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RINA-QINETIQ Maritime Innovation Award

Innovation is key to success in all sectors of the maritime industry and such innovation will stem from the development of research carried out by engineers and scientists in universities and industry, pushing forward the boundaries of design, construction and operation of marine vessels and structures

The Maritime Innovation Award seeks to encourage such innovation by recognising outstanding scientific or technological research in the areas of hydrodynamics, propulsion, structures and material which has the potential to make a significant improvement in the design, construction and operation of marine vessels and structures

The Award is made annually to either an individual or an organisation, in any country. Nominations for the Award may be made by any member of the global maritime community, and are judged by a panel of members of the Institution and QinetiQ. The award will be announced at the Institution's Annual Dinner.

Nominations are now invited for the 2020 Maritime Innovation Award. Individuals may not nominate themselves, although employees may nominate their company or organisation.

QINETIQ

Nominations may be up to 750 words and should describe the research and its potential contribution to improving the design, construction and operation of maritime vessels and structures.

Nominations may be forwarded online at www.rina.org.uk/maritimeinnovationaward

or by email to: maritimeinnovationaward@rina.org.uk

Nominations should arrive at RINA Headquarters by 31st January 2021.

Queries about the award should be forwarded to the Chief Executive at hq@rina.org.uk

EILY KEARY AWARD

The Royal Institution of Naval Architects is committed to ensuring that all individuals, regardless of gender, faith or ethnicity, have equal opportunity to participate fully in all the Institution's activities. The Institution also seeks to encourage such equality of opportunity and involvement throughout the global maritime industry.

The annual **Eily Keary Award** recognises the contribution by an individual, organisation or part of an organisation to increasing equality, diversity and inclusion in their sector of the maritime industry. Such contribution may have been made by a specific activity or over a period of time. Individuals may not nominate themselves for the Award

Nominations are now invited for the 2020 Eily Keary Award.

The Award will be announced at the Institution's 2021 Annual Dinner.

Nominations may be up to 750 words and should describe the contribution which the individual, company or organisation has made.

Nominations may be forwarded online at www.rina.org.uk/EilyAward

or by email to EilyKearyAward@rina.org.uk

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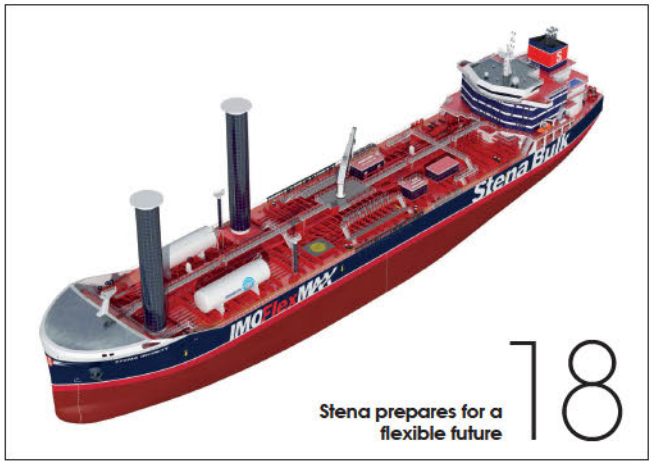

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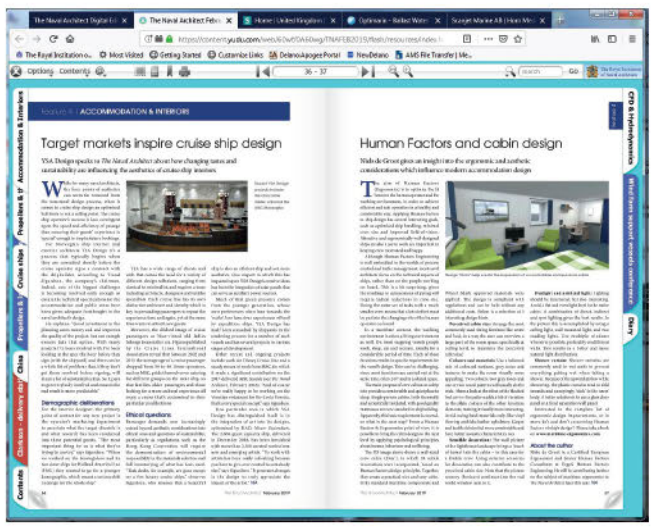

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RINA - Lloyd's Register
Maritime Safety Award

The Institution believes that safety at sea begins with good design, followed by sound construction and efficient operation. Whilst naval architects and other engineers involved in the design, construction and operation of maritime vessels and structures do not have a patent on such issues, nonetheless their work can make a significant contribution.

The Institution also believes that it has a role to play in recognising achievement of engineers in improving safety at sea. Such recognition serves to raise awareness and promote further improvements.

The Maritime Safety Award is presented by the Institution, in association with Lloyd's Register, to an individual, company or organisation which has made a significant technological contribution to improving maritime safety. Such contribution can have been made either by a specific activity or over a period of time. Nominations may be made by any member of the global maritime community, and are judged by a panel of members of the Institution and Lloyd's Register. The Award will be announced at the Institution's Annual Dinner.

Nominations are invited for the 2020 Maritime Safety Award

Lloyd's Register

Nominations may be up to 750 words and should describe the technological contribution which the individual, company or organisation has made in the field of design, construction and operation of maritime vessels and structures.

Nominations may be forwarded online at:
www.rina.org.uk/maritimesafetyaward

or by email to:
maritimesafetyaward@rina.org.uk

Nominations should arrive at RINA Headquarters by **31 January 2021**

Queries about the Award should be forwarded to the Chief Executive at:
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The trouble with maritime journalism

Surprisingly, writing and editing *The Naval Architect* is nothing like All the President's Men

One of the great frustrations in being editor of a magazine is juggling the various responsibilities with telling the kinds of stories you would like to. Perhaps I shouldn't be admitting this, but the fact is most articles require a degree of compromise. Making time to write and research those more involved articles while editing, commissioning, proof reading and the sundry tasks that come with a relatively small publication such as this can be extremely challenging. On top of that comes the difficulty of finding people who are willing to talk openly about subjects without fear of professional repercussions, even 'off the record'. Recently, I put a call out on social media for naval architects who might be willing to discuss the problem of enclosed spaces from a design perspective and was met with…. a deafening silence.

As a journalist there's a tendency to look upon the great achievements in investigative reporting, *The Washington Post*'s exposure of Watergate being the classic example, with reverence and more than a little envy. But while shipping is not without its share of political intrigue, one quickly comes to appreciate that in trade journalism, particularly when a publication is focused on technologies and innovation, it's probably not a good idea to bite the hand that feeds you. There's a symbiosis between the medium and the messengers; PR roles are often filled by friends and former colleagues and it's difficult to be too critical of companies when they go out of their way to be friendly and approachable. Moreover, I've never been comfortable with salacious muckraking for its own sake; too often a juicy tidbit one chances upon in conversation either doesn't justify being blown into a story or can't be substantiated. I've seen it done and I don't like it.

Sometimes you simply need more time than is available to research a topic to your satisfaction. A prime example is this very column. Last night, I spent several hours drafting a piece about an entirely different subject (car carriers) and touching upon work currently being undertaken by RINA's own IMO committee, before deciding it might be better to wait until the publication of the NTSB's investigation report into last year's *Golden Ray* capsize in the US, which hopefully will emerge before the end of the year. The stability and loading implications of that incident, like that of *Hoegh Osaka*'s deliberate grounding in the Solent Channel in 2015, are a matter in which I believe *The Naval Architect* should be taking the lead in terms of editorial coverage and something I hope we can do in 2021.

At the time of *Hoegh Osaka* I was working as the de facto editor of *Safety at Sea* (*SaS*) magazine, which sadly announced last week it was to cease publication after 53 years. Although there probably wasn't a great deal of overlap between the readerships of our respective periodicals, *SaS* being particularly focused on the welfare and wellbeing of seafarers, one of the things it did particularly well was drilling down into the underlying causes of accidents, whether that was safety culture or, sometimes, structural. Like *TNA* it was slightly removed from the cut and thrust of markets and charter rates, since the bottom line was always the human element. Diplomacy prevents me from saying everything I would like to about its demise, although its biggest problem was one shared across all traditional print media: how to retain readers when they can get their news for free. The trouble is, even speaking as someone with a vested interest in preserving the sovereignty of independent journalism, persuading people to treat it as a commodity in an age of ubiquitous information is a huge challenge. For many maritime publishers even advertising no longer suffices, with a growing dependency on organising conferences and sponsored events (undermined, needless to say, by the current pandemic).

One of the great cliches, although supported to some extent by scientific evidence, is that people have a shorter attention span nowadays. Online news stories, we're told, need to be short and direct in the points they're making. But the great pleasure of traditional books and magazines is that lack of immediacy; you can put them down and come back later on without the concern that your battery is running low.

I think there's still a place for longer format journalism and why I particularly enjoyed writing 'A Manx Tale' (p.22-25), about the current Isle of Man's ferry and the forthcoming replacement vessel. Again, it's something I'd like to do more of in the future and welcome suggestions from readers about vessels and projects they've been directly involved with that can serve as 'raw material', much like Jack Brown approached me a couple a months ago.

Rest assured, however, that *TNA* will remain a technically focused publication for as long as I'm the editor and we'll continue to use a variety of formats and approaches to tell the bigger story of maritime's ongoing evolution. *NA*

Alternative fuels

Vessel sails 2,000 hours on sustainable biofuel

Jan De Nul's hopper dredger, *Alexander von Humboldt*, has become the first ship to travel for 2,000 hours using 100% renewable, marine biofuel oil (BFO).

Powered by one of MAN Energy Solutions' 7L32/40 and two 12V32/40 main engines, *Alexander von Humboldt* was refuelled with BFO at various points in its journey, thus achieving a CO_2 emission reduction of 85%. The ship also operated on BFO during its maintenance dredging work at seaports in Belgium and the UK.

The BFO used by *Alexander von Humboldt* was introduced to the market by Netherlands-based biofuel specialist, GoodFuels, in 2018 and is derived entirely from sustainable waste feedstock.

According to Jan De Nul, the voyage is a major milestone and the longest continuous use of 100% sustainable biofuel in the industry, proving that BFO is a viable, available fuel that could be used as a drop-in to meet industry emission targets.

Michel Deruyck, head of energy department at Jan De Nul Group, adds: "It is very important now that the right policies and regulations follow to leverage the full potential of BFO. Research into fuels of the future is useful, but it should not prevent us from using sustainable solutions already available today for the much-needed energy transition within the shipping industry."

Jan De Nul's *Alexander von Humboldt* is the first vessel to travel for 2,000hours running entirely on biofuel oil

Alternative fuels

Danish consortium to develop ammonia-fuelled engine

Innovation Fund Denmark has established the AEngine project, a consortium that aims to deliver a two-stroke ammonia-fuelled engine by 2024. It also plans to develop a full propulsion system for the industry's first commercial order of an ammonia-fuelled vessel.

The project comprises three main stages: the ammonia engine concept development and initial design, ammonia fuel supply system design and full-scale testing. The wider implications of using ammonia as fuel will be covered by the project partners, MAN Energy Solutions, Eltronic FuelTech, the Technical University of Denmark (DTU) and DNV GL.

While Eltronic FuelTech will handle the engine's fuel supply, purging and venting systems, classification society DNV-GL will cover safety regulations and design-related safety queries. DTU's departments will investigate ammonia's combustion and corresponding pollutants and act as consultant through its previous experience in small ammonia-engine research.

The consortium plans to demonstrate its large ammonia-fuelled engine at MAN's test facility, Research Centre Copenhagen. As project coordinator, MAN will integrate its technology into an ammonia propulsion-train and take on responsibility for fuel injection, the combustion system, emission after-treatment technology and on-engine components.

MAN states that ammonia has been selected as it is a carbon-free fuel, equally its production from electricity is infinitely scalable and does not require a carbon-based source. Further, the company adds that ammonia has an established infrastructure and large quantities are already transported worldwide, with over 120 ports involved in import, export and storage.

Emissions control

BIMCO voices concerns over EU's carbon plans

BIMCO claims that shipping's inclusion in the EU Emissions Trading Scheme (ETS) will impede the sectors' global efforts to reduce CO_2 emissions.

The EU ETS, the world's largest GHG trading scheme, is deliberating plans to include shipping in a regional ETS. However, BIMCO advocates for the EU to collaborate with IMO and instead create a global market-based measure once the necessary technology is available.

A regional market-based measure will not incentivise shipowners to invest in carbon reducing technologies, BIMCO says, as it is difficult to determine how frequently a ship will call at EU ports in its lifetime and, therefore, whether new technology investments will pay off.

Additionally, viable technology solutions must be commercially available in order to reduce carbon emissions and BIMCO comments that it will consider market-based measures only when the technology is ready. "In the meantime, BIMCO advocates for an International Maritime Research Fund to drive

innovation, paid for by a mandatory contribution on fuel used by ships, into technology the industry needs to cut carbon emissions by 50% in 2050," says David Loosley, BIMCO secretary general.

BIMCO highlights that the EU ETS's previous attempt to implement similar restrictions in the aviation industry has not ultimately reduced the sector's CO_2 production. Further, upon enforcing its aviation ETS, the EU faced opposition from China, India and the US, which BIMCO states could happen in response to shipping restrictions, made worse by 2020's strained political climate. The association adds that it could cause discord between IMO member states and decrease the likelihood of a more effective, global measure being put into place.

Alternative fuels

HySHIP project wins European funding award

The HySHIP Project, which aims to design and construct a demonstration vessel running on liquid green hydrogen (LH2), has received €8million funding from the EU's Research and Innovation programme, Horizon 2020.

The demonstration vessel, *Topeka*, will be the first of its kind to enter commercial service. Travelling on a fixed schedule, the ship will carry both coastwise customer cargo and containerised LH2 to bunkering hubs along Norway's coast. The vessel will be equipped with 1,000kWh battery capacity and a 3MW proton exchange membrane (PEM) hydrogen fuel cell, preparing it for zero emission operations.

Due for service in 2024, *Topeka* will be operated by Wilhelmsen, and hydrogen for its fuel cell will be sourced from a new LH2 production plant to be built at Mongstad, Norway.

HySHIP also plans for three replica studies; a 1MW tanker barge used on inland waterways, a 3MW fast ferry and a scaled-up 20MW energy system for deep sea vessels using a Capesize bulk carrier.

HySHIP Project's *Topeka* will operate entirely on liquid green hydrogen

According to Wilhelmsen, the project will be a large-scale validation of the vessel, its power system and distribution network. HySHIP also aims to establish a corresponding LH2 supply chain and bunkering platform, as well as reducing the development and operational costs of a broader transition to LH2 ship propulsion in Europe.

Horizon 2020 will grant the €8 million funding under its Fuel Cells and Hydrogen Joint Undertaking (FCH2 JU), dependent upon HySHIP's 14 European project partners signing a grant agreement before the end of 2020.

Regulations

Former IMO chief William O'Neil dies

The death has been announced of William A O'Neil, former secretary general of the IMO, at the age of 93.

O'Neil led IMO from 1990-2003, the second longest incumbency in the position. During his tenure, the organisation adopted several new treaties and responded to global maritime security and piracy issues.

His actions led to substantial improvements in maritime safety standards; he worked with the IMO membership to tackle safety issues of bulk carrier and large passenger ships and after the *Estonia* ferry sank in 1994, he set up a team of experts to investigate ro-ro safety measures.

In 1997, he oversaw Protocol's adoption of Annex VI 'Prevention of Air Pollution from Ships' to the MARPOL Convention, as well as revisions to accelerate the phasing out of single hull tankers. His foundational work in protecting marine biodiversity led to developing measures to prevent the spread of harmful aquatic species, which was ultimately adopted as a new IMO treaty on ballast water management in 2004.

In response to the 11 September 2001 attacks, Mr O'Neil led the development of the International Ship and Port Facility Security Code, a new regime for maritime security. He also established the Seafarers Memorial Fund, which paid for the public memorial to seafarers at IMO's headquarters in London.

