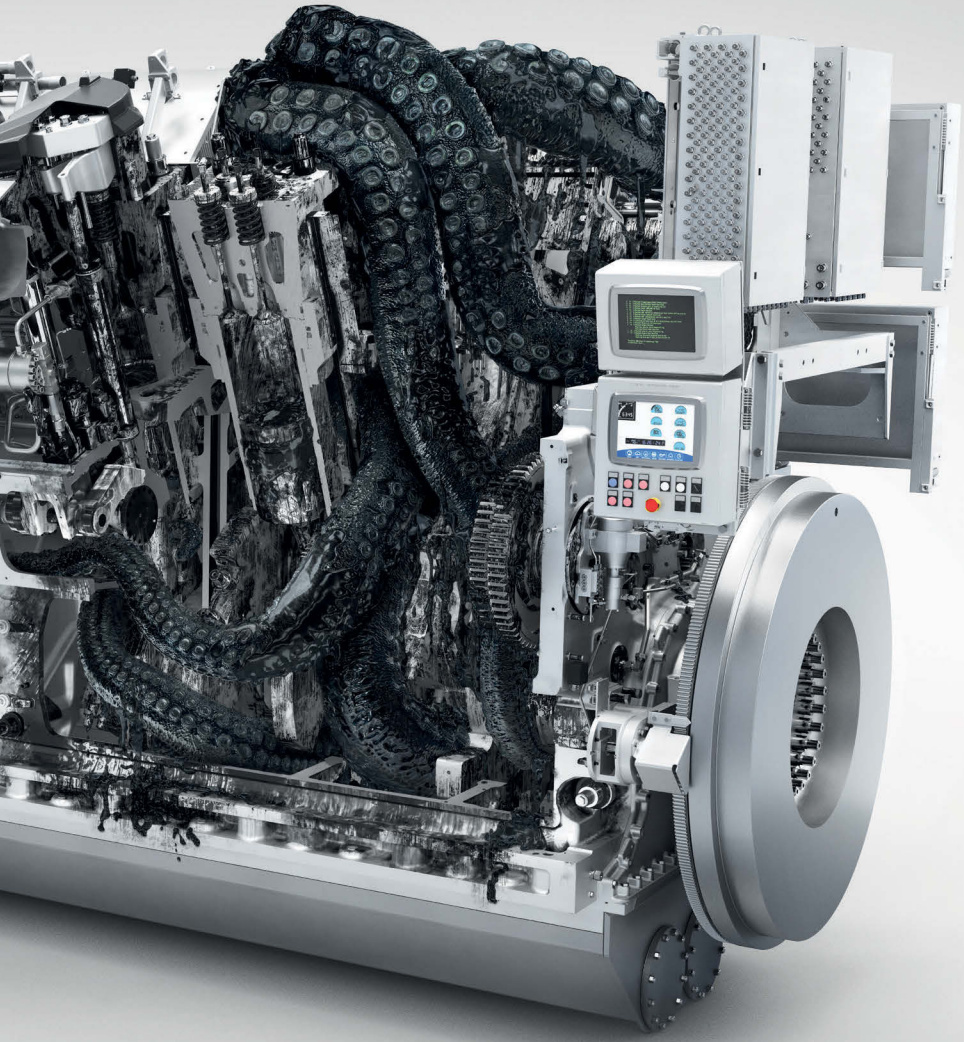
THE NAVAL ARCHITECT

A publication of The Royal Institution of Naval Architects | www.rina.org.uk/tna

Chemical & product tankers / Eco ship technology / Russia / Japan / **November 2019**



DON'T LET **CONTAMINATION TAKE A GRIP** ON YOUR ENGINE

Developments in modern engines and fuels that are better for the environment can have a negative impact on engine health. New combinations are likely to increase contamination build ups that could lead to unreliable performance, unless your oil can deal with the increased stress.

At Castrol, our experts have developed Castrol TLX Xtra with enhanced detergency system technology (EDS). TLX Xtra can help fight soot, sludge, and asphaltene build ups, giving your business the Xtra operational confidence that comes from an Xtra clean engine.

Discover how the advantages add up.
Castrol.com/TLXxtra

IT'S MORE THAN JUST OIL. IT'S LIQUID ENGINEERING.

Castrol TLX XTRA

Editor: Richard Halfhide
Editorial Assistant: Kaylee Maddison
Production Manager: Nicola Stuart
Advertisement Production Manager: Stephen Bell
Subscriptions & Publications Manager: Tasharna Francis
Publisher: Dmitriy Ponkratov

Advertising Sales: J P Media Services
Email advertising: jpayten@jpmediaservices.com
Telephone: +44 (0)1737 852135

Published by:
The Royal Institution of Naval Architects
Editorial Office:
8-9 Northumberland Street
London, WC2N 5DA, UK
Telephone: +44 (0) 20 7235 4622
Telefax: +44 (0) 20 7245 6959
E-mail editorial: editorial@rina.org.uk
E-mail production: production@rina.org.uk
E-mail subscriptions: subscriptions@rina.org.uk

Printed in Wales by Stephens & George Magazines.

A 2019 subscription to *The Naval Architect* costs:

NAVAL ARCHITECT (10 issues per year)

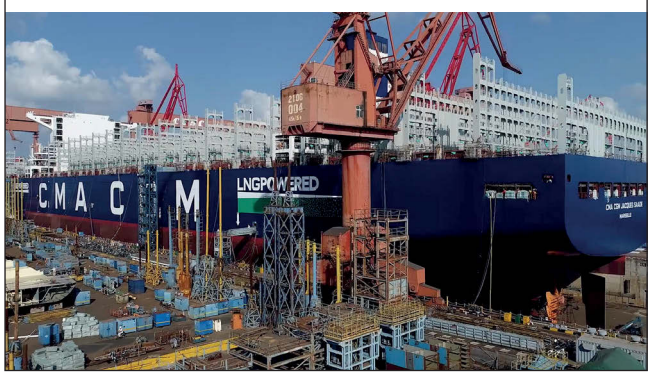
12 months	**Print only†**	**Digital Only***	**Print + Digital**
UK	£196	£196	£250
Rest of Europe	£205	£196	£258
Rest of World	£220	£196	£274

†Incudes p+p
*Inclusive of VAT

The Naval Architect Group (English Edition)
Average Net Circulation 10,291 (total)
1 January to 31 December 2018
ISSN 0306 0209

8 **Collaboration pushes wind power to the forefront**

19 **Hudong Zhonghua completes its first MARK III membrane tank**



the 16th edition of
ASIA PACIFIC MARITIME
APM

FUTURE OF VESSELS SOLUTIONS FOR TOMORROW

18-20 MARCH 2020 | MARINA BAY SANDS, SINGAPORE
HALLS A, B, C, D, E & F | WWW.APMARITIME.COM

EXHIBITION

ONE OF ASIA'S LARGEST MARKETPLACE FEATURING:

- **14,158** trade visitors from Asia
- **1,432** brands with **69%** international participation
- **18** official pavilions
- **6** exhibition halls across **21,000 sqm**
- More than **100** bespoke meetings
- **3** days of networking events
- **74** seminars & partner events
- **10** delegation tours

CONFERENCE

STEEN BRODSGAARD LUND
Chief Commercial Officer and Group Chief Digital Officer, Executive Ship Management

ANDY POWELL
Chief Information Security Officer, Maersk

KENNETH LIM
Senior Director, Innovation, Technology & Talent Development / Chief Technology Officer, Maritime and Port Authority of Singapore

ANDRE SIMHA
Global Chief Digital & Information Officer, MSC Mediterranean Shipping Company

and many more...

- **Enabling digitalisation through standardisation & collaboration**
- **Understanding maritime 5G connectivity**
- **Scrubbers vs desulphurisation of fuel**
- **Maximising economic transformation via digital solutions**
- **2020 global sulphur limit**
- **Hybrid, low emissions or LNG engines**

REGISTER NOW

Organised by: Reed Exhibitions®

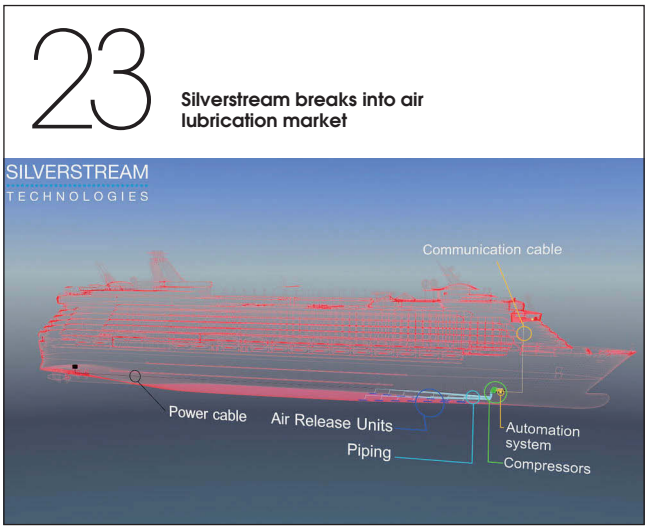
Endorsed by: aif Approved International Fair

Supported by: MPA SINGAPORE; SINGAPORE EXHIBITION & CONVENTION BUREAU

Held in: Singapore Passion Made Possible

Gold Sponsor: WEICHAI

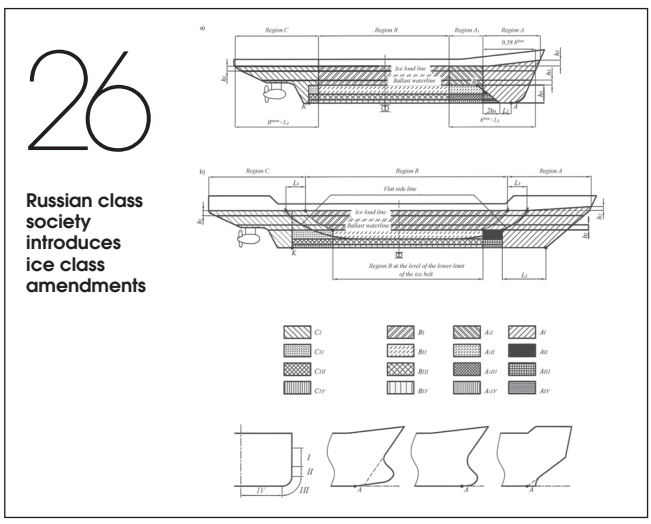
20-34 Features

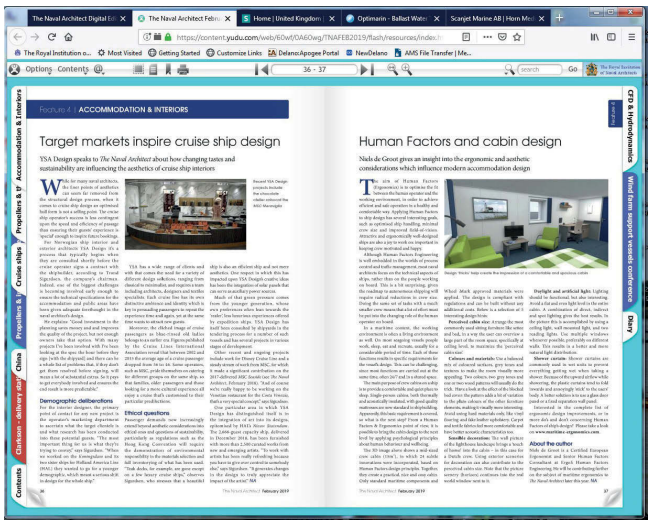


Digital Editions

The Naval Architect is published in print and digital editions. The current and archived digital editions may be read on PC, iPad or other touchpad.

Visit http: www//rina.org.uk/Naval-architect-digital.html to read the digital editions, or download the free RINA Publications App.





Listen to the sea

Posidonia

1-5 June 2020

Metropolitan Expo, Athens Greece

Posidonia Ποσειδώνια

The International Shipping Exhibition

Organisers: **Posidonia Exhibitions SA,** e-mail: posidonia@posidonia-events.com

www.posidonia-events.com

It's time to get serious about green technologies

A meeting of the IMO Global Industry Alliance (GIA) taskforce in March 2019

While researching my article on Silverstream Technologies (p.23) for this issue I chanced upon a page on Wärtsilä's website detailing some of the other air lubrication devices currently on the market. It was sobering warning that a number of the technologies developed so far had actually proven to achieve the very opposite of the energy savings they expected to offer, often using more power to operate than they saved with friction reduction. It is also to Silverstream CEO Noah Silberschmidt's credit, and perhaps savvy, that he has preferred to stick to conservative estimates; a strategy that now appears to be reaping rewards.

Yet it highlights the inherent risks, as shipowners are increasingly asked to not merely consider green technologies as 'nice to haves' but told they are intrinsic to them achieving the requisite efficiency ratings for their vessels. Many eco technologies begin life as small startup companies, which may or may not then be acquired by the bigger players, and there is inevitably pressure from investors to come good on their promise. Claims get exaggerated and test results presented in a way that makes them more palatable – providing you don't check the small print.

It would be unfair to suggest the current landscape is a Wild West in which the green technologists are medicine shows hawking snake oil to gullible shipowners, but there's probably a kernel of reality to that. For one thing there's the potentially conflicting interests of whether 'efficiency' relates to operational costs or environmental footprint. Often, it's an awkward balancing of the two but a highly subjective one. Given the risk of unreliable 'evidence' and fine margins between profit and loss the shipowner's oft-commented upon conservatism should probably be interpreted as sensible pragmatism. Adhere to the regulatory requirements and beware the (green) white elephants if you want to stay solvent.

Conversely, there is obviously a need for technologies to be tested in the real operating conditions and finite public resources to subsidise that, particularly with regard to IMO's GHG targets. But how best to ensure shipowners have the information they need to understand the environmental and cost implications of eco technologies? According to Silberschmidt the Global Industry Alliance (GIA), the private-public initiative launched by IMO to support an energy efficient and low carbon maritime transport system, is seeking to develop such a tool but to be effective it will require a tamper proof methodology and unambiguous data.

Methodology has been a repeated criticism of the Energy Efficiency Design Index (EEDI), in particular that lower scores achieved by not measuring results in real conditions (see p.24-25). The Royal Institution of Naval Architects' own IMO committee has been among those lobbying for greater transparency on how EEDI figures are achieved while for the first time we hope to include actual and required EEDI values among the ship data in our *Significant Ships* title, as well as information of which energy saving devices may have been installed on the vessel.

It's our hope that by highlighting EEDI scores we can help promote broader recognition of the value of sharing such data. Ironically, at a time when sharing more information would be to everyone's advantage if carbon targets are to actually be achieved, it's been our experience that shipyards are growing more protective than ever about their intellectual property, while a culture of obfuscation often surrounds the reporting of trials and project results.

One article that we had hoped to include in this month's edition, but sadly had to withdraw at the last moment, concerned the 'techno-economic' modelling for a Flettner-equipped tanker operating on a typical European trade route in the North Sea. It concluded that a strong business case based on fuel savings, existing regulatory measures and the protection offered against stricter legislation in the future. While not perfect, one can see how such a multi-disciplinary approach to assessing green technologies could play an important role over the next few years. I certainly hope so.

