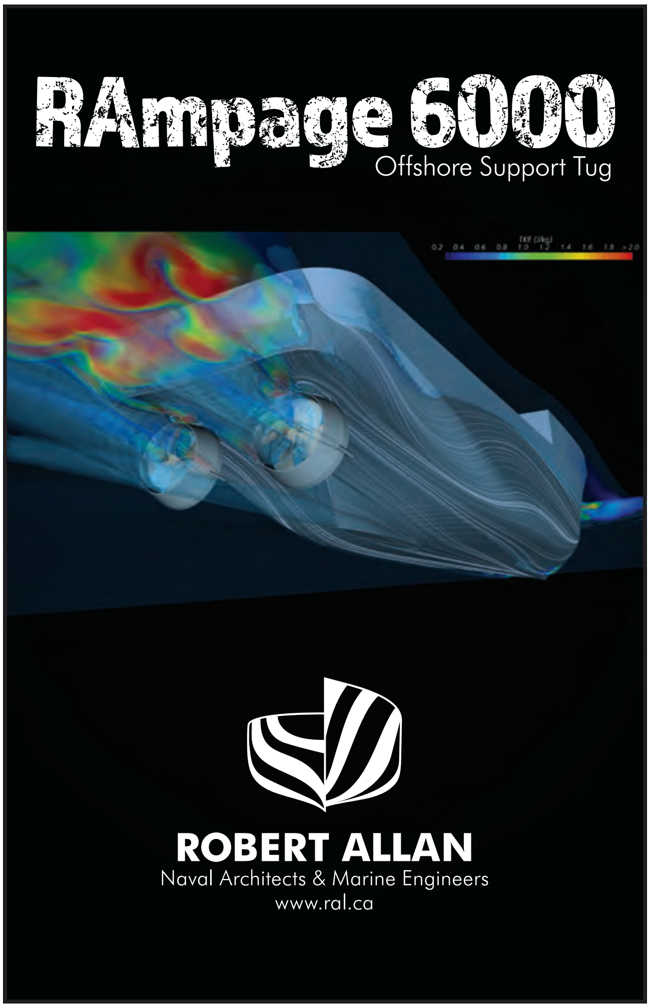

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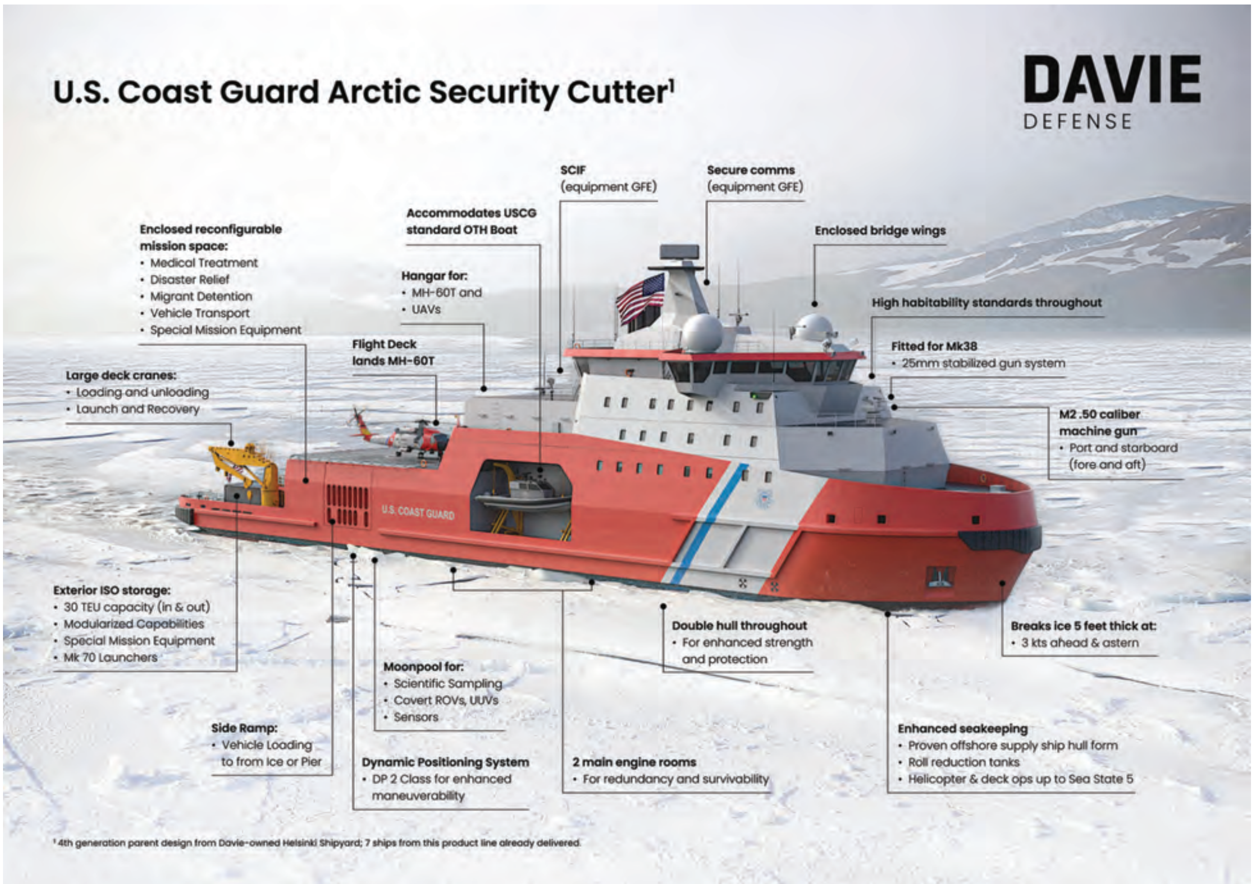


# DAVIE DEFENSE AWARDED ASC DEAL

Finnish shipyard to help boost US company's expertise and extend US polar capabilities

American shipbuilder Davie Defense has been awarded a contract by the United States Coast Guard to construct five Arctic Security Cutters (ASC), a new class of polar icebreaker intended to strengthen US presence in the High North. The award, announced in early 2026, forms part of a wider programme of up to 11 vessels authorised by Presidential Memorandum and represents one of the most significant US polar shipbuilding contracts in a generation.

The ASC is a substantial vessel: 99.9m in length, 21m in beam, displacing 9,000tonnes at normal operating draught of 7m. Ice Class PC3 rated, she is designed to maintain 3knots through 1.5m of ice. A diesel-electric propulsion system delivers 22MW of total installed power through two azimuth thrusters of 6.5MW each, supplemented by two 1.3MW bow thrusters, generating a bollard pull of 150tonnes.

Two independent engine rooms provide redundancy critical for operations in remote polar waters. Top speed is 16knots, with a range exceeding 6,500nm at 12knots in normal operating mode, extending beyond 12,000nm in high endurance configuration at deeper draught.

Endurance is up to 60 days, with accommodation for up to 124 crew and passengers. Mission payload capacity stands at 650m$^2$ of covered and uncovered main deck space, capable of carrying up to 17 TEU, ground vehicles, unmanned systems and boats. The vessel also carries a helicopter platform and hangar sized for the MH-60 and UAVs.

The design draws on a proven platform with seven previous variants delivered from Helsinki Shipyard, accumulating a combined 85 years of winter operation in Arctic regions. One vessel from the existing fleet has transited the Northeast Passage unescorted in 8.5 days, a data point that speaks directly to the platform's operational credibility in the conditions the Coast Guard requires.

The programme's construction strategy is split across two countries. To meet the accelerated delivery schedule, the first two hulls will be built at Helsinki Shipyard in Finland, a sister facility within the UK-owned Inocea maritime group, targeting delivery of the inaugural vessel in 2028. The remaining three cutters will follow at Davie's facilities in Galveston and Port Arthur, Texas, yards acquired from Gulf Copper & Manufacturing in 2025 and bringing over 75 years of Gulf Coast fabrication experience.

The rationale for opening the programme in Finland is that no active American yard has the icebreaker construction expertise needed to hit the schedule. The technology transfer dimension is therefore the most industrially significant aspect of the contract.

US shipbuilders will work alongside Helsinki's specialists during the Finnish builds to develop the domestic competency needed for series production in Texas. It is an ambitious timeline, and whether Galveston and Port Arthur can absorb that knowledge base within the compressed window of the first two hulls will be the programme's defining industrial challenge.

The strategic impetus is clear. Russia operates the world's largest icebreaker fleet, including nuclear-powered vessels capable of year-round polar transit, while China has been steadily expanding its polar capabilities.

The United States has operated with a critically thin polar fleet for decades, and the Presidential Memorandum authorising the ASC programme reflects a belated but determined effort to address that deficit.

Davie Defense sits within Inocea, a privately held British marine industrial group with operations across the US, Canada and Finland. The Coast Guard's decision to award to a group with operationally proven icebreaker heritage, rather than a domestic yard learning the discipline from scratch, reflects the urgency of the delivery timeline.

With Arctic competition intensifying and the Polar Security Cutter programme still unresolved, Washington needed a credible near-term answer. The ASC's specifications and its platform's track record suggest the design is capable of providing one. Whether the industrial strategy can match the vessel's ambition will become clear as the first hull takes shape in Helsinki.

Kai Skvarla, CEO of Davie Defense, said: "We're deeply honoured by this vote of confidence. We can't wait to get started on delivering mission-ready cutters to our valued US Coast Guard partner. By anchoring construction in Texas, while drawing on Helsinki Shipyard's proven icebreaker expertise, we can deliver the ASCs to meet the Coast Guard's operational needs in the world's harshest environments." ■

## ARCTIC SECURITY CUTTER STATISTICS

**Length:** 99.9m
**Breadth:** 21m
**Draught:** 6.5m-7.9m
**Normal operation mode:** 7m draught
**High endurance/max cargo mode:** 7.6m draught
**Displacement:** 9,000tonnes
**Ice Class PC3:** 1.5m ice @3knots
Breaks ice 5ft thick at 3knots ahead and astern
**Speed:** 16knots
**Range:** 6,500+nm @12knots in normal operation mode; 12,000+nm @12knots in high endurance mode
**Endurance:** up to 60 days
**Crew/PAX:** max 124
**Machinery:** diesel-electric total installed power 22MW, two independent engine rooms
**Propulsion:** azimuth thrusters (2 x 6.5MW), bow thrusters (2 x 1.3MW), bollard pull 150tonnes
**Seakeeping:** roll reduction tanks for roll damping
**Helicopter:** platform and hangar for MH-60 and UAVs
**Mission payload capacity:** $650m^2$ covered/uncovered main deck space, e.g. 17 TEU, ground vehicles, UXVs, boats
**Large deck cranes:** loading and unloading; launch and recovery
**Enclosed reconfigurable mission space:** e.g. for medical treatment, disaster relief, vehicle transport, special mission equipment


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Hanwha Ocean's KSS-III submarines are designed for long-range operations

# HANWHA OCEAN SIGNS LANDMARK AGREEMENTS WITH CANADA

South Korean shipbuilder pledges to share expertise with Ontario Shipyards and Mohawk College in bid for Canadian Patrol Submarine Project contract

Hanwha Ocean is embedding its shipbuilding expertise directly into Canadian industry. The South Korean shipbuilder has signed a Memorandum of Understanding (MoU) with Ontario Shipyards and a trilateral Letter of Intent (LoI) with Ontario Shipyards and Mohawk College, establishing a technology transfer, industrial modernisation and workforce development framework in the Great Lakes region. The move is part of an effort to position itself for the Canadian Patrol Submarine Project (CPSP), one of the most consequential naval procurement decisions in Canadian history.

The CPSP aims to replace the Royal Canadian Navy's ageing Victoria-class submarines with up to 12 modern vessels. Hanwha's proposed platform is the KSS-III, a conventionally powered submarine designed for long-range operations and sustained presence at sea, including in Arctic environments, with a mature, production-ready design and lithium-ion propulsion.


**Hanwha's Geoje shipyard has built more than 1,400 vessels since 1973**

**Mohawk College will teach welding**

The lithium-ion battery system offers significantly higher energy density than traditional lead-acid batteries. Combined with a fuel cell-based Air Independent Propulsion system, this advanced configuration enables the submarine to remain submerged for extended periods and sustain maximum underwater speed up to three times longer than submarines using lead-acid batteries. This system has enabled the KSS-III to set a world record for the longest continuous underwater operation by a conventional submarine.
In addition, lithium-ion batteries provide longer life cycles and simplified maintenance, lowering both operational and sustainment costs.

Hanwha Ocean claims the programme would generate 200,000 job-years over 15 years and support approximately 15,000 jobs per year on average across a pan-Canadian industrial alliance of more than 100 companies.

The bilateral MoU commits Hanwha Ocean to structured technical and operational support across design and engineering, production planning, construction sequencing, quality management and smart-yard best practices. A near-term proof-of-concept is built into the agreement: Hanwha Ocean will support the design and construction of a training and recruitment vessel that Ontario Shipyards will begin building in 2026, providing a live demonstration of the partnership's industrial intent rather than relying on declarations alone.

Workforce development will be addressed through the trilateral LOI, which establishes an embedded training hub at Ontario Shipyards' Hamilton facility in partnership with Mohawk College. The college will lead programming across welding, electrical trades, marine mechanics, robotics and non-destructive evaluation. It is a curriculum mapped directly onto the skilled trades shortfall that has constrained Canadian shipbuilding for years.

Apprenticeship pathways will be integrated with production schedules, with applied research in automation and digital manufacturing on the agenda too. Hanwha Ocean will contribute technical advisory support and access to its global industrial networks to align training with international standards.

Both documents contain conditional language tying further Hanwha investment, including a dedicated training centre and expanded supply chain engagement, to the award of the CPSP contract.