Current IMO Secretary-General, Kitack Lim, passed on his own condolences and those of IMO to the Canadian Government and Mr O'Neil's family. "It is with great sadness that we have learned of the passing of Mr. O'Neil, who was a great friend and mentor who made a huge personal contribution to securing globally applicable safety, security and environmental standards," he said.

As an Honorary Fellow of the Royal Institution of Naval Architects (RINA), Mr O'Neil was a great supporter of RINA and the institution would also like to extend its sincere condolences. *NA*

Security concerns, ballast deadlines and an efficiency row

Security issues sandwiched a month during which the concerns over Covid did not actually subside but were overshadowed by other events, writes Malcolm Latarche

Cybercrime has been on shipping's agenda for some time now, so much so that from 1 January ship operators are obliged under the latest ISM Code regulations to make provision for attacks within safety management systems. At the end of September, French owner CMA CGM became the last of the big three European liner operators to fall victim to a cyber attack with its systems offline for over a week.

Reports of CMA CGM's problems had only just surfaced when IMO itself was hit. At first the industry regulator would admit only to technical problems affecting its website but later admitted it had been the victim of a 'sophisticated cyber-attack against its IT systems that overcame robust security measures in place'.

The attack on IMO did not hit the platform it uses for its online meetings and the FAL Committee meeting was able to go ahead. However, the GISIS database, IMODOCS and Virtual Publications services were offline for some time – perhaps not the best advert for the electronic Single Window concept that national and regional authorities are being encouraged to develop.

IMO did at least have support from the UN International Computing Centre and security experts to restore systems as soon as possible and to take measures to enhance future security. Ship operators probably do not have the luxury of such support.

At the end of the month, it was security of another sort that grabbed headlines after British special forces were called upon to end the 'hijacking' of the Liberian-flagged Navios-owned product tanker *Nave Andromeda*.

Reports of the incident suggest that seven stowaways entered the vessel during its call to Lagos in early October and were discovered by crew during the voyage. French authorities are reported to have denied the ship permission to land the stowaways in Saint Nazaire. The stowaways were then said to have become violent after the crew attempted to detain them and the crew then took refuge in the ship's citadel where they called for emergency assistance. The incident resembles a similar occurrence in 2018 involving four Nigerian stowaways onboard an Italian-owned vessel.

Investigation into the *Nave Andromeda* incident is continuing but given the situation with attacks on vessels in West African waters, the question of crew collusion has been raised. Under ISPS requirements, all ships should have a pre-departure procedure for ensuring no stowaways are onboard. When people gain entry to a ship hidden inside cargo there could be a good reason why they are not found prior to departure but that would hardly be the case for a tanker.

On a completely different issue, October has also seen the passing of the end of the line for older ballast water treatment systems. From 28 October, only systems approved under the new revised G8 procedure should be installed. There has been a last minute scramble by system makers to get the required certification, but some may have missed the boat.

The passing of the deadline does not mean that systems already installed are now illegal however, if installation of a now non-compliant system was planned but not completed, it would be a good precaution for owners to check with flag states what its status might be.

The rule change does mean that the number of approved systems is now much smaller than it was and doubtless some suppliers will now quietly depart the scene.

As October drew to a close it was another environment related issue that was dominating headlines and this time the IMO was attracting high praise and strong criticism in equal measures. The cause of this disagreement was the outcome of the IMO's Intersessional Working Group on Greenhouse Gases held from 20 to 23 October.

The meeting came up with a draft text on decarbonisation measures for existing ships to be discussed at the next MEPC meeting in November and if adopted likely to come into effect in 2023. It has to be said that the meeting was apparently contentious with the final draft being very much of a compromise that may well be rejected at MEPC or sent back for amendment.

Shipping bodies such as ICS were generally satisfied with the draft, which will require all existing vessels not subject to EEDI ratings to make improvements and reductions to their carbon output. This could be done by switching fuels, making other efficiency improvements or by reducing speed. BIMCO said the measures lacked clarity at this stage.

Environmental groups and some shipowners including Maersk were far from happy with the proposals saying they represented almost a business as usual approach and accused the IMO of ducking the issue. No doubt, the debate will continue through to and beyond the delayed MEPC 75 meeting to be held online in November. *NA*

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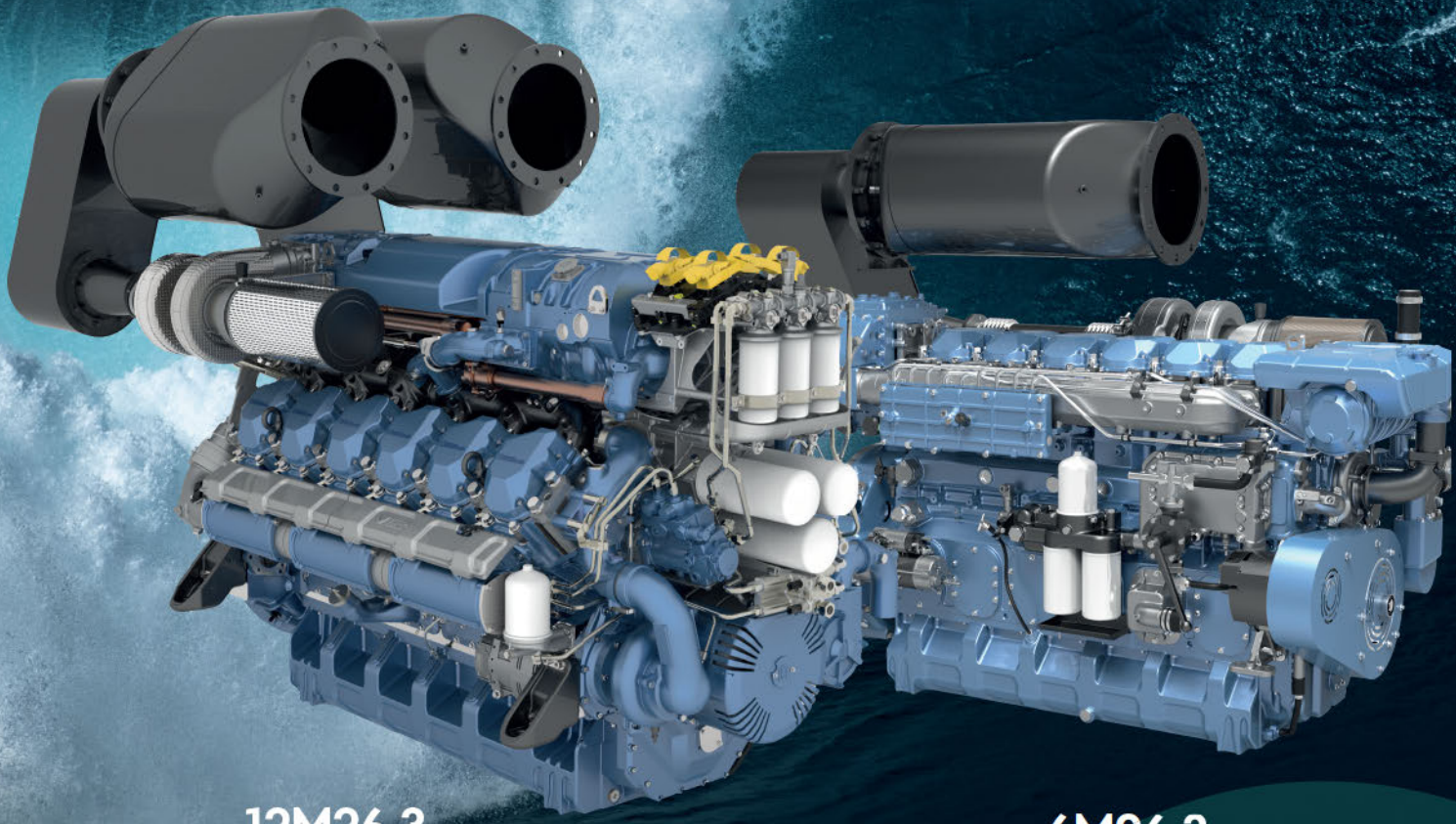

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Propulsion

Wärtsilä to power largest NGO hospital ship

Mercy Ships' new 174m long hospital ship, *Global Mercy*, the world's largest of its kind, will be powered by four Wärtsilä 32 engines.

The engines will be double resilient mounted and comply with DNV GL's VIBR vibration classification, which will enable the smooth running necessary for surgical operations happening onboard. Wärtsilä will also provide a five-year service maintenance agreement to keep the 37,000tonnne vessel running at all times, which covers parts, field service, asset monitoring, and full technical support.

The contract is part of Wärtsilä's Lifecycle Solutions, which uses measured data with indicators such as availability, reliability and fuel consumption to provide performance targets for the vessel and guarantee operational reliability. These targets are then achieved using automated key performance measurements, optimised maintenance and remote advisory.

While previous hospital ships have been passenger ship or other vessel conversions, *Global Mercy* is fully purpose built, making it one-of-a-kind; it has 12 decks, two dedicated to the hospital which has six operating theatres, 102 acute care beds and 90 self-care beds.

Mercy Ships provides essential healthcare to patients in developing countries, and *Global Mercy* will supply free surgical care during its maiden voyage to Africa after its expected delivery in 2021.

The latest Mercy Ships floating hospital, *Global Mercy* will be powered by four Wärtsilä 32 engines

Gas containment

GTT designs for four VLEC's

GTT will provide the tank design for four second generation 98,000m³ capacity VLECs, which will feature the Mark III membrane containment system.

The units will be designed for multi-gas purposes, allowing for the transport of ethane and several other gas types including propylene, LPG and ethylene. The cargo tanks will also have an 'LNG cargo ready' notation, which will offer vessels the future possibility of transporting/carrying LNG.

While the shipowner remains confidential, Korean shipyards Hyundai Heavy Industries (HHI) and Samsung Heavy Industries (SHI) will each build two VLECs. Scheduled for delivery in Q2 2022, the vessels are designed to optimise fuel consumption, reduce boil-off rate and increase cargo capacity.

GTT has previously been involved in an order for six second generation VLECs by Zhejiang Satellite Petrochemical from HHI and SHI, and the company claims this new order confirms its market position as the reference solution for VLECs.

Navigation

C-Map launches ITS system update

Marine cartography specialist C-MAP has launched an update to its IMS, a back-of-bridge voyage planning station that generates optimised routes to meet the ship's commercial objectives while minimising fuel consumption, maintaining seakeeping limits and avoiding dangerous weather conditions.

Where previously C-MAP's IMS relied on the manual process of working with Worldwide Navigational Warning Service (WWNWS) data, the IMS update includes a NAVAREA Warnings Service that provides automated and continuously updated data. The IMS system will overlay NAVEREA data onto the ship's chart, identify warnings along the vessel's route and include them within its Passage Plan Report.

Fully integrated with IMS' existing voyage planning and weather routing technology, the new weather warnings include global coverage of NAVAREA and Sub-Area warnings and coastal warnings for the Baltic, UK, Pakistan, Brazil, Australia, Argentina, South Africa, India, Japan, New Zealand and Norway, with further regions available.

Coatings

Nippon expands hull monitoring solution

Nippon Paint Marine has added the XSHIP performance tool to its existing KP Analysis fuel saving system, expanding its hull condition monitoring capabilities.

Since 2006, the company has offered an in-house service for verifying the fuel and power savings of its low friction (LF) self-polishing antifouling coatings range, LF-Sea, through its KP Analysis team.

However, after the ISO 19030 standard was introduced in 2016 it became widely accepted by the industry as a means to verify the performance of hull coatings. The company's new XSHIP tool is ISO 19030-compliant and enhances its existing ability to monitor and verify vessel performance by generating real-time management reports, weather reports and performance assessments.

After introducing the XSHIP tool, Nippon confirmed the supply of its A-LF Sea coating on a fleet of bulk carriers owned by Berge Bulk Maritime. The company claims that having a monitoring system compliant with ISO 19030 was a critical factor in Berge Bulk Maritime's decision to apply the coating as part of its current drydocking schedule.

Bill Phua, managing director of Nippon Paint Marine Singapore, adds: "Our enhanced hull performance measurement software enables the shipowner to have a continuous evaluation of the interaction between a vessel's hull and propeller. We can provide more precise data on how the hull coating is affecting speed loss, fuel efficiency and emissions."

LNG

Babcock delivers LNG carrier reliquefication system

Babcock LGE has supplied its LNG single mixed refrigerant (SMR) solution, ecoSMRT, onboard SCF Group's LNG carrier, *SCF Barents*.

The ecoSMRT system, which was developed in collaboration with Hyundai Heavy industries, provides efficient reliquefaction of LNG boil-off-gas using an SMR circuit. The product is currently fitted on five LNG carriers, but there are existing plans for a further 40 vessel installations in the next few years.

The 174,000m³ *SCF Barents* was delivered by Hyundai Samho Heavy Industries and will operate on a long-term charter for Shell. *SCF Barents* is second in SCF's new series of Atlanticmax LNG carriers ordered by the company in 2018 and all ships in the series will have the ecoSMRT system installed. They are among the first globally to feature the technology, which SCF Group claims will significantly reduce cargo losses while on long voyages or awaiting cargo operations.

According to Babcock, the ecoSMRT system provides the highest efficiency on the market as well as significant environmental and economic benefits for its customers. Roman Pokromkin, head of SCF Group's technical policy and shipbuilding unit, comments: "Since early days after commissioning of the ecoSMRT system onboard *SCF La Perouse*, it has been used whenever operational circumstances permitted. This has already provided a significant reduction in environmental footprint – to date, the vessel has liquefied 750tonnes of boil-off gas."

Babcock has installed its ecoSMRT LNG single mixed refrigerant solution on the 174,000m³ *SCF Barents*

Interiors

Bolidt builds momentum in ferry market

Bolidt has been expanding its presence in the global ferry sector, with the announcement of a number of new projects.

The company's Bolideck 525 decking system will be installed on three of NYC DOT Staten Island Ferries' new double-ended vessels, following a successful small-scale trial of the product. Bolideck 525 has already been applied to 4,000m² of indoor decks and passenger areas on two of the ferries and further work is planned on the second ship, with the final vessel due for delivery by Eastern Shipbuilding Group in 2021.

Bolidt has collaborated with GVB IJ Ferries on 14 vessels, including a recent order on five all-electric ferries that will operate between Amsterdam Centraal-Amsterdam Noord. Built at Holland Shipyard Group in the Netherlands, each ship will be fitted with Bolidt's Bolideck Select Hard and Boligrip solutions, a combination that Bolidt says will provide the ferries with a durable, non-slip surface for the foot and bicycle traffic prevalent in small ferries.

Elsewhere, Bolidt will install its Bolideck Future Teak and newly launched Boliscreed 400 ULW solution on the outdoor decks of four Havila Voyages' costal ferries under construction at Tersan Shipyard, Turkey. Bolidt's flooring solutions and Bolideck Future Teak will also be installed onboard a Tallink LNG-powered fast ferry, which will operate on the Tallinn-Helsinki route.

The company has further projects based in China, which Jacco van Overbeek, director of maritime at Bolidt, says is evidence of the company's growing international reputation. *NA*

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SHIP ECONOMY & TRADE

Realising the 'cruise made in China' dream

China Merchants Industrial Group is expanding its operations and facilities for the construction of medium-sized cruise ships and, alongside China Shipbuilding Group, helping to grow the country's comprehensive cruise ship industry

Covid-19 has caused the global cruise industry to come to a standstill, but the pandemic has also allowed China's cruise industry time for some self-reflection. At the first High Quality Development of Cruise Shipbuilding Forum held by China Merchants Industrial Group (CMI) this August, Hu Xianfu, CEO of CMI, spoke about the company's continuing efforts in the sector.

In May last year, CMI signed its first construction contract for a domestic medium-sized luxury cruise ship, but Xianfu explains that the company is involved in the sector from the perspective of the whole industry chain and is attempting to create a cruise industry ecosystem. He says: "China Merchants Industry Group undertakes important tasks in the industrial chain. The company takes into consideration its service capabilities from the perspective of the entire process and providing customers with cruise ship manufacturing solutions, rather than just building a factory and making a product."