Having just mentioned *Significant Ships*, I would like to remind shipyards and shipowners that it's not too late to submit your vessel for consideration among the vessels featured in our next edition. As it has since the first edition in 1990, the title will focus upon the most innovative and important vessels (over 100m LOA) of the past year, with a technical description, technical particulars and its general arrangement plans.

For further information and to download a copy of the review form visit: **www.rina.org.uk/sigships** *NA*

Wind power

Wärtsilä and Norsepower team up to boost wind propulsion

Wärtsilä and rotor sail manufacturer Norsepower have signed a service cooperation agreement, which will support the sale and promotion of Norsepower's wind technology.

The deal allows Norsepower to order service work from the tech giant, while Wärtsilä can pursue and sell Norsepower rotor sail projects with backing from the manufacturer.

Since its launch in 2014, Norsepower has installed rotor sails on three different vessels, with a fourth installation planned for 2020 on a Scandlines' hybrid passenger ferry. The company anticipates an increased demand for their wind powered technology, making the collaboration with Wärtsilä a significant step in scaling up their service offerings.

"We are delighted by this partnership agreement, and the ability it gives us to support our customers no matter where they are sailing and operating our technology. It also comes at a time when the global shipping industry is looking for proven and economical solutions to reduce their carbon footprint," said Jukka Kuuskoski, Norsepower's CSO.

Target sectors for the wind technology includes tanks, passenger ferries, cruise ships and dry cargo vessels. In March, Norsepower was issued its first type approval design certificate certifying the rotor sails for use onboard commercial vessels.

Norsepower has grown considerably since its founding in 2014

Autonomous shipping

NYK completes world's first autonomous voyage

NYK has conducted what it is claiming to be the world's first Maritime Autonomous Surface Ship (MASS) trial carried out in line with the IMO interim guidelines for MASS trials.

The 70,826tonne NYK-operated car carrier, *Iris Leader*, was navigated day and night on a journey from China to Japan using the Sherpa System for Real Ship (SSR) navigation system. The trial took a total of three days, during which time a crew performed their usual duties.

Throughout the voyage, the SSR's performance was monitored in actual sea conditions. Additionally, the system collected information on environmental conditions around the ship from existing navigational devices and calculated collision risk, while determining optimal routes and speeds that were both safe and economical in order to automatically navigate the ship.

The Japanese company hopes to make SSR the basic technology for remote and unmanned navigation. NYK has also stated that it aims to further develop the technology into "a more advanced navigation-support system by making adjustments to the difference between the optimal course derived by the program and that determined by professional human judgement."

As part of its mission of "bringing value to life", the SSR verified by the trial will be applied to future coastal ships, which currently face crew shortages (see *The Naval Architect*, July/Aug 2019).

Ferries

P&O invests in two double-enders

P&O Ferries had ordered two double-ended shuttle ferries from China's Guangzhou Shipyard International and states they will be the largest to sail the route between Dover, UK and Calais, France.

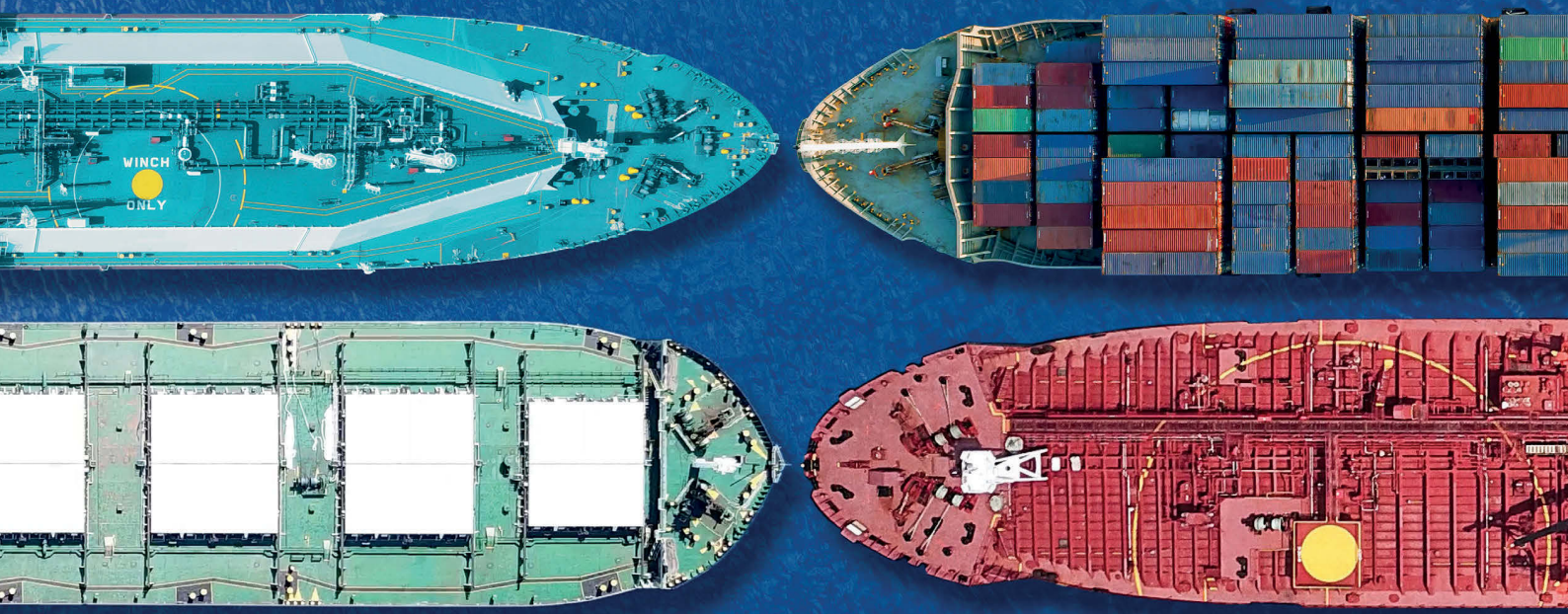
Designed by Danish naval architects OSK-ShipTech, the ferries are to have a bridge at both the stern and bow, from which the captain can navigate. Therefore, the ships will not have to turn around in port, saving around seven minutes of time per one way journey.

According to P&O, this concept was more economical and environmentally friendly compared with their 2011/2012-built Spirit Class ferries as they will save on time and fuel. The double-ended construction, in combination with the ferries' diesel-battery driven propulsion system, is expected to reduce fuel consumption by approximately one tonne per trip, equating to about a sixth of the amount consumed during the 21-mile crossing.

The batteries will be charged through peak shaving, with the surplus energy generated by the engines being stored in the batteries. Although the ships will not be equipped with scrubbers, they will feature heat recovery systems. Additionally, the operator plans to minimise the vessel's environmental impact by equipping both with the capacity for carbon-neutral sailing in the future.

Whatever your vessel, we have a fuel solution that fits

MAN Energy Solutions
Future in the making



Introducing the upgraded MAN B&W ME-GI Mk. 2 and the new low-pressure MAN B&W ME-GA two-stroke dual-fuel engines

Demand is a powerful driver for innovation; you told us exactly what you needed to stay competitive and compliant for the future, and we listened.

The upgraded MAN B&W ME-GI Mk. 2 and new low-pressure MAN B&W ME-GA two-stroke gas engines provide you with the most advanced, energy-efficient dual-fuel LNG solutions on the market, no matter whether you operate an LNG carrier or any other type of vessel.

Today, with next generation technology, best-in-class efficiency and sophisticated new control and safety systems, our multi-fuel engine portfolio is complete – and your needs are covered.

Power ahead at: www.man-es.com/MEGI-MEGA

The 230m-long newbuilds will have a capacity of 2,800 freight lane metres, split between the main deck and upper freight deck, and a passenger capacity of 1,500 people.

P&O's order represents an investment of €260 million (US$286 million). The ferries are due for delivery by 2023.

LNG

Total launches its first LNG bunker vessel

Total has launched the world's largest LNG bunker vessel to date, marking a leap forward for natural gas supporters and a construction milestone.

The yet-to-be-named 135m-long vessel is under construction in China, at Hudong-Zhonghua Shipbuilding's Shanghai yard and features GTT cargo containment technology.

With a capacity of 18,600m^3 the vessel is more than double the size of Nauticor's 7,500m^3 *Kaiors*, which currently holds the title of largest bunker vessel. However, Avenir LNG has ordered two 20,000m^3 LNG bunker vessels from CIMC Sinopacific Offshore & Engineering Co, meaning Total will not hold the top slot for long.

After delivery next year, the vessel will operate in northern Europe under a long-term agreement between Total and Mitsui OSK Lines. It is set to supply LNG to commercial vessels for at least 10 years. Among the ships it will support is CMG CGM's nine new 23,000TEU newbuild containerships, including the recently launched *CMA CGM Jacques Saade* (see p.19).

Ship construction

German yard scores outfitting contract for research ship

Norwegian businessman, Kjell Inge Røkke, has selected Germany-based shipyard Lloyd Werft Bremerhaven to complete the final construction stage and outfitting of what is said to be the world's largest research and expedition vessel.

The 183m long, 17,440gt *REV Ocean* is scheduled to arrive at the German yard in the spring of 2020 and will be docked there until April 2021. Bremerhaven's team is expected to carry out tasks including the installation of interiors, filling, fairing and painting of the superstructure, the laying of the deck and the assembly of outer ceilings.

The vessel's initial construction took place in Romania at Verd Tulcea. Following its launch, the vessel was transfer to Vard Brattvaag in Norway for technical and scientific equipping.

Lloyd Werft Bremerhaven is expected to deliver *REV Ocean* by April 2021

REV Ocean, which will conduct marine research missions worldwide, has been labelled as the world's largest superyacht. It will be capable of accommodating 60 scientists and guests plus 30 crew members, and will feature an operational range of more than 21,000nm.

Future fuels

IMO: Promising alternative fuels on the horizon

Major shipping players who spoke at the IMO's Symposium on IMO 2020 and Alternative Fuels, held in London last month, agree that hydrogen and ammonia offer the key to the decarbonisation of the maritime industry.

There was a consensus among attending delegates that fossil fuels must be replaced with alternative technologies and fuels if GHG emissions are to be reduced by at least 50% by 2050. The primary issues that must be overcome are the speed of uptake and scaling of production.

It was stated that collaboration, research and development and overarching policies are needed in order to decide how to decarbonise the industry.

Additionally, the symposium discussed the preparedness of all stakeholders on the forthcoming January 2020 sulphur cap, highlighting the challenges new blends of fuel oil might bring and the impact of market dynamics.

"The topics of the last two days have a common element, which is essential to sustainable future shipping – and that is fuels," IMO Secretary-General Kitack Lim said. "The development and provision of viable alternative fuels cannot be solved by the shipping industry alone – but needs support from the wider maritime industry, such as oil industries, charterers and ports." *NA*

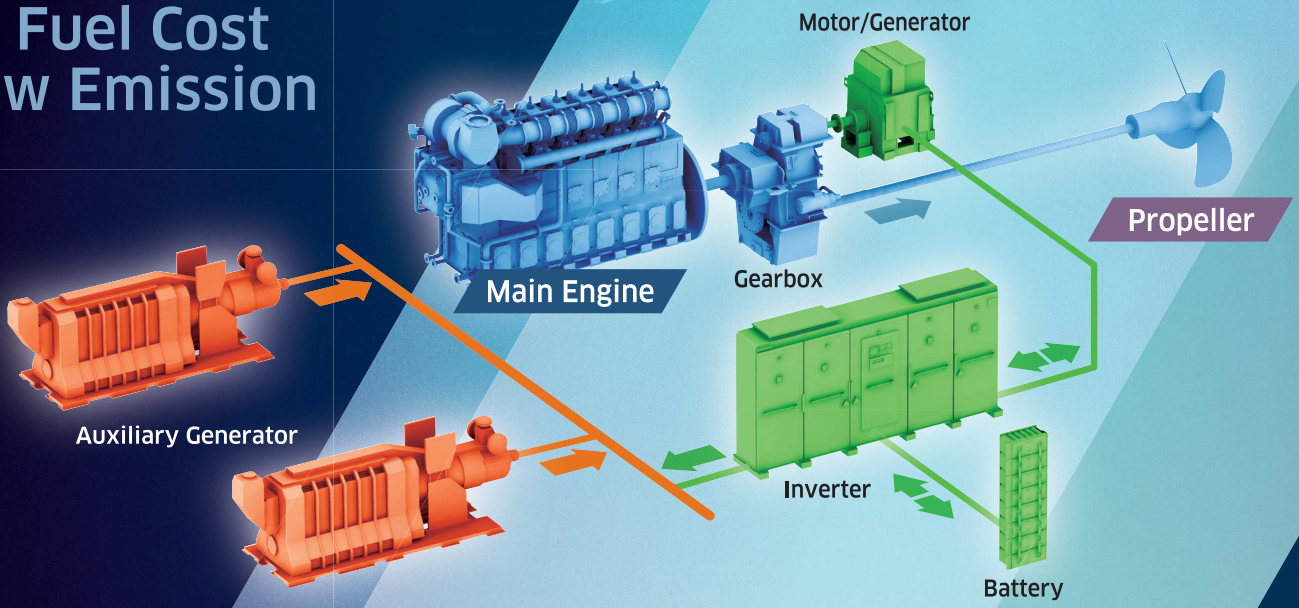
Kawasaki
Powering your potential

Environmental Friendliness & High Efficiency

with Kawasaki technology

Kawasaki Hybrid Propulsion System

Low Fuel Cost & Low Emission



Kawasaki Green Gas Engine

Marine Propulsion Machinery


Controllable Pitch Propeller


Side Thruster


REXPELLER® (Azimuth Thruster)

Kawasaki Heavy Industries, Ltd.

1-14-5, Kaigan, Minato-ku, Tokyo 105-8315, Japan
Tel: +81-3-3435-2374 Fax: +81-3-3435-2022

For more information, please contact
E-mail: marine-machinery-sales-e@khi.co.jp
global.kawasaki.com

Where will the IMO GHG roadmap lead?

The pursuit of decarbonisation is seeing the forging of new industry partnerships with a view to identifying viable solutions, writes Malcolm Latarche

Two concerns have occupied shipowners' attention for several years: selecting and installing a ballast treatment system and meeting the requirements of the impending 2020 global cap on sulphur in fuel.

Both of those concerns are a long way from being in the past. The final five-year countdown for meeting the requirements of the 2004 ballast water convention only began on 8 September this year and although owners must by now have determined their strategy for 2020 compliance, the full impact of the changes have yet to be experienced and assessed.

The next issue that shipping will have to confront is that of decarbonisation. The subject is not particularly new because, to some extent, it has been addressed by the EEDI regulations in place since 2013 and also the recently introduced MRV requirements of the EU and the IMO. However, ambition was hugely ramped up by the IMO in April last year with the GHG Roadmap and aims to cut emissions by 50% in 2050, and to reduce the average carbon intensity by 40% in 2030 and 70% in 2050, compared to 2008. Since then MEPC 74 has advanced the Phase III EEDI requirements for some ship types to 2022 from 2025 and increased the severity at the same time.