Hanwha has been active across Canada, with Quebec's minister of international relations, Christopher Skeete, visiting the Geoje shipyard in February, and Canadian yard leaders separately touring the facility to discuss collaboration and MRO opportunities. Hanwha's Geoje shipyard covers $5km^2$, employs more than 31,000 people and has delivered more than 1,400 vessels since 1973, including submarines and surface combatants for the Republic of Korea Navy.

Ontario Shipyards, the largest ship repair and construction company on the Great Lakes, now has facilities at Hamilton, Port Weller and Thunder Bay.

The combination of Hanwha's production systems and Ontario's existing infrastructure represents a credible industrial base, although execution of the knowledge transfer at the pace and depth the CPSP would require remains the programme's defining test. ■

**Front row, from left: Paul Armstrong, president of Mohawk College, Hee-cheul Kim, president and CEO of Hanwha Ocean, and Shaun Padulo, president and CEO of Ontario Shipyards, pictured with other attendees (back row) after signing a Letter of Intent**

# ‘EFFICIENCY IS THE TRANSITIONAL FUEL’

**Nick Savvides** examines how energy saving devices have helped Odfjell slash its fuel costs across its chemical tanker fleet

A cut in fuel costs of 53%, achieved without switching to a single alternative fuel. That is the headline finding from Odfjell Ship Management, the Norwegian chemical tanker operator, and it may be the most compelling argument yet that efficiency, not ammonia, methanol or hydrogen, is the maritime industry’s most practical path to decarbonisation.

The drive to decarbonise shipping has split the industry along sectoral lines. Container shipping lines, closer to consumers, are being pushed by customers seeking to reduce scope 3 emissions. Liquid and dry bulk operators, typically running at lower speeds and on less fixed routes, are less inclined to shift to alternative fuels that are difficult to source, costly to buy and require new vessels. These three sectors together, tankers, dry bulk and container, account for more than 80% of maritime emissions, so their choices matter.

Against that backdrop, Odfjell has taken a different route. The company operates a fleet of 70 chemical tankers of varying ages and has developed a methodology it believes will allow it to meet net-zero targets through to 2040, using the ships it already has. Erik Hjortland, VP of technology at Odfjell Ship Management, says the company began planning its operational efficiency programme in 2007 and started upgrading its fleet in 2014, benchmarking against a 2008 baseline. The fuel cost reduction of 53% has been independently corroborated.

“We have done that without putting any stress on the renewable electricity infrastructure in the world, which we would have had to do if we had gone through the alternative fuels route,” says Hjortland. He points to a Clarkson study showing that 63% of the world’s fleet has still not installed any energy saving devices. “Imagine the potential, what we as a sector could have accomplished if everybody had made these changes.”

## Wind in their sails

The tools Odfjell has deployed are neither exotic nor experimental. Energy saving devices, including Mewis Ducts, propeller boss caps, shaft generators and weather routing technology, have been fitted across the fleet. Last year, four bound4blue rigid suction sails were installed on the *Bow Olympus*, a 48,500dwt tanker. The results were sufficiently

**“We expect that with these sails we will not need biofuel until 2031, and very little biofuel after that up to 2034”**


**Odfjell’s *Bow Olympus* sports four bound4blue rigid suction sails**

positive that Odfjell intends to fit suction sails across its entire fleet eventually.

"Our first voyage with sails showed positive results," says Hjortland. "We expect that with these sails we will not need biofuel until 2031, and very little biofuel after that up to 2034."

Underpinning all of this is a data system that Odfjell built in 2014, an automated tool that processes noon reports from captains and crew, flagging energy inefficiencies in real time. "We get approximately 100 alarms every day in that system, and we have a separate team who deal with those alarms, interact with the crew and work to reduce consumption," says Hjortland. A business intelligence layer then benchmarks each vessel against the rest of the fleet, identifying best practice and spreading it across the operation. "I cannot stress enough how important this is," he adds.

The investment case is equally straightforward. Odfjell has committed US$40 million across 140 energy saving devices, with most delivering a return on investment of between four and six months.

### A numbers game

The economics of why this beats alternative fuels, at least for now, are stark. Odfjell's analysis shows that a kilowatt-hour of renewable energy suffers significant losses through the alternative fuel production chain – 30% lost producing hydrogen, a further 30% converting it to ammonia or methanol, and up to 60% of what remains lost at the propeller. Wind power via rigid sails, by contrast, loses just 10% between sail and propeller.

Hjortland does not dismiss alternative fuels. Ammonia, methanol and hydrogen will ultimately be needed to reach net zero, but they represent, in his words, "huge projects somewhere down the line, multi-billion-dollar investments". The business case for halving your fuel bill through efficiency measures, by contrast, is available to any operator today.

With 63% of the global fleet yet to fit a single energy saving device, the gap between what is possible and what is being done has rarely looked wider. ■

**"Odfjell has committed US$40 million across 140 energy saving devices, with most delivering a return on investment of between four and six months"**

# DEAL SMOOTHES PATH TO NET ZERO

UK's first commercial biomethanol bunkering service launches at Port of Immingham

Three energy companies and Associated British Ports have joined forces to establish the UK's first commercially ready biomethanol storage and bunkering service for shipping. It marks a significant step in the sector's transition to low-carbon fuels and signals growing industry confidence in alternative marine fuels as a practical, near-term solution.

Exolum, Methanex Corporation and Ørsted announced the initiative at the Port of Immingham, the UK's largest port by cargo volume and a key hub for energy and bulk materials. Exolum will provide storage and fuelling infrastructure, Methanex will supply the biomethanol and Ørsted will be the first customer, bunkering vessels that support its North Sea offshore wind farm maintenance operations.

These offshore support vessels are well suited to early adoption: their frequent port calls and predictable operating patterns make bunkering availability the critical constraint rather than tank range. The arrangement represents a fully integrated supply chain delivered through commercial partnership rather than public subsidy.

The launch comes amid ongoing uncertainty at the IMO, which recently deferred its vote on implementing its Net Zero Framework, a package of measures – including a global fuel standard and carbon pricing mechanism – designed to put shipping on a trajectory to net zero by 2050. The deferral had prompted concern that decarbonisation momentum could stall without a clear international framework, though the partners said it had not diminished their own commitment to action.

The collaboration demonstrates how existing energy infrastructure can be repurposed for emerging alternative fuels, reducing the capital cost and complexity of transition for ports and ship operators alike. Domestic shipping accounts for 4.7% of the UK's transport-related $CO_2$ emissions, more than buses, trains and domestic aviation combined, while international shipping contributes roughly 3% of global greenhouse gas emissions, a share expected to grow as other sectors decarbonise more rapidly.

The ISCC-certified biomethanol is produced at Methanex's Gulf Coast facilities from waste-derived feedstocks and reduces lifecycle greenhouse gas emissions by up to 80%, compared with conventional marine fuels. Biomethanol is liquid at ambient temperature and pressure, and is chemically identical to fossil methanol, meaning methanol-capable vessels require no modification to use it.

The fuel's growing commercial availability has tangible design implications. Biomethanol's lower energy density, compared with heavy fuel

**Fuel storage and supply facilities at Port of Immingham (Image: Frank Henshall. Source: Exolum)**


> "By enabling biomethanol bunkering, we are taking practical steps toward decarbonising one of the hardest-to-abate industries"

**A service operation vessel supporting Ørsted's North Sea offshore wind operations at the Port of Immingham. Biomethanol is liquid at ambient temperature and pressure and chemically identical to fossil methanol, meaning methanol-capable vessels require no modification to use it (Image: Frank Henshall. Source: Exolum)**

oil means larger tank volumes are needed for equivalent range, with direct consequences for hull form, internal arrangement, stability, and the trade-off against cargo capacity. An orderbook of methanol-ready newbuilds, spanning container ships, offshore support vessels and ferries, reflects increasing owner confidence.

Vessels involved on these projects must also comply with the IMO's IGF Code, which governs tank location, double-wall piping, ventilation, gas detection and emergency shutdown systems. Retrofit work presents additional complexity, requiring structural modifications, upgraded fuel handling systems and reassessment of stability and freeboard, an area of growing demand as bunkering infrastructure such as Immingham's comes online.

The UK's Department for Transport has published a roadmap targeting a 30% reduction in shipping emissions by 2030, 80% by 2040, and zero emissions by 2050, with biomethanol increasingly regarded as one of the more viable near-term pathways, particularly where hydrogen and ammonia remain constrained by infrastructure and technology readiness.

Steven Clapperton, head of marine (Humber) at Associated British Ports, says: "This initiative marks a significant moment for the Port of Immingham and the wider maritime sector. By enabling biomethanol bunkering, we are taking practical steps toward decarbonising one of the hardest-to-abate industries."

Stuart McCall, vice president, low-carbon global market development, at Methanex, says: "As the world's largest producer and supplier of methanol, Methanex is committed to developing and supporting innovative solutions that accelerate the transition to low-carbon shipping." ■

# HYDROGEN HITS THE BIG TIME WITH PROJECTS ON THE RISE


Hydrogen is moving from pilot projects to mainstream maritime adoption, with landmark vessel orders and emerging bunkering hubs signalling growing industry confidence, says **Patrik Wheater**

While there are more commercially appealing alternative marine fuels available, hydrogen ($H_2$), a highly flammable and odourless gas that in its super-cooled liquid form will propel man's return to the moon, is possibly the 'greenest' to have made significant maritime inroads over the past 12 months.

Landmark vessel announcements, a regulatory breakthrough at the 11th session of the IMO Sub-Committee on Carriage of Cargoes and Containers in London last September, and the first serious infrastructure commitments have combined to give hydrogen the credibility it lacked just two years ago.

Indeed, there are now more than 20 hydrogen ships in operation, with twice that under construction, representing a number of ship-type 'firsts'. As far as hydrogen is concerned, 2026 is seeing a real surge in ship design and construction.

The clearest sign that the industry is taking $H_2$ more seriously was in April 2025, when Fincantieri and Viking announced the building of a pair of 54,300gt hydrogen-fuelled cruiseships – the world's first designed with hydrogen to be stored onboard. *Viking Libra*, set to join the Viking fleet later this year, features a hybrid 6MW propulsion system based around Isotta Fraschini Motori's proton exchange membrane (PEM) fuel cell technology. The decision to store the fuel onboard as cryogenic liquid hydrogen ($LH_2$) in a bespoke container loaded on to the vessel during port calls is a pragmatic workaround to the absence of any fixed $LH_2$ bunkering infrastructure to speak of.

The shortage of $H_2$ bunkering ports is the main impediment to larger deep-sea vessels getting off the drawing board. But things are changing fast.

**"There are now more than 20 hydrogen ships in operation, with twice that under construction, representing ship-type 'firsts'"**

In May last year, for instance, the Port of Rotterdam and Oslo-based EDGE Navigation signed a Letter of Intent to develop a large-scale hydrogen network across Europe's largest port complex. The Norwegian maritime technology company is developing a series of commercial $LH_2$-powered cargo ships, as well as an $LH_2$ tanker that can be used for ship-to-ship bunkering. Rotterdam aims to prepare the port for the arrival of these ships from 2028.

Come 2050, it is widely anticipated that global demand for hydrogen will hit 60 million tonnes, fuelling 19% of the world fleet. To this end, Kawasaki Heavy Industries (KHI) and Japan Suiso Energy (JSE) announced at the beginning of this year plans to build a 40,000$m^3$ liquefied hydrogen carrier, the world's largest, under the New Energy and Industrial Technology Development Organization (NEDO) Green Innovation Fund Project. JSE plans to use the new LHC to demonstrate the ship-to-base loading/unloading under ocean-going conditions by 2023.


**Unlike its sister ship, *Viking Sky*, *Viking Libra* will run on hydrogen**

The vessel, slated for a building slot at KHI's Sakaide Works, will join KHI's 2021-built 1,250m$^3$ capacity *Suiso Frontier* in taking $LH_2$ cargoes at the Hy touch Kobe $LH_2$ demonstration terminal.

Interestingly, the new vessel's cargo tanks will use a high-performance insulation system designed to reduce the generation of boil-off gas (BOG) caused by natural heat ingress from the outside, enabling the much larger volume of cryogenic liquid hydrogen to be transported. A heat exchanger will also be installed to allow the BOG to be used for propulsive power. Together with the vessel's hull form and draught, combined with the low density of liquefied hydrogen, the vessel will have a higher propulsion efficiency for less power, resulting in zero emissions. KHI believes the new vessel will provide the foundation for the future hydrogen supply chain.

Other large commercial ship hydrogen newbuild developments include a pair of 85m bulk carriers for Norwegian shipowner GMI Rederi. Each of these 4,000dwt bulkers will adopt seven PowerCell Marine System 225 units to deliver 3MW of zero-emissions power. When launched in early 2027, the vessels could be the world's first hydrogen-powered bulk carriers.

Meanwhile, Samskip's SeaShuttle project represents one of the most ambitious leaps in the maritime industry's hydrogen surge. Two 135m container ships, currently under construction at Cochin Shipyard in India, are being designed to establish a "green corridor" between Rotterdam and Oslo.