Over the past year, CMI has invested considerably in its cruise ship infrastructure. It has acquired Finnish ship design group Deltamarin, established a cruise ship research & development (R&D) centre in Italy, as well as a China Merchants Group Cruise Research Institute in Shanghai, which aims to establish front-end capabilities in basic cruise ship design, concept design, aesthetic design, interior design, ship type R&D, material R&D and product research. Xianfu adds: "At the same time, we have promoted the construction of a world-class cruise ship intelligent manufacturing base, planned and built a supporting industrial park for cruise ship construction located adjacent to the base, and built China's first site for cruise ship refurbishment, which can provide customers with full life cycle services."

In September 2019, CMI delivered China's first domestic polar exploration cruise ship, *Greg Mortimer*, through which Xianfu comments that CMI has built up its experience with Safe Return to Port provisions, welding-induced deformation of sheet metal, vibration and noise control, complex cooperative operations, and more. He adds that: "Since the completion of the first polar exploration cruise ship, we have carried out special analysis to determine competency gaps between our construction of polar cruise ships and medium-sized cruise ships, such as detailed design, production design, general arrangement design, ship performance, etc."

Hu Xianfu

However, Covid-19 brought with it some additional considerations, as Xianfu notes: "After the outbreak, we also included the pandemic prevention requirements of cruise ships in our scope, for which our China Merchants Group Cruise Research Institute undertook the special analysis."

Based on these experiences and benchmarking, CMI has gradually identified the gaps in its development of medium-sized cruise ship construction and clarified which direction the company should go. Xianfu notes that, at present, the company is in the process of exploring ways to resolve future key problems in the construction of such cruise ships, including materials, vibration and noise reduction, fire protection and control measures, ventilation and so on.

He comments: "In this regard, we pay particular attention to the problems with cabin units as well as firefighting and life-saving equipment. For cabin units, their standardised production needs to be addressed and, even if it does not affect the beauty and structure of a cruise ship, the layout of firefighting and life-saving equipment is worth studying.

"There will also be some difficulties in the construction stage, and thermal deformation related to sheet metal cutting and welding has always been a major problem in the field of cruise ship construction."

In the construction of polar exploration cruise ships, the joint research and development between CMI's Haimen site and steel manufacturing enterprises has resolved problems with sheet metal thickness (5mm) and tolerance (0-0.2mm) as well as welding deformation issues in the manufacturing process. However, Xianfu notes that, in contrast to polar exploration vessels, medium-sized cruise ships have larger volumes and have a greater uncertainty of sheet deformation, which increases the difficulty of construction. "In addition, controlling the lightweight during the construction process is very important and involves many issues with materials, equipment, technology and more. In this regard, every step in the design and construction of cruise ships is closely linked, which is both complex and extremely important," Xianfu comments.

While CMI has built small cruise ships in the past and is exploring medium-sized ones, the business does not intend to branch out into large-scale luxury vessels. Xianfu says this is because, at present, China Shipbuilding Group wants to make the most of its position as China's biggest shipbuilder and its established advantage

with regards to accumulated resources.

CMI and China Shipbuilding Group take on separate market roles for different types of cruise ships, each with their own complementary products. However, Xianfu notes that the two companies are also closely connected: "At the same time, the two groups cooperate and share industrial chain resources in cruise manufacturing, jointly cultivating and developing the supporting industrial chain, and promoting China's ship supporting industry to move towards medium and high-end products."

Design renderings of the polar expedition cruise ship built by China Merchant Industry Group

"If you want to construct high-quality cruise ships, you must build an industrial ecosystem related to cruise ship manufacturing, and so we have set up a cruise ship industrial park in Haimen," says Xianfu. According to the needs of cruise ship construction, CMI composed a list of materials and equipment and searched for domestic factories that could produce the relevant products, so as to attract them to settle in its industrial park. He adds: "For some equipment has not yet been localised, but that we are in need of, we will negotiate and cooperate with foreign enterprises to attract them into building factories at the industrial park. For enterprises entering the park, we will provide a series of services as well as rent and tax incentives or explore innovative models such as equity cooperation."

At present, there are over 30 enterprises at the company's industrial park, 18 of which are now fully operational. These enterprises are gathered for the purpose of facilitating the construction of cruise ships, however there will be some that have not yet had a hand in supporting cruise ship manufacturing. For such businesses, Xianfu states that CMI will use its experience in cruise construction to provide technical standards and specifications for these companies and assist them in carrying out cruise support operations. *NA*

CCS focuses on ship efficiency, intelligence and survey technologies

Yu Chun, deputy director, CCS Science & Technology Innovation and Test Centre, reveals some of the classification society's latest developments

China Classification Society (CCS) has launched a range of initiatives aimed at helping ship operators to track and reduce their fuel consumption and resulting emissions profile. Recognising IMO's target for the industry to reduce its emissions by at least 40% by 2030, CCS now offers a multi-indicator assessment system covering various IMO indices including the energy efficiency design index (EEDI), estimated index value (EIV), efficiency existing ship index (EEXI), the annual efficiency ratio (AER), and the Energy Efficiency Operational Indicator (EEOI).

The multi-index system can be used by ship operators to evaluate the impact of emission-reducing initiatives on existing ships as compared with the IMO's strategic target reductions for specific ship size and types. CCS can then provide tailored services to enable ship operators to achieve further emission reductions, including consultation on existing measures, formulation of new initiatives, on-site assessments, regulatory compliance, and the preparation of short-, medium- and long-term emission reduction targets.

Delivered in November 2019, *Jin Dou Yun 0 Hao*, China's first autonomous cargo ship, developed by Yunzhou Tech, in collaboration with the Zhuhai municipal government, Wuhan University of Technology and CCS

Improving efficiency through AI

CCS believes that Artificial Intelligence will play an important part in supporting the shipping industry's transition to a lower carbon future. Of course, reliable data provides an essential foundation for gauging progress and the classification society has therefore introduced a range of data collection, monitoring and management services. Based on laptop or mobile, the Online Intelligent Management System logs a series of variables to provide a thorough energy efficiency profile across a wide range of merchant ships and service vessels.

Continuing research initiatives are an increasingly important component of shipping's energy-reducing journey. CCS has therefore established two new research laboratories in a joint initiative with other industry stakeholders.

The new labs – Ship Intelligent Technology and Safety Lab, and Key Technologies for Unmanned Ship Systems and Equipment Lab – have been equipped with the latest applications relevant for the research initiatives, including collision avoidance, digital twins both for ships themselves and their components, intelligent ship trials technology, and cyber security testing and assessment.

Drone surveys

Leading classification societies have been developing remote ship survey technology for some time. However, 2020 and the impact of the pandemic has hastened research and development in this area. CCS is no exception and has set up a new Survey Technology and Equipment Laboratory to strengthen related R&D resources. Key areas of focus and how they can have an impact on ship survey procedures involve electronic information, artificial intelligence, robotics, as well as other fields of science and technology.

Drones, including unmanned aerial vehicles for detailed hull surveys, robots, smart 'wearables', portable measuring technology, and internet of things devices relating to ship survey, are also an important area of research. CCS has built up a dynamic database comprising full life-cycle digital ships. The society has set up digital and intelligent survey services and data sharing platforms; it has adopted new survey techniques including condition monitoring, remote attendance, visual survey based on remote collaboration, online monitoring, data analysis, intelligent diagnosis and risk analysis techniques.

Image recognition

CCS has also established an image recognition platform for ship survey and a typical node of ship structure and data-defect set. This has been based on CCS' survey resources and will form the basis of a range of image recognition algorithms for certain aspects of ship hull degradation and rusting steel structures. The society is also conducting research on the possible application of virtual reality technology to its business.

At the end of 2019, CCS was the world's sixth largest classification society. It is growing faster than any other society and recorded an increase in gross tonnage of more than 20% in 2019. *NA*

StormGeo launches all-in-one routing support tool

The new platform, s-Suite, brings together voyage planning, route optimisation and data analytics under a single interface

Norwegian meteorological services provider StormGeo AS has launched s-Suite, a software and services tool for shipowners and managers. The new product combines its existing navigation s-Planner, s-Routing and s-Insight services into a single platform that can be used together or as individual modules.

The idea is that the s-Suite delivers an optimised workflow where both ship and shore are working from the same integrated platform, with faster decision making based on common real-time data. With that comes cost savings and smarter decisions, bringing with it improvements in vessel performance.

What does that mean in real terms? Kim Hedegaard Sørensen, StormGeo's COO for shipping, explains to *The Naval Architect*: "Say you have an operator of a bulk carrier going from A to B and there are certain agreements with respect to the cargo. The commercial team might want it delivered there as quickly as possible, but the technical guys want it delivered at the lowest cost. Sometimes the two things are matching, but sometimes not.

"When the two products – technical performance and the route advisory services – are overlapping you can see the optimal point for arrival, speed and thereby fuel consumption and make the best overall decision for the company. Previously one department might make a suboptimal decision that only takes its own interests into consideration."

s-Suite has been developed in close consultation with the shipping industry, notably StormGeo's longstanding customer Hartmann Schiffahrts. "We have software developers who understand the industry, but primarily because companies like Hartmann have been demanding this. We've been listening carefully to what the industry wants, and that's a one-stop decision support tool that utilises the same data."

Kim Hedegaard Sørensen

The software, which can be easily integrated into whatever third-party hardware may be installed on a vessel, is the culmination of a journey that StormGeo was discussing when this publication last spoke with them two years ago (see *TNA*, November 2018). Sørensen, who only recently joined the company, admits that the development process for the new platform took longer than expected but believes the wait is worthwhile.

"We didn't want to go to the market with something that's not working, this is a major step for us as a company. The challenge has been in getting the three products integrated into one, creating a powerful user interface," he explains.

Needless to say that the potential efficiency gains are seen as a primary benefit that StormGeo is keen for its customers to understand. To complement its route advisory services clients are also sent an end of voyage report outlining what decisions were made, the advice that StormGeo provided at each stage, and how that translated into improved time and bunker consumption.

These are in turn compiled into monthly or quarterly 'return on investment' reports. A similar report is also provided for fleet management. Sørensen says: "It gives various advice such as how to save on the use of the boiler, or auxiliary engine, or if you should reschedule hull cleaning. That converts into energy saving and, importantly, reduced emissions."

One of StormGeo's unique selling points, and one which Sørensen is particularly proud of, are the Fleet Performance Centres. Client ship data is monitored 24/7 at these sites by specialist staff who provide tailor-made advice on technical performance with the assistance of AI and algorithms. "It's people who come from the industry, either navigators or engineers, who've largely been at sea themselves. If you want to work in one of our centres you need to have been onboard a ship for a considerable period of time, or worked in the technical department of a shipowner.

"We don't see our customers getting sufficient value if they're not supported by the third point in the triangle, which is the people; whether that's the meteorologists doing the route advisory or the experts in the Fleet Performance Centre backing it up."

In summation, Sørensen believes StormGeo is perfectly positioned to take advantage of the two megatrends in shipping: climate change and digitalisation. "We're helping shipping companies with [our solutions] to reduce emissions and have accrued a huge amount of data that we can use assisting them practically." *NA*

Stena flexes its design muscles

IMOFlexMAX, a prototype chemical tanker concept, would cut greenhouse gas emissions by more than a quarter, according to the company's estimates

Swedish tanker operator Stena Bulk prides itself on being forward thinking. In 2013, it set about revitalising its fleet with the IMOIIMAX class of oil and chemical tankers. Starting with the *Stena Impression*, a total of 13 of the 18-tank MR tankers were built by Chinese shipyard Guangzhou Shipyard International between 2015 and 2018.

In June, the company unveiled a 'prototype' of its successor: the IMOFlexMAX. The concept design, which has been developed by Stena's in-house team, Stena Teknik, draws upon the experiences of operating the IMOIIMAX, as well Stena's expectations for the future in developing a solution that's said to be both flexible and efficient.

Erik Hånell, Stena Bulk's president and CEO, tells *The Naval Architect* that the new design has been influenced in part by the changing nature of Stena's shipments. "We have gone more towards trading chemical parcels, hence our need for one or two tank pairs of stainless steel which you see in our IMOFlexMAX design. We have also seen that the maximum 3,000m^3 capacity tanks which we have on the IMOIIMAXes [which have a total of 18 tanks each] can be a bit unnecessary and have scaled up a few tanks for quicker operation."

Stena believes the new design will be able to cut greenhouse gas (GHG) emissions by 25-45% compared to equivalent product tankers currently running on low sulphur fuel oil (LSFO). In addition to enhanced hull design, there will be a variety of other energy saving technologies (see table). Power will principally come from dual-fuel engines that run on LSFO and LNG, but supplemented by solar panels and Flettner rotors, which Hånell thinks offers a "cost effective" solution for GHG reduction and realising IMO's carbon goals.

For now, Stena is yet to approach any yards about placing an order for the IMOFlexMAX, but the plan is that they would be deployed in the company's global logistics system, alongside the IMOIIMAX vessels.

At the same time, Stena continues to keep its eye on the viability of alternative fuels with other projects. "We are turning every stone, like many shipowners are today, and looking heavily into fuel cells as well as hydrogen, but we believe this will be several years away," states Hånell. "We have also invested in two MRs with Proman Shipping which will run on methanol, and Stena Lines' ferry *Stena Germanica* has been running on methanol with good results...

Stena says the new design represents a major step forward in shipping's mission to achieve the Paris Agreement and UN Development and Sustainability Goals

Stena Bulk estimates potential GHG savings of 40% compared to equivalent MR tankers

ESTIMATED REDUCTION OF GREENHOUSE GAS EMISSIONS	
Enhanced hull design	10%
Flettner rotors	12%
Dual-fuel LNG propulsion	15%
Main engine shaft generator	2%
Solar panels	0.5%
ESS battery	0.5%

most likely we will see a mix of different solutions in the future depending on trading patterns and the size of the vessel."

Recent developments in the European Parliament have raised the possibility that vessels operating in EU waters may be compelled to comply with the Emission Trading Scheme (ETS) intended to curb carbon emissions. Unsurprisingly Hånell says that Stena, while supporting GHG reduction initiatives, believes international regulations are imperative for fair competition, rather than a localised approach.

Another perceived threat, which Stena has been very vocal on in the past (see *TNA* April 2020), is age discrimination with regard to tanker chartering, since it diverts spending away from new fuel technologies. "Tanker owners have proven that quality standards are extremely high in our segment. To scrap ships that are in mint condition solely because of age is counter productive to investing in sustainable shipping, we think," concludes Hånell. *NA*

Are cargo tank coatings more important than the design of the vessel?

Andy Hopkinson, managing director of Safinah Group, explains why caution should be applied before opting for generic tank coatings

Just because a chemical or product tanker is designed and certified to carry a certain grade of liquid cargo, it doesn't mean it can. The coating selection for cargo tanks plays a critical role in the operational capabilities of a vessel with the thin layer of coating, typically 100-300µm (the same thickness of 2 – 6 sheets of A4 paper) often dictating which cargoes can and cannot be carried and hence, the earnings and profitability of the vessel. A crazy concept indeed that the design and construction requirements of a highly engineered asset are well-defined through legislation, though requirements of the coating technology, which is often perceived as low cost, low value and not considered a part of the engineering equation, are not.

This article discusses, in a broad sense, ship types and generic cargo tank coatings but focuses on the impact of coating selection on a vessel's capabilities and the risks around adopting a generic and non-functional approach.

Rarely are tank coatings available that cover everything the ship has been built to carry. Credit: Shutterstock

Regulations and ship types

The shipping of chemicals in bulk is covered by regulation in SOLAS chapter VII – Carriage of dangerous goods, and MARPOL Annex II – Regulations for control of Pollution by Noxious Liquid Substances. Both conventions require chemical tankers to be designed and constructed to a certain standard as defined in the International Code for Design and Equipment of Ships carrying Dangerous Chemicals in Bulk (IBC Code).

MARPOL Annex II regulations sets out the requirement for handling and shipping liquid cargoes and defines a categorisation of cargoes depending on the challenge posed to the environment and to human health. In the simplest form, cargoes deemed the greatest risk are required to be carried on the most sophisticated vessels with the greatest control measures in place.