As a consequence, the new buzz word in shipping is decarbonisation and it is being picked up in several developments across the industry. It was a major discussion topic during LISW in September and at the UN Climate Action Summit in New York later the same month. It was at the latter event that the Getting to Zero Coalition, a partnership between the Global Maritime Forum (GMF), the Friends of Ocean Action, and the World Economic Forum, was launched.

Those organisations may not be the most well-known in the maritime sphere as the GMF is a quite recent initiative, founded in 2017, having built on the success of the Danish Maritime Forums started in 2014. From its Danish roots – Maersk and Hempel were among the founders – the GMF has expanded rapidly. The Getting to Zero Coalition, which is concentrating on decarbonisation, has over 70 members mostly shipping companies, class societies and equipment makers.

The aim of the group is to align with the IMO's GHG Roadmap target for 2050, whilst pursuing efforts towards phasing them out as soon as possible in this century. Alastair Marsh, CEO, Lloyd's Register, summed up the ambition and highlighted the difficulty in achieving it when he said: "The IMO's 2050 GHG ambitions require substantial and collaborative input from all maritime stakeholders and beyond. Getting to zero is about more than the delivery of zero emission vessels into the world fleet by 2030. As an industry we need to ensure that the infrastructure and supply chain is in place to support this change".

It is no small task that the coalition has set itself, but it has come up with a timetable and roadmap of its own, setting out how it hopes to achieve its ambitions. This involves a a multi-year initiative that will run until 2023 in two phases. Through to the end of next year the focus is on building the coalition, gathering information and ensuring representation across segments on a global scale.

The following phase is working to achieve critical mass on a few technology solutions and their supply chains, and work to build the partnerships and policies that will enable the testing, demonstration and eventual scaling of these solutions. The coalition has reiterated that it is technology-neutral and will focus on defining solutions that are most likely to be technologically and economically feasible at scale even if these have yet to be identified.

It has said that success will result in enabling multiple demonstrations of full-scale zero emission vessels operating along deep sea trade routes, supported by the necessary technologies and infrastructure for scalable net-zero emissions fuels across production, distribution, storage, and bunkering.

It is obviously too early to know what the Getting to Zero coalition can achieve but there are many other developments aimed at reducing shipping's emissions, either voluntarily or by way of compulsion. There have been numerous attempts – so far rejected by the IMO – to set speed limits for shipping even though slow steaming is widely practiced.

A new idea that was submitted by BIMCO to the IMO's GHG Intersessional Working Group meeting in London in early October suggests regulating the propulsion power of ships in order to sustain the CO_2 savings already achieved through slower steaming. Setting a limit for ships' power has already been suggested by Japan. The BIMCO recommendation is that the power limit should be derived for each shipping sector from an assumed performance of an average ship sailing at current average trading speed within each sector. *NA*

NAVALIA

INTERNATIONAL SHIPBUILDING EXHIBITION

Sponsors:

//ABANCA · DNV·GL · FERNÁNDEZ JOVE · REPSOL · Sika · WIRESA · VULKAN

CONCELLO DE VIGO · XUNTA DE GALICIA · igape · Puerto de Vigo · ZONA FRANCA VIGO · IFEVI

Organised by:

muéstralo

Lubricants

Chevron ready for sulphur cap oil demands

Chevron Marine Lubricants tells *The Naval Architect* that it is confident its supply chain will be able to meet the demands of vessels with the introduction of IMO's 0.5% global sulphur cap on 1 January but stressed the importance of shipowners sharing information on their particular cylinder oil needs.

Ian Thurloway, Chevron's brand and marketing manager, says: "We did a survey recently that indicated 75-80% of vessels will run on compliant fuel, which is what we anticipated three years ago. Scrubbers have taken off more than we've prepared for that with our higher base number (BN) products for [predominantly two-stroke] vessels running on 3.5% fuel."

He adds that Chevron is expecting the last quarter of 2019 as the supply paradigm changes. "The top tier ports like Rotterdam and Singapore will be well equipped but some of the secondary ports perhaps can't cope with three or four fuels. But we're working very hard strengthening our supply chain and making it more agile."

Chevron recently launched its new new Taro Ultra range of lubricants, comprising products from 25 BN through to 140 BN which is said to have a formulation that specifically supports multi-fuel use. "There isn't a one size fits all for cylinder lubricants, you have to tailor them to the application," explains Thuroway.

With vessels increasingly switching between fuels, depending upon operating profiles, running on the correct strength of lubricant has never been more important. If the BN is too low it will fail to neutralise the sulphur, but too much use of high BN fuel can result in alkalinity and affect the liner surface condition.

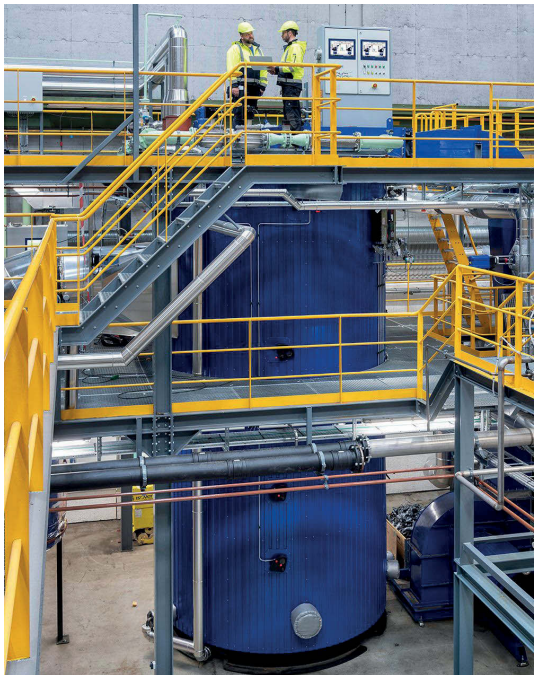
It also means that ongoing testing and analysis of drip oil is critical, so that the user can make feed rate adjustments and reduce the risk of engine damage. To support this Chevron has launched DOT.FAST, and onboard and onshore testing service. "The OEMs really focus on making sure you're doing this drip testing, so you're really running blind if you're not doing it properly," warns Thurloway.

Boilers

Alfa Laval boiler supports transition to LNG

Alfa Laval's Aalborg boiler technology offers a compact and simple way of managing boil-off gas (BOG), thereby offering shipowners an easier path to LNG propulsion, says the Swedish manufacturer.

For vessels to run on LNG, they must be able to deal with BOG, which can increase tank pressure. Reliquefaction of the gas is possible, however, it is an expensive and complex process to carry out onboard. Likewise, so is burning the gas in auxiliary engines or gensets. Boilers are a more affordable way of handling the BOG, given that vessels need boilers anyways – either for producing steam or heating water.



Dual-fuel boilers are best option, claims Alfa Laval

"On some vessels you can use a Type C tank to allow pressure to accumulate," says Markus Tauriainen, sales manager of Exhaust & Combustion Systems at Alfa Laval. "But what most vessels need is a safe solution for burning off the gas at low pressure. That can be a GCU on LNG carriers, but the best and most economical solution for vessels using LNG as fuel is usually a dual-fuel boiler."

According to the company, its Aalborg boiler is "tipping the balance in LNG's favour for a far larger number of vessels." To date, it has sold over 100 Aalborg dual-fuel boiler systems.

Coatings

Nippon expands NOA range with tank coating

Japanese Nippon Paint Marine has introduced a new tank specific coating to its longstanding Nippon Optimised and Advanced (NOA) range.

Dubbed NOA PC 700, the new system is specifically designed to protect chemical and product tanks from corrosion and cargo contamination. According to the company, the phenolic/novolac-based epoxy is resistant to a wide range of chemicals, solvents and petroleum products, including those containing xylenes, methyl

ethyl ketone, methanol, caustic soda and LSA fuel oil.

Each product within the NOA range – launched to market in 1998 – is developed in line with the anti-corrosive requirements of different ship parts. The key selling feature of the epoxy coatings, states Nippon, is that they use pigments that have various opacities depending on film thickness. The NOA coatings are self-indicating in that if the layer is too thin, the NOA coating remains transparent. Once optimal thickness has been reached, the coating becomes opaque.

Digitalisation

Inmarsat's Fleet Data secures class approval

French classification society Bureau Veritas has granted Inmarsat Approval in Principle for Fleet Data, its Internet of Things platform.

The approval, which the satellite communications company views as a milestone, verifies that the platform can be safely installed onboard, without its operation interfering with existing navigation, safety and radio communication systems. No longer is further approval, certification or testing of the system needed before installation on any vessel.

"Securing approval demonstrates that the maritime industry's impartial standard bearers on safety, security and the environment identify Fleet Data as supportive of their objectives," said Stefano Poli, vice president of business development at Inmarsat Maritime.

The bandwidth-inclusive platform enables shipowners and manager to control the sensor data collected onboard pre-process, extract and gather it in cloud-based storage. From its storage base, it can be utilised by the operator's own decision-making software or third-party applications.

Fleet Data is currently available via Fleet Xpress but is expected to be rolled out to Inmarsat FleetBroadband later this year or early next year.

BWMS

Ballast water testing for all size organisms needed, warns LuminUltra

Microbiological monitoring equipment producer, LuminUltra, has advised the maritime industry that it must thoroughly test for all types and sizes of ballast water organisms in order to prevent the spread of invasive aquatic species.

The company suggests that greater attention needs to be placed on detecting and treating zooplankton – the most difficult organisms to get rid of in ballast water. Blooms of zooplankton can clog up ballast water treatment systems (BWTS), which could cause the filters to fail. However, to achieve compliance with the D2 discharge requirement, the organism must be properly treated.

Over 4,000 species of organisms of various sizes and resilience can be carried in ballast water. Ballast water management systems are required to measure and assess three fractions of these organisms: bacteria, organisms between 10-50µm and organisms greater than 50µm.

Carine Magdo, business development manager for Ballast Water Monitoring Solutions, LuminUltra, said: "It is important that all three fractions and especially those greater than 50µm are considered when testing ballast water, as experience proves that if a system fails it is most likely in this category."

LuminUltra's B-QUA ballast water monitoring system has been scientifically validated to measure ballast water readings across all three factions.

Power and propulsion

GE's technology powers giant crane vessel

GE's electric power and propulsion system recently enabled Heerema Marine Contractors semi-submersible crane vessel (SSCV) to complete a world record lift of 15,300tonnes.

During its first project, the 220m long and 102m wide *Sleipnir* installed topsides of the Leviathan development in the Mediterranean using its two 10,000tonne revolving cranes in less than 20 hours.

GE provided the vessel with the electrical part of its power and propulsion system, including 8MW generators, propulsion motors, switchboards, transformers and MV7000 drives. The energy supplier's solution was designed from scratch so that it would meet the requirements of the project. This resulted in the entire power system being designed for fault tolerance in line with Lloyd's Register's Rules and Regulations (DP AAA). GE's solution also features advanced built in sensors to help operators monitor the health of each piece of equipment in real time and signal possible malfunctions.

Sleipnir, the world's largest semi-submersible crane vessel

ICCAS 2019: From Digital Twin to weld distortion control

RINA's bi-annual conference offered new insights on how computing solutions are transforming ship design and the maritime industry, reports J L Martin

The Royal Institution of Naval Architect's bi-annual International Conference on Computer Applications in Shipbuilding (ICCAS) is renowned for its philosophy of 'Practical Application' of computing technologies. Most papers presented centred on the use of computing tools in the field, improvement of implemented computing systems, development of processes to ensure maximum benefit is gained from applying the technology, and research verified in the field or during trials. The conference attracts international participants, whose papers address a wide variety of topics (Figure 1).

This year's ICCAS conference was held in Rotterdam and showcased the latest trends in computer application

An interesting aspect of the ICCAS conference is the indication of global trends in the industry on applying computing technologies. ICCAS 2019, held in Rotterdam in September, was no exception.

A particularly notable trend this year was the increased effort expended during the concept and early stages of design. It has become apparent over recent years that a major portion of the cost of a ship is committed at the concept design phase, with companies increasing the early design process by taking advantage of the availability of computing technologies.

Design and production solutions

Papers at ICCAS 2019 presented several innovative ideas to apply during the early design stage of the ship product lifecycle. General arrangement layout during early design was a popular topic addressed in several papers.

One presentation introduced an advanced system for naval engineering, which aims to procure more effective and affordable naval units by understanding design space and identifying efficient design solutions. It utilises queuing networks to analyse variations in layout in process driven ships such as LPD's and cruise ships and allows for comparison of layouts and optimisation based on process performance. A highly interactive generic algorithm-based layout exploration and optimisation method is proposed for generating spatial configuration of a ship.

A methodology for estimating weight and space demands of distributed ship service systems, electrical, fluids and HVAC, beyond those associated with ship propulsion systems, are being applied during early design. Additionally, an expert system for ship design with automated computing techniques and tools to interact on critical decisions during early design was presented. Virtual Reality (VR) technologies used in human factors engineering to provide an ergonomics-focused design perspective were described and explained.

Another continuing trend noted at ICCAS conferences is the increased use of computing technologies in manufacturing and production. An advanced Augmented Reality (AR) system was described for the inspection of complex pipes in the pipe manufacturing shop. This resolves complex setting up of jigs and measuring tools normally required for post pipe bending inspection. The logical process flow between panel fabrication and assembly stages through simulation was presented as a means to address the problem of fabrication, assembly, and block erection that are not addressed in typical lean production methodologies used in mass

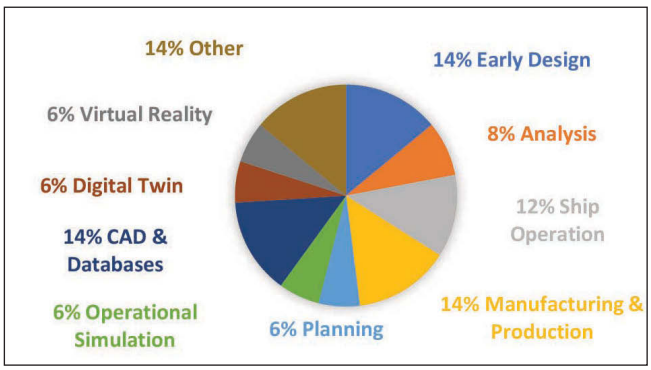


Figure 1: Topics presented at ICCAS 2019 by percentage

produced products such as cars.

An exploration of available laser scanning technologies as an aid to detail design, particularly for refit projects, was described and exemplified the ever-increasing use of laser technologies in the industry. Analysis and prediction of weld deformation was addressed with a process of defining a weld sequence to minimise the deformation. A methodology was presented for forming sheet metal shell plates in a steel press by defining press position, press angle, and press load, using AR to inspect the formed plate and reduce/eliminate the need for template 'sets' as traditionally used for shell plate bending construction.

The use of a discrete particle swarm optimisation algorithm to automatically identify sub-assembly divisions for hull structure based on clustering techniques was proposed to improve the 'experience' method of sub-assembly breakdown whilst significantly reducing cost and time.

The movement, turning and lifting of large fabricated blocks is critical and complex. A proposed assessment tool for ship block lifting based on dynamics and physics to make processes safer and more efficient was also demonstrated. The procedure is a combination of multibody dynamics and finite element methods to calculate the motion, stress, deformation of a block, and wire tensions when lifting.