Each vessel is equipped with a massive 3.2MW hydrogen fuel cell system, a significant scale-up


**Samskip's SeaShuttles will establish a "green corridor"**

**Renderings of Torghatten's hydrogen ferries, due for delivery later this year**

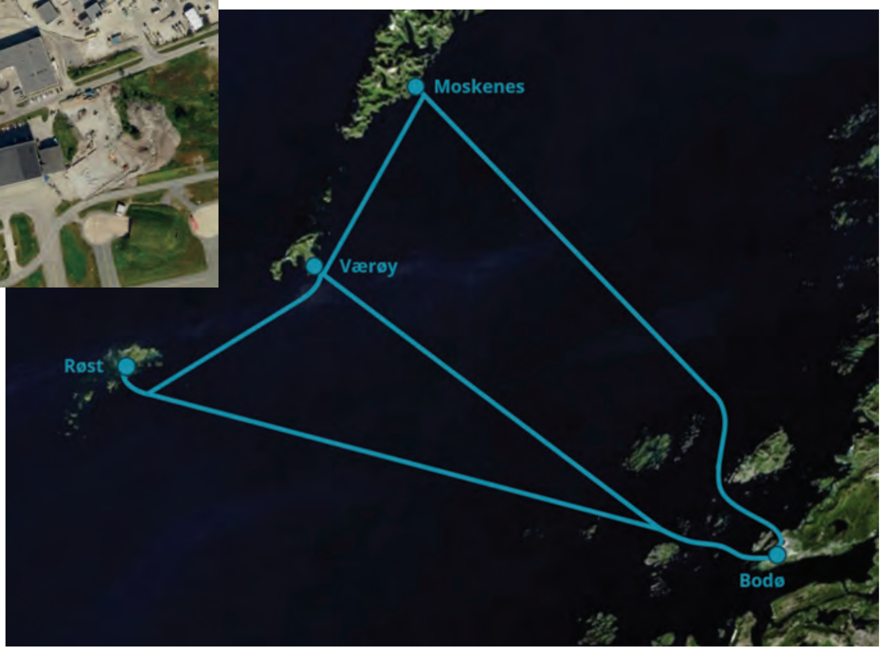
from earlier pilot projects, with liquid hydrogen supplied by Norwegian Hydrogen's Rjukan plant. These ships have a hatch coverless design, which speeds up port operations, and "autonomous-ready" technology, aiming for remote-controlled efficiency. The first of these vessels is expected to be delivered late in 2026, with full commercial operations beginning in Q2 2027.

While these are some of the larger $H_2$ AMF projects under development, existing smaller-scale projects are providing more immediate operational evidence for the fuel's wider maritime potential.

One example is the operational data from the 75-passenger hydrogen-fuelled ferry *Sea Change*, which entered service in San Francisco Bay in July 2024. A study, published in 2025 in the *International Journal of Hydrogen Energy*, found that its 360kW PEM fuel cells and 246kg of hydrogen (stored at 250 bar) delivered stable and reliable power under real-world duty cycles, achieving an average electrical efficiency of approximately 45-46%.

However, the paper also noted that delivered hydrogen costs averaged approximately US$30/kg during operations, roughly 10 times the cost of diesel, although this increase represents only a 20% hike in total annual operating costs given hydrogen's higher efficiency. You get more combustion bang for your buck.

Norway's 3,400gt, 82m-long *Hydra*, the world's first $LH_2$-powered car and passenger ferry (in service since 2023), is also providing the shipping world with evidence that liquid hydrogen will play an




**Above: GreenH is building a hydrogen bunkering facility at Langstranda, near Bodø**
**Right: Torghatten Nord's ferry routes**


> **"*Hydra* has been eclipsed in scale by Torghatten Nord's two new 117m hydrogen ferries, *Røst and Moskenes*"**

important role in the green maritime transition. Although not as informative as the *Sea Change* study, 2024 reports from Ballard Power Systems – the fuel cell manufacturer – noted that *Hydra* has made more than 20,000 crossings, establishing efficient bunkering turnarounds.

However, *Hydra* has since been eclipsed in scale by Torghatten Nord's two new 117m hydrogen ferries, Røst and Moskenes, ordered for the Bodø–Lofoten route. These LR-classed double-enders, scheduled for delivery from Myklebust Verft later this year, bring hydrogen fuel cell technology firmly into the size range of conventional long-distance ro-pax tonnage, reducing annual $CO_2$ emissions on the Vestfjord route by some 26,500tonnes.

Hydrogen for the route will be supplied by GreenH, which is building a bunkering facility at Langstranda, near Bodø, with an eventual output of up to 10tonnes of hydrogen per day. The facility, the first of its kind in Northern Europe, will be the first functioning value chain for hydrogen as a maritime fuel in Norway. And once the first phase is complete later this year, compressed green hydrogen will be delivered directly from the production plant to the vessels via a dedicated pipeline, eliminating the high costs and logistical complexities of road transport. The system utilises a "cascade bunkering" method involving pressure transfer, achieving a minimum transfer speed of 1,700kg/h, allowing full daily refuelling in about three hours. ■

## *SEA CHANGE* PARTNERS DEVELOP $H_2$ FERRY FOR NYC

Australian shipbuilder Incat Crowther and Switch Maritime in the US have announced a project to design and build a hydrogen-fuelled fast ferry for New York City.

The Big Apple's first ever hydrogen-fuelled ferry, the 28.5m vessel has capacity to ferry 150 passengers at cruising speeds of 25knots. Featuring four $H_2$ tanks capable of storing 720kg of compressed hydrogen, the vessel's 16 98kW fuel cells will provide power to four Danfoss EM-PMI540-T3000 electric motors, which will in turn drive the catamaran's twin propellers and other consumers.

Incat Crowther and Switch previously partnered on the design, delivery and regulatory approval for *Sea Change* – the world's first zero-emissions hydrogen fuel cell-powered electric passenger ferry. Incat Crowther's technical manager, Dan Mace, said the design showcases a feasible solution for mass transit operators looking to begin the fleet decarbonisation process, while maintaining existing operational profiles.

"The vessel's ability to drop in to existing fleets is a real positive step to reduce emissions and ensures the vessel can be deployed quickly without the need for constructing additional shoreside infrastructure," he said.

The project team plans to launch a ZEF-150 demonstration vessel at the Brooklyn Navy Yard.

# PROFESSIONAL PROFILE

## EDWIN PANG

FOUNDER
**Arcsilea**

CHAIR
**RINA IMO Committee**

**Employment and education**

**2018-present** Founder at Arcsilea Ltd

**2016-2018** Herbert Engineering Europe (UK)

**2012** UCL APMP

**2005-2015** Senior naval architect at Knud E. Hansen, Copenhagen and London

**2000-2005** Project naval architect at Three Quays Marine Services, London

**1997-2000** University of Strathclyde, B.Eng 1st Class Honours, Naval Architecture and Offshore Engineering

Edwin Pang describes himself as a 'regulatory repairman' on his LinkedIn page. Perhaps not surprising for someone who chairs RINA's IMO Committee, and has been the Institution's representative to the IMO since 2018. Like all those who serve on RINA's committees, Edwin is a volunteer. His day job is running a niche consultancy business, Arcsilea, which he founded in 2018 and which focuses on greenhouse gas (GHG) reductions, decarbonisation, alternative fuels and energy efficiency, with a particular specialism in regulatory impact analysis.

"I came to RINA somewhat late in my career, having spent the first decade or so in a rather peripatetic existence," says Edwin. "But I'd always been involved in regulatory policy development, so it was a natural progression. It has been a real honour and a privilege to have been elected by my peers to serve as chair, and to be the Institution's representative to the IMO."

After university, Edwin held naval architect roles with Three Quays Marine Services, Knud E. Hansen and Herbert Engineering Europe. Much of this early work concentrated on passenger ship design, covering ferries and cruise ships, with a focus on safety issues, especially stability. In time that experience widened to cover a broader range of vessel types, and other segments such as ballast water and offshore wind.

One of the highlights of Edwin's early career was as on-site project coordinator on a nine-month lengthening project for a 220m-long ro-ro passenger ship at Lloyd Werft Bremerhaven. "The floating calculations for the fore and aft sections of the vessel lengthening project were especially significant," he says. "Effectively, this was a detailed estimate of weights and centres of gravity, with a limited amount of documentation, after the ship had been cut in two, which showed we needed to weld a barge to the aft part of the ship, to enable it to have a reasonable trim to minimise draught."

Edwin also singles out his important work with the Lloyd's Register Foundation-funded FerrySafe team, looking at improving domestic passenger ship safety in developing countries. The team tried to understand what the Philippines had done to improve its overall safety record so that these measures could be replicated elsewhere.

"Regulations can be somewhat theoretical," he says, "especially if the issue is complex, and you need real-world maritime industry feedback to make them usable. That is what I have ended up doing – taking practical examples of what happens in reality and then assessing how to develop regulations properly based on that experience."

In the past eight years, Edwin has undertaken a series of projects in energy efficiency and GHG reduction. This has included an analysis of the Energy Efficiency Design Index (EEDI) for new and existing ro-ro cargo and passenger ships for Interferry, leading to a revision of EEDI reference lines for both ship types at MEPC 72. He also helped develop and finalise Energy Efficiency Existing Ship Index and carbon intensity indicator regulations at IMO, working for the European Commission as well as industry, carrying out impact assessments on ships based on analysis of fuel consumption data and acting as joint coordinator of the IMO Correspondence group developing those measures.

As chair of the RINA IMO Committee, Edwin is responsible for the Institution's submissions to the organisation, determining positions to take on key issues, discussing regulatory developments with member states and other NGOs, and much more.

"RINA plays a key, and perhaps unique, role at the IMO as one of the few organisations whose membership comes from right across the maritime industry value chain," he says. "In many ways, RINA is in an ideal position to be the 'honest broker', presenting technical advice in a balanced way. Other parties appreciate our input, which is not constrained by political or commercial considerations. We are not a lobby group, and don't stand to gain one way or another. We are there simply to represent what we think is right or technically justified."

**"There is a fair amount of regulatory drafting that has our fingerprints on it, as we have made the case for sensible regulatory changes"**

Over the past decade, Edwin says RINA has achieved a lot with IMO. "There is a fair amount of regulatory drafting that has our fingerprints on it, as we have made the case for sensible regulatory changes. Also, we have been adept at finding technical compromises to get different parties onboard and regulatory initiatives over the line."

Currently the RINA IMO Technical Committee is involved in a number of areas, with a heavy focus on work relating to the revision of SOLAS Chapter III, which governs life-saving appliances, biofouling, the safety of new fuels and energy efficiency, among others. Edwin says: "Over the past few years we have submitted 10-20 papers a year to IMO. This is quite exceptional for any organisation, let alone one run by volunteers."

RINA's contribution to the IMO was recognised by the IMO secretary-general, Arsenio Dominguez, at the 2024 Annual Dinner. In his speech, he said that he had asked his team to summarise RINA's work, and they sent him pages and pages of information, which he flipped through on stage. He reiterated to his team that he just wanted a summary, to which the reply was: "That is the summary!"

In the alternative fuels space, RINA, heavily supported by the Maersk Mc-Kinney Møller Center for Zero Carbon Shipping, is helping to develop a global maritime fuel certification system through the IMO to provide assurance on the GHG credentials of alternative fuels supplied as bunker fuels. Edwin says: "We took on the responsibility for coordinating the drafting of a certification framework even though it isn't core naval architectural competence, simply because it needed to be done. When we first flagged it, there were very few who recognised the importance of such a framework and were willing to engage."

Draft guidelines will be presented to the IMO's MEPC Committee in April, now with widespread input from many member states and NGOs, and hopefully will enable certification schemes to be audited and recognised by IMO in due course. "This broadly sums up the approach that RINA has taken at the IMO – identifying needs and proposing solutions," Edwin says.

The emergence of alternative fuels as part of the industry's drive to net zero is a significant challenge. "The technical and safety issues are solvable," says Edwin, "but there is such a rush to embrace new fuels and associated technology that perhaps the rules and regulations as well as crew training have some way to catch up. The pressure to achieve rapid change is in itself a risk."

Some of the key things that Edwin says he has learned in his career include the importance of connecting practice with theory, the necessity of compromise in design and the need to see the wider picture. "Naval architects often think of safety in terms of design and hardware, but the role of the human element is equally, if not more, important. Issues such as crew training are certainly something we need to remember when we are regulating in an era of new fuels."

Looking back on his 25 years of experience in ship design, what advice would he give to anyone starting out in naval architecture? He says: "There are so many aspects to naval architecture, so be curious and gain experience in as many of them as you can. Just because you have specialised in something for 10 years doesn't mean you might not do something else later. It is important to get a range of experiences and to achieve a balance between generalist and specialist." ■

# SAFETY FIRST FOR NEW FUELS

The shift from heavy fuel oil to low-carbon alternatives promises deep emissions cuts but it also introduces a new generation of safety challenges. Against a backdrop of regulatory uncertainty, the challenge now is ensuring the industry meets its decarbonisation goals without compromising on safety. **Amy McLellan** talks to Dr Thomas Beard of BMT about how the industry is rising to this challenge

Safety is not theoretical in maritime operations. The high seas remain an unforgiving environment where systems are routinely pushed to their limits. Heavy fuel oil is well understood, with decades of operational experience behind its safety protocols – yet incidents still occur.

Of the alternative fuels, LNG has matured into a proven marine fuel and one that is firmly back in favour after the IMO paused elements of its Net Zero Framework in October 2025. The regulatory hesitancy was quickly reflected in orderbooks, with LNG re-emerging as a favoured and well-understood bridge towards a lower-carbon future.

The other alternative fuels, however, introduce unfamiliar hazards. Hydrogen's extremely low ignition energy, ammonia's acute toxicity and methanol's combination of flammability and toxicity all demand new layers of engineering scrutiny.

For Dr Thomas Beard, clean shipping service lead and principal marine engineer at BMT, the challenge is both technical and urgent. His doctorate in hydrogen safety, completed years before the current fuel debate intensified, has become newly relevant as shipowners seek to find ways to stay profitable, compliant and safe against a backdrop of regulatory uncertainty.

## Designing for an uncertain fuel future

With no single alternative poised to displace heavy fuel oil in the near term, and limited fuel availability weighing on shipowner decisions, designers are increasingly adopting flexible, future-proofed layouts.