The IBC code lays out a comprehensive set of requirements including tank size, alarms, pumping arrangements, valves, venting, segregations and many more as well as defining the type of chemical carrier required per individual cargo. During the design phase of a vessel, the intended cargo list forms a Certificate of Fitness (CoF) for the vessel which is signed off by Classification Societies.

Three main types of bulk liquid tankers exist; Crude Oil Tankers (not discussed further), Product Tankers and Chemical Tankers, the latter being subdivided into Chemical Tanker Type I, II and III.

Product Tankers normally have between 10 – 14 cargo tanks and carry white oils consisting of diesel oil, gasoline, distillates and other hydrocarbons plus some easy chemicals. Most of these cargoes could in theory be carried in uncoated tanks due to their non-corrosive nature, but the requirement to clean tanks using water to move from one grade of cargo to the next generates a requirement for anti-corrosive protection. Coatings applied need to offer the desired anti-corrosive protection but also need to resist all cargoes being carried and should minimise cross-contamination potential from one cargo to the next.

Chemical tankers can be complex structures, some having up to 52 individual cargo tanks carrying a multitude of different cargoes at the same time. Tanks are either constructed of stainless steel which brings a significant additional build cost, but arguably greater operational flexibility, or mild steel which requires coating to offer the chemical and anti-corrosive protection.

Coatings

Coatings used in product tankers are generally of pure epoxy chemistry, similar to anti-corrosive coatings used elsewhere on the vessel but often with greater control of molecular weight distribution within the resin systems to ensure more predictable cross-linked films and performance.

Coatings in chemical tankers have been dominated by two main technologies over the past 30-40 years; zinc based coatings (either solvent based or water based) typically applied at 75 - 125µm dry film thickness (DFT) or Novolac Phenolic Epoxy (Phenolic

Epoxy) coatings, typically applied at 300µm DFT in either two or three coats. Other technologies exist, including isocyanate cured epoxies and a new generation aimed at reducing cargo absorption, often referred to as low absorption coatings.

Zinc coatings galvanically protect steel, although zinc oxide produced through the anodic reaction also creates some barrier properties. Often difficult to apply due to tight controls around the maximum film thickness before cracking, zinc coatings offer a low-cost option when considering cost per m^2 and very good long-term protection against pure, pH neutral and aggressive chemicals such as methanol. An operational downside for zinc coatings is a rough surface meaning a difficult cleaning challenge when moving from viscous cargoes such as veg oils, gas oils etc. to pure chemicals. Cleaning of tanks on chemical tankers can contribute 30% of the overall vessel fuel consumption with subsequent emissions through the requirement to heat water and circulate through tank cleaning machines. Zinc coatings are also limited in their cargo carriage scope as they can't carry acidic or alkaline based products due to reaction with zinc and are not the preferred option for aqueous based cargoes.

Phenolic epoxy coatings perform via barrier properties enabling a wider cargo carriage capability and are formulated with low molecular weight resins with an increased number of reactive sites compared to standard anti-corrosive epoxies, creating a denser network (cross-linked system) when cured. The density of the network among other factors controls the type and amount of cargo that can penetrate the coating, which in turn dictates what cargoes are acceptable to be carried and the potential for cross contamination from one cargo to the next.

When compared with product tank linings, Phenolic epoxy coatings require stricter application control of temperature, humidity, film thickness and often require a secondary conditioning referred to a post-cure or heat-cure to achieve the maximum chemical resistance properties. Due to the highly cross-linked nature of these coatings, the paint film has less flexibility than pure epoxy product tank linings and can be more prone to cracking with operational stresses that increase with vessel size.

Formulating a coating is a process that can take years. Credit: Safinah

Although designed to minimise cargo absorption, Phenolic epoxies do absorb and retain certain low molecular weight cargoes such as Ethylene Dichloride and Vinyl Acetate Monomer, which are very difficult to remove unless aggressive cleaning regimes are adopted such as methanol washing. This technique is now effectively banned (although still allowed if tanks are inerted) based on health and safety grounds meaning it is difficult for owners to trade between certain high specification cargoes. This market driver created a requirement for the next generation of coatings based on even lower molecular weight resins creating even tighter coating networks. The latest coating class brings yet more stringent application controls and curing requirements to achieve the step change in chemical resistance.

Selection and impact

Normally at New Construction tendering stage, paint companies are presented a list of cargoes from the CoF from which they are required to propose the most suitable coating(s) and provide cargo resistance information. Rarely, however, are coatings available that can carry 100% of cargoes the ship has been designed to carry and the owner/yards are required to make a selection based on the information available or charterer demands. This means the owner can only trade assets in accordance with the chosen coating's capabilities or risk early coating breakdown, rejected cargoes, loss of earnings and expensive and untimely repairs.

Partly due to the relative low cost of coatings and the lack of an engineering approach to specification and selection, coatings are often categorised as generic equivalents. This tendency is amplified by the complexity of the cargo resistance guide information and associated notes provided by paint manufacturers and often results in the lowest cost 'equivalent' product being selected.

When formulating coatings, many months and years are required to select optimal formulations, including small percentage changes in resin composition and proportion, filler blends and levels, solvent types and mixtures among other items. A small percentage change in one of these items can be the difference between acceptable chemical resistance and failure. It is therefore inconceivable that each supplier's generic technology performs in the same way. This is a misconception that can be easily overlooked in less challenging environments but becomes critical in such aggressive environments as chemical tanks.

Now we enter a whole new world of cargo resistance guides and cargo notations; extremely complicated documents required to offer advice from paint companies to owners on the 2000+ cargoes that could be carried by sea. Encyclopedic on what can and can't be done with regards to ability to carry individual cargoes, requirements in moving from one cargo to the next and preparation of coatings before and after carriage. Additional complexity of allowable cargo temperature, carriage duration, moisture and insoluble content and many other factors make these information packs difficult to the trained eye let alone ship operators who tend not to have chemistry as their core discipline.

Coatings manufacturers are usually approached during the tendering for a newbuilding to provide resistance information for specific cargoes. Credit: Safinah

Cargo resistance guides are used by paint manufacturers as both a marketing tool to demonstrate their coating capabilities and as a form of liability control should the operation or treatment of the coating fall outside of the permissible parameters. Sadly, we often end up with a theoretical versus practical situation; paint companies rightly need to limit their exposure and define the conditions by which coatings will or will not perform but the practicalities of operating the ship often means that the defined conditions are unachievable.

Summary

Here in lies the issue – ships are designed to carry certain cargoes which they can't always accomplish due to the applied coatings; extensive CoF are used as a mechanism to select coating capabilities rather than focusing on the vessels intended trade; complexity of cargo resistance guide information means generic equivalency is often used to simplify the process with the lowest price option selected and then the practical operation of ships does not always match the theoretical operational requirements from the coating manufacturers. Decisions made at new construction can leave vessel operational teams with huge headaches from premature failure to limited trading flexibility by making generic assessments and not truly understanding the impacts of the detail within cargo resistance guides.

The solution is to treat coatings as an engineering system. Understand the operational constraints of a vessel, understand the real life application restrictions, focus the coating comparison on the intended trade and use independent trained coating experts to pick through the nuances of the cargo resistance guides to make a selection that minimises owner risk.

In the majority of cases, tank linings supplied do not permit 100% of cargoes listed on the CoF and the chemical tank coatings themselves do not need to be certified or approved by Classification Societies. Therefore, one could argue that chemical tank linings are indeed more important than vessel design. *NA*

www.safinah-group.com

A Manx tale

Ferries services are vital for the Isle of Man, but the current flagship ro-pax has not been without its critics. Following the recent announcement that a replacement has been commissioned, *The Naval Architect* explores the story behind it

Ben-my-Chree, pictured in 2010, is the sixth Isle of Man Steam Packet ferry to bear the name. Image: Philphos (Creative Commons)

Since 1830, the Isle of Man Steam Packet Co (IoMSPCo), has been providing freight, passenger and vehicle ferry services between the island and ports in the UK and Ireland, making it the oldest continuously operating shipping company in the world. From the earliest wooden paddle steamers through to today's ro-paxes, IoMSPCo might not offer the same extensive services as in the early twentieth century, when it regularly called at ports in Wales and Scotland, but it remains a lifeline for the residents, not to mention tourists.

Under a sea services agreement signed with the Isle of Man (IoM) government, IoMSPCo performs more than 900 sailings per year to and from ports in the north-west of the UK (principally Heysham), supplemented by a daily summer service to Liverpool and regular services to Ireland's east coast. Around 600,000 passengers are carried annually; 35,000 of these during the TT Race Festival alone, when the ferries also carry around 10,500 motorcycles.

Although publicly owned for much of its existence in 1996, after years of financial difficulties, IoMSPCo was acquired by Sea Containers. A little more than two years later Sea Containers introduced a new ro-pax on its twice daily service: *Ben-my-Chree*. But the vessel, the name of which means 'woman of my heart' in the Manx language, wasn't taken to with much affection by many of its passengers.

Manx resident and naval architect Jack Brown recalls how his first visit to see *Ben-my-Chree* left him incredulous: "While there was adequate space for ro-ro freight, the passenger accommodation was very restricted and located high up in the superstructure. Passenger access from the main vehicle deck through four deck levels was by eight steel tread ladders in two forward and one midship locations. A single smallish elevator connects the decks… I recall thinking 'freight goes first class, passengers go steerage."

As one of the elder statesmen of ro-ro technology, Brown was more qualified than most to express an opinion on the vessel's shortcomings. He's been designing vessels since the late 1950s, beginning with the Canadian passenger and car ferry *C A Combeau* (1961), which was built at the shipyard owned by his family, George Brown & Co, in Greenock, Scotland.

Perhaps more significantly, Brown also took responsibility for the design and supply of *C A Combeau*'s stern door via a newly-established subsidiary company named Cargospeed Equipment. Over the next 20 years, Cargospeed would supply roll-on roll-off equipment for more than 40 vessels around the world and is widely considered to have broken new ground with its ramp arrangements.

Shallow draught

Passenger complaints were just one component of a litany of problems which led the IoM government to hastily order a public enquiry. It was alleged that the *Ben-my-Chree*'s draught was so small that, even with passengers and freight, the

The *Herald of Free Enterprise* disaster prompted a rethink of damage stability requirements with SOLAS 90. Image: Geoff Watson

tops of the propellers were not submerged. Furthermore, it was claimed the small draught meant there was such a large freeboard that the stern ramp of the main vehicle deck was unable to land on the shore linkspan pontoons. Although IoMSPCo clarifies to *TNA* that, fully loaded, *Ben-my-Chree*'s draught would have been around 5.6m, and the propellers well submerged, steel and concrete were subsequently added as permanent ballast to assist with the stability comfort of the vessel, since it did not operate fully loaded.

Brown, who had been regularly consulted by IoMSPCo prior to the Sea Containers takeover, was among those who presented at the enquiry. He pointed out in his deposition that *Ben-my-Chree* was a scaled-down version of earlier vessels built at the same shipyard, Van Der Giessen-de Noord, but that its deadweight remained far in excess of the island's freight requirements.

Consequently, *Ben-my-Chree* was operating at far less than its 5m design draught and far in excess of its 3.6m design freeboard. Furthermore, the subsequent attempt at ballasting the vessel would increase its GM value and transverse accelerations on the accommodation decks.

But how had this happened? Ironically it partly originates in the event Brown describes as the worst experience of his professional career, The *Herald of Free Enterprise* disaster in 1987. The ill-fated vessel was one of 10 owned and operated by Townsend Thoresen for which Brown's company, Cargospeed, had supplied the 'Neatstow' bow doors built to his own design. During the construction of the 'Spirit class' series (*Herald of Free Enterprise* was the second of three) in Bremerhaven several years earlier, he had gone so far as to suggest to Townsend Thoresen's naval architects that CCTV coverage of the doors should be relayed to the bridge during operations, a provision which would have alerted the captain that the bow door was open and might have saved countless lives.

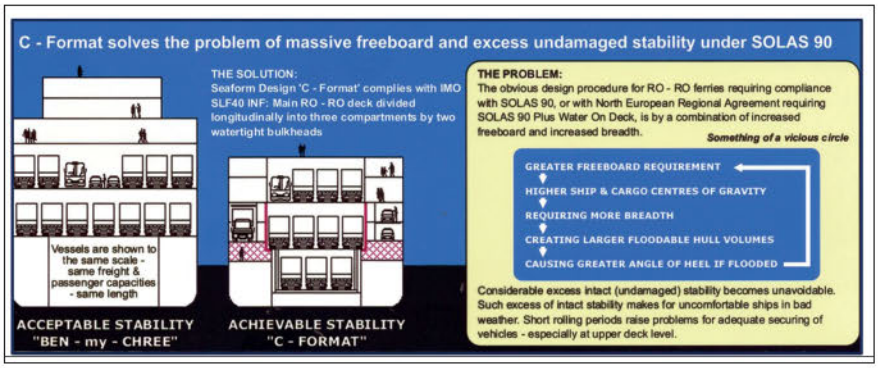
Three years after the disaster, IMO mandated SOLAS 90, which increased the required freeboard (in ro-ros the distance between the waterline and vehicle deck) from 76cm (30 inches) to 125cm (49 inches). Because achieving this increased freeboard meant raising the centre of gravity, Van Der Giessen-de Noord's approach had been to correspondingly increase the breadth. Brown notes that the result is a vicious circle, since the additional breadth creates larger floodable volumes in the lower hull, which in turn demands yet more breadth to redress the greater angles of heel. In other words, damage stability compliance is achieved at the cost of excessive undamaged stability and diminished propulsive efficiency.

In the meantime, Brown had also been developing his own ideas for improving ro-ro safety. Although Cargospeed had been forced into closure by the bankruptcy of its parent George Brown & Co in the early 80s, Brown's other company, Seaform Design, was among those to submit proposals when the UK Department of Transport (DoT) created a £500,000 fund to explore how ferry design might be advanced in the aftermath of *Herald of Free Enterprise*.

Brown suggested a design in which the hull above the vehicle deck level was divided transversely by two longitudinal bulkheads, while below the vehicle deck it would be divided longitudinally by two transverse bulkheads, as normal. He estimated this 'C-Format' concept, had it been applied to *Herald of Free Enterprise*, could have improved its stability against capsize by as much as 20 times. Renamed 'Buoyant Wing Spaces' by British Maritime Technology (BMT), who were assigned to evaluate the proposals, it received the endorsement of several leading classification societies in the early 1990s, as well as winning a Seatrade Award. Sadly, like many good ideas, it then suffered the ignominy of sinking without trace.

Design proposal

By 2016, *Ben-my-Chree* had clocked up 18 years of regular service. That year, Brown presented a paper at RINA's 'Design and Operation of Ferries & Ro-Pax Vessels' conference in which he offered his own concept of what an Isle of Man ferry should be like. Based on his earlier C-Format concept, the proposed design had an overall length of 135m, 950 lane metres for 76 semi-trailers, a further 300 lane metres for cars, passenger seating capacity of 1,150 and open-deck seating for 90 passengers. The problem of



A comparison of *Ben-my-Chree* with Jack Brown's ferry concept, presented during a 2016 RINA conference. Image: Jack Brown

passenger access to the upper decks, such a bone of contention with *Ben-my-Chree*, was addressed by the inclusion of four stairways and two lifts.

The accommodation was also located two decks lower than on the current vessel, made possible by locating a dozen semi-trailers on a Tiltdek, a concept that Brown had developed in the early 90s for hydraulic or winch-operated wide tilting ramps with a gentle gradient. Unusually, this would require all truck-trailers to load and unload in a forward motion only, irrespective of whether it's a single or two-level linkspan. However, it would utilise the void spaces below the main vehicle deck level and also help lower the vessel's centre of gravity. Another feature of the design was single-screw azipod propulsion for increased efficiency.