A topic not generally discussed, but of significant interest to all shipbuilding and marine structure fabricators and operators, is paint. A project database was presented which allows engineers and specialists to access legacy information when organising painting schedules, enable the assessment of paint weight and application cost, and provide information to the production departments. A new concept of using paint replacement film was also proposed, demonstrated by application on a bulk carrier.

One particularly interesting production-based paper discussed the evacuation of employees during the build stage of a very large complex ship in a build dock. It described the analysis of escape routes, determining the need for dual escape paths when one is blocked, clearly marking the escape routes, particularly in cases of limited vision such as emergency lighting or smoke, and calculating the number of access gangways needed from ship to shore for swift evacuation of up to 1,300 people. This is a common and extremely important problem in all shipyards and the paper offered a very practical, tried and tested, innovative methodology that was implemented and used successfully.

Digital Twins

A further noticeable trend observed during the conference was the increase in consideration of the concept of 'Digital

Twin' as a methodology for managing data. In addition to the papers specifically dedicated to the topic, Digital Twin was mentioned in several other papers as a future potential development. Digital Twin discussions involved a range of diverse ideas. Different proposals for Digital Twin for the marine design, build, and operational environment were analysed to clarify the differences with discussion on results of a joint initiative to create a Digital Twin compared to the identified alternate methodologies.

The current role of the Digital Twin was explored demonstrating the benefits and path towards an integrated cross enterprise digital environment. Guidance for successful application of Digital Twin in shipbuilding was offered based on lessons from other industry use, together with the challenges faced when adopting such an approach. The use of games engines as a technology for AR and VR was proposed as the framework to enable an accurate 3D representation of a vessel, its simulated behaviours, and all of the data needed through the lifecycle of a ship, as a possible basis of a Digital Twin.

Virtual Reality

ICCAS has shown an increasing trend for acceptance of VR tools, with this year's iteration having a high proportion of interesting papers on the subject, seen as a beneficial to productivity and quality. Simple and intuitive use of VR by operators who are not CAD trained was proposed as a key consideration for implementing and operating a successful VR system. Who should use a VR system, how, when, and why they should use it, and the selection and use of available viewing technologies, were discussed. How visualisation is used as an 'intersection area' between different design fields was defined, comparing CAD models by loading files from engineering tools to analyse the design whilst remaining in the VR environment.

Significant findings on emerging best practices for effective collaboration on ship design in VR were also presented, with benefits achieved through application of the technologies during design, engineering and construction phases. Of equal importance to VR visualisation is analogy with real time simulations in the form of information received through input devices. The concept that there is constant need to present controls and menus and the use of 'virtual reality joysticks' and a new form of menu was offered.

Big Data and sensors

Operating a ship at sea is an environment where the implementation of onboard computing technologies is becoming a critical contribution of performance, cost minimisation, and environmental efficiency. Information collected at sea is being fed back to shipowners and ship designers to improve future vessels, as described in several ICCAS papers. Big Data – the real time interface of equipment and sensors whilst at sea – is enabling a better understanding of how a ship behaves in operational conditions. Papers on defining the operational profile of a ship using available information, optimisation of coastal routing based on the ocean environment, design for emission optimisation in compliance with regulations, collision avoidance based on deep reinforced learning algorithm, and a tracking method for navigation using image based object detection were all presented and discussed.

A ship operation paper that attracted high interest from delegates involved ship motion prediction of quiescent periods using wave sensors and Lidar systems, a technique to safely expand ship operating deck limits. Applied to a ship-air interface for the use of helicopters on naval vessels, the technology is equally applicable to any at sea launch and recovery operation, such as boats or offshore operations transferring items from ship to fixed structures. Verification and validation of simulation results by means of sea trials were discussed, with the quiescent period prediction identifying when the ship motion is most favourable to perform the launch/recovery operation in high seas.

An evolving toolkit

CAD and engineering databases have been evolving continuously over the past 30 plus years and ICCAS always has a large number of papers on the subject. CAD/EDM/digital databases were addressed by a wide range of authors, with the technologies moving towards use in early design as well as in manufacturing and production. The Digital Twin concept described above is based around a high-quality comprehensive CAD 3D model. The digital model was a term used by several authors discussing the collection and management of ever-increasing quantities of CAD and engineering data through the lifecycle of a ship.

Engineering tools, a mainstay of ICCAS since the first conference in 1973, are increasingly understood and innovatively used within the industry. Using functional analysis to ensure value for money in complex engineering projects by analysing differing layers of data, representing customer requirement, functional breakdown, performance and engineering solutions, illustrated a logical approach to cost analysis. Buckling assessment software using Finite Element modelling conforming to Common Structural Rules was discussed. A non-linear Finite Element model is used for calculating container and lashing forces for efficient container stowage. Hull form generation, a long term ICCAS topic, attracted alternate solutions. Coons patches were proposed for creating a hull form for structural analysis.

ICCAS offers authors an opportunity to present on how their company is using advanced technologies to ensure high quality, cost effective solutions for design, build and/or operation of ships and marine structures. Delegates, on the other hand, are given the opportunity to see how computing technologies are successfully being applied across the international industry, while engineers have the chance to exchange views and opinions on common problems.

ICCAS 2019 proceedings, printed and digital, are available from The Royal Institution of Naval Architects. ICCAS 2021 will be held in Japan. *NA*

About the author

John Martin BA. C.Eng. MRINA. is the founder and director of SAMOSC Ltd (UK), an IT consultancy focused on marine design, engineering and construction solutions. He is also an International Programme Committee UK member for ICCAS.

World's largest LNG-powered containership launched in Shanghai

The *CMA CGM Jacques Saade* represents a watershed moment for Chinese shipbuilding

In September 2017, CMA CGM broke the 22-month silence of the global super-large containership market and announced that it has ordered nine 23,000TEU dual-fuel containerships from the CSSC Group. Ten months later, construction on the ships officially began in Changxing Island, Shanghai. Hudong Zhonghua is set to build five of the nine vessels, while the other four are to be built by Jiangnan Shipbuilding (Group) Co., Ltd.

The *CMA CGM Jacques Saade* during construction at Hudong Zhonghua Shipbuilding

The first containership of the series, *CMA CGM Jacques Saade*, was launched on 25 September. Designed by China Shipbuilding and Marine Engineering Design and Research Institute (MARIC) and fellow CSSSC subsidiary Hudong Zhonghua Shipbuilding (Group) Co., the LNG-powered ship is equipped with a 18,600m^3 MARK III membrane fuel tank, which can support the vessel on a journey to and from China to Europe. It will join CMA CGM's fleet in 2020 and will be operating on the French Asia Line (Asia-Northern Europe).

Described by the industry as the 'Hulk', the containership measures a total length of 400m, by 61.3m wide, with a service speed of 21.55knots and a load capacity of nearly 220,000tonnes. The *CMA CGM Jacques Saade*, named after Jacques Saadé, the founder of CMA CGM, can carry 2,200 40-foot refrigerated containers.

At the launching ceremony, Rudolf Saadé, the chairman and CEO of CMA CGM, said: "With the launching of the first 23,000TEU ship powered by LNG, we demonstrate that energy transition can be successful in our industry if all the players work together. It paves the way to a global shipping approach where economic growth and competitiveness can coexist with sustainability and the fight against climate change."

Lei Fanpei, Chairman of CSSC Industrial Co., Ltd. commented: "Two years ago, during a low point in the global shipping and shipbuilding market, CMA CGM was far-sighted, with extraordinary vision and courage. CSSC officially signed the construction contract for nine large containerships with the largest, most advanced and environmentally friendly container load in the world, leading the development direction of the large containership market in the future."

WinGD engine

The containership is equipped with WinGD's patented W12X92DF engine – the world's largest installed low-speed dual-fuel engine. Its Energy Efficiency Design Index (EEDI) score is in line with Phase 3 and meets the world's most stringent emission requirements. When compared with existing fuel oil-powered ships, the vessel can achieve a reduction in CO_2 emissions by up to 20% while its oxide emissions are reduced by nearly 85%, and particulate matter and sulphur oxide emissions are by 99%. Additionally, the integrated line type and structure are optimised, and the layout and system of large-capacity reefer containers are further improved, which greatly reduces the operating cost of a single-box while meeting the diverse operational needs of shipowners.

"The maximum scale of the breakthrough limit, the comprehensive performance of the ship, the structural safety, and the system configuration are all beyond the design complexity of the previous ship type," said a MARIC spokesperson, adding that LNG storage needed to occupy a compact space on the containership. Through the design process, the project team considered various factors such as fuel tank liquid level change, structural deformation control, and maximum packing capacity. After numerous calculations, the current large fuel tank programme was finalised. "The risk assessment of this type of ship is inseparable from the collective efforts of shipowners, classification societies, shipyards, etc," he stressed.

LNG has never before been used to power large containerships, making the vessel a huge technical feat for the entire industry. So far, the construction technology of MARK III membrane-type storage systems has been monopolised by Japanese and Korean companies. This is the first time Hudong Zhonghua, which has more than 20 NO96 film-type LNG carriers, has manufactured MARK III membrane tanks. In the face of technical barriers, the company adhered to independent innovation, and has overcome more than 10 technical challenges including: 3D coordinate laser positioning, secondary shielding adhesion, and corrugated board welding. For the first time zero leakage was realised during the secondary shielding tightness test. At present, Hudong Zhonghua is the only company in China with the ability to manufacture MARK III membrane fuel tanks.

The *CMA CGM Jacques Saade* is scheduled for delivery in April 2020 and is to be certified by French classification society Bureau Veritas (BV), as are the other vessels in the series. ***NA***

Chemical tankers ready to benefit from 2020 changes

The chemical/product tanker sector appears robust and well positioned ahead of the sulphur cap, writes Malcolm Latarche

Defining a chemical tanker is simple enough if the only criteria is if an IMO type I, II, or III designation has been assigned. Type I ships are the pure chemical carriers as their design is based around the requirements of the most hazardous cargoes. Type II and III ships are less specialised, and a very high percentage will be destined to spend most of their lives operating as product tankers carrying oil refinery production, even though they may be defined as a chemical or chemical/products tanker.

This versatility looks to be much in demand in the future as the impact of the IMO sulphur cap begins in January 2020. Chemical tankers will be hit just as hard though by the changes and expected fuel cost rises as other ship types. However, they will find benefits as well, given that they will transport the myriad of new fuels from refineries to bunker storage facilities.

That opportunity was likely very much uppermost in the minds of chemical tanker owners who have been quite bullish in placing orders in recent years. They have also sent relatively few vessels to the scrapyard since the IMO announced the 2020 date for the sulphur cut.

The general slowdown in the world economy will inevitably have some effect on the chemical tanker market because the cargoes – other than refinery products – are used for industrial processes and manufacturing of goods. An area where the effect is less certain is in vegetable oils. Over recent years, palm oil production has soared but has also attracted bad press for its environmental impact. The chemical tanker sector has profited from palm oil production but may well suffer if there are cutbacks. Against that must be weighed the demand for shipping space from products to be used in biofuel production.

Fure West is one of first chemical tankers converted to run on LNG

World fleet

Currently, the world fleet of in service vessels comprises 5,581 ships totalling 117,409,115dwt tonnes and the orderbook is made up of 340 vessels for a total 9,066,626dwt, according to IHS Markit data. Testifying to the confidence in the sector, deletions since the beginning of 2015 amounts to only 164 ships with a combined deadweight of 3,213,209tonnes. There may of course be a spike in scrapping figures over the next few years as the requirement to fit ballast treatment systems begins to make an impact.

Chemical tankers are generally the smallest of the tanker types with a very high proportion of the world fleet under 10,000dwt. Being smaller vessels, many of them already operate on MDO or MGO rather than HFO, so the changeover in 2020 will be less of a financial shock. In terms of numbers, vessels under 10,000dwt in the in service fleet comes in at 2,364 or 43%. When added to the other vessels between 10,000 and 30,000dwt, the figures rise to 3,737 or 68%.

In deadweight figures, the smaller size vessels obviously lose the advantage of numbers. Ships under 10,000dwt account for only 9.8mdwt or just over 8%. On the other hand, there are just 1,367 vessels above 40,000dwt, yet they account for almost 67mdwt or 57%. The bulk of the larger vessels – some 1,027 ships – fall in the 40,000-50,000dwt range and between them total 48.7mdwt.

When looking at the age range of the fleet, it should come as no surprise that the 1,668 ships built in the five-year period between 2004 and 2009 is where the highest number of ships is concentrated. Although this spans the economic crash of 2008, it also includes one of the most active periods in shipbuilding history. The two five-year periods since (2009/2014 and 2014/2019) demonstrate the increasing size of chemical tankers with 1,064 ships totalling 25.8mdwt and 1,003 ships for 30.6mdwt respectively.

Age and sophistication

Older vessels comprise a relatively high percentage of the fleet with one in three ships being over 15 years. These are mainly small vessels and include some very specialist vessels such as all of the wine tankers in the fleet and a high number of vegetable and edible oil tankers. The more modern fleet is dominated by chemical/product tanker types.

Their relatively small size belies the degree of sophistication that can go into a chemical tanker. There is a much higher degree of separation of cargoes than in other tanker types due to the fact that many of the typical

cargoes are shipped in lots measured in hundreds rather than thousands of tonnes. Even the smallest tankers will have around a dozen tanks and the larger vessels many more.

This degree of separation allows for many different types of cargoes to be carried simultaneously but that can cause problems of its own. There must be no mixing of cargoes as this can be hazardous, so each tank usually has its own dedicated pumps. The stripping pumps in particular have to remove all but a few dregs of cargoes under the latest IMO regulations. Tank cleaning equipment is also essential so that residues are removed and not allowed to contaminate future cargoes.

The construction of chemical tankers is quite niche, with far fewer countries and shipbuilders in the sector than other vessel types. Unsurprisingly, the three leading nations are China, Japan and South Korea. For the in-service fleet, Japan claims the largest number of ships (1,798), followed by South Korea (1,584) and China (961). However, the two leading positions are reversed in terms of tonnage with South Korea's 58mdwt being almost three times that of Japan's 20.1mdwt. China trails behind Japan with 18.2mdwt. Those figures highlight Japan's leading position in the smallest size segments.

Behind the big three, Turkey is well back. Its 410 vessels totalling 3.4mdwt was enough to lift it into the top ten of shipbuilding nations in the first decade of the 21st century. Like Japan, Turkey concentrated on smaller chemical tankers allowing fifth placed Croatia with just 106 vessels to exceed it in terms of tonnage with a little under 5mdwt.

Orderbook and recent deliveries

The leading positions in the newbuildings orderbook sees China take top spot with 133 vessels for 3.5mdwt followed by South Korea with 61 vessels for 2.6mdwt and Japan with 84 ships but just 1.6mdwt. Turkey has been relegated into fifth place and has a small orderbook of 13 ships for only 99,320dwt. Vietnam, in sixth place as far as the in-service fleet, has moved to fourth place in the orderbook with 20 ships for 861,896dwt.