"In a design perspective, it'll be like a space grab," Beard says. "You allocate space for certain equipment and piping that can be retrofitted once the fuels become more available. Then we don't have the weight penalty of piping we don't need."

Space pressures are already acute because all leading alternative fuels have lower volumetric energy density than diesel:

- Methanol: ~15MJ/litre
- LNG (methane): ~13MJ/litre
- Ammonia: ~11.5MJ/litre
- Hydrogen: roughly 3-8MJ/litre depending on storage method.

Thomas Beard helps shipowners comply with safety rules

Lower energy density means larger tanks, which in turn affects vessel layout, cargo capacity and stability calculations.

Storage conditions further complicate matters. Methanol is liquid at ambient conditions and can be stored similarly to diesel. LNG requires cryogenic storage at approximately –162°C, hydrogen at around –253°C or at considerable pressure, and ammonia at roughly –35°C under refrigerated conditions. Each demands dedicated tank systems and safety envelopes.

**"Lower energy density means larger tanks, which in turn affects vessel layout, cargo capacity and stability calculations"**

## Reclaiming space through smart design

Some of the lost volume can be clawed back through careful naval architecture. Beard notes that cofferdam (air gap) distances for certain fuels can be reduced from traditional 600mm to around 30mm in specific configurations and with suitable technology.

Methanol offers particular flexibility. Because it is water-soluble, tanks do not always require double-hull separation from the ship's side shell below the waterline.

"It means we can leverage bits of the design to start maximising the space for the additional storage requirements," Beard explains.

All of these fuels fall under the IMO's International Code of Safety for Ship Using Gases or Other Low-flashpoint Fuels (IGF Code). That brings extensive mandatory safeguards and existing knowhow to bear for new problems.

## Layers of protection

Modern low-flashpoint fuel systems rely on multiple defensive layers, including:

- Double-walled piping
- Nitrogen inerting systems
- Gas detection and alarm networks
- Airlocks and hazardous zoning
- Dedicated mechanical ventilation
- Redundant power supplies.

Redundancy is particularly critical. Safety and firefighting systems must remain operational even during major failures.

"The fuels are either highly toxic, highly flammable, or a mixture," Beard says. "You have to design accordingly."

## Ammonia: the toxic threat

Ammonia's primary hazard is toxicity rather than flammability. It is highly hydrophilic, which means it aggressively attacks moist tissue such as eyes, nose and throat. Exposure risks are severe. Concentrations above 0.25% can be fatal within 30 minutes and, unlike with exposure to some other chemicals, there is no cure.

Under normal operating conditions, the risks are manageable. But maritime operations rarely remain normal.

"At sea, normal conditions can quickly flip into a dark and stormy night scenario," Beard warns. "That's where redundancy becomes vital."

Engineers must ensure sufficient backup power to allow crew in hazmat suits to isolate leaks, purge systems with nitrogen and restore safe conditions.

These realities may limit ammonia's suitability for passenger vessels.

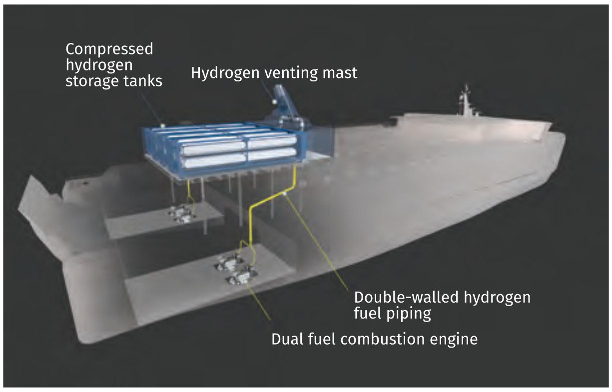
"It might be feasible on a crew transfer vessel where everyone is trained and buckled into their seats," Beard says. "On a ferry or cruiseship, passengers are untrained and mobile, and that's a very big challenge."

## Methanol: the double hazard

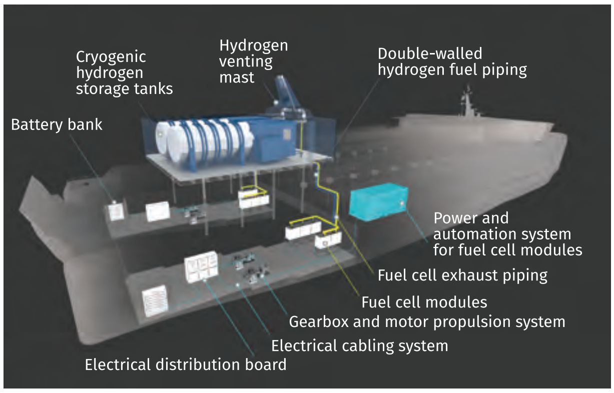
Methanol presents both flammability and toxicity risks. It can harm through ingestion, skin absorption or inhalation.

Treatment exists – most commonly fomepizole – but Beard notes an unusual secondary remedy: high-strength ethanol, such as vodka

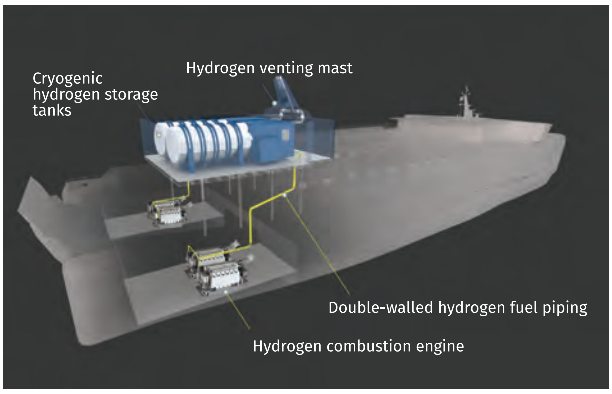
## SMART DESIGN



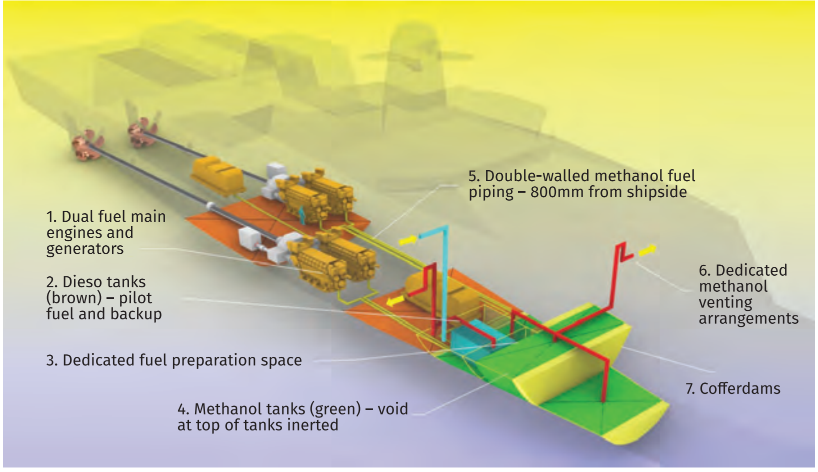

**Compressed hydrogen with dual fuel engines:** BMT's retrofit concept minimises structural disruption by pairing modular topside storage and venting with dual fuel machinery, giving ro-pax operators a practical first step into hydrogen while retaining diesel resilience and protecting service schedules.




**Liquid hydrogen with fuel cells and battery hybridisation:** A zero-emission architecture that uses cryogenic storage, fuel cells and batteries to deliver quiet, efficient electric propulsion and hotel loads, showing how existing ferries can be repositioned as truly green assets without starting from a blank sheet of paper.




**Liquid hydrogen with dedicated hydrogen engines:** For when the use of mechanical drive is still required, this concept combines cryogenic tanks with hydrogen ICEs. Minimising change to the propulsion while providing a route to zero-emission operations.




**BMT Venator dual fuel frigate (methanol & F-76)**
BMT shows how warships can transition to low-carbon methanol without trading combat resilience, using dedicated fuel prep spaces, double-walled pipework, optimised cofferdams and segregated venting to stack multiple layers of protection around a flexible machinery arrangement. Allows cleaner operations in peace time but offers full operational capability in times of conflict.

or whisky, which competes metabolically with methanol in the body.

Firefighting presents another complication. Methanol flames can be nearly invisible in daylight, requiring alcohol-resistant foam systems and enhanced detection procedures.

## Hydrogen: ultra-flammable but with inbuilt safety features

Hydrogen's minimum ignition energy is about 0.02MJ – low enough that static electricity from clothing can ignite it. Although this is at ~38% concentration, at 10% concentration the ignition energy is similar to methane (LNG). Yet the fuel also has intrinsic safety advantages.

"What I do like about hydrogen is that it has its own inbuilt safety mechanisms," Beard says. "It's the most buoyant and diffusive gas on Earth. It wants to rise and spread out."

**"It's no good just designing a ship. You also need to work out how to fuel it, wherever it goes. It's a whole ecosystem"**

Open-deck storage can, therefore, be advantageous. Below-deck storage, however, introduces major ventilation and explosion-proofing requirements.

Thomas Beard: "At sea, normal conditions can quickly flip"

Blast-proof ducting, hazardous-zone equipment ratings and dense sensor networks become essential. Detection systems typically trigger at around 50% of the lower flammability limit – well before ignition is possible.

## LNG: A familiar contender

Compared with the newer fuels, LNG benefits from a more mature safety framework. Engineers are "quietly confident" in handling it and it now has a proven track record as a marine fuel, even if its well-to-wake emissions are less compelling than some of the potential cleaner alternatives.

## The human factor

While engineering controls are advancing rapidly, Beard believes crew competence may be the industry's greatest challenge.

"These fuels are so different that there's a strong argument for specialism," he says.

Yet excessive specialisation could restrict seafarer mobility between vessel types – something crews and operators alike are keen to avoid. The uncertainty over which fuels will dominate further complicates planning. Training investment must be balanced against an unclear long-term fuel mix.

## A whole-system challenge

Decarbonisation isn't just about ships. Beard emphasises that vessel design cannot be separated from shoreside infrastructure.

"It's no good just designing a ship," he says. "You also need to work out how to fuel it, wherever it goes. It's a whole ecosystem. Nobody wants stranded assets."

It's clear that decarbonisation will test maritime engineering in ways not seen for generations, and safety will remain the ultimate measure of success. ■

# WATCH RINA EVENTS ON-DEMAND

Wherever you are in the world, you can now watch our events at the time of your convenience. Our members enjoy online access to selected events in RINA's 2026 calendar, including the inaugural Naval Architect (Glasgow) and the sold-out Wind Propulsion Conference (London).

**"When many conferences are barely disguised sales events, having over 200 people come together to share knowledge and advance wind propulsion for ships is something special."**

**ATTENDEE, WIND PROPULSION CONFERENCE 2026**

Our events bring together naval architects, maritime engineers and associated professionals in pursuit of solutions to the industry's challenges. They capture the breadth of today's naval architecture profession, combining expert insights, practical applications and cutting-edge technical discussion.

On-demand events are available exclusively to RINA members. See all membership benefits at **rina.org.uk/membership**

## About RINA

Royal Institution of Naval Architects (RINA) is a global membership body for the maritime industry, covering everything from super yachts and green propulsion to warship resilience. With members in 140 countries, we promote the interdisciplinary conversation at the heart of maritime innovation.

Renowned for the technical excellence of our publications, events and learning, we drive the career development and credibility of our members.

For over 160 years, we have advanced the art and science of naval architecture through shared expertise and innovation.

**WATCH ON-DEMAND EVENTS:**


Peter Osborn at RINA's Wind Propulsion Conference

# THE WIND IS WITH US

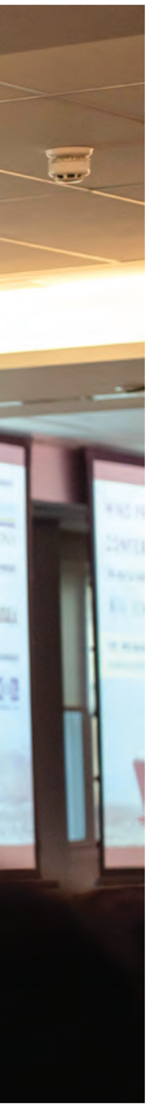
Wind propulsion remains a practical and cost-effective tool for decarbonising shipping, despite the regulatory headwinds, and the time for action is now, says **David Osborn**, director of the IMO's Marine Environment Division

There is a temptation, amid the complexity of global shipping regulation and the slow grind of intergovernmental negotiation, to conclude that the maritime sector's decarbonisation agenda has stalled. That temptation should be firmly resisted. The wind has not gone out of the sails of maritime decarbonisation, and those who work in wind propulsion are among the clearest proof of it.

That was the central message I brought to the Wind Propulsion Conference, hosted jointly by the International Windship Association and the Royal Institution of Naval Architects in February. Speaking to an audience of naval architects, operators and technology developers, people who have committed careers and capital to the practical deployment of wind-assisted propulsion, I wanted to make one point above all others: progress continues, and we must maintain our course.

The IMO's World Maritime Day theme for 2026 and 2027, 'From Policy to Practice: Powering Maritime Excellence', captures precisely the challenge and the opportunity. It is not enough to have agreed ambitious targets. The real work lies in turning collective regulatory decisions into real-world results that deliver tangible benefits for the sector and for the planet. No single organisation can do that alone. It requires administrations, classification societies, naval architects, shipowners, operators and individual mariners all pulling in the same direction.

Wind propulsion sits squarely within that 'policy to practice' agenda. It is a mature, cost-effective solution to reducing greenhouse gas emissions from international shipping and, crucially, it is available today. Not in 10 years' time. Not in five years. Now.



The regulatory framework that underpins this is already well established. For more than a decade, IMO has developed and strengthened a suite of energy efficiency standards – the Energy Efficiency Design Index, the Energy Efficiency Existing Ship Index, the Carbon Intensity Indicator, and the Ship Energy Efficiency Management Plan – that have delivered concrete results.