The intervening years since *Ben-my-Chree* entered service had been turbulent ones for IoMSPCo. Sea Containers sold the company in 2003, and it passed into the hands of a succession of private equity funds and foreign banks before finally returning to the ownership of the IoM Government following a £124 million acquisition in 2018. When the government requested submissions to a public survey on the ferry's future, Brown again scented an opportunity and reached out to them with his proposal.

Brown reflects: "It was my expectation when the IoM Government purchased the Steam Packet from Portuguese Banco Espirito Santo that they would establish a stronger presence in the top levels of management of the company… There was strong initial interest in the design from several Members of the House of Keys [the Manx Parliament]... but."

Replacement announced

In August this year, IoMSPCo announced a new diesel electric ferry to replace *Ben-my-Chree*, a key point in the new sea services agreement signed between the operator and the IoM government in 2019. Like its predecessor it will primarily serve the Douglas-Heysham route, making two round trips per day between the two ports.

But the new design isn't based on Jack Brown's. Instead, IoMSPCo awarded the contract to London-based design and engineering consultancy Houlder, which will act as technical advisors to builders Hyundai Mipo Dockyard in South Korea, with delivery expected in the spring of 2023.

Houlder already has a longstanding relationship with IoMSPCo, having previously acquired HartFenton, the ship designing subsidiary of Sea Containers, in 2006. Several years later, it assisted with the procurement and conversion of a US Naval vessel to become the 96m *HSC Manannan*, IoMSPCo's high-speed catamaran, which completes the summer service between Douglas and Liverpool. The company also previously provided support for *Ben-my-Chree*, such as the installation of an additional passenger lounge.

"We've had the vessel in our sights for quite a while," David Wing, Houlder's ship design and engineering director, tells *The Naval Architect*. "It's a 130m ro-pax, which is quite a specialised market and one of the most complex sizes you can design for. Bigger vessels are much easier because you have a lot more space, while smaller ones are usually single-deck and have less demanding requirements."

The sea services agreement sets out a number of specific requirements for the new vessel, including a minimum 1,250 lane metres for freight and capacity for no less than 800 passengers. Because of the small, tight harbours at which the vessel will have to berth, there's a hard limit on how long it can be, allowing also for turning. Achieving the specified lane metres within those constraints puts deck space at a premium.

Safe Return to Port

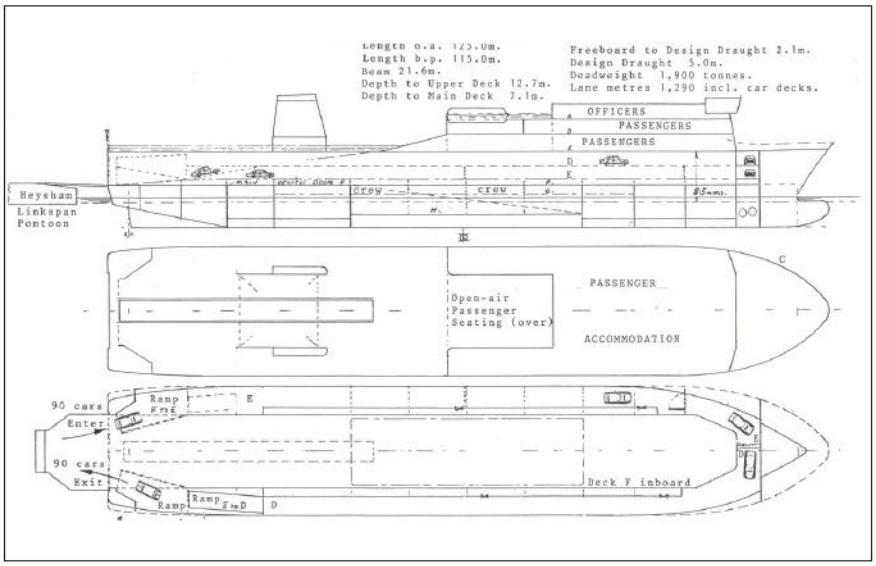
A further consideration, not applicable at the time *Ben-my-Chree* was built, is the Safe Return to Port (SRtP) regulations which entered into force in 2012, which bring extra space in terms of fire and flood protection.

Wing says: "The starting point was really to dedicate as much space as possible to achieving the lane metres, which drove us to the configuration we've ended up with, with a centre casing and two freight decks. SRtP drives us to a very different arrangement below the main deck. Cars have gotten bigger while freight is taller, by and large, leading to increased deck heights, which means longer ramps. That can make getting freight to the upper deck and then turned round increasingly challenging. We've lost maybe 5-10m because of the increased deck height."

IoMSPCo is keen for the new vessel to be environmentally friendly as possible and will voluntarily comply with NOx Tier III standards. Although diesel, and potentially biodiesel, is felt to be a more practical option than LNG, given the limitations for bunkering, the design also makes some provision for the potential conversion to alternative fuels in the future.

Unsurprisingly, the passenger accommodation arrangements have also been a key consideration. IoMSPCo has appointed interior specialists SMC

The general arrangement for Brown's proposed replacement. Image: Jack Brown



Concept illustration for the new IoM ferry, designed by Houlder. Image: IoMSPCo

Design to realise the aesthetics and flow of passenger spaces. The design will take into account feedback from the earlier public consultation exercise.

Overall, Wing says it's a very different set of arrangements to those arrived at by Jack Brown. "Early on we looked at something in a similar vein, with a lower hold for loading the ship. In the end we discounted it because the SOLAS 2020 damage stability requirements put us off having a large lower hold space. In addition, the need to get around down there, or put in a hoistable deck, all makes turnaround a bit slower which, if you're looking to achieve four trips a day, means those trips have to be faster, which demands more fuel.

"So we stuck with the tried and tested. A single hoistable ramp gives pretty efficient loading and minimises the things – such as sheaves, cylinders and hydraulics – that can go wrong and stop your lifeline service."

The new vessel will by no means be the end of the line for *Ben-my-Chree*, which will be kept as a backup vessel, and Wing disagrees that the ship was such a failure. "I think with that series of ships Van Der Giessen-de Noord did a really good job of optimising the design. Through that process they came to some very neat arrangements and really maximised the cargo space, albeit probably more than the Isle of Man needed on a day to day basis." *NA*

Time could be right to think of lightweight construction ferries

The Covid-19 crisis has hit the European ferry sector hard, but efforts to mitigate the aftermath could drive innovation, writes Kari Reinikainen

A rethink of the design of ferries for short international crossings could provide a platform to turn things around and move the European shipbuilding sector forward in the process.

The European Union's plan to shipping in its carbon emission trading regime means that the ferry industry now faces a challenge and an opportunity. The construction of ferries used in short international crossings could be radically changed in the future to pave way for greener solutions, believes Vesa Marttinen, development executive at MarineCycles, a Finnish consulting company.

Vesa Marttinen, MarineCycles

Henrik Nordhammar, Stena Teknik

"We could approach the design ferries used on short international crossings from a fresh angle and focus on three key areas. Firstly, they could employ lightweight construction to e.g. save fuel, manning levels could be reduced compared to present day ones and the design of the bridge could be rethought," he tells *The Naval Architect*.

The design of the bridge today requires a location from where the operations of the vessel are controlled plus a separate 'back office'. However, in high speed craft, all these are brought together and Marttinen thinks this type of vessel could offer a platform for the design of a new kind of short haul ferry that would not be any faster than ones in service today.

The hull of the vessel could be built of composite materials that save a lot of weight compared to steel, which again would reduce power requirement of the vessel and hence its fuel consumption and environmental footprint. Marttinen points out that his proposal would not mean a jump into the unknown, but rather to expand the High Speed Craft Code of the IMO to different kinds of ferries. "There is a lot of experience and statistics from the construction and operation of fast ferries: this does not mean a ground zero start," he noted.

Many ferry services in Europe could embrace the technology derived from fast ferries, although the exact parameters regarding e.g. the length of the voyage etc. would need to be defined by the IMO. However, as the European Union has earmarked €750 billion in funding for projects to help economies of its member states to recover from the Covid-19 pandemic, Marttinen says his proposal could become part of these efforts and benefit from the said funding.

Until recently, it was the norm that European ferry companies would mostly place their newbuilding orders at European yards. However, this has changed in the recent years as some countries in the Far East have established strong maritime clusters. "Australia has cheap bauxite, the raw material of aluminium, which helped that country to develop a strong position in the construction of fast ferries," Marttinen continues. China has emerged as a major builder of ro-pax ferries for European owners.

Against this background, Europeans should move from festive speeches to concrete action to develop its maritime cluster and ferries are an obvious area where Europe, including both the EU the UK, could launch a new concept and propel themselves to the forefront of technology, he concludes.

That Europe should use the present situation as a platform to drive innovation is a point that has also drawn the attention of Holger Appel, Global Head of Marine at KfW-IPEX bank in Germany. Speaking in a webinar on the state of the ferry industry in early October, he said that the recovery plans that the European Union has presented provide an opportunity to boost green and sustainable transport.

SOLAS could provide alternative framework

Andreas Ullrich, Global Market Leader, Passenger Ships & Ferries at Bureau Veritas, the French classification society, thinks that rules to allow the construction of the kind of ferries Marttinen suggests could be produced, but these might actually be based on SOLAS rather than the High Speed Craft (HSC) Code.

"By purpose IMO had developed the HSC Code to enable to design, construct and build light and fast ships without making compromises on safety. However, the HSC Code is a combination of prescriptive requirements and operational requirements, mostly restrictions in operating area – fixed routes, close to shore, etc. To comply with the HSC Code you have to install powerful engines in order to reach the required speed. That means high fuel consumption, which today is a big issue – sustainability, environmental protection, reduction of greenhouse gas emissions," Ullrich tells *The Naval Architect*.

He points out that already now, ferries complying with SOLAS can be built using aluminium as long as it insulated in a way that achieves A-class fire resistance, which unfortunately often 'eats' into the weight reduction when using it. "And on top of this, the price for aluminium is higher than steel. That's one reason why most of the conventional ferries' hull and superstructure (SOLAS compliant) are of steel construction, except in same cases where superstructures are made of aluminium due to stability issues," he continues.

Against this background, Ullrich says that SOLAS provides a platform to pave the way for the kinds of ferries that Marttinen is suggesting. "I believe it should be possible to develop rules for short haul ferries not complying with the HSC Code – speed is often the criteria for not using and/or complying – but with the SOLAS Convention by taking into account operational limitations similar to the HSC Code," he adds.

On a purely practical note, Ullrich points out that this work should be done at IMO and for the moment, there is no such work item on the agenda. To introduce this to the organisation's agenda, an administration has to provide a document to IMO requesting such a work item, in which compelling need has to be clearly demonstrated. "BV is also open to discuss what Vesa has proposed and to support the industry in finding solutions," he concludes.

Stena Elektra has weight saving in focus

Stena Line, the Swedish ferry company that has operations in the Baltic, the North Sea and the Irish Sea, is working on a concept design called *Stena Elektra*, in which weight saving is an important aspect, says Henrik Nordhammar, deputy technical manager at Stena Teknik, the technology unit of the Stena group whose business ranges from shipping to recycling and property. The vessel is planned to operate between Gothenburg in Sweden and Fredrikshavn in Denmark and it is projected to enter service in 2030. As the name suggests, it should be able to make the 58mile crossing entirely on battery power.

The design tracks thinking employed in the 1990s, when Stena worked on the High Speed Sea Service (HSS) catamaran ferry design. Four units were built, three of which measured about 20,000gt and had a cruising speed of 40knots. "In HSS, the thinking was that every kilo counts – it was necessary to think so to make the concept work," Nordhammar tells *The Naval Architect*.

In the case of *Stena Elektra*, the company has more flexibility that with the HSS craft: weight reduction will enhance the profitability to the projected vessel, but it is not an equally crucial aspect than what it was with the HSS. "Energy savings target to reduce the size of the battery pack – this is the cost driver," he says.

As the ship is intended for international crossings, the plan is to build the hull from steel, but Nordhammar said higher tensile steel is likely to be used than what is customary. Composite materials may be used in the superstructure of the vessel. *Stena Elektra* will have a length of about 200m, roughly twice the figure of the largest vessel built of glass reinforced plastic (GRP) at the moment, he adds.

Ferries form part of the infrastructure and many operators, including even first-rank companies in terms of size, have vessels built in the 1980s or even earlier in their fleets. As their remaining life must be limited, renewal of fleets, quite a lot of which has taken place in recent years, is likely to continue once the present crisis has passed and ferry companies can justify newbuilding orders from a financial point of view.

The question of what a planned ferry newbuilding should look like probably has more variables now than it has had for a long time, largely thanks to the question of what fuels the vessel may use over its lifetime and the potential use of lightweight construction can be regarded as another variable in the picture. Any departure from a convention always includes a risk. But it also includes an opportunity: a new concept might not only serve the ferry industry well, but the European shipbuilding sector also.

As Chinese builders are now well established in the ro-pax sector for European customers and new orders for cruise ships unlikely to emerge for a few years, European yards probably need to keep doors wide open for new ideas. *NA*

Concept illustration for the *Stena Elektra*

Aquarius MRE: zero emissions propulsion and power for ships

Greg Atkinson details the ongoing development of Eco Marine Power's unique rigid sail and solar power solution

World shipping, along with other sectors of the global economy, is faced with the challenge of moving towards a zero emissions and decarbonised future. Although neither of these terms are perhaps well defined at the moment, what we do know is that there is increasing pressure on shipping to adopt measures and technologies that will significantly reduce its greenhouse gas (GHG) emissions and carbon intensity. During the last few years this has triggered a surge of interest in a range of fuel saving and emission reduction technologies including sail-based solutions and solar power, both of which have the potential to provide ships with a supplementary source of propulsion and power without the release of GHG and harmful airborne emissions including particulate matter.

In Japan, a project led by Eco Marine Power was started in 2010 to investigate and then develop a fully-automated rigid sail and solar power solution for use on ships. This solution is known as Aquarius Marine Renewable Energy (Aquarius MRE). Aquarius MRE is not however simply a wind-assisted or sail-assisted propulsion system, but rather comprised of a range of technologies incorporating rigid sails, solar power, energy storage, computer-based automation and management systems, and an input/output communications architecture. It is primarily a fuel and emissions reduction solution and is designed to work with existing and future propulsion technologies, including hydrogen fuel cells.

A key feature of the solution is the patented EnergySail; a computer-controlled rigid sail device designed to act as a form of supplementary propulsion for ocean-going powered ships. Earlier types of rigid sails were previously fitted to a number of Japanese vessels during the 1980's and fuel savings of up to 30% were reported under favourable conditions. So there is no doubt that the use of rigid sails can lead to significant fuel consumption and emission reductions.

Figure 1. Overview of the Aquarius MRE main system elements and an impression of the Aquarius Eco Ship

However, these earlier sail systems had a number of shortcomings and therefore, during the design of the EnergySail, Eco Marine Power has worked with strategic partners to resolve these shortcomings and incorporate a number of new and innovative features. Important insights have also been gained from working with Teramoto Iron Works, a Japanese company based in Onomichi that was involved with the production of rigid sails in the 1980's.

Each EnergySail is automatically raised, lowered and positioned via the EnergySail Automated Control System (ACS) although they can also be manipulated by the crew through the use of remote and local control units. This control system uses the class-approved KEI-64S marine computer with a 1.33GHz dual core processor and the same computer hardware is now also utilised for the Aquarius Management and Automation System (MAS). This second computer system manages the solar power sub-system and can also perform a range of other functions including fuel consumption monitoring, emissions calculations, condition-based monitoring and data logging. In addition, various sensors, devices and equipment communication interfaces can be integrated into the Aquarius MRE system architecture via an input/output link system. Numerous communications protocols are supported including NMEA, MODBUS, CANBUS and RS-232C. Connections to the ship's LAN are also possible via Ethernet ports.