Chemical tankers rarely hit the headlines for innovation in design or construction but that is not to say that they are lagging behind other ship types. For example, in April 2016, *Lindanger* became the first chemical tanker built specifically to run on methanol. The 50,000dwt vessel built by Hyundai Mipo was the first of a seven-ships series with the last – *Creole Sun* – due for delivery later this year. This year has already seen the delivery of three ships in the series, *Mari Couva*, *Mari Kokako* and *Takaroa Sun*. The series mainly carry methanol as cargo with one of the slop tanks set aside for use as fuel for the MAN 6G50ME-C9-LGIM main engines.

Methanol is one of the fuels marked out as a future option for shipping in much the same way as LNG was some years ago. The take up of LNG was quite slow but is now accelerating and chemical tankers are among the ships adopting it. There are already 19 ships with dual-fuel engines in service and a further 16 on order.

The oldest three chemical tankers running on LNG – the 2006-built *Fure West* and the 2007-built *Bergen Viking* and *Bit Viking* – are all pioneering conversions from oil burning ships. With the conversions taking place in 2017, 2015 and 2011 respectively. The first chemical tanker built with a dual-fuel engine was the *Ternsund*, constructed by AVIC Dingheng Shipbuilding of China in 2016. The yard is the most active of those building dual-fuel chemical tankers, having 15 of the 32 in service and on order ships. Only five other yards have built or are building dual-fuel vessels. The Chinese builders Wuhu Shipyard (four ships), Nantong Xiangyu Shipbuilding (four ships) and Hudong-Zhonghua Shipbuilding (two ships) are joined by Turkey's Besiktas Gemi Insa with three ships and Ferus Smit of the Netherands with four vessels.

It is not only new vessels that are involved in pioneering developments in the chemical tanker sector. The 37,500dwt *Bow Cecil*, built in 1998, has had a high-profile history having been one of the first ships constructed with a mechanical camshaft engine to be converted to electronic operation. In 2008, MAN installed the necessary components to allow the vessel's engine to be used as an operational test bed.

Earlier this year the ship was again in the news after Odfjell sold it to the South African operator Nduna Maritime. The sale of an ageing vessel would not normally be considered newsworthy, but *Bow Cecil* gained the distinction of being the first ever chemical tanker to be acquired by a South African company and operate under the South African flag. The acquisition is more notable because its owner is one of the few Black-owned companies operating ships in South Africa. ***NA***

Mari Couva **was delivered in August from Hyundai Mipo dockyard in August**

Hydrogen fuel cells: the path forward

There is a growing consensus within the maritime industry that hydrogen powered fuel cells could hold the key to decarbonisation, but questions surrounding fuel storage still remain

Marine fuel cells have finally been accepted as a reality. Questions of if they're possible have dissolved under the weight of mounting research and evidence; now it's more a matter of when and how we will begin to see their widespread introduction into the maritime industry.

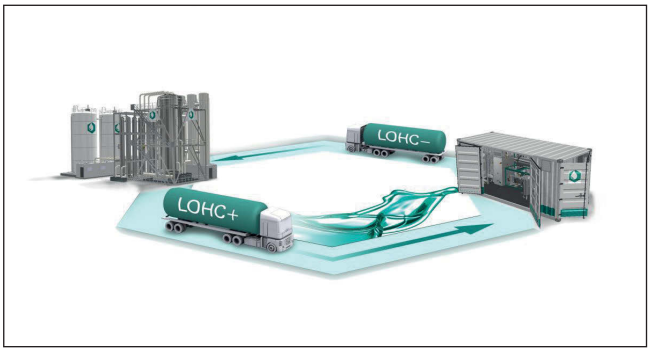
But the technology is still in its infancy and pilot projects are difficult to get off the ground. Conversely, while fuel cells for surface ships are still struggling through their growing pains, the use of proton exchange membrane (PEM) solutions, which convert hydrogen and oxygen into electrical energy for power generation, are already well-established on submarines due to their minimal noise generation and efficiency. Likewise, PEM has stood out as the most popular choice for surface vessels.

But although the basic principle of the two applications remains the same, their operating environments significantly impact how hydrogen fuel can be stored and delivered to the fuel cells. Metal alloys can be utilised in submarines to safely store and release hydrogen reversibly, however the weight of these metals means it's not a practical or usable method of storing hydrogen for surface vessels.

Storage solutions

Determining the best manner to store hydrogen is part of the great debate currently surrounding the use of PEM fuel cells on ships, with the main question being: liquified or compressed?

The problem with using compressed hydrogen is that you need a huge volume in order to travel long distances, says Dr Joachim Hoffmann, fuel cell expert and product manager at Siemens, which has been researching and developing fuel cells for over three decades. Liquified hydrogen, meanwhile, must be stored at extremely low temperatures and is liable to losing some of its hydrogen in the form of boil-off gas.



LOHC binds hydrogen in a chemical bound for safe storage

Siemens has partnered with Germany-based Hydrogenious, who are exploring a newer, promising method of hydrogen storage – Liquid Organic Hydrogen Carriers (LOHC). The concept uses thermal oil, which has a high storage density, to transport the hydrogen. Through a chemical process, the hydrogen is bonded to the organic oil. There is no need for refrigeration or pressurisation, meaning one of the biggest advantages – in terms of cost saving and ease of construction – is that you can simply use an ordinary diesel tank for storage.

Hoffmann explains the oil is typically used in industry for heat storage of temperatures up to 300-400°C, so its risk of ignition or explosion is low. "This makes it interesting as a storage system for hydrogen because pure hydrogen is always risky if it gets mixed with air."

To dehydrogenate the liquid for use in the fuel cell, it must first pass through a reactor. Once the hydrogen is released, it is cleaned from any leftover by-products of the LOHC and then enters the fuel cell. Therefore, "the only hydrogen in the system is between the reactor and the fuel cell. That's a tube system of around 5-10m, nothing more," says Hoffmann, effectively making the potential danger quiet low. The liquid is also recyclable, as it can be re-charged as often as required at an on-land site with more hydrogen.

Although the system's risks are low in comparison to other storage concepts, LOHC lacks in efficiency. "You'll consume some hydrogen when producing the heat that is required to release the hydrogen from the oil," says Hoffman. This disadvantage can be viewed as a necessary comprise, however, if hydrogen fuel cell powered vessels are to meet potential safety requirements.

Competing systems

Of course, hydrogen fuel cells aren't the only way forward for the maritime industry. Other alternatives, such as batteries, are becoming an increasingly attractive and viable choice for shipowners.

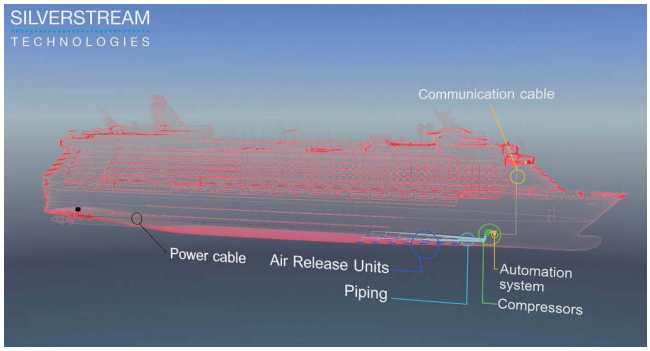
Hoffmann, however, doesn't view fuel cells and batteries as competing technologies. Rather, he sees both as necessary drivers for large oceangoing vessels. A ship running at a constant speed is ideally operated by fuel cells, but additional energy is needed to manoeuvre around a harbour. "Either you can have a large fuel cell installation that has a high investment to cover the manoeuvring stage or you have a reasonably designed fuel cell suitable for operating the long-distance travelling. Then once you enter to the harbour you take out the peak load that is required from the batteries."

The biggest rivalry marine fuel cells face is not another new "green" alternative but traditional diesel technology. "We are competing with an existing technology. If you come up with a new technology you must be cheaper or better," says Hoffmann. *NA*

More than froth and bubble

With growing interest from east Asian shipbuilders, Silverstream Technologies may have achieved a breakthrough for air lubrication technology where others have failed

Shipping, as you can hardly have failed to notice, is a highly conservative industry, and persuading owners to take a chance is a challenge that has thwarted the ambitions of many innovative startups. "If you're trying something new the natural reaction is to question why somebody hasn't tried it before," says Noah Silberschmidt, CEO of Silverstream Technologies. "Starting a company in the technology space is a lot of fun but very hard. We've believed in our technology and worked continuously to get to the point where we're signing MOUs."



Silverstream's patented air lubrication system

The MOU in question was signed in August with CSSC's Hudong-Zonghua shipbuilding group and will see Silverstream's patented air lubrication technology incorporated into the newbuilding designs for future LNG carriers and with that, a potential fuel and emission savings of 6-8%. It marked a watershed moment for the company that Silberschmidt founded nearly a decade ago.

"Because our system will be installed as standard it means they won't charge extra for designing it in. Our experience in China is that they're very open to making their ships better, whereas other shipbuilding nations can be reluctant to changing designs because they're set up for building ships to a high standard in a very well planned way and to develop an integrated design can take more than two years."

Although the concept of using air bubbles to reduce hull frictional resistance was first developed by the US Navy during World War II, primarily as a means of making a ship less detectable by radar, it's potential as an energy-saving technology has only been explored in more recent years. However, one of the challenges is delivering compressed air to the ship's bottom in a manner that both uses as little energy as possible while getting the best lubrication effect.

The uniqueness of Silverstream's air release system, Silberschmidt tells *The Naval Architect*, is that it exploits Kelvin-Helmotz instability, the sheering effect created by the differing velocities of air and water, giving rise to microbubbles. At a draught of 10m or more these bubbles have hydrostatic pressure, meaning they have no buoyancy, bouncing off each other in the boundary layer. Meanwhile, the system's algorithm ensures air production is regulated according to the speed, draft and weather to prevent energy waste.

"If you have a 280m-long cruise ship, with a flat bottom of 230m, travelling at 16knots, then within 30 seconds the bottom is fully lubricated and you'll see the shaft power go down. When we're testing, we'll keep the RPM constant and compare the speed from before the system was started until 15 minutes later. Typically there will be a gain, which at low speeds could be 1knot or more. We convert the speed increase into a power saving then deduct the compressor power, to find the net saving."

The methods used by some rival manufacturers when making claims about energy savings is a particular point of contention for Silberschmidt. "When we started out Mitsubishi was claiming its [Mitsubishi Air Lubrication System] could save you 25%, while we initially said we could save 5%. If we are talking about saving 1MW for a given vessel then our gross saving would be 1.3MW, because we're using 0.3MW on compressor power. So we cannot understand when we see competitors that are expending 1 or 1.5MW in energy because they cannot be making any saving."

Air lubrication is an EEDI-approved technology and for some sectors of the merchant fleet struggling to achieve the requisite efficiency score, such as ro-ro's and ro-paxes, it could offer a potential solution (last year, Silverstream signed a contract with Grimaldi that will see the system installed onboard 12 new hybrid ro-ro ships). However, there is no third-party testing process for air lubrication systems and a number of trial projects involving rival technologies have either presorted negative results or declined to make their findings public. "When I came into the industry, I found a complete disconnect with how people come up with their numbers. You have to be extremely well educated and used to working within this area to understand what it really means," explains Silberschmidt.

To that end, Silverstream is a member of the IMO Global Industry Alliance, a private-public partnership involving the IMO, technology companies and classification societies, which is developing a model to help shipowners better understand how energy efficient technologies work and give shipowners a better understanding of the likely savings. "This is not about promoting any particular technology but give the shipowner a tool and be able to better evaluate what's being offered." *NA*

Half measures: could 'slender' ships be the answer to IMO's GHG targets?

While much of the industry is looking towards alternative fuels and new technologies, might there be a simpler solution in lengthening vessels?

While it wasn't entirely a surprise, IMO's momentous declaration in April last year that the maritime industry must reduce its overall greenhouse gas (GHG) emissions by 50% by 2050 has seismic implications most people are only just beginning to get to grips with. The general consensus continues to be that such ambitious targets can only be realised with as-yet-unproven alternative fuels and technologies.

The latest iteration of DNV GL's annual Maritime Forecast to 2050 (now in its third edition), published in September, gave particular importance to the need for shipowners to take a future-proof multi-scenario approach to their newbuilding strategies. This applies not only to ensuring their ships will be technically equipped to run on low or zero-carbon fuels, but also the probable regulatory developments and the prospect that IMO's GHG targets could yet become stricter when the GHG strategy is revised in 2023.

But what if it might already be possible to achieve the 50% GHG reduction target with today's technology? That was the conclusion of a 2017 study conducted by Norwegian research organisation Stiftelsen for Industriell og Teknisk Forskning (SINTEF), which reviewed more than 150 different papers looking at the current available measures for improving energy efficiency and reducing GHG emissions (Figure 1). Technologies considered covered hull design, power and propulsion, alternative fuels, alternative energy sources and operations.

One of the study's findings is that on a well-to-wake basis there are no truly zero-GHG fuels, something which perhaps rankles with the pro-environment rhetoric that's particularly prevalent in Norway. "Politicians are talking about low and zero carbon fuels. But these fuels still have an impact on the climate and just switching to them will not bring

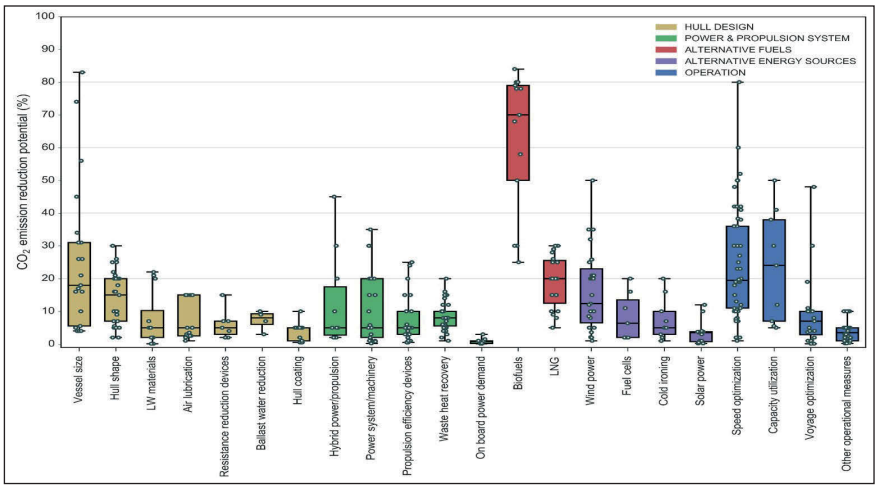


Figure 1: SINTEF's 2017 study considered the GHG reduction potential of state-of-the-art technologies

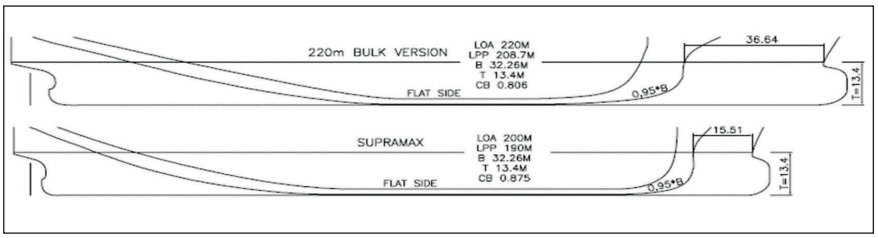
GHG emissions to zero. We have to do something more," says Dr Elizabeth Lindstad, chief scientist at SINTEF Ocean in Trondheim.