Taken together, these measures have reduced the carbon intensity of international shipping by more than 38%, compared with 2008 levels. Ships today emit roughly 38% less $CO_2$ for the same transport work than they did at the start of this century. That is a significant achievement, and one that is too often overlooked in debate dominated by what remains to be done.

Market data reinforces the direction of travel. According to recent figures from Clarksons Research, nearly half the global fleet, 47% of world tonnage, is now fitted with at least one energy-saving technology. The trend towards further uptake is clear and accelerating. Wind propulsion technologies are part of that picture, and the industry's investment in them continues to grow.

I must be clear on one point: IMO is technology neutral. The Secretariat does not promote or discourage any particular solution. There is no silver bullet and no one-size-fits-all pathway. Multiple routes to decarbonisation will coexist, and that is as it should be. What the regulatory framework must do, and what it is actively being designed to do, is ensure that all fuels and technologies are treated fairly and consistently, based on their well-to-wake emissions.

**"Wind propulsion ... is a mature, cost-effective solution to reducing greenhouse gas emissions from international shipping and, crucially, it is available today"**

This is where wind propulsion faces both an opportunity and a challenge. In January 2026, the IMO's Sub-Committee on Ship Design and Construction developed a draft safety workplan for greenhouse gas-reducing technologies, explicitly including wind propulsion. That workplan will go to the Maritime Safety Committee for approval in May 2026. It marks an important step: the formal integration of wind technologies into IMO's safety framework, providing the regulatory clarity that owners and operators need to invest with confidence.

On the regulatory horizon, the picture is more complex. Discussions on the next set of measures under the IMO Net-Zero Framework were adjourned last October. This was not a retreat from ambition. The commitment among Member States and industry to global regulation remains strong. But it created additional time, and that time is being used. MEPC 84, scheduled for April 2026, will continue discussions on the way forward, including the greenhouse gas fuel intensity (GFI) reduction requirements that will form the core of the next regulatory package.

Within that work, the development of GFI Calculation Guidelines is giving due consideration to the inclusion and fair treatment of wind propulsion, a recognition that its contribution to fuel saving must be properly accounted for if owners are to have the certainty they need. Contributions from the International Windship Association have been genuinely valuable here, helping to shape how the GFI will function in practice. That kind of direct industry engagement with the regulatory process is exactly what is needed.

Yet there is a shadow over the progress. Despite the improvement in carbon intensity, total fuel consumption by ships has remained broadly stable in recent years. Absolute greenhouse gas emissions have not yet declined significantly. Efficiency gains are being absorbed by growth in trade and fleet size. This is why the next regulatory package matters so much, and why inaction is not an option.

For naval architects and marine engineers, the message is one of both validation and urgency. The technologies you design, specify and integrate are not peripheral to the decarbonisation agenda, they are central to it. Wind propulsion, in particular, offers something rare in the energy transition: a proven, scalable, fuel-free reduction in emissions that can be retrofitted to existing vessels and designed into new ones. The regulatory framework is catching up. The market is moving. The only question is pace.

There may be diplomatic storms to navigate and regulatory mechanisms to refine, but the direction is set. We must maintain our course. The wind is with us. ■


***SC Connector*** **has Norsepower Rotor Sails (image: Alamy)**


Orcelle Horizon Wind tunnel testing in December 2024 (image: Wallenius Marine)

# WHAT'S NEXT FOR WAPS?

DNV's senior principal engineer, **Hasso Hoffmeister**, examines the evolution of wind-assisted propulsion systems, and what comes next

Only a few years ago, wind-assisted propulsion systems (WAPS) were considered pioneering technology, but they have now matured into reliable and commercially viable solutions.

WAPS providers have been gathering extensive operational experience and, based on the lessons learned, are ready to deliver their second-generation products, focusing on improved performance, higher reliability and better system integration. System builders are also continuing to invest in upscaling their capacity to deliver, which will not only meet the current demand but predicts continuing growth.

In 2026, we will almost certainly see 100 vessels equipped with WAPS globally, which will be a significant milestone and signal strong growth for the years ahead. Today, 77 ships have installed modern wind-assisted propulsion systems, with 62% of the vessels retrofitted. And while this is still only a small fraction of the global fleet, recent uptake has been rapid.

## Setting standards

One key enabler of this development has been the evolution of technical standards. By reducing uncertainty in the viability of the technology, they have built up market acceptance. From the DNV side, we have released the first WAPS-ready notation, published a new white paper, and a new recommended practice to assess the performance of WAPS. We'll be working with industry to make sure this reflects their needs – and we hope it will be a big step forward in building confidence in the systems, by providing a new, transparent methodology, backed up by verifiable data.

DNV's rules and guidelines have supported providers, designers and shipowners by offering structured tools to confirm operational safety and to evaluate performance, both at the design stage and during operation.

## Designing for WAPS

When assessing the feasibility of a specific WAPS installation, it is important to identify the design and operational challenges that must be addressed for the successful implementation of the system. The ship type and size, along with the main particulars, choice of technology, newbuild or retrofit will all affect the range of feasible solutions and dictate the technical considerations and constraints.

Additionally, the desired level of supplemental wind power for ship propulsion will determine the scale of the sail unit and the complexity of the machinery systems. Finally, the operational trade routes, including the prevailing winds, weather patterns and local regulations, also need to be taken into consideration.

## Safe and efficient integration

Installations will generally require class approval. For major retrofitting projects, a comprehensive risk assessment is generally advisable and, in many cases, will be required by class or the authorities.

WAPS change the loads acting on the vessel structure as well as the ship's aerodynamics and manoeuvrability significantly. Furthermore, they have an impact on port operations and may interfere with overhead structures such as bridges when operating in coastal areas. Ensuring the ship's structural fitness for WAPS and the chosen system's robustness, reliability and operational safety in harsh marine environments is critical, requiring thorough testing.

WAPS can interfere with the line of sight and the visibility of navigation lights, and affect the radar blind sector, all of which have implications for compliance with statutory requirements. In some cases, WAPS may result in noise and vibration, which can affect crew comfort and vessel integrity.

In operation, navigating a ship with active WAPS typically requires updates to on-board practices, safety protocols, maintenance routines and equipment. Control systems for the propulsion engine and WAPS should be integrated to allow the efficient coordination of both. Comprehensive crew training is essential to ensure safe and efficient WAPS and vessel operation.

## Verifying fuel savings

Verifying the fuel-saving performance of wind-propulsion solutions at full-scale is essential for both shipowners and technology providers. Knowing the actual performance helps to predict fuel savings and cost, can be shared with charterers and cargo owners, and help to determine future investments.

A dedicated sea trial under controlled conditions can offer a cost-effective and fast way to verify performance immediately after installation. DNV recommended practice, DNV-RP-0686 'Performance of wind assisted propulsion systems', aims to set a standard on how to measure, evaluate and verify the power saving of WAPS from long-term, in-service measurements by so-called on-off tests.

## Pure wind future

In the past few years, vessel concepts designed to rely on wind as the main source of propulsion have been gaining momentum. A good example is the upcoming Oceanbird wing sail installation onboard the Wallenius Wilhelmsen vessel *Tirranna*. These tests are setting a platform for the first fully wind-powered vessel – hopefully a milestone we will see soon. And the potential here is for fuel savings and emissions reductions of more than 50%, although their application is likely limited, at least initially, to lighter vessels.

WAPS are rapidly becoming one of the default technologies shipowners consider when planning newbuilds – at least for certain vessel types and routes. Their modular nature allows shipowners to achieve immediate fuel and emissions savings while maintaining flexibility for the future. ■

### RELEVANT DESIGN CONSIDERATIONS

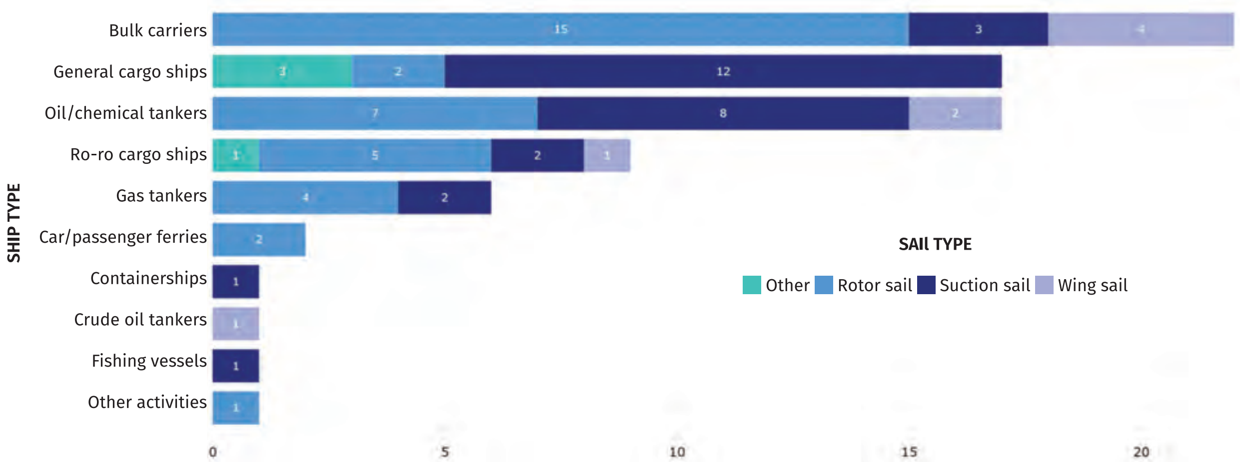
- Free air and deck space
- Structural integration
- Intact stability
- Installation in hazardous zones
- Added weight
- Air draft
- Obstruction of mooring configuration
- Performance optimisation
- Navigational: line of sight, navigation lights, radar sector

### RELEVANT OPERATIONAL CONSIDERATIONS

- Robustness/reliability/operational safety
- Interference with deck/cargo handling
- Engine and propeller derating
- Impaired manoeuvrability
- Crew education
- Port operations, pilots, towage, channels, locks
- Interference with helicopter/evacuation procedures

**Table: DNV feasibility study; design and operational considerations for WAPS installations**

## WAPS-EQUIPPED VESSELS BY SHIP TYPE




STATISTICS FROM AFI DASHBOARD, AS PER FEBRUARY 2026

# MIT RESEARCH SHOWS HOW TO CUT SHIP DRAG BY UP TO 7.5%

Study shows how wedge-shaped vortex generators reduce drag in ship hulls, which could help in the drive to decarbonise the shipping industry

Researchers at MIT have demonstrated that small wedge-shaped vortex generators fitted to a ship's hull can reduce drag by up to 7.5%, offering a practical and potentially low-cost route to cutting fuel consumption and emissions.

The findings were presented at the Society of Naval Architects and Marine Engineers' Maritime Convention in Norfolk, Virginia. The research team, drawn from MIT Sea Grant, the Department of Mechanical Engineering, and the Center for Bits and Atoms, used a combination of computational fluid dynamics, AI-assisted optimisation and physical scale model testing to identify the most effective vortex generator geometry.

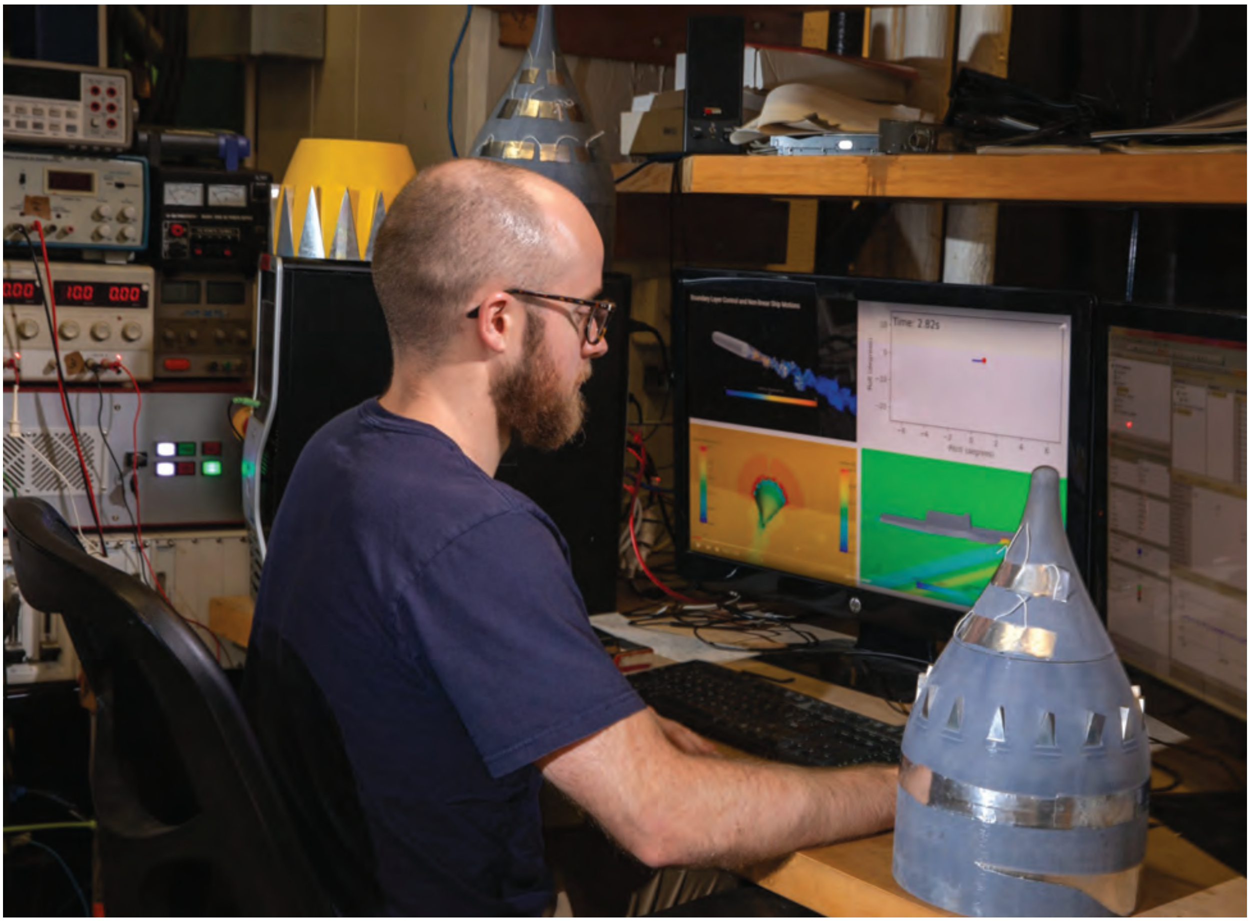
> **"The process began with extensive parametric analysis through computational fluid dynamics to establish design trends"**

The process began with extensive parametric analysis through computational fluid dynamics to establish design trends, before multiple hull variants were produced through rapid prototyping and tested experimentally to validate the computational results.