Figure 2. Lab testing of the EnergySail Automated Control System (ACS)

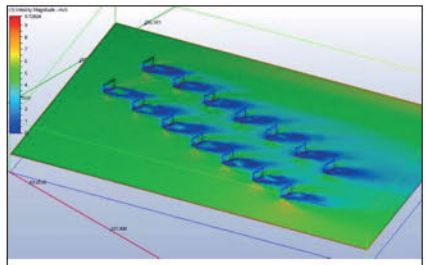


Figure 3. CFD study of airflow around multiple rigid sails

Figure 4. PV modules undergoing long-term evaluation at the Onomichi MTTC

In many ways the automation and control functions for the EnergySail have been the most important and difficult area of development and the EnergySail ACS, along with the Aquarius MAS, have involved a joint development effort over several years between KEI System based in Osaka, Japan, and Eco Marine Power.

The EnergySail's themselves are designed to be upgradeable, easy to maintain and robust. Several patented storage options have also been developed and these enable the sails to withstand wind speeds in excess of 50m/s when lowered and protect the sails from being damaged. Numerous unique safety features have also been incorporated into the design both in terms of hardware and software, so that they do not present a risk to the crew or to the ship.

It is envisaged that several EnergySails each up to 15m high would be used on a ship and on a large tanker or bulker 14 sails or more could be installed. Research using computational fluid dynamics (CFD) based simulations have shown that such an arrangement of sails with a total area of 1,400m^2 could provide a significant amount of propulsive power even in relatively light wind conditions and that this power could be increased by optimising the positions of the sails (Atkinson, 2019). Further analysis has indicated that over the course of a voyage lasting around two weeks a similar arrangement of sails could provide up to 7.7% of the required propulsive power for a Post-Panamax sized vessel. This modelling took into account variable ship speeds and wind conditions and included days when the sails were not used. Under ideal conditions with the ship travelling at low speeds this figure could be as high as 47% (Atkinson, 2020).

Of course much larger rigid sails (i.e. 20m or higher) have the potential to provide more propulsive power under favourable conditions; however they also present a number of risks and operational challenges related to their size. On certain routes and for certain types of ships though, very large sails may be feasible.

Another source of emissions-free power can be derived from photovoltaic (PV) modules fitted as arrays mounted on a ship and/or by embedding lightweight flexible PV modules onto the EnergySails. These along with Maximum Power Point Tracking (MPPT) charge controllers, batteries & the Aquarius MAS form the core of the marine-solar power sub-system.

Eco Marine Power has spent more than five years researching the use of solar power on ships and although this may at first appear to be a straightforward proposition, there are, in reality, many potential problems and pitfalls. One significant issue that can be encountered is the quality of the specialised marine-grade PV modules that are necessary for ship related projects. These modules are often suitable for recreational vessels but they can begin to show signs of deterioration after a few years when exposed constantly to harsh marine conditions. Bearing this in mind no final decision has been made as yet regarding what type of PV modules will be fitted to the EnergySails and ongoing testing and evaluation of PV modules is being conducted at the Onomichi Marine Technology Test Centre (MTTC) in Hiroshima Prefecture, Japan.

A complete marine-solar power solution was recently installed on a large general cargo ship and in addition to providing this ship with a source of emissions free power, the Aquarius MAS also monitors

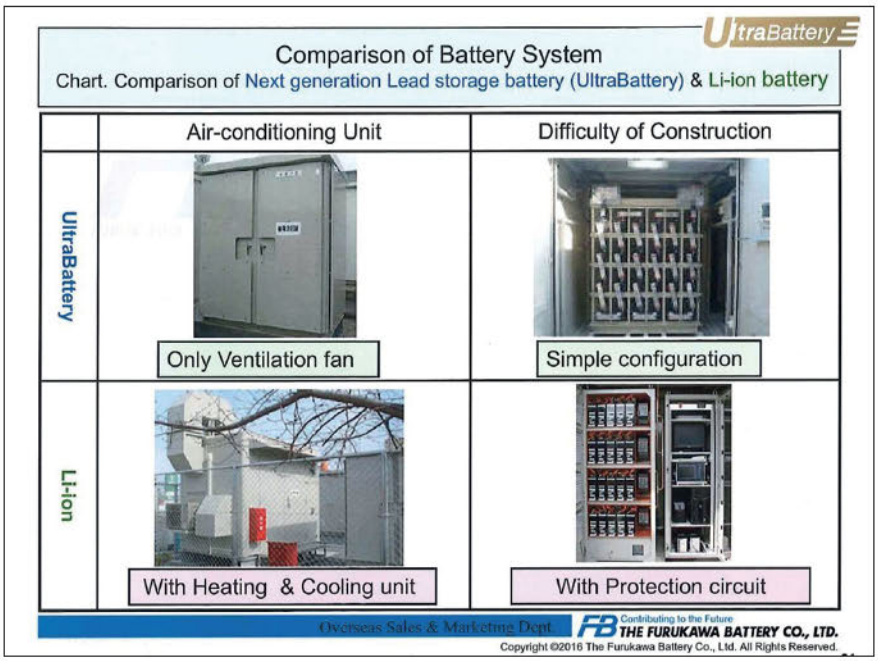


Figure 5. Comparison of storage battery installations (Source: Furukawa Battery)

and logs fuel consumption and calculates vessel emissions (CO_2 and SOx). It is worth noting that the equipment required for this solution was delivered as installation kits and fitted entirely by the crew without any impact on the vessel's operation.

For energy storage, valve regulated lead-acid (VRLA) batteries are used due to their proven reliability, safety, cost effectiveness, recyclability, ease of installation and low maintenance requirements. It is a common misconception that in regards to battery development only advancements in technologies such as lithium-ion (Li-Ion) have been made, whereas in reality there have been significant improvements in regards to VRLA battery technologies as well.

For example, the ClassNK approved FCR series batteries from Furukawa Battery of Japan have a cycle-life comparable to lithium-ion batteries and can be used for renewable energy applications and also for other uses including emergency-back up batteries and for starting rescue boat engines. Recently, the first set of FCR batteries were supplied to a ship to take the place of older battery types that were previously being replaced every two to four years.

Another common misconception is that VLRA battery installations require considerably more space than a similar capacity solution using lithium-ion batteries. Generally speaking, lithium-ion batteries do have a higher energy density; however other equipment often needs to be installed along with the batteries including protection circuitry. As a result, the space needed for a complete Li-Ion battery system can be similar to that required for a VRLA based solution.

A range of VRLA batteries are also available in addition to the FCR series including the hybrid UltraBattery® and FCP series. These high quality marine-grade batteries can be installed in a variety of locations on a ship, including specially designed deck-mounted modules or containers.

Figure 6. EnergySail test and demonstration unit in Onomichi, Japan

Overall good progress has been made in getting Aquarius MRE ready for commercial release, notwithstanding some of the setbacks that are often experienced during the development of a new and complex system. Differing guidelines from several classification societies have also complicated setting the baseline specifications, but this issue is gradually being resolved. Nonetheless all of the various sub-systems have now being tested and an operational EnergySail has been installed at the Onomichi MTTC for evaluation and demonstration purposes. Upgraded versions of this device will be used for sea trials with the aim to install a complete system on a ship once approval-in-principle (AIP) has been obtained.

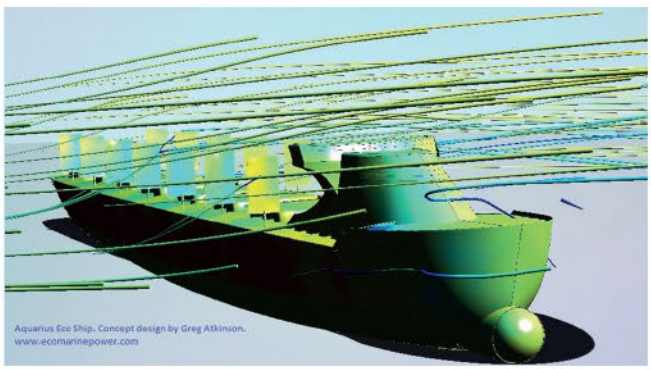


Figure 7. Airflow study around Aquarius Eco Ship fitted with EnergySail array

Several versions of the EnergySail in terms of aerodynamic profiles, sizes and operability are also being developed with a view to adapting this technology for use with autonomous surface vessels (ASV) and special variants for cruise ships and roll-on/off (RoRo) vessels. It may also be possible to adapt various sub-systems for other applications such as offshore power and land-based renewable energy projects and these possibilities are currently being explored.

Work is also continuing on the Aquarius Eco Ship project, a comprehensive design study focused on optimising the designs of large ocean-going ships including bulk carriers, tankers, ro-ro vessels and cruise ships, so that these vessels can best utilise Aquarius MRE and other emissions reduction and alternative propulsion technologies. *NA*

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About the author

Greg Atkinson is the founder and Chief Technology Officer of Eco Marine Power Ltd. Before founding Eco Marine Power he spent approximately 12 years in the telecommunications industry where he held senior management roles for a number of major multinational companies in Australia and Japan. During this time he managed a number of complex projects including several large national mobile network rollouts. Prior to this he served 10 years in the Royal Australian Navy in the electrical engineering branch. His qualifications include a PhD in Maritime Engineering, an MBA, a B.Sc in Electrical Engineering, an Associate Diploma in Electronic Systems. He is also a Fellow of the Royal Institution of Naval Architects (FRINA) and a Fellow of the Institute of Marine Engineering, Science & Technology (FIMarEST). *NA*

Rotor sails: putting a new spin on shipping?

In early March, an interview study with shipowners, technology providers and the crew of a rotor ship was performed to investigate the impact of wind propulsion on operations and crew and uncover clues to unlocking the full potential of this technology. David Newman reports on the findings

A number of wind devices have seen renewed interest in recent years due to their potential to future-proof vessels by considerably reducing fuel consumption, such as hard and soft sails, turbosails and kites. Rotor sails have been the most widespread solution so far, being now operational on seven vessels worldwide, with up to four rotors per vessel.

From the small cargo coaster, *Fehn Pollux*, to large vessels such as the 110,000dwt LR tanker, *Maersk Pelican* and 64,000dwt geared bulk carrier *MV Afros*, the rotor sail is establishing a reputation as a proven technology, offering reliable, simple, efficient and low-maintenance wind propulsion tailored to specific vessel needs. As one interviewee put it: "they are not rocket science".

Despite these advantages, the promising technology is held back by a policy landscape that continues to favour traditional fossil fuel propulsion and design choices which fail to recognise the human element in operation.

A master's student project was recently completed at the maritime consultancy SSPA Sweden AB as part of the Interreg North Sea Europe's project Wind-Assisted Ship Propulsion (WASP), investigating the state of the art in this sector's innovation and to gain insight into the human factors influencing their operation and performance.

What are rotor sails?

Developed in Germany by Anton Flettner in 1922, rotor sails are electrically powered rotating columns which exploit renewable wind energy using the Magnus Effect to provide forward propulsion to a vessel. The same effect used by a tennis player who 'slices' or 'curves' the ball by spinning it to change its trajectory can be applied to the sail which, when spinning, transfers perpendicular wind force into forward propulsion. The resulting auxiliary thrust reduces main engine fuel consumption.

Figure 1: *Viking Grace* was retrofitted with a rotor sail in 2018

Rotor sails saw a brief and limited deployment at sea when first invented but were swiftly made obsolete by cheap oil, seemingly dooming the device to the dustbin of failed maritime contraptions. However, we live in fast-changing and challenging times and Anton's long-forgotten device has re-emerged revamped for the digital age, to alleviate both the environmental impact of international shipping and the financial woes of unpredictable oil prices.

With proven fuel savings ranging between 300 and 920tonnes annually, rotor sails offer shipowners hundreds of thousands of dollars in savings each year and considerable reductions in carbon emissions and air pollutants. The technology is a potential co-solution for shipowners to meet coming regulations such as EEDI (and possibly EEXI) energy efficiency requirements while simultaneously lowering fuel spending. As stand-alone systems, rotor sails can be retrofitted easily onto existing vessels or integrated into the design of new builds.

Achieving self-sustaining innovation

Interviews with key shipowners and rotor sail manufacturers revealed an innovation trend in this blossoming sector. By analysing key innovation indicators centred around the creation and sharing of technical knowledge, a cyclical interaction was identified: (1) full-scale installations acquire funding, (2) creating valuable operational experience and learning by doing, (3) in-turn increasing the general awareness of rotor sails and raising shipowner expectations which, finally, (4) validates interest groups who lobby for more funding, and so on. The cyclical innovation loop is shown in Figure 2.

This cycle has been instrumental in the early uptake of the rotor sail but illustrates the sector's reliance on outside funding. To date, every rotor sail installation has received government subsidy in some form, confining the technology in a pre-commercial snare. Rotor sail manufacturers struggle to offer affordable payback times, or returns of investment, to operators of large vessels. Attractive returns on large vessels remain elusive because of the large overall fuel costs despite substantial absolute fuel savings.

Even hundreds of tonnes of fuel saved per year may only translate to a few percent of overall costs. For ro-pax, ro-ro and tankers, the payback period has not yet quite reached a 'sweet spot' of under five years. Anything under this and the short leases and high insurance fees on vessels make rotor sail capex unviable for shipowners. One solution to drive down

payback times is to increase the fuel saving performance of rotor sails.

Ramping up performance with human factors

On a Monday morning, I arrived at Stockholm's Stadsgårdskajen terminal to interview the crew of the *M/S Viking Grace*, which has entered into a small but fast-growing group of vessels that hail a promising new trend in international shipping: the return of wind power. Since 2018, the 57,000gt luxury RoPax ferry has operated a single Norsepower rotor sail on its route between the Swedish capital and Turku, Finland via the complex Åland Archipelago. While the engine crew reported very little change in their tasks and no complaints, the navigators and Master provided special insight into rotor sail operation.

Many might assume that humans are designed out of rotor sail operation through automation, but this was found not to be true. Granted, all rotor sails do function automatically. Onboard or onshore software controls their speed and rotation direction to extract the maximum thrust available from the existing wind conditions, based on real-time data for wind speed and direction. But, decisions by the bridge crew about when to reduce main engine power are entirely manual and can greatly impact fuel saving performance.

If this is left unacknowledged, bridge crews will be frustrated by not being able to access fuel savings data or calculation methodologies which could help improve their understanding of the system and their navigational decisions. Giving the bridge the best possible information for their decision making is key to ensuring that rotor sails are used to their full potential while simultaneously reducing the burden of their already-demanding workload.

A myriad of quite simple solutions exist which can help to achieve this. Shipowner investment in high-quality, in-depth training ensures the crew's understanding of sailing to save fuel. Supporting this, proper design of user interfaces can instruct crew on how much main engine power can be reduced while maintaining speed. Such initiatives increase bridge crew motivation, as do the introduction of financial or competitive incentives for crews of vessels with low fuel consumption. Finally, improvements in communication between crew and technology providers is generally an invaluable measure to improve the usage of any automatic technology.

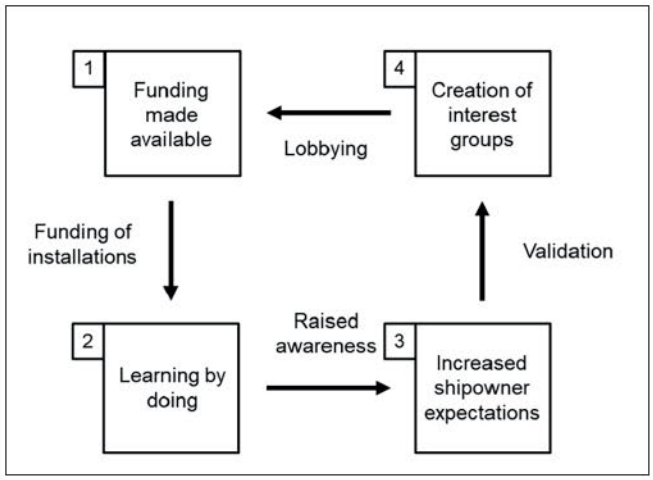


Figure 2: The cyclical innovation loop

These relatively simple measures are low-hanging fruit and should be adopted before further complex technological solutions are implemented, such as route optimisation. The stacking of ever more disjointed and fragmented systems atop one another risks harming usability and can result in misuse. A successful Fourth Industrial Revolution for shipping must rely on automated and smart technologies being transparent and integrated and human factor issues should be addressed first, before ever more complexity is introduced.