Lindstad is also one of the authors of '*The Ocean as a Solution to Climate Change*', a report presented to the United Nations in September by the High Level Panel for a Sustainable Ocean Economy (HLP, see www.coeanpanel.org), a collective of world leaders seeking pragmatic solutions for ensuring ocean health.

The report outlines a number of short and medium-term priorities for ocean transportation, including the need to reformulate the Energy Efficiency Design Index (EEDI) so that vessels are being optimised for actual operations at sea (rather than suboptimal performances for test purposes), which it describes as "inadequate". It also calls for policy measures that incentivise the maximum operational efficiency of existing ships, rather than IMO's current tool of the Ship Energy Efficiency Management Plan (SEEMP).

Both EEDI and SEEMP were implemented in 2013, but numerous studies have revealed that vessels perform far in excess of their initial EEDI thresholds of a 10% CO_2 reduction (based on baselines established dependent on the ship type). However, the HLP report notes that as the stringency of the regulation increases with EEDI Phases 2 and 3, shipyards and shipowners may seek to optimise their ship designs pass the short calm water trials from which

Figure 2: The 'slender supramax' design (top) is 20m longer than a traditional model



the EEDI measurement is derived. Even 'bulky' hullforms can be improved for calm water performance with simple modifications that bear no relation to realistic sea conditions.

HLP's report also highlights that EEDI has no mechanism for ensuring the fuel used during those tests is the same as that which will be used in operation, but Linsdtad says it focuses very little on low-carbon fuel solutions. "It's more about the need for improved naval architecture, marine engineering and testing, because we really need to reduce global energy consumption. Going back to 1970 we used 5 billion tonnes of oil equivalent annually, now we're using nearly 50 billion tonnes.

"But what we're seeing is that a lot of these efforts to emit less carbon actually increase energy consumption. To do things in a smart way, to use less energy to propel the vessel through the water."

To illustrate the points argued in the HLP report, Lindstad has paid particular attention to the 'work horses' of merchant shipping, supramax bulk carriers, which comprise of 3,000-4,000 vessels, carrying 10% of global freight. Few supramaxes are likely to win any design awards but with a typical block coefficient (Cb) of close 0.9 they do offer maximised cargo capacity.

Linstad and her fellow researchers found that by increasing the length of a 63,000dwt supramax from 200m to 220m, creating a 'slender supramax', with a modest reduction to the Cb from 0.875 to 0.806, it becomes possible on a typical northern European sea route to achieve power consumption savings 15-20% in real-sea conditions while operating at the same speed (see Figure 2).

Historically, the supramax size had the particular advantage that it could operate in regions where length and draught restrictions were enforced in ports, such as Japan. The deadweight of such vessels has swelled over the years to the point that the biggest supramaxes now tip the scales at 65,000dwt. For Lindstad the commercial pressures that have driven this upscaling are the essence of the problem, increasing fuel consumption and thereby GHG emissions.

"If you go back 30-40 years nobody was building vessels of Cb 0.9. Bulkers and tankers were 0.7-0.8 for a long time. But what we see is that it pays off to increase the length of ships. That applies across all shipping segments, because increasing length is the best way of reducing fuel consumption," she argues.

"But with the present EEDI testing rules you're not rewarded for building a better vessel. When we test the difference between a traditional supramax and a slender supramax with a typical operational profile these vessels against IMO's current procedures for EEDI then the traditional vessel gets an EEDI value in the same range, but the annual consumption is 10-15% less [Figure 3]."

Of course, that efficiency legislation will still need to be satisfied. Linstad and her fellow researchers considered different permutations of power setups, fuels and hull designs that would be capable of satisfying EEDI Phase 3 (which requires that ships are 30% more efficient than the baseline standard set in 2025) while also contributing to overall GHG reduction. It was found that while LNG could bring a 5% reduction the substantial reductions (in the region of 26%) were achieved when it was combined with the slender vessel design and hybrid propulsion utilising a Power Take Off/Power Take In management system, battery hybrid propulsion and a controllable pitch propeller (see Figure 4).

For now at least these ideas remain theoretical. It's also important to note that to achieve the 50% GHG reduction there is an assumption that upstream GHG emissions will be significantly reduced through the use of no- or low-carbon fuels derived from renewable feedstocks. In other words, it depends on the wider energy system cutting GHG emissions faster than shipping is able in order to compensate for shipping's particular needs. The point, however, is that relatively simple modifications to ship design could bring significant efficiency benefits. *NA*

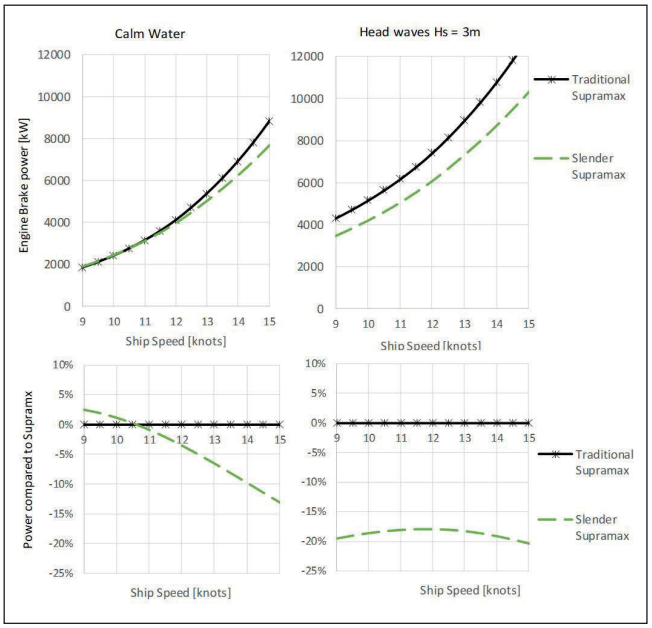


Figure 3: In 'real' sea conditions the slender supramax significantly outperforms the traditional model

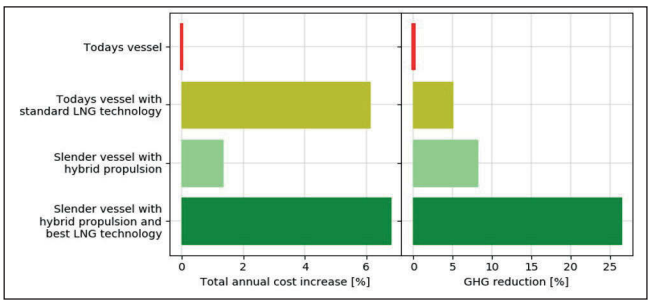


Figure 4: Combined with LNG and hybrid propulsion, a slender vessel could cut its GHG by more than a quarter

RS sets new ice class standards

Having over 500 Arc4 and higher units plus more than 40 icebreakers under its wing, the Russian classification society is strongly involved in supporting industry demands with up-to-date ice class standards

In order to reflect the wide range of modern-day ship design features, more than 20 new class notations have been implemented by the Russian Maritime Register of Shipping (RS) over the last three years, along with amendments concerning hull structure of ice class ships.

To introduce the latest developments to the industry parties concerned, as well as to encourage an open dialogue between the classification society and the maritime community RS has established a dedicated programme of meetings. The RS Rules Update conference, which took place during the NEVA 2019 international exhibition in St. Petersburg, Russia, following up the spring and summer meetings as well as an earlier one in 2018.

A capstone of the conference was the introduction of the new distinguishing mark for double-acting ships (DAS) – DAS ( ) indicating the ice class for stern-first operation in brackets. The new DAS requirements cover:

- Aft end design, in way of skegs and azimuth thrusters
- New approximate dependencies for shape functions
- Termination of ice loads on the aft region

By the end of 2019, RS is to complete the development of the relevant requirements for machinery, propulsion and navigation equipment. More information can be found at: https://rs-class.org/en/news/general/rs-rules-update-distinguishing-mark-das/

The conference's inaugural speaker, RS director general Konstantin Palnikov, emphasised that classification rules are one of the fundamental parts of the maritime industry, providing a shipowner with the long-term planning opportunity. However, Palnikov pointed out, that to meet the demands of RS clients, the rules require timely updating. Today, all the amendments of the RS Rules throughout the current year are available online at rs-class.org in the RS Publications section. (https://lk.rs-class.org/regbook/rules)

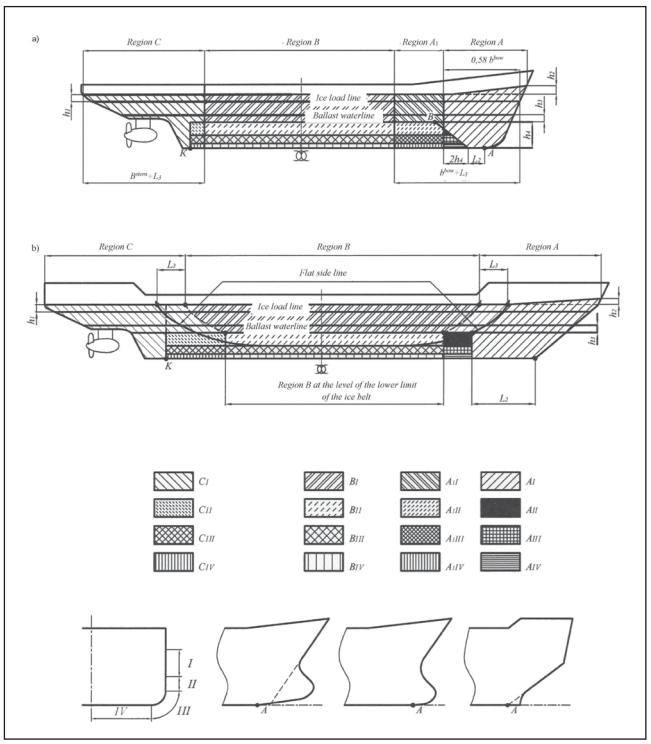


Figure 1: DAS Class Notation: requirements for hull structure in the ice strengthening area

Ice class for the hull and machinery

"During recent years, RS continuously came up across a situation where the hull and propulsion of a designed ship complied with different ice classes. Starting from 2019, RS Rules provide a possibility of the separate ice class indication for the hull and machinery," explains head of RS Classification Division, Sergey Shishkin. If the ship's hull and machinery fall under different ice class requirements, the class notation will reflect this by indicating two ice classes respectively, e.g. KM(*) Arc4 (hull) Ice3 (machinery). Whereas, if a ship complies with the rules in full scope, the (hull; machinery) sign is indicated after the ice class notation. "The gradation also enables us to assign an ice class to non-self-propelled vessels," adds Shishkin.

Max draught in fresh water

Since 2019, RS Rules specify maximum draught in fresh water for ice class ships that have restricted ice draught. "This amendment is dedicated to meet the operational demands of shipowners who load ships in fresh water ports and afterwards enter sea waters. At the shipowner's discretion, maximum draught in fresh water can be additionally indicated in the class notation," Shishkin says.

For example:

Arc7 (hull at d/df≤11.0 m/11.265 m; machinery)

df — max draught in fresh water, corresponding to ice class requirements.

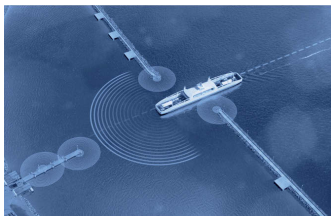
Key hull requirements

The key requirements in terms of ice class hull have been reviewed by RS, such as slopes of load waterline and frame, transom stern, bulbous bow as well as stem design and allowances for abrasive wear and corrosion. "Ship designers

The Royal Institution of Naval Architects

International Conference:
Autonomous Shipping
1-2 April 2020, London, UK

Call for Papers



Remote and autonomous ships have the potential to redefine the maritime industry and the roles of the players in it with implications for shipping companies, shipbuilders and maritime systems providers, as well as technology companies from other (especially the automotive) sectors.

The operation of remote and autonomous ships will need to be at least as safe as existing vessels if they are to secure regulatory approval, the support of ship owners, operators, seafarers and wider public acceptance.

RINA invites papers from ship designers, builders, operators, classification societies, legislative government bodies and organisations/companies with experience in other related autonomous domains, on topics including:

- Maritime remote-control technology
- Automated onboard systems
- Autonomous technology
- E-navigation
- Impact on maritime workforce and human factors
- Legal implications and maritime regulations
- Case studies and research projects

Register your Interest | Submit an Abstract | Sponsorship Opportunities

conference@rina.org.uk Tel: +44(0)20 7235 4622

www.rina.org.uk/Autonomous_Ships

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 2019 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**

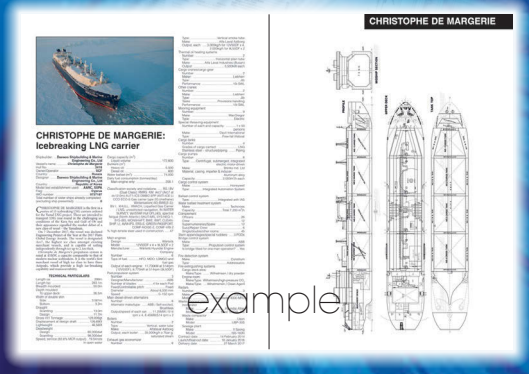
Nominations should arrive at RINA Headquarters by 31st December 2019.

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

Newbuildings nominated:

MSC Gulsun
Costa Venezia
New Journey
Hourai Maru
Roald Amundsen

plus many more...



SIGNIFICANT SHIPS

available in printed or USB format

The Royal Institution of Naval Architects will publish the **30th** edition of its annual **Significant Ships** series in February 2020. Produced in our usual technically orientated style, **Significant Ships of 2019** presents approximately 50 of the most innovative and important commercial designs delivered during the year by shipyards worldwide. Emphasis is placed on newbuildings over 100m in length, although some significant smaller cargo ships, fast ferries and offshore vessels were considered, including a cross-section of ship types, with each vessel being either representative of its type or singularly significant. Each ship presentation comprises of a concise technical description, extensive tabular principal particulars including major equipment suppliers, detailed general arrangement plans and a colour ship photograph.

PRE PUBLICATION OFFER

Non-member £35 (RINA member £29)

or order a set:

One copy of **SIGNIFICANT SHIPS 2019** &
one copy of **SIGNIFICANT SMALL SHIPS 2019**
price £45 (RINA member £39)

When ordering please advise if printed or CD ROM format is required,

contact:

The Publications Department, RINA,
8-9 Northumberland Street, London WC2N 5DA, UK.
Tel: +44 (0)20 7235 4622 Fax +44 (0)20 7259 5912
E-mail: publications@rina.org.uk Website: www.rina.org.uk

often misinterpreted previous version of the RS requirements to abrasive wear and corrosion. This sometimes lead to a significant weighting up of the designed ship's hull," Shishkin says. In 2018, RS introduced abrasive wear allowances update for outer shell with due account for corrosion/abrasion rate and application of ice resistant coating. The new requirements introduce gradation into class I and II coatings. For example, class I enables 50% reduction of the annual average outer shell corrosion wear and abrasive thinning rate.