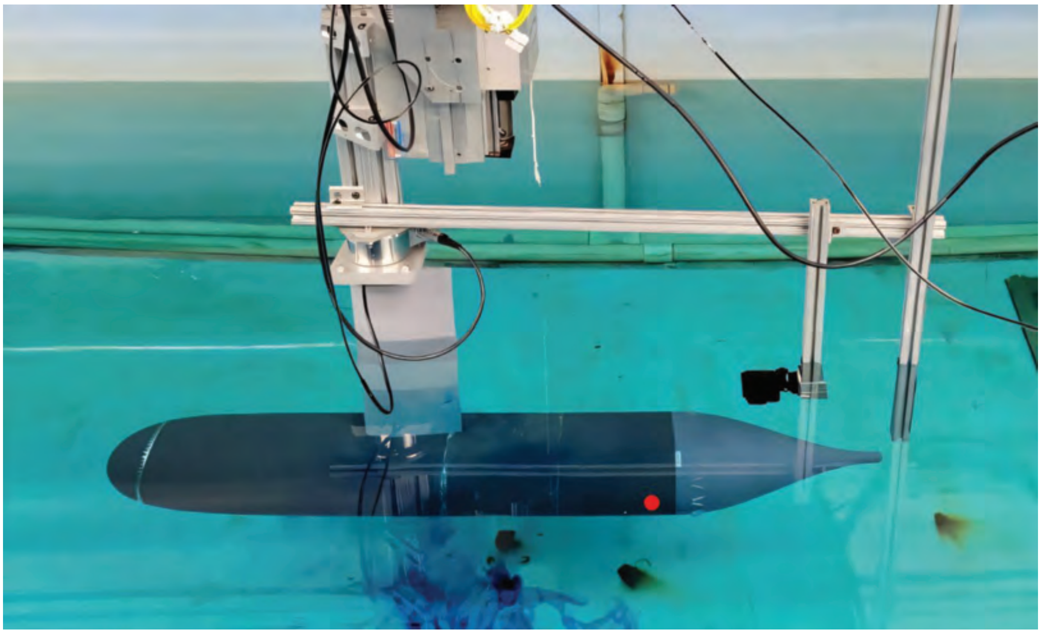
Three configurations were evaluated: a bare hull tail, a tail fitted with delta-wing vortex generators, and a tail fitted with wedge vortex generators. The wedge design emerged as the strongest performer, achieving attached flow along the hull with a lower skin friction coefficient than the delta variant.

By delaying turbulent flow separation, the devices help water travel more smoothly along the hull, significantly reducing the size of the vessel's wake. The resulting uniformity of flow also allows the propeller and rudder to operate more efficiently, compounding the overall performance benefit.

Lead researcher Michael Triantafyllou, professor of mechanical engineering and director of MIT Sea



**MIT used computational fluid dynamics, AI-assisted optimisation and physical scale model testing for their study**



**Left: Initial experimental setup showing the submerged axisymmetric model attached to the towing carriage**
**Below from top: Visualisations of hull setups; experimental flow visualisation using dye, compared to CFD flow visualisation at a speed of 1.3m/s; Tail 3, the best performing configuration**

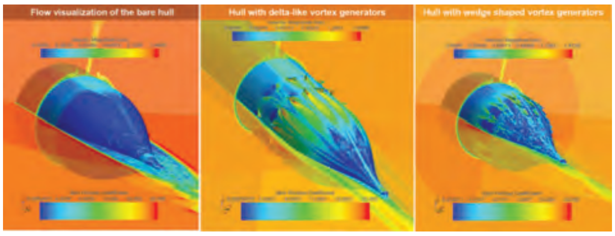
Grant, noted it was the first time a fuel reduction from vortex generators had been demonstrated experimentally on a ship hull. While vortex generators have been used for decades in aircraft wing design to maintain lift and delay stalling, their application to commercial shipping had not previously been validated at this level.

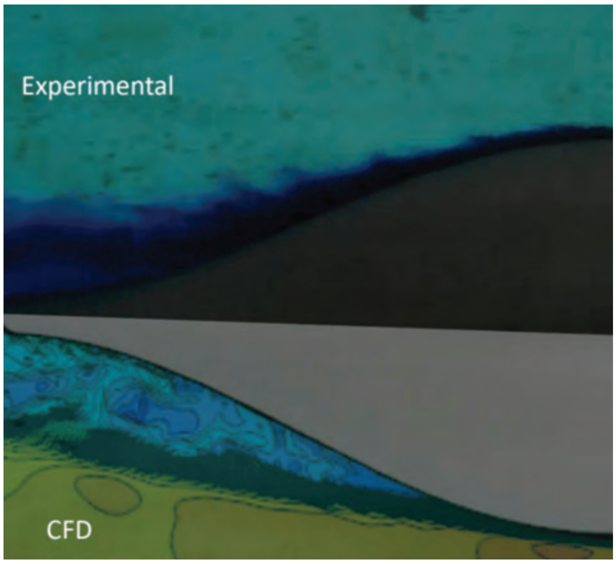
The team estimated that retrofitting the devices to a 300m Newcastlemax bulk carrier operating at 14.5knots on a trans-Pacific route would yield fuel savings of approximately US$750,000 per year, alongside a meaningful reduction in emissions. The modular nature of the wedge generators means they could be applied across a broad range of hull forms, including tankers and bulk carriers, and are compatible with existing drag-reduction technologies such as pre-swirl stators, which they could complement or, in some cases, replace.

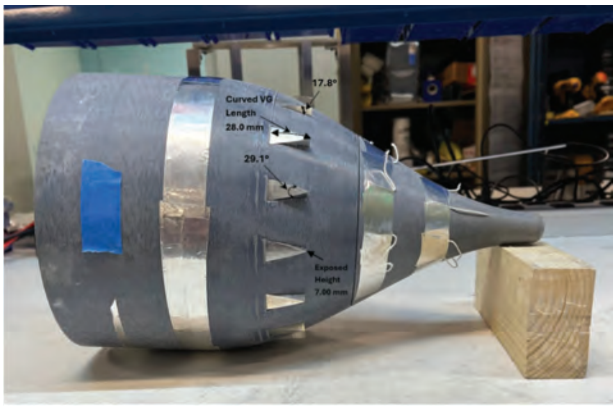
The practical appeal of the technology lies in its retrofit potential. Rather than requiring newbuild designs, the vortex generators could be integrated into existing vessels, offering shipowners a relatively straightforward path to improved efficiency at a time when the IMO's target of reducing carbon intensity by at least 40% against 2008 levels by 2030 is placing the industry under growing pressure to act.

The research was supported by the CBA Consortium in collaboration with Oldendorff Carriers, which operates around 700 bulk carriers worldwide, with further work backed by the MIT Maritime Consortium, established in 2025 to drive interdisciplinary research into the modernisation of the commercial fleet. ■

**"Rather than requiring new-build designs, the vortex generators could be integrated into existing vessels"**



# THE COANDĂ EFFECT

**Khaled M Karmous** explains his patented high-pressure water jet system that is showing promise as a new class of active friction-reduction technology, designed to cut fuel consumption by reducing hull drag

For most commercial vessels, frictional resistance accounts for between 50 and 92% of total hydrodynamic resistance, a figure that has defined naval architecture for generations. Hull-form refinement, low-friction coatings and reduction of wetted surface area have all pushed that figure down, but each successive gain is harder won. As designs approach established practical limits, the engineering community is looking elsewhere.

The regulatory context sharpens the urgency. The Energy Efficiency Existing Ship Index and the Energy Efficiency Design Index are demanding measurable, demonstrable gains. Even a 5-10% reduction in skin friction translates directly into reduced propulsion power demand, lower specific fuel oil consumption and improved headroom against compliance thresholds, figures that fleet operators and designers are watching closely.

Active flow control, techniques that modify boundary-layer behaviour dynamically rather than passively, represents one of the most technically promising avenues remaining. It is in this space that a new approach, based on a well-known but underexploited fluid dynamics phenomenon, is attracting attention.

## The Coandă effect in water

The Coandă effect describes the tendency of a fluid jet to adhere to an adjacent curved or flat surface. The mechanism is well understood in aerodynamics: entrainment of surrounding fluid by the jet creates a localised pressure drop between jet and surface, bending the jet toward the surface and sustaining its attachment. What is less commonly exploited is that the effect operates in liquid flows as well as gaseous ones.

The system described here, protected under US Patent 12,280,854 B2 (2024), directs high-velocity water jets along the hull surface at shallow incidence angles, with jet momentum sufficient to dominate the local near-wall flow field. Under these conditions, the jet adheres to the hull surface and travels with it, the precondition for everything that follows.

The low-pressure region is generated dynamically by the jet, not imposed by hull geometry. That distinction is fundamental.

## From surface attachment to vacuum air sheet

As the surface-attached jet travels along the hull, entrainment continuously reduces static pressure in the near-wall region, forming a sustained low-pressure line. This low-pressure region is not a consequence of hull form – it is generated dynamically by the jet–surface interaction, and it persists as long as the jet operates. The distinction matters: it means the air entrainment mechanism is active and controllable, not a fixed function of hull geometry.

Before crossing the waterline, the free jet naturally entrains atmospheric air through its shear layer. As the jet penetrates the free surface and travels down the hull, it carries this entrained air with it, forming a submerged vacuum air sheet, a continuous, surface-attached layer of air between hull plating and the surrounding water. Computational fluid dynamics (CFD) analysis using volume-fraction contours confirms that this sheet achieves near-complete air coverage (volume fraction approaching 1.0) over substantial hull areas.

Where the system departs significantly from conventional air lubrication systems is in the character of the air layer itself. Pressurised bubble injection produces buoyancy-dominated bubbles that migrate vertically and disperse away from the hull surface, requiring continuous replenishment and exhibiting inherently inconsistent coverage. The vacuum air sheet produced by jet-induced entrainment is flow-controlled rather than buoyancy-dominated. Because the entrained air moves with the hull-mounted jet, and therefore at vessel speed, it remains attached to the hull surface, resisting the rapid vertical migration that compromises conventional systems.

**"The low-pressure region is generated dynamically by the jet, not imposed by hull geometry. That distinction is fundamental"**

## Pressure mechanics and operational stability

Pressure distribution measurements across the air sheet, perpendicular to the hull, reveal a distinct negative pressure peak near the hull surface, recovering toward ambient conditions further out. This sub-atmospheric core is the entrainment-driven vacuum that holds the sheet in place. On the outer boundary of the air sheet, the vessel's passage through the water creates a relative flow that acts as a pressure barrier, further resisting disruption of the layer.