Towards zero-emission shipping

The IMO's target of 50% GHG emissions reduction by 2050 will help ensure that a catastrophic 2°C of warming is not reached. Despite the benefits of rotor sails, they alone cannot reach this target or meet the power demands of modern ocean-going vessels. To develop truly zero-carbon vessels, main propulsion using hydrogen or sustainable e-fuels to power fuel cells must be coupled with auxiliary thrust from wind systems and/or batteries. The European Parliament's recent decision to include shipping in the Emission Trading Scheme is an important signal that environmental regulation anticipated by shipowners will come into force. Carbon prices must now rise and marine fuel tax exemptions scrapped.

Rotor sails are already proven to cause immediate carbon emissions reductions and, with the right collaboration between actors and operational improvements in human factors, they can fill a technological niche between energy efficiency measures and expensive zero-emissions fuels. Access to such a solution, especially in developing countries, small island states and remote areas, will be key to international shipping tackling the climate crisis on a truly global scale.

It is hoped that this study will add to the growing effort to facilitate the transition of shipping towards a sustainable future in line with IMO strategy and Paris Agreement commitments. Analysis of rotor sail innovation trends showed that the length of return-of-investment periods prevents widespread uptake. One solution to drive down payback times is to increase fuel saving performance through the acknowledgement and understanding of human factors. By implementing in-depth training for bridge crews, improving the user interface and generally maintaining strong communication with crews, technology providers can maximise fuel savings to bring rotor sails closer to commercialisation and widespread uptake.

About the author

David Newman is a graduate of the MESPOM master's program, completing his thesis at Lund University in Environmental Science, Policy and Management, in collaboration with SSPA Sweden AB under the WASP project. He now works for the Zero Emissions Ship Technology Association (ZESTAs) and is compiling a compendium of regulations, standards and policies for zero-emission ship technologies. *NA*

The contribution of pure silicone coatings to improve vessel energy efficiency

Shipping's need to meet the IMO requirements for carbon emission reductions places heavy emphasis on operational measures, writes Ariana Psomas, PPG

The shipping industry faces a formidable challenge in achieving IMO's targets to reduce carbon emissions in line with the Paris Agreement, requiring major adaptations in the way new ships are designed and existing ones are operated.

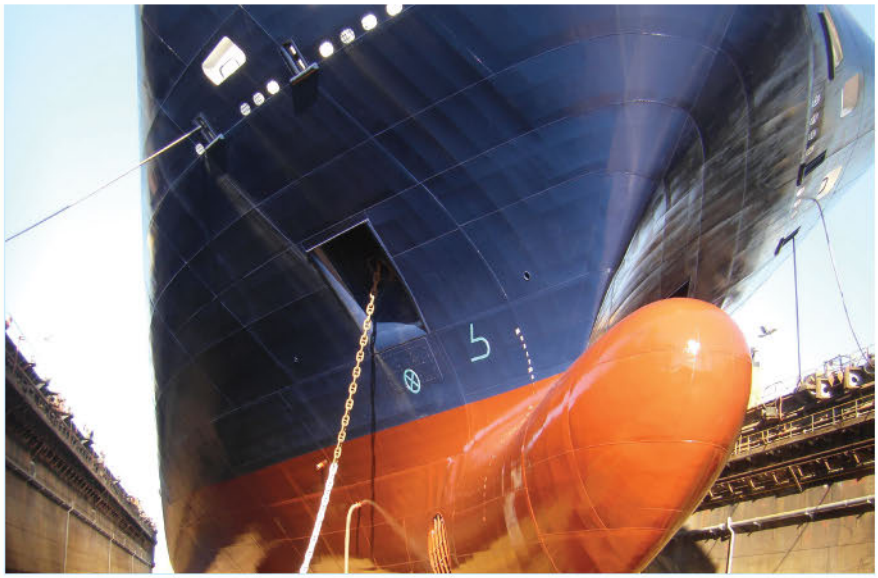
IMO's plan calls for a reduction in carbon emissions intensity by at least 40% compared with 2008 levels by 2030, and at least 70% by 2050, as well as reducing total emissions by 50% by 2050.

For shipowners, the ability to achieve savings of this magnitude will require new fuels, new vessel designs and radical improvements in operating efficiency.

Other options such as mandatory speed reductions, engine/shaft power limitations and market-based measures such as emissions trading or a bunker levy are subject to safety concerns or political uncertainty.

A tightening of EEDI requirements is expected and potentially, for existing ships, compliance with a new measure, the Energy Efficiency Existing Ship Index (EEXI). Tabled to IMO by a group of influential member states, the EEXI, if adopted, will have a considerable impact on the profile of the global fleet as it seeks to apply the EEDI phase 2 or phase 3 standard to existing ships in service. If adopted it could have an implementation date as soon as 2023, meaning the industry has only a couple of years to implement the technologies they will need for compliance.

EEXI will be built upon existing framework under MARPOL Annex VI, so that enforcement in accordance with the IMO's system of survey and certification can be ensured. After the application date, EEXI requires a survey to be conducted before the ship can operate. Therefore, unlike operational requirements that can only be enforced through retroactive inspections and where there is no alternative compliance mechanism if a ship does not meet the requirement, EEXI prevents the operation of non-compliant ships in advance.



Sigmaglide application

Energy efficiency technologies

EEXI is designed as a goal-based measure which allows a variety of options to meet the requirement as long they are verifiable and measurable. These include the installation of energy saving devices as well as the adoption of alternative fuels.

However, since the new fuels which will be vital to the future of low and zero carbon shipping will be far more expensive than those of the past, improving operational performance using new innovative energy efficiency technologies is vital.

The IMO has published a list of categorised Energy Efficiency Technologies. Among which, low friction coatings have been recognised as a technology that can shift the power curve in calculation and verification of attained EEDI for newbuildings – and thus for a future EEXI on existing

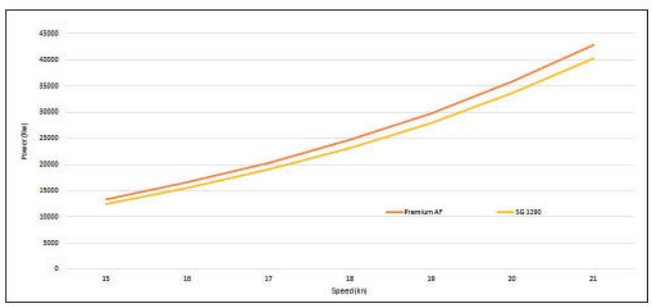


Figure 1. An LNG Carrier shows 7% reduced power consumption after retrofit with PPG Sigmaglide

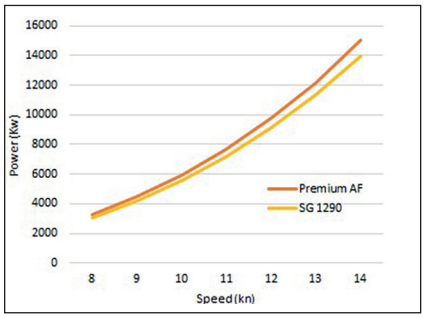


Figure 2. A VLCC after retrofit with PPG Sigmaglide

vessels. The evaluation of the innovative technology's benefits needs to be carried out in conjunction with the hull form and propulsion system with which it is intended to be used.

In the area of low friction coatings, several studies have concluded that silicone technology stands out in comparison to antifouling technologies, as it can significantly decrease hull drag resistance.

The reason is its unique combination of low surface free energy and high elasticity – it has the lowest critical surface tension of any engineered material. As a result of these properties, silicone coatings are smoother and can deliver a significant benefit over antifouling coatings, optimising the vessel design parameters by shifting the speed and power curves.

A 2011 investigation concluded that silicone coatings offered potential skin frictional drag reduction of between 9% and 22% at speeds between 6.5knots and 22.7knots, when compared to speciality polymer coating technologies and also delivered high durability, antifouling properties and anticorrosive effectiveness.

Adding to the design improvement, silicone coatings provide a significant operational benefit for the shipowners, as they deliver optimum fouling anti-adhesion due to their hydrophobicity and low surface energy properties.

Most marine organisms possess some degree of polarity – or surface charge – and therefore they do not recognise the low surface energy silicone surfaces as attractive to attach to. As a result, the silicone technologies deliver minimal hull degradation over time.

Real world testing

PPG performed several studies in cooperation with leading independent marine institutes in Europe, in order to measure the power and speed impact on vessels retrofitted with PPG's Sigmaglide 1290 silicone coating.

Using computational fluid dynamics analysis (CFD) following ITTC standards, on different ship model geometries and hull forms, a significant shift in the speed and power curves was confirmed. The measured improvement in power demand averaged 7% less power for the same speeds across the different ship models.

Additional studies, including mathematical extrapolations and practical validation with ships in service, confirmed the improvement in speed and power curves, which can provide a significant benefit for shipowners wishing to boost energy efficiency performance.

Of the major studies undertaken recently, classification society DNV GL conducted research into the efficiency of vessels coated with PPG Sigmaglide 1290. The analysis was performed on actual vessels of 11 and 15 years old whose performance in service was compared against the performance levels during sea trials.

The research found that a sample of vessels coated with Sigmaglide 1290 demonstrated speed improvement, as well as very low speed loss during the operation.

Pure silicone technology

The impressive results with PPG Sigmaglide 1290 silicone technology are attributed to the choice of the appropriate polysiloxane precursors and cross-linkers, which result in the highest known silicone density of any coating on the market today. The higher the silicone density, the lower the surface energy and therefore the lower the frictional resistance, and the higher the foul release properties.

This can be observed visually by the degree of wetting of the silicone surface with water (as shown in Figure 3). The lower surface free energy, as compared with other commercial products, produces higher contact angles, which is a good indicator of the hydrophobicity and unique performance.

It also means that less surface area of water is in contact with the hull, minimising the drag the drag forces that occur as ships sail through the water. So not only does the higher silicone content release fouling more effectively, but also it delivers an effective solution to the vessels seeking to meet the stringent IMO efficiency requirements.

As a result, shipowners wishing to improve their EEDI and EEXI performance will benefit from significant reduction in power demand as well as improved operational performance and minimal speed loss. *NA*

Figure 3. Sigmaglide 1290 offers demonstrable advantages in hydrophobicity

Understanding and considering the effects of national culture

Differences in the culture, values and practices can mean the safety measures recommended in one country may not work effectively in another

While attending working groups on the safety of ships, Dr Youngsub Kwon, a specialist in maritime engineering safety and assessments at Chosun University, South Korea, began to realise that there are substantial gaps in the perception of safety in his home country and that of the west.

"The first thing I encountered is that most of the measures or methodology being introduced to tackle the safety issues came from western countries, whose culture is different to what I am living or thinking," he explains. "Another gap was that Korean colleagues involved in maritime safety were, and still are, complaining about statistics of human factors and blaming the seafarers. But few mariners were taking an active role in searching for the underlying reasons for accidents at sea."

Kwon found that the prevailing rhetoric within the maritime safety community is a strategy of investing heavily in equipment to minimise accidents. "Sufficient budget, and introducing western technical measures, can be of help for reducing the frequency and consequences of accidents, but I'm not convinced this will work as well as the theory predicts. This is, of course, due to cultural differences."

By the very nature of the profession, seafarers are drawn from a diverse range of cultures and must work together in a contained and stressful environment. Previous analysis of the role of cultural factors in safety has identified that it's often the underlying factor in an entire chain of events leading to an incident. Researchers in this area have suggested that developing a deeper understanding of how cultural background influences the way the world is interpreted could improve seafarers' ability to manage challenging circumstances.

Kwon's paper 'Perceptions of the West and the East and National Culture on the Human Factors', presented at RINA's Human Factors 2020 conference earlier this year, explores the mechanisms of behavioural customs with respect to safety. The work builds upon the findings of Kwon's previous research, which contrasted the 'individualist' ethos of western ontology with the more 'collective' outlook of eastern relationism. It also draws heavily from the theories of the pioneering social psychologist Geert Hofstede concerning national cultures.

Dr Kwon began to notice the importance of safety after attending a RINA meeting which discussed the loss of MV *Derbyshire* in 1990

"Hofstede's opinion seems quite pertinent to consider seriously as, from my experiences of safety issues in South Korea and the measures of the west, I've found that there are gaps in the latter in order for them to be effective in South Korea. The same, I suspected, would be the case for other third world countries," Kwon explains.

Hofstede's cultural dimensions

While working on personnel research for IBM Europe in the 1960's, Hofstede conducted a survey of 117,000 employees, comparing attitudes across 50 different countries. It formed the basis for what Hofstede eventually defined as the six 'dimensions' of each nation's culture: Power Distance, Uncertainty Avoidance, Individualism, Long Term Orientation, Masculinity and Indulgence. The work has not been without its detractors, with some critics claiming Hofstede's model to be excessive and unbalanced. However, Kwon believes that: "Hofstede's framework of national culture is not a complete one, but instead comprehensive, which is a good starting point to investigate many activities, including safety practices."

Given that the car is the most popular form of transport across the world, road traffic behaviour is also highly reflective of national cultures and attitudes to safety. It acts as the starting point for Kwon's research, as he notes: "Road traffic safety is the most efficient subject to consider as its ripple effect onto the whole community would be paramount."

To begin with, Kwon looked at road traffic accidents and compared five countries with poor (or 'vulnerable') fatality records to those with a low (or 'advanced') rate (Fig.1). From the results, it was found that among the six dimensions, Power Distance, Individualism-Collectivism and Uncertainty Avoidance appeared to be related with road traffic accidents. Moreover, there was a correlation between countries that scored highly in these dimensions according to Hofstede's research and those which had an increased rate of accidents. Kwon then applied a similar approach to maritime accidents, drawing upon previously collated casualty figures drawn from between 1997 and 2011 (Fig.2). While by no means a perfect measure, since some countries such as Panama operate open flag registries available to non-resident vessels, South Korea continued to score highly with

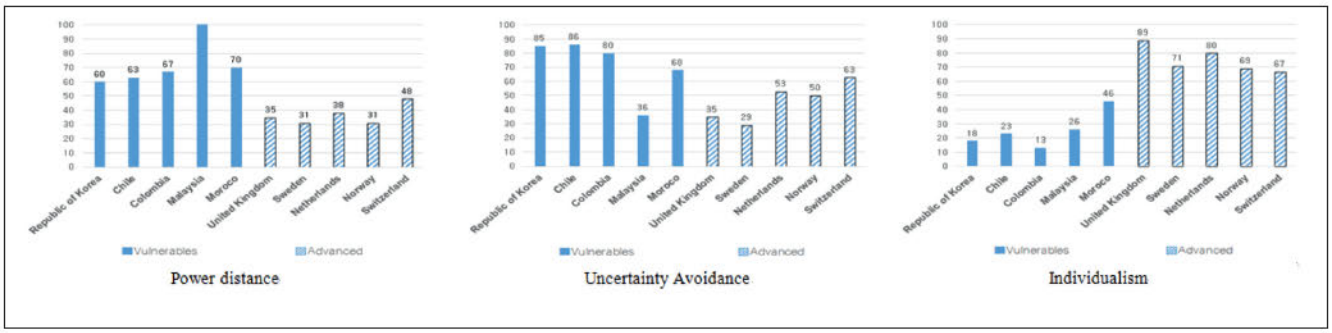


Figure 1 Comparison of national cultural dimensions in case of road traffic accidents

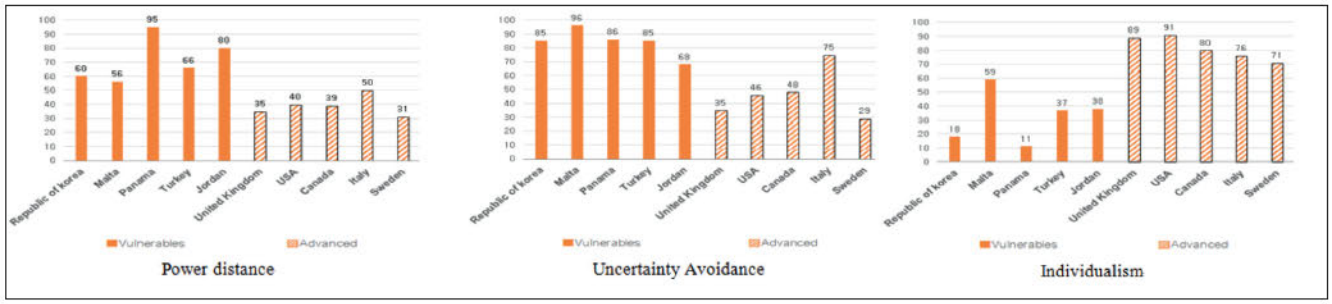


Figure 2 Characteristics of national culture dimensions in case of marine accidents

regard to accidents as a proportion of its overall fleet.