Previously, bulbous bow was accepted by RS for ice classes up to Arc4. Upon the industry demand and R&D since 2019, RS Rules introduce bulbous bow structure specifications for Arc4 – Arc7 as well as transom stern in way of ice belt for ice class Arc4 and Arc5. This year, formulation of ice load parameters, where the hull form angles are outside the Rule limits, were introduced.

"For a long time RS accepted only cast stems for ice class ships due to high structural reliability. Due to the steadily growing gross tonnage increase of ice class ships the size of the cast increased respectively, which lead to compromise in the quality of the cast," says Shishkin. "Therefore, since 2017, the RS Rules application of welded stems is allowed for Arctic classes from Arc4 to Arc7, Icebreaker6 and Icebreaker7," he adds.

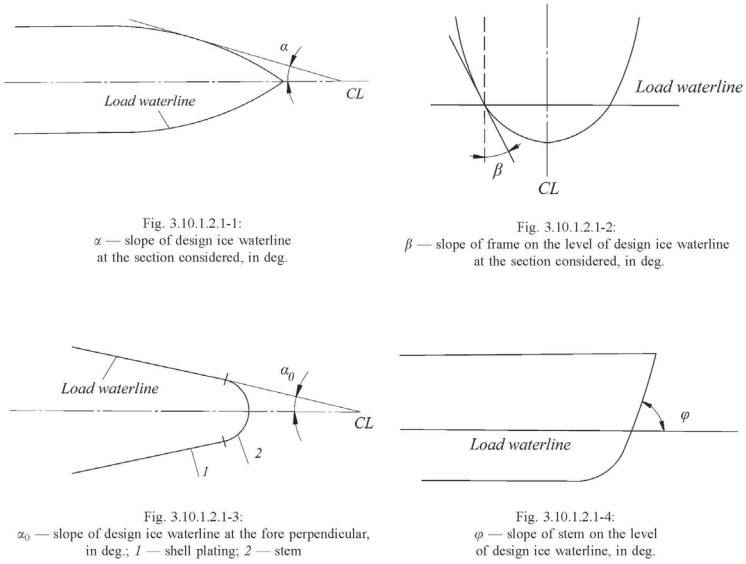


Fig. 3.10.1.2.1-1:
α — slope of design ice waterline at the section considered, in deg.

Fig. 3.10.1.2.1-2:
β — slope of frame on the level of design ice waterline at the section considered, in deg.

Fig. 3.10.1.2.1-3:
α_0 — slope of design ice waterline at the fore perpendicular, in deg.; *1* — shell plating; *2* — stem

Fig. 3.10.1.2.1-4:
φ — slope of stem on the level of design ice waterline, in deg.

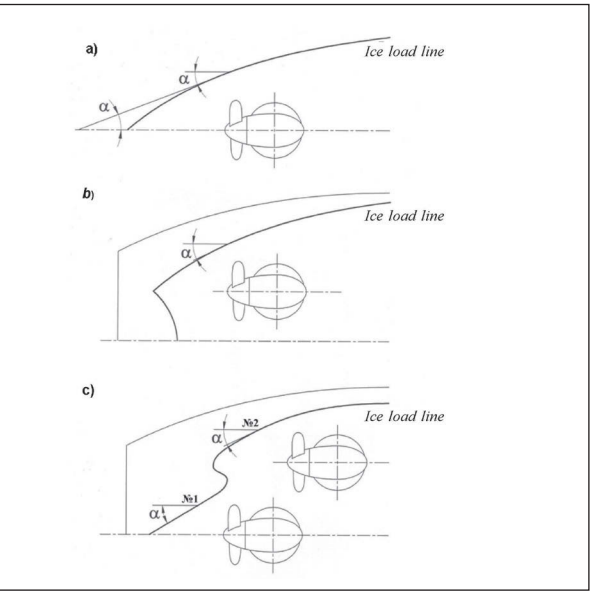


Figure 2: Formulation of ice load parameters where the hull form angles are outside the Rule limits

LNG carriers

Recently RS has granted the Approval in Principle (AiP) for the new LNG containment systems, designed by Gaztransport & Technigaz (GTT) for Arc7 ice class ships. The new containment systems Mark III Flex and NO 96 L03+ by GTT are based upon proven LNG containment systems designs, enabling, in addition, to reduce the in-service boil-off rate. RS and GTT analysed the containment systems in terms of safety of operation aboard a ship navigating in ice-covered waters.

Under the AiP procedure, RS and GTT considered containment system strength under hull vibrations, as well as fatigue endurance of the containment system elements. Additionally, containment systems safety in case of possible interaction with floating ice or icebergs, and also structural strength of the membrane systems to potential impacts (sloshing events) related to liquefied gas movements in the cargo tanks have been analysed and validated.

RS gradually implements a comprehensive programme of the development and promotion of services for marine transportation of LNG. RS possesses a successful track record of gas carrier construction surveys at world leading shipyards and has developed in-house professional training programmes on gas carrier surveys under construction and during operation. In March 2019, RS and GTT signed a bilateral cooperation agreement covering experience exchange and membrane cargo containment systems installation aboard RS-classed ships. The agreement foresees communication during the development of technical requirements and additions to the RS rules as well as the RS approval of materials, products, technologies and GTT-designed LNG containment systems. Under the agreement, RS surveyors undertake a training course on technical know-how of the LNG containment systems. *NA*

Reference

Russian Maritime Register of Shipping (RS) is a leading classification society. Established in 1913. RS is recognised by the largest flag states and the EU. It has been an IACS member since 1969.

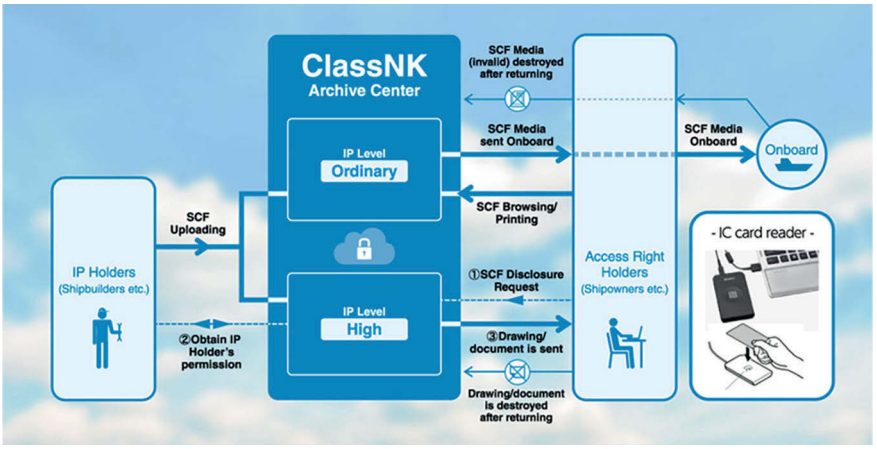
ClassNK unveils archive centre

New initiatives from ClassNK to protect safety and the marine environment are supported by the world's first centre for IMO GBS information

In order to reduce atmospheric pollution caused by sulphur oxides (SOx) and particle matter (PM) found in vessel emissions, enforcement of shipping's environmental regulations is becoming ever stronger.

However, with greenhouse gases now also within the sights of regulators, LNG's ability to reduce CO_2 emissions by 10% to 20% compared to conventional oil fuels brings a new dimension to the future viability of a marine fuel that is already sulphur-free.

Recently, ClassNK granted Approval in Principle (AIP) based on its Rule Part GF, which adopts the IGF Code (regulation for ships using low-flashpoint fuels). The development supports various joint projects on the concept design of LNG-fuelled bulk carriers led by companies such as NYK Line/Japan Marine United and Kawasaki Heavy Industries.



The ClassNK Archive Centre serves as a secure repository for Ship Construction Files

Archive centre

But perhaps ClassNK's most remarkable recent safety initiative, especially for dry cargo ships, is the establishment of ClassNK Archive Centre (NKAC). As international regulations are requiring the industry to enhance the safety of highly sensitive design and construction information, ClassNK's world-first and only viable onshore Archive Center provides an essential service, enabling both shipowners and shipbuilders to comply with new IMO Goal Based Standards (GBS) – Ship Construction Files (SCF) and the related industry standard. In October 2018, NKAC stored its first Ship Construction Files fully in line with IMO-GBS.

To encourage design transparency throughout the life of vessels for ensuring safety, the SOLAS regulation II-1/3-10 entered into force in 2012, requiring an SCF complying with IMO GBS to be provided by the shipyard on a new ship's delivery and kept onboard and/or ashore.

The SCF provides the vessel design and construction information needed to ensure the safety of the ship throughout its operational life. According to the SCF guidelines, this information must be stored onboard. Other information, including the high-level intellectual property (IP) drawings belonging to the shipyards such as the yard plan, lines and detailed structural calculations, is kept confidential and does not need to be carried onboard.

Cross-industry support

To supplement the regulation, the Industry Standard was also developed by a cross-industry group including the Shipbuilders' Association of Japan (SAJ) and other organizations such as CANSI, CESA, Koshipa, SCA, ICS, Intercargo, Intertanko, BIMCO, OCIMF and IACS.

As of June 2019, no service other than NKAC has announced the storage of GBS-SCF. Although the necessity to have SCF onboard to improve the safety of ships is unquestionable, at the same time SCF is an intellectual property developed by shipbuilders. In order to tackle this conflict between players, ClassNK has utilized innovative and secure cloud-based technology to develop NKAC for the storage and management of SCF and other electronic documents.

NKAC simplifies the storage of important files by offering a paperless, user-friendly way to manage drawings, thus enabling effective communication between shipbuilders, shipowners and ship management companies by bringing them all under one umbrella and providing a central resource through which files can be exchanged.

IP security

To ensure confidentiality of IP, shipbuilders can set the desired IP security levels for each drawing. High IP-level drawings such as the lines plan are only stored ashore in NKAC and, as a rule, the shipowner is required to ask NKAC for permission to access these files. The NKAC then notifies the IP-holder (shipbuilder and/or equipment manufacturer) of the request.

IMO's regulations are applicable to bulk carriers and oil tankers of 150m in length and above, with a building contract placed on or after 1 July 2016. In the absence of a building contract, the regulations apply to keels laid on or after 1 July 2017 or delivery made on or after 1 July 2020. This means that the requirement will be applied to many ships that are going to be delivered and eventually to all bulk carrier and oil tankers of 150m. Today, NKAC is the only solution to comply with and realise the scope of IMO's safety initiative. *NA*

Forecasting and hindcasting

Yoshiko Sato and Kuniaki Matsuura of the Japan Meteorological Association consider accuracy of meteorological and oceanographic phenomena and their utilisation in the shipping industry

With recent advances in ship-to-land communication and sensor technology, a great deal of important ship monitoring data is being collected, from such sources as navigation instruments and engine loggers. This has made it possible to perform estimates of a ship's propulsion performance and seaworthiness in the actual seaways where it must operate. Since knowledge of meteorological and oceanographic conditions is indispensable to making accurate estimates of the external forces being sustained by ships, valuable field observation data can be obtained by measuring these phenomena. However, at present it is difficult to claim that measured values collected onboard are sufficiently detailed, especially when it comes to oceanographic data.

On the other hand, the estimated values of meteorological and oceanographic phenomena using numerical calculations are based on data that is continuous in time and space, so they can be used to represent phenomena with good accuracy at various scales. These estimated values include such types as actual estimated values (Nowcast), predicted values (Forecast), and values added for the analysis of past events (Hindcast) (Table 1). When using estimations based on monitoring data to analyse the propulsion and seaworthiness performance of a ship, it is best practice to use additional values with higher accuracy.

Therefore, we would like to discuss here the estimation of meteorological and oceanographic phenomena that are most useful for analysing ship monitoring data, focusing especially on the results of wave hindcasting. This paper also presents means of applying this data in the shipping industry and some contributions the Japan Meteorological Association has made to the field.

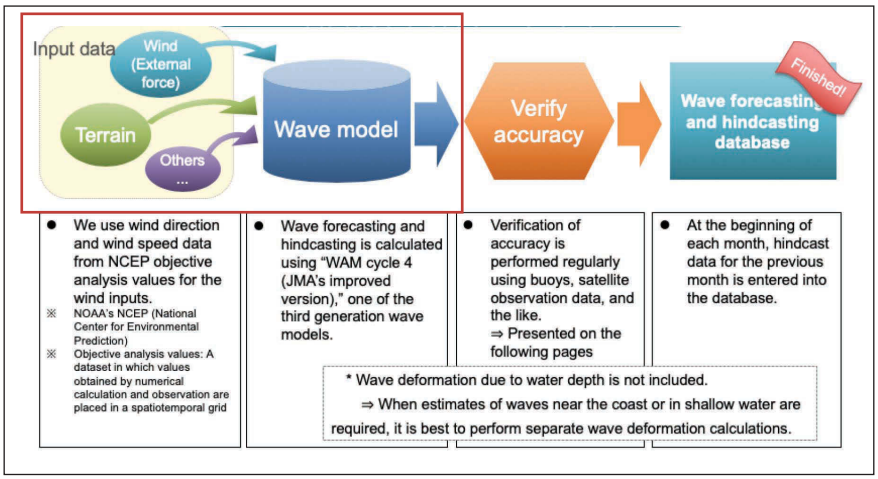


Figure 1: Wave forecasting and hindcasting flowchart

Table 1: Types of estimated values

Types of estimated values	Characteristics
Estimated actual value (Nowcasting)	Value obtained by correcting the approximate initial time of the estimated value in the numerical model (the first estimated value), based on the actual observed value
Forecasted values (Forecasting)	A future value estimated from the estimated actual value, based on Nowcasts
Additionally calculated values (Hindcasting)	Estimating values of past meteorological and oceanographic conditions using observation values determined throughout an analysis period

Wave forecasting and hindcasting

Wave forecasts and hindcasts are obtained by calculating the spatiotemporal changes in the directional spectrum of waves as they are generated, develop and become attenuated. These forecasts are obtained by using a computer to solve a series of energy equations.

Estimated values include such types as actual estimated values (Nowcasts), forecasting values (Forecasts), and additionally calculated values (Hindcasts) (Table 1). Therefore, we can expect to obtain a strong analytic effect by applying any of these values appropriately, on a case by case basis.

The wave forecasting and hindcasting flowchart is shown in the red frame in Figure 1. All hindcasting values are calculated using the same model, but the wind data inputs are different for each hindcasting value. Nowcasts and Forecasts are calculated daily using the latest wind data forecast, and the Hindcasts are recalculated later using actual confirmed wind data. This means that the hindcasting is calculated as "the most probable past data" by the application of the global mesh.

Then, as is shown in the areas other than the red framed part in Figure 1, the accuracy of the hindcast is verified at a point measured by a buoy or the like and the output is stored in a database. Figure 2, which shows a comparison between our Forecasts and Hindcasts, illustrates a scatter diagram comparing our estimated values for Forecasts and Hindcasts with the values observed using buoy data, etc. We can see that the Hindcasts have less variation than the Forecasts.