Longitudinally, the air sheet exhibits a pressure gradient: lower at the forward end, recovering

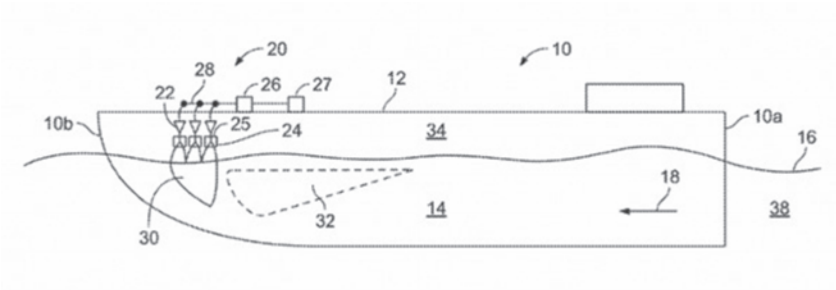



**Figure 1: Concept of Coandă-effect water jets on ship hull (reproduced from patent, US 12,280,854 B2, System and Method for Reducing Drag on the Hull of a Vessel)**

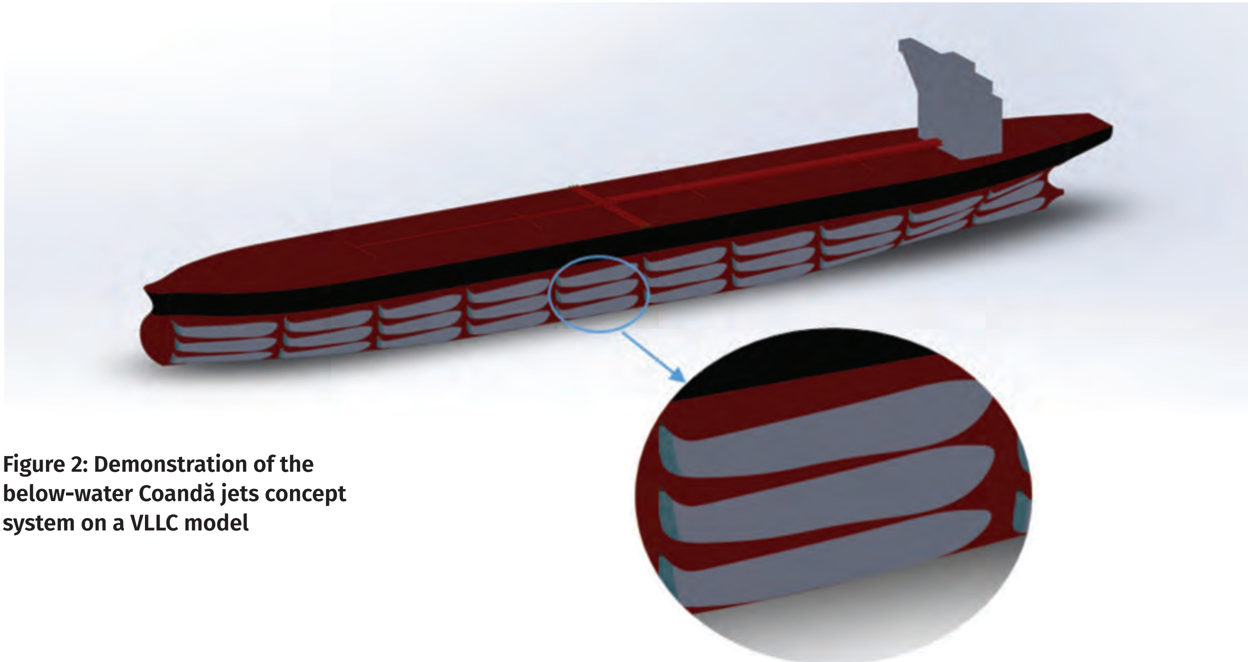


**Figure 2: Demonstration of the below-water Coandă jets concept system on a VLLC model**

towards the stern. Importantly, the sheet conforms to hull form contours irrespective of local curvature, which has direct implications for applicability across vessel types. Nozzles can be positioned along bow, midship, bottom, and stern sections; pump configurations can be selectively activated; and jet incidence angles and operating pressures are adjustable to optimise the balance between power input and air-layer behaviour.

## Retrofit potential and practical implications

The system's surface-following character, combined with its independence from hull-integrated air plenums or distribution networks, makes it technically suitable for retrofit. The nozzle assemblies attach to existing hull structure; no cavity machining or major structural modification is required. This is a meaningful practical advantage over cavity-based air lubrication systems, which typically require dry-dock integration during newbuild or major conversion.

Where the air sheet achieves full coverage, the system offers zero skin friction in that region, and the hull is effectively isolated from the surrounding water. The question of net energy benefit, however, requires careful analysis: pump power demand must be offset against propulsive power savings, and this balance is expected to be vessel-type and speed-dependent. Also, when the entire wetted area of a vessel is covered with vacuum air sheets, a feasible objective, then vessel speed can be increased dramatically. The Coandă effect fluid jet system can be fitted to any size vessel.

## Open questions and the road ahead

We are transparent about what remains to be characterised. Scaling behaviour from model to full-scale needs to be established systematically. Interaction of the air sheet with surface roughness and biofouling, which alter near-wall turbulence structure, requires dedicated study. Long-term operational stability under varying sea states, trim, and loading conditions represents another gap in the current dataset. However, since the air sheet adheres to the hull, then we believe this system will perform best-in-class when it comes to vessel motions.

The most technically intriguing near-term development is the investigation of pulsed Coandă jets as an alternative to continuous operation. Evidence from related flow-control research suggests that pulsed jets preserve momentum more efficiently and reduce average power consumption, while potentially improving air transport across the air–water interface. Future CFD work is being planned in this area.

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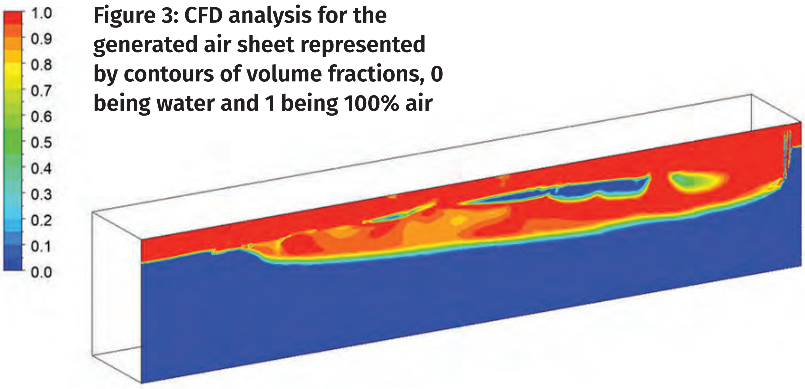
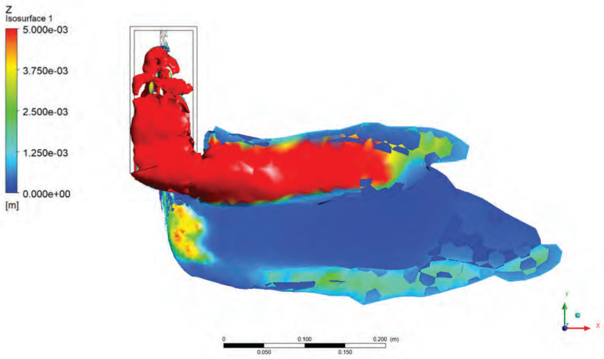



**Figure 3: CFD analysis for the generated air sheet represented by contours of volume fractions, 0 being water and 1 being 100% air**



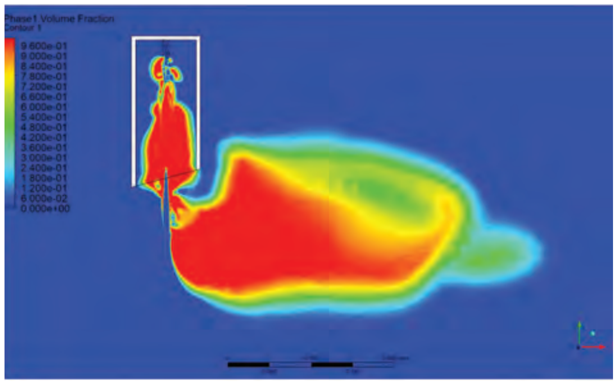



**Figure 4: Single jet fixed below waterline contours of volume fraction (left) and isosurface of 0.5 volume fraction (right)**

**Figure 5: Pressure distribution across the air sheet (perpendicular to the hull) showing the negative pressure region**

As a concept, Coandă-based jet-induced air entrainment occupies a distinct position in the friction-reduction landscape: neither a passive surface treatment nor a conventional pressurised air system, but a form of active multiphase boundary-layer manipulation with its own physical principles. Whether it can deliver net energy gains at operational scale, and at what cost per vessel type, will determine its place in the toolkit available to naval architects navigating an increasingly demanding regulatory environment. ■

## Note:

Khaled M Karmous is the named inventor of US Patent 12,280,854 B2, System and Method for Reducing Drag on the Hull of a Vessel, 2024.

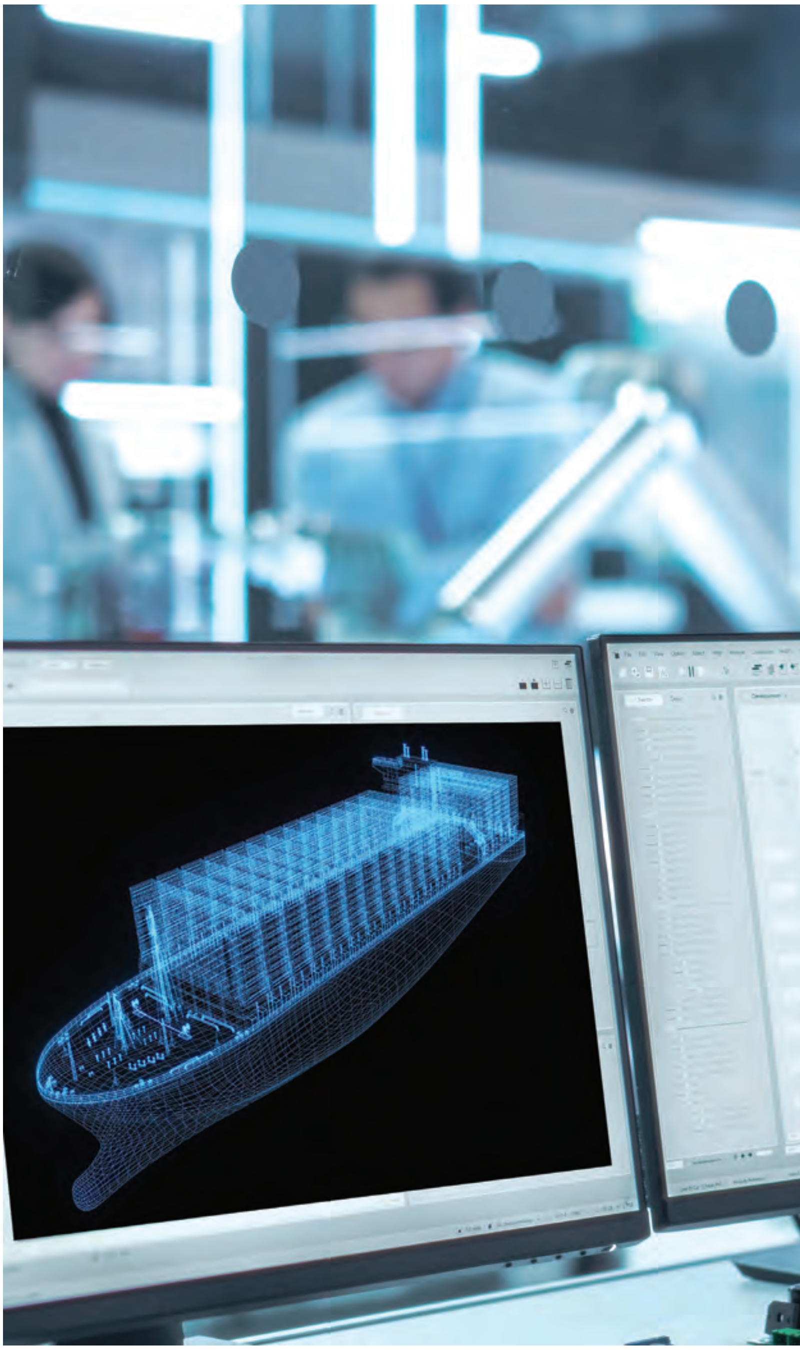
*__Khaled M Karmous__ (pictured right) is a mechanical engineer, who graduated from North Carolina State University. He has more than 30 years' experience in oil and gas drilling operations and engineering, and now focuses on developing and advancing practical engineering inventions.*

*With thanks for the help of __Mohamed Hussain__, PhD, PE, who specialises in marine hydrodynamics, multiphase CFD, and innovative energy-saving concepts, with a focus on reducing hull drag and improving energy efficiency solutions for the shipping industry.*

**"As a concept, Coandă-based jet-induced air entrainment occupies a distinct position in the friction-reduction landscape"**

# TECH TONIC

**Dr Rodrigo Pérez Fernández** examines digitalisation and AI as enablers of next-generation shipbuilding



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Shipbuilding has always absorbed the technologies of its era, from iron hulls to diesel propulsion to computer-aided design. The current transition is no different in kind, but it is different in scale. Digitalisation and artificial intelligence (AI) are not simply new tools added to an existing process, they are reshaping the logic of how vessels are conceived, built and operated. For shipyards that move quickly, the competitive implications are substantial.

Machine learning algorithms can evaluate thousands of hull configurations, propulsion options and internal layouts in the time it would take a design team to assess a handful. Predictive analytics can flag structural risks and schedule delays before they materialise on the shop floor. The effect is not just faster work, but qualitatively better decisions, made earlier, when they are still cheap to act on.

## The design imperative

Design typically accounts for 5 to 10% of a vessel's total production cost, yet that investment determines roughly 85% of final construction expenditure and conditions nearly 90% of operational performance across the vessel's lifetime. The early decisions made regarding hull form, structural approach, propulsion and energy systems cascade through every subsequent phase. Getting them right is not merely a design office concern, it is the single greatest lever available to improve project economics.

Fragmented or linear workflows are no longer adequate to manage this responsibility. The interdependence between hull, structure, mechanical systems, piping and electrical architecture means that changes in one domain propagate unpredictably through others. AI-assisted integrated design environments address this directly: optimising weight distribution, identifying interference risks between components, and running multiphysics simulations that analyse several interacting physical phenomena simultaneously. Engineers can explore a far larger solution space in the concept phase, which is where that exploration has the highest return.

The traditional spiral design model, iterating sequentially through concept, preliminary and detailed phases, struggles to accommodate this level of interdisciplinary integration. A model-based approach, closer to the V-model used in other advanced engineering disciplines, better reflects how modern design actually works: in parallel, with continuous validation against requirements rather than staged handoffs.

## Digital twins across the lifecycle

The digital twin has become a central concept in next-generation shipbuilding, although its value depends entirely on how it is implemented. A static geometric model is not a digital twin in any meaningful sense. The useful version is a live, data-enriched representation of the vessel that is updated throughout its lifecycle, first with design and simulation data, then with construction data, and finally with operational data from IoT sensors monitoring systems at sea.

This continuous feedback loop changes the economics of both construction and operation.

**"Predictive analytics can flag structural risks and schedule delays before they materialise on the shop floor"**

Validating vessel behaviour under a wide range of conditions before the first steel plate is cut reduces costly late-stage design changes. Once in service, condition-based monitoring and predictive maintenance strategies, driven by real-time sensor data, can extend equipment lifespan and reduce unplanned downtime. Crucially, the operational data also feeds back into future design processes, improving the accuracy of the models used on the next vessel.