It's worth looking at the three dimensions most pertinent to safety measures in more detail, as Kwon notes that two or more dimensions need to be considered together in order to closely examine a culture and its effects:

Individualism-Collectivism

Individualism-Collectivism (IDV) represents the degree to which people within society are integrated into groups and the perceived obligations and dependency on said groups. In a more collectivist culture, for instance South Korea (with its low IDV score of 18), loyalty is paramount and overrides most other societal rules and regulations. In such a society an offence does not lead to guilt and loss of self-respect, but instead to shame, loss of 'face' and can bring about recurring violation of safety practices, which Kwon comments is the most common contributing factor in traffic accidents.

This is because where shame is social (or collectivist) in nature, guilt is individual; whether shame is felt depends on if the infringement has become known by others. Kwon explains: "While there are merits in feeling shame and loss of face, a responsible citizen should be firstly expected to feel guilt and correct practices, and South Korea has much to improve on in this regard."

He adds: "For most South Koreans, individualism means selfishness, unfortunately, although that misconception is changing slowly." A classic example of this mindset and its repercussions is that, in a collectivist society, children take their bearings from others and education is perceived as instruction in how to do things rather than how to learn. Consequently, in South Korean culture seldom do students raise their hands to ask questions, and this phenomena even extends to journalists at press conferences. One can easily see how, within a maritime environment, a mariner might be reluctant to report a flaw in an established procedure, allowing safety practices to be continually compromised.

Power Distance

Power Distance (PD) refers to the relationship between those in power and their subordinates, and how those in lower ranking positions react to that authority. It impacts upon people's behaviour in every interaction. Hofstede himself discerned that South Korea, which has a PD score of 60, is a slight hierarchical society, where people accept a hierarchical order and value is placed upon respect and honour. This contrasts with lower PD scoring countries, such as those in the west, where hierarchy is established as much for convenience and organisations are expected to have structured ways for dealing with the abuse of power.

Moreover, the need for self-actualisation within the hierarchical society can lead to a distorted sense of status, and Kwon highlights that the consequential misuse of power is prevalent in traffic activities. He is, however, hopeful that ongoing efforts to reform prosecutorial affairs in South Korea may in turn lead to political change and a shift away from its right-wing bias. "Creating a democratic power structure is believed as one of the key reformations which will encourage the public to take responsibility in various modes of daily life in a relaxed way. This would affect the states of power distance, individualism as well as uncertainty avoidance, which will lead to safer environments and behaviour."

Uncertainty Avoidance

Uncertainty Avoidance (UA) is defined as the extent to which the members of a culture feel threatened by ambiguous or unknown situations, and is strongly related to the degree of anxiety, where extreme ambiguity creates intolerable anxiety. A typical manifestation of anxiety in society is high suicide rates. Another, somewhat paradoxically, is faster driving, leading to

greater risk and more fatal accidents.

The anxiety component of UA leads to noticeable differences between strong and weak UA societies. Stronger UA societies, such as South Korea (UA score of 85), show a priority for saving time over saving lives. The country's traffic incident data reflects this and is of great concern. Pedestrians account for 39.9% of all fatalities in South Korea, compared with the OECD average of 19.7%. By contrast, driver fatalities stand at just 19.2% compared to the OECD mean value of 46.6%. In light of this, in recent years the South Korean government has been working hard to create safer environments, with lower speed limits introduced in city centres.

In high-scoring UA countries like South Korea, authorities are deemed to have more expertise than those with a lower score. Typically, citizens from these countries also record higher self-ratings with regard to unhappiness and Hofstede noted that the emotional need for laws and regulations in such societies can lead to rules or rule-oriented behaviours that are purely ritual, inconsistent, or even dysfunctional.

Conclusions and recommendations

Eastern and western cultures alike have an evolving grammar for their own ways of living, which are essentially different means to the same ends, but Kwon finds that, in terms of safety, countries are often limited in scope: "It is unfortunate that many countries do not recognise accidents due to organisational culture, let alone national culture."

All three of the above described cultural dimensions are related with violence and physical/verbal abuse which compromise safety practices. To that effect, Kwon believes safety policies applied to a particular society or country require analysis of that country's culture. Such studies may include selecting and dealing with social impact factors, their causes and effects, to establish social calibrations.

He adds that further long-term scrutiny and research are necessary in order to analyse and draw an effective policy in relation to national culture and its effects on a specific country: "It may well need the collaboration of the experts of, for instance, psychology, sociology, pedagogy, political science, cultural anthropology as well as transport safety."

In particular, Kwon thinks there are potential benefits to incorporating such an approach into 'Just Culture', the notion that mistakes are a result of poor organisational systems rather than the fault of specific persons. "The background and key issues of Just Culture, as shown in the IMO documents (MSC 88/16/1, MEPC 62/17/2), are quite relevant as it aims to address the deep underlying causes of accidents and to obtain the essential safety information and our ability to learn," he explains.

Just Culture is more commonly utilised at individual and organisational levels, but Kwon thinks it could be effectively applied to national cultures. "Even multi-national companies consider national culture along with their own organisational aims and visions. Therefore [national culture] can be incorporated within Just Culture, as the common goals and the tools are the same.

"It is obvious that people's way of thinking and practices depends not only on education and the organisation they are involved in, but also the country(s) he was born and brought up. In fact, various maritime communities including authorities at times point out the need to consider 'cultural differences and the sub-cultures', particularly for those with multinational crewing," says Kwon.

He adds that, as far as his home country is concerned, there is still progress yet to be made: "South Korea has long been a third world country and nowadays it has become a so-called advanced country, but it is anticipated that it will take a long time to become advanced as far as safety is concerned." *NA*

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Critical onboard tasks such mooring rely heavily on communication and commonly understood safety protocols. Image: Shutterstock

Propeller skew definition

There appears to be some confusion regarding the determination of propeller skew, right from the design stage.

The current rule states that skew angle is defined between propeller tip and the tangent to the midchord curve. The propeller tip in itself – in our view – remains vague depending mainly on propeller geometry. Having discussed the issue with an authority, we agreed that this should be the point where the maximum chordal span from the generator line meets the 'T.E.' profile. Another way to define a propeller skew would be the section of the diametral (or max radius) tangent and the contour profile (see relevant drawings).

Considering the projected view as suggested by IACS, the skew angle is measured between this (in our view) ill-defined point and the tangent to the midchord curve, both centred at the shaft centreline. This implies that the midchord curve need not progress any further than its contact point with the straight line as it only serves to define this point. Then, by measuring the angle between this line and the "propeller tip point" we have the skew angle.

More often than not we have come across designs where the midchord curve is extended to cut the contour and define this as the propeller tip.

This, in the authors view, is not in line with IACS, it may happen as an exception but not as a rule.

We therefore feel that "propeller tip point" should be defined more clearly in order to avoid classing high skew as low skew propellers, which come under different Class Rules and requirements. *NA*

Yours faithfully,

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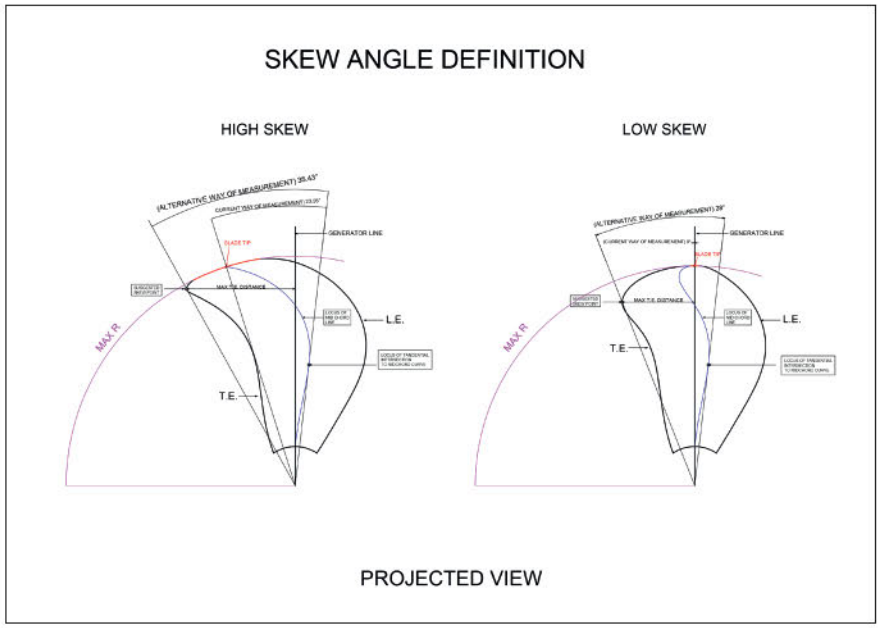

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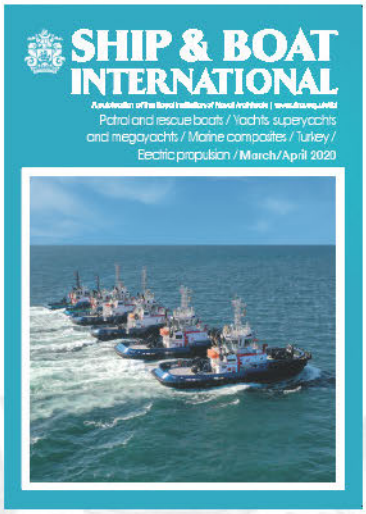

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International forum,
Online
www.imo.org/en/MediaCentre

November 18-19, 2020
Green Shipping
WEGEMT/RINA Course
Online
www.rina.org.uk/WEGEMT_Course_on_Green_Shipping_online_course

November 26, 2020
Presidents Invitation Lecture
RINA event
Online
www.rina.org.uk/Presidents_Invitations_Online_Lecture_2020

December 1-2, 2020
Postgraduate Research in the field of Maritime Technology
International conference,
Online
www.icep.com.my/ipmc

December 2-3, 2020
Historic Ships
RINA conference,
Online
www.rina.org.uk/events_programme

December 7-8, 2020
Decommissioning of Offshore & Subsea Structures (DECOM)
International conference,
Aberdeen, UK
asranet.co.uk/Conferences/DECOM

December 7-11, 2020
Technical Cooperation (TC) Committee
International forum,
Online
www.imo.org/en/MediaCentre

January 26-27, 2021
Ship conversion, repair & maintenance
RINA conference
Online
rina.org.uk/SCR_M_2021

February 2-5, 2021
SMM
International exhibition,
Online
www.smm-hamburg.com/en/

February 10-11, 2021
Full-Scale Ship Performance
RINA conference
Online
www.rina.org.uk/events_programme

February 16-17, 2021
Wind Propulsion
RINA conference
Online
www.rina.org.uk/events_programme

March 2-5, 2021
Dry Dock
Training course
Online
rina.org.uk/Dry_Dock_Training

March 2021
Ships' Life Cycle
RINA conference
Online
rina.org.uk/events_programme

March 2021
Innovation/Emerging Technologies
RINA conference
Online
rina.org.uk/events_programme

April 8, 2021
The Road to Maritime Autonomy
RINA/One Sea forum
London, UK

April 19-20, 2021
Smart & Green Technology for Shipping and Maritime Industries (SMATECH)
International conference,
Glasgow, UK
asranet.co.uk/Conferences/SMATECH

April 29, 2021
RINA Annual Dinner
Royal Lancaster London
London, UK

May 4-6, 2021
Safety, Reliability of Ships, Offshore & Subsea Structures (SAROSS)
International conference,
Glasgow,
UK
asranet.co.uk/Conferences/SAROSS

May 9-13, 2021
11th Symposium on Cavitation
International conference,
Online
cav2021.org

May 24-25, 2021
Offshore Renewable Energy (CORE)
International conference,
Glasgow, UK
asranet.co.uk/Conferences/CORE

May 27-28, 2021
Structural Integrity for Offshore Energy Industry (SI)
International conference,
Aberdeen,
UK
asranet.co.uk/Conferences/SI

May 2021
Contract Management
RINA conference
Online
rina.org.uk/events_programme

June 2021
Warship
RINA conference
Online
rina.org.uk/WARSHIP_2020_Future_Technologies_In_Naval_Submarines

September 28-30, 2021
ICCAS
International conference
Yokohama,
Japan
rina.org.uk/ICCAS_2021

October 2021
Contract Management
RINA conference
Online
rina.org.uk/events_programme

The Royal Institution of Naval Architects

The International Journal of Maritime Engineering (IJME)

The IJME is published four times a year and all papers are peer reviewed. The third issue of 2020 contains the following papers:

Submit your paper for consideration

www.rina.org.uk/ijme

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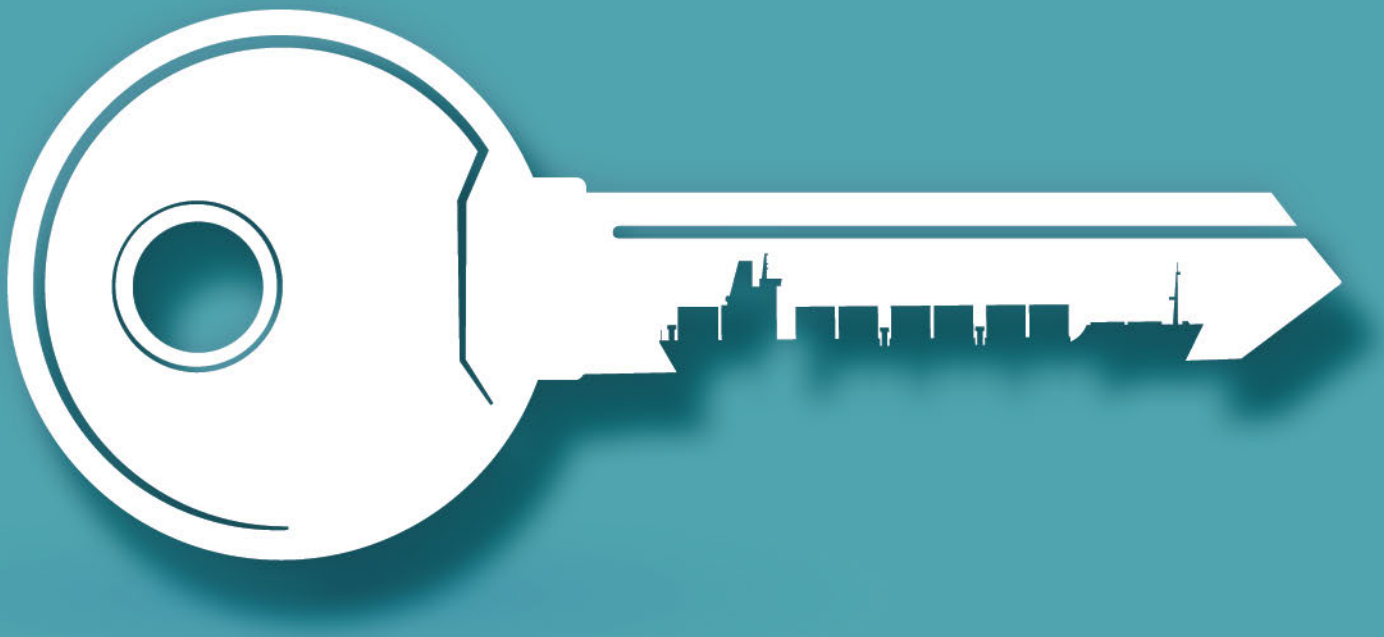

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