Underpinning all of this is what practitioners call the digital thread: a single, authoritative data environment that consolidates mechanical, electrical, piping and structural design into one system. Global teams work from the same model regardless of location or time zone, eliminating the version-control failures and conflicting drawings that have historically generated rework. The digital thread does not just accelerate the process; it changes its error profile, removing entire categories of mistake.

## AI in the shipyard

The application of AI extends well beyond the design office. On the production floor, AI-driven planning systems optimise construction sequences, predict schedule risk and identify inefficiencies before they compound. Computer vision algorithms inspect welds and component

# ICCAS 2026

## International Conference on Computer Applications in Shipbuilding

The International Conference on Computer Applications in Shipbuilding (ICCAS) was first organised in 1973 and has since taken place all around the world. Over the decades, ICCAS has become a well-established and highly respected event within the maritime industry, known for presenting cutting-edge research and fostering in-depth technical discussions. The conference consistently brings together a unique mix of academic experts and industry practitioners, providing a collaborative platform to share knowledge, challenges, and innovations in shipbuilding technologies.

ICCAS focuses on the practical application of digital technologies across all stages of the ship lifecycle. Topics include data capture and management, cybersecurity, digital twin decision support, artificial intelligence, virtual sensors, naval architecture, project management tools, environmental performance including decarbonisation and wind-assisted propulsion, operational optimisation, 3D modelling, and the design of unmanned and autonomous vessels. ICCAS also welcomes research on advanced computing technologies relevant to the maritime sector.

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alignment in real time, catching defects that human inspectors may miss under production-line conditions and that, if left undetected, become exponentially more expensive to rectify.

The integration of machine learning into computational fluid dynamics (CFD) simulations is particularly significant. CFD has long been a bottleneck in hull optimisation, computationally expensive and therefore limited in how many alternatives a design team can practically evaluate. Machine-learning-accelerated CFD dramatically shortens computation times, allowing iterative hull form optimisation across resistance, energy efficiency and fuel consumption without proportionally increasing engineering cost.

Augmented and virtual reality tools are changing workforce training and assembly guidance. Rather than relying on paper drawings or static digital files, technicians can work with spatially accurate overlays that guide complex assembly tasks, reducing errors and accelerating the learning curve for less experienced workers. As yards compete for skilled labour in a tight market, these tools have operational as well as quality implications.

## Challenges that remain

None of this is straightforward to implement. Technological interoperability, getting legacy systems, supplier data and new platforms to communicate cleanly, remains a significant operational headache. Initial investment costs are substantial and the return on investment, while real, is distributed over years rather than visible in a single project. Cybersecurity risks increase as shipyard infrastructure becomes more connected. And workforce transformation requires sustained investment in training that many yards have historically under-resourced.

**"As yards compete for skilled labour in a tight market, augmented and virtual reality tools have operational as well as quality implications"**

Regulatory compliance adds another layer of complexity. IMO emission reduction targets – 70 to 80% reduction in greenhouse gas emissions by 2040 and net zero by 2050 – create design requirements that did not exist a decade ago. Meeting those targets while managing cost and schedule pressure demands exactly the kind of multi-variable optimisation that AI tools are best suited to support. But it also requires regulatory frameworks to keep pace with the technologies being adopted, which is not always the case.

Product Lifecycle Management solutions have proven their value in managing the data complexity associated with these challenges. Yards that have centralised their data environments report improved resilience against supply chain disruptions, better customisation capability for client requirements, and more reliable planning processes. The pandemic-era

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supply chain failures accelerated adoption in a number of cases, demonstrating that digital integration is not just a competitive advantage but an operational necessity.

## The direction of travel

The convergence of naval engineering and AI is not a future prospect – it is already visible in yards across Europe, Asia and the Americas. Digital twins are reducing construction time and cost. AI is cutting material waste and catching operational issues before delivery. Simulation tools are informing maintenance planning in military and commercial contexts alike. The technology is available; the differentiating variable is the organisational will and capability to deploy it effectively.

The next step in this evolution is the genuinely paperless vessel – not just a ship designed without drawings, but one operated and maintained through precise digital records, live system data and AI-supported decision-making throughout its service life. That is a more significant transformation than the industry has seen in generations, and the yards that position themselves for it now will have an advantage that compounds over time.

For naval architects, this shift redefines the scope of the discipline. The skills required to design a hull remain essential; the skills required to model its behaviour in a connected digital environment, and to interpret what that model tells you, are becoming equally so. The best engineering judgement has always been informed by the best available data. The change is that the data is now better, faster and more comprehensive than anything the industry has previously worked with. ■

***Dr Rodrigo Pérez Fernández***
*is senior director for software engineering at Siemens Digital Industries Software*

# WHY ANCHORING SYSTEM LAYOUT DESERVES GREATER DESIGN ATTENTION

As vessel designers push the boundaries of space and efficiency, the humble anchoring system is increasingly caught in the squeeze

The anchoring and mooring equipment sector has developed a troubling tendency in recent years, according to Muir, a company based in Hobart, Australia. More and more equipment suppliers are adopting what the company describes as a "hands-off" approach to system integration and layout: hardware is specified, priced and delivered, but meaningful guidance on how it should be installed and arranged within the vessel is absent. For a naval architect or design engineer already managing competing pressures across a complex project, that gap in support can have real consequences, it says.

The firm says the issue is compounded by the direction contemporary vessel design is taking. Whether in the superyacht sector, commercial shipping or defence procurement, designers are under constant pressure to save space and reduce topside weight, while simultaneously minimising the exposure of crew and operators to mechanical hazards. These are entirely legitimate design objectives, but they are reshaping the environments into which anchoring systems must fit, often without adequate consideration of the implications for the systems themselves.

## The shrinking foredeck

The superyacht sector offers perhaps the starkest illustration, says Max Buckley, general manager at Muir. The trend towards enclosed or semi-enclosed mooring decks, designed to present a cleaner aesthetic and reduce operator exposure to deck hazards, has dramatically reduced the working area available for anchoring equipment. Muir estimates that mooring island footprints on some modern yachts have contracted by as much as 50% compared with earlier generations of vessels of similar size.

What was once a relatively open deck area, the company says, where a windlass could be positioned with generous clearance and access for

**An example of Muir's anchoring system design**

installation and maintenance, has become a tightly choreographed space in which every component must earn its place. Chain stoppers and rollers must now sit far closer to windlasses than was historically standard. Hawse pipes and spurling pipes, the conduits that guide chain from the deck to the chain locker below, must navigate far more aggressive angles to connect all the equipment within the constrained footprint. The tolerances that experienced riggers once relied upon have, in many cases, been engineered away.

Commercial and defence projects present a parallel set of challenges, says Muir, though driven by different forces. Safety regulations and risk assessment requirements are increasingly dictating where operators can stand in relation to moving chain and rotating equipment. Chain stopper handwheels and windlass brake controls must now be positioned at specified distances and angles from the equipment itself. These requirements are sensible in isolation, but when they are layered onto a layout that was designed without them in mind, the entire anchor island may need to be rearranged, with consequent knock-on effects for chain run angles, equipment heights and deck penetrations.

## The cost of poor layout

The consequences of inadequate attention to anchoring system layout are not merely theoretical. Muir's field experience points to a recurring set of problems that emerge during commissioning, sea trials and early operation, issues that are invariably more expensive and disruptive to fix at that stage than they would have been to prevent on the drawing board.

- Chain whip during deployment, caused by misalignment between hawse pipe geometry and the windlass gypsy, can create dangerous conditions on the foredeck and accelerate wear on both chain and equipment.
- Excessive chain twist, which often arises from incorrect geometry in the chain path, can cause jams and require time-consuming manual intervention at sea.
- Wear on chain and equipment is accelerated wherever hawse and spurling pipe angles have not been properly matched to chain stopper and roller positions, leading to premature replacement of expensive components.
- Noise and vibration from misaligned equipment generate owner and captain complaints that ultimately reflect on the shipyard, not the equipment supplier.
- New pinch points between handwheels and adjacent structure, created when equipment is reshuffled to meet safety siting requirements, can introduce new hazards even as they resolve existing ones.

**A recommended design**

**"What was once a relatively open deck area where a windlass could be positioned with generous clearance, has become a tightly choreographed space"**

- Impact damage to vessel structures can occur where poorly arranged chain runs allow chain to strike hull or deck elements under load.
- Access and serviceability are often severely compromised in reduced-footprint anchor islands, making routine maintenance difficult and driving up the cost of ownership over the vessel's working life.

Many of these problems share a common root: they arise when each component in the anchoring system has been considered in isolation, without modelling the full chain path from locker to gypsy and confirming that geometry, clearances and alignments are consistent throughout.

## Getting it right in the design phase

The good news, Muir emphasises, is that most of these issues are preventable, provided the right questions are asked at the right time. The anchoring system should not be the last item considered on a foredeck layout; it should be integrated into the design process from the outset, with its geometry informing decisions about deck penetrations, locker volumes and equipment siting in the same way that other critical systems are treated.

Key considerations that designers should work through with their anchoring system supplier include:

- Chain alignment in both horizontal and vertical planes, including confirming that the chain run matches the pitch circle diameter of the windlass gypsy and that sufficient wrap is provided for reliable chain-to-gypsy engagement.
- Angular compatibility between chain stopper positions and the angles of hawse and spurling pipes, ensuring smooth chain passage without stress concentrations.
- Chain locker volume, which must be sufficient to accommodate the anticipated chain pile without causing windlass jams or inducing chain twist as the locker fills.
- Lead-in angles on capstans, which must be controlled to prevent overwrapping of rope or wire.
- Unsupported chain run lengths between components, which should not exceed manufacturer-specified maximums – and where they do, chain guides must be incorporated into the design.
- Safe positioning of all handwheels and manual controls, away from chain firing lines and the arc of any moving components.
- Correct alignment of chain strippers with chain paths, to prevent fouling during retrieval.

### Putting experience to work earlier

To help bridge the gap between system supply and system integration, Muir has developed a comprehensive design guide for anchoring and mooring systems, aimed at naval architects and project engineers working through the early stages of vessel design. The guide addresses the full chain path in detail and provides reference data to assist with system sizing and space allocation.

The company also offers full three-dimensional drawing packages for its equipment, allowing designers to import accurate geometry into their models at an early stage, before deck penetrations are cut and structural commitments made that are difficult to reverse. The goal, Muir says, is to shift the conversation about anchoring systems from the commissioning dock back to the design office.

Six decades of watching vessels leave the shipyard and return with avoidable problems has given the Tasmanian manufacturer a clear conviction: the anchoring system that nobody thinks about until the foredeck is almost finished is the one most likely to cause trouble. In a discipline that prides itself on rigour and systems thinking, that is an oversight the industry can ill afford.

"Our core philosophy is on 'inherently safe design'," says Buckley. "While effective maintenance regimes can mitigate wear interface risks, failures in the actuation and retainer systems require a more fundamental engineering solution." ■

## BUILT ON THE FINISH LINE

There are few manufacturers that can claim their founding location sits quite as close to the action as Muir. Established in 1968, the company's original workshop was positioned on the finish line of the Sydney to Hobart Yacht Race in Hobart, Tasmania, close enough, the company says, that crews could watch the fleet arrive from the slipway next door. Tasmania's rich maritime heritage provided a fitting cradle for what would become one of the world's most experienced anchoring system specialists.

Over the past 60 years, Muir has designed and manufactured anchoring systems for a remarkably diverse range of vessels: from 5m aluminium plate runabouts built in backyards to 120m superyachts, and from commercial workboats to 80m offshore patrol vessels for defence clients. That breadth of experience, the company says, has given it an unusually clear view of where the industry is going wrong, and how relatively straightforward design decisions made early in a project can prevent significant problems down the line.


**Muir's Boatyard, set up in 1968 (image: Muir's Boatyard)**

Andrew Buckley, Muir's executive chairman, says: "One of the things that sets Muir apart is the fact we've been able to build a culture and team of people who are really proud of what they do. We are proud to say we build something in Tasmania, Australia, that is used on some of the top superyachts in the world."

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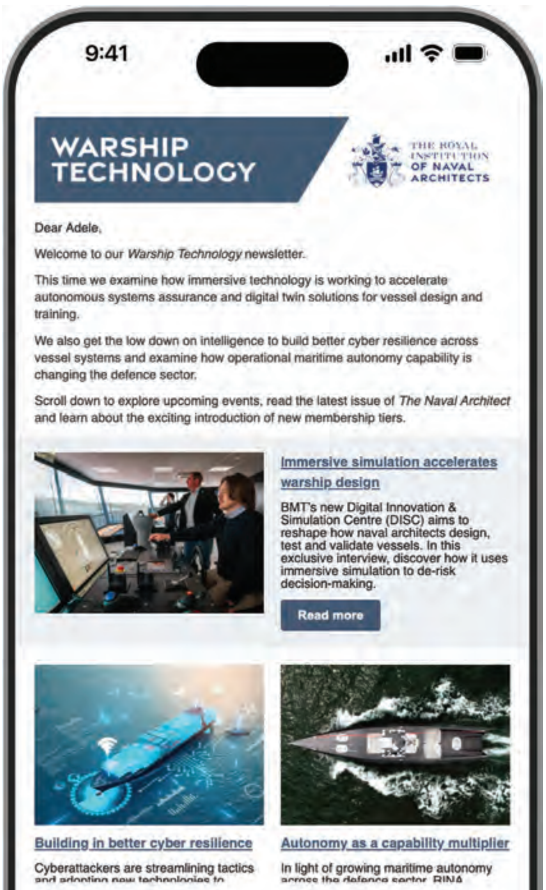


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