Using this high-quality database, we can eliminate the need to make wave forecasts and hindcasts for each analysis situation, which saves effort. The Japan Meteorological Association has configured over 30 years of its continuous Global Ocean Wave Hindcast Database (POLARIS Hindcast: wave hindcasts consisting of a total of 32 elements: wind direction/velocity; representative wave specifications: significant wave height/period/mean wave direction, etc.) In this paper we discuss that database and present the results of verifying the accuracy of the wave hindcasts made using the database and present their characteristics.

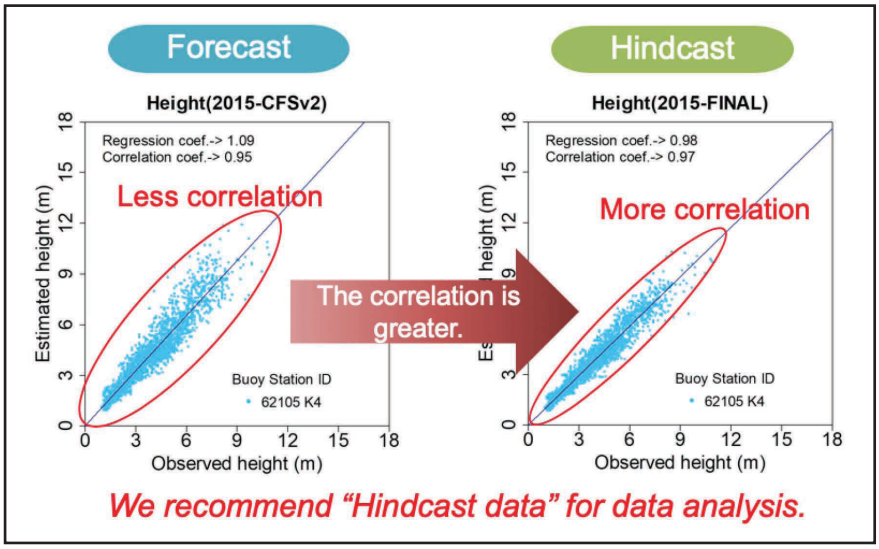


Figure 2: Comparison of Forecasts and Hindcasts

The accuracy of wave hindcasting data

The geographic range of the Global Ocean Wave Hindcast Database is ±75 degrees latitude, the spatial resolution is 0.5 degrees, and the temporal resolution is 1 hour. At the time of writing this paper, we are applying NCEP Final Analysis (1 degree spatial resolution) when inputting sea winds. It should be noted that the ocean wind data input for wave hindcasting has a regression coefficient of 1.01 and a small deviation in magnitude as compared with the wind speed obtained by the Jason-2 satellite, and can thus be said to be very highly accurate, with a correlation coefficient of 0.97. (Figure 3).

Ocean currents

Currents such as the Kuroshio Current (the Japan Current) are estimated by numerical calculations using an ocean circulation model that can be used to calculate global ocean currents. The estimated ocean current is corrected using observation data (sea level altitude data via satellite, sea surface temperatures via satellite, and on-site water temperature salinity data, etc.) so the reproducibility of the data is high.

However, because ocean observation data is scant in both space and time, the estimated current values are not accurate enough to be relied upon absolutely for pinpoint precision that can be use as the current data for planning a navigation route. For this reason, when estimated current values are used, the average value is used, or they are used as threshold values.

Tidal currents

Tidal currents from an ocean to an inland sea are estimated by numerical calculations using harmonic constants calculated in advance. In particular, it is possible to estimate tidal currents in an inner bay with high accuracy. For example, if you look at the results of estimating the tidal current in the Seto Inland Sea of Japan at any time and place, you can see that the estimated tidal current and the observed values match quite well, except for some areas such as the Kanmon Strait.

Utilisation in the maritime field

As mentioned above, a powerful predictive effect can be expected by using the appropriate type of estimated values (from Forecasts or Hindcasts) depending on the application. In keeping with recent advances in the IoT for the shipping industry, we are planning to develop a service that can easily obtain data for each type using an Application

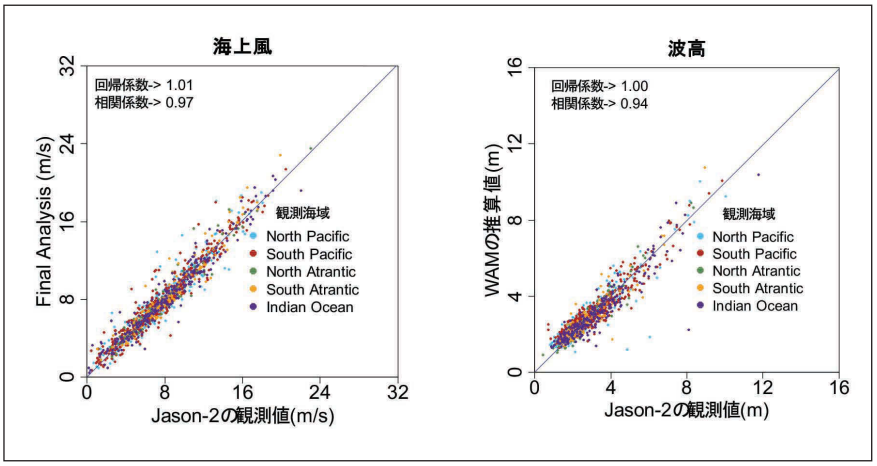


Figure 3: Comparison of wave hindcasting values and satellite observation values (Jason-2) (1 year - 2015). Left: sea wind speeds, right: wave heights

Programming Interface (API), which we expect to release this fall (Figure 4). This service will not only handle the waves and ocean currents discussed to this point, but also various other meteorological and oceanographic data.

In particular, we can expect to use services for IoT support using POLARIS Hindcast, our unique application of technology and our global meteorological oceanographic database. The following discussion includes examples of use.

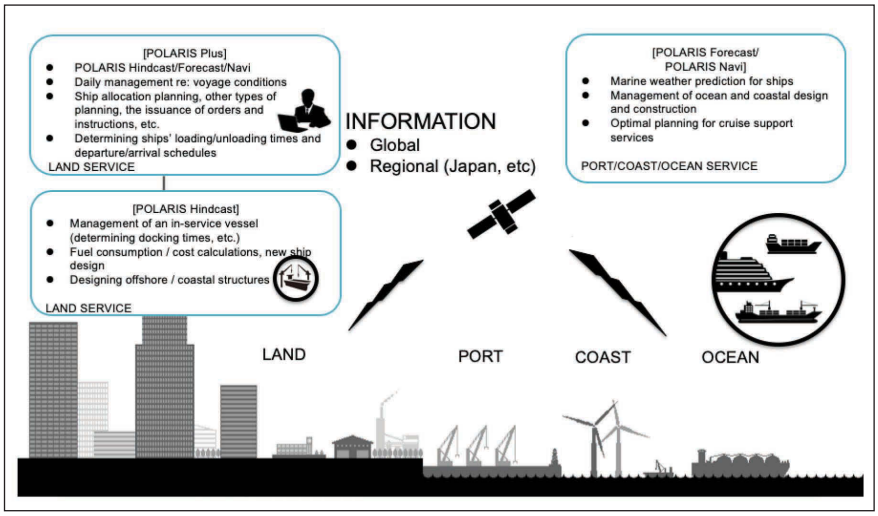


Figure 4: Diagram showing how the POLARIS service is used

Monitoring analysis

This can be used as a source of the external force data that is required to estimate ship performance in actual sea locations and evaluate the effects of energy-saving adjuncts. POLARIS Hindcast makes it easy to extract meteorological and oceanographic data linked to tracking and AIS data (latitude, longitude, date and time). In addition, the data provided are hindcasting values, and are high-quality data with globally verified accuracy. Therefore, it is most suitable for use in detailed analyses, including performance evaluations.

Furthermore, since changes in the performance of a ship's hull, propeller, etc. can be confirmed in near real time, this data can also be used to determine the timing of docking and routine maintenance activities.

Basic information for ship building and design

POLARIS Hindcast's continuous data has been accumulated over the past 30 years. Thus it is possible to generate statistical values derived from a long period of observation, to be used for such tasks as establishing sea margins, understanding external forces as they apply to the application of steel ship rules, etc. Therefore, they can be used as basic data for ship building and design.

Basic data for use when planning routes

It is possible to use POLARIS Hindcast data to calculate the frequency distribution of ocean waves. This frequency distribution can be created for a specific period or a specific location (which can be an area or a route) and is used to optimise operating efficiency and costs. Specifically, it can be used for a wide range of applications in an actual region of the sea, including setting sea margins for typical and specifically planned routes, and basic data for calculating fuel consumption and costs.

Summary

We have described the accuracy we have achieved when estimating ocean waves and current flow velocities, and the points to consider when using the obtained data. These are the four key points of this discussion:

1) If a high-quality database is used, the numerical calculation of estimates for each circumstance being analysed is not required, which can be expected to reduce effort.
2) The wave hindcasting values are very accurate, and it is best to use not only the representative wave specifications but also the direction spectrum, as required.
3) Current estimated values are not accurate enough to be used for the analysis of ships' actual sea area performance, and are currently only being used as average values or threshold values.
4) Tidal currents from oceans to inland seas can be estimated, and predictions for inner bays have particularly good accuracy.

Understanding and utilising the characteristics of the estimated values, as described above, will improve the accuracy of results of monitoring analysis, including ship propulsion performance in actual sea regions.

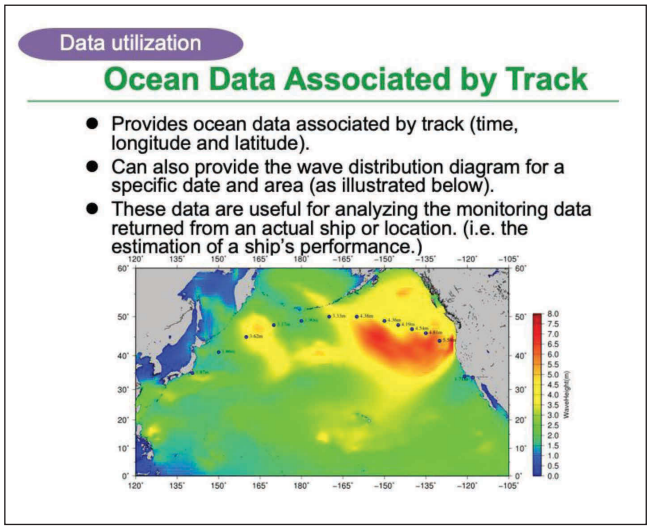


Figure 5: Ocean data combined with tracking data

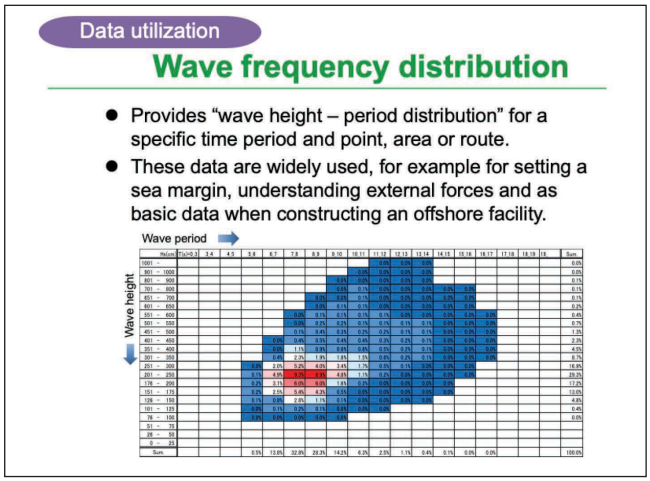


Figure 6: Wave frequency distributions

Future prospects for our database

The method of obtaining the maximum likelihood estimate using both onboard measurements and estimated values, as described earlier, can also be used to take into account the uncertainty of onboard measurements of meteorological sea state data. By applying the estimated values over a range of time and space, it is possible to verify observations made using equipment of uncertain accuracy, and to compensate for missing measurements.

The authors have made several studies over the last few years to improve the accuracy of the Global Ocean Wave Hindcast Database. For example, it is possible to increase the accuracy of the wave hindcasting values by increasing the resolution of the sea wind inputs used in the current global wave forecasting and hindcasting database, by reducing the measurement size from 1 degree to 0.2 degrees. We are creating a more accurate database based on the examination of the past 30 years of data and will start offering the API in the POLARIS service, starting in 2019.

In addition, hindcasts of current velocity are now being prepared, including not only those for tidal currents but also the estimated values of existing ocean currents. We hope to present information about the application of these estimations at another time. *NA*

ADVERTISERS INDEX

If you would like to receive further information on the advertisers featured within The Naval Architect please contact JP Media Services: jpayten@jpmediaservices.com

RINA publications

Books

Please note all prices include postage & packaging

LAMENTABLE INTELLIGENCE FROM THE ADMIRALITY
By Chris Thomas
HMS Vanguard sank in thick fog in Dublin Bay in September 1875 rammed by her sister ship. No lives were lost (except perhaps that of the Captain's dog) but this one event provides valuable insight into naval history of the late nineteenth century. Chris Thomas examines what happened, setting it in the context of naval life, the social and economic situation of officers and ratings. He describes the furore caused by the unjust verdict of the Court Martial, vividly illustrating the joys and trials of the seagoing life in the Victorian era, and the tragic effect on the life of Captain Richard Dawkins and his family.
Price: UK £9.00 EUR £10.00 OVS £12.00
AMAZON PRICE: £12.74

SHIPS AND SHIPBUILDERS: PIONEERS OF SHIP DESIGN AND CONSTRUCTION
By Fred Walker FRINA
Ships and Shipbuilders describes the lives and work of more than 120 great engineers, scientists, shipwrights and naval architects who shaped ship design and shipbuilding world wide. Told chronologically, such well-known names as Anthony Deane, Peter the Great, James Watt, and Isambard Kingdom Brunel share space with lesser known characters like the luckless Frederic Sauvage, a pioneer of screw propulsion who, unable to interest the French navy in his tests in the early 1830s, was bankrupted and landed in debtor's prison. With the inclusion of such names as Ben Lexcen, the Australian yacht designer who developed the controversial winged keel for the 1983 America's Cup, the story is brought right up to date.
Price UK £12.50 EUR £16 OVS £18
AMAZON PRICE: £21.25

THE ROYAL INSTITUTION OF NAVAL ARCHITECTS 1860-2010
Published to commemorate the 150th anniversary of the founding of the Institution, The Royal Institution of Naval Architects 1860-2010 provides a history of the Institution as reflected in the development of the naval architecture profession and the maritime industry over that time. In the book, members give their personal views on the development of their sector of the maritime industry and how it will develop in the future.
Price UK £5.50 EUR £6 OVS £7
NOT ON AMAZON

International Journal of Maritime Engineering (IJME)

2019

Members Part Ref: IJME19 Set Ref: ST19

Part A1	Part A2	Part A3	Part A4	Set
£19	£19	£19	£19	£52

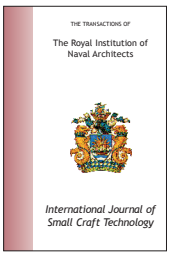
Non-Members Part Ref: IJME19 Set Ref: ST119

Part A1	Part A2	Part A3	Part A4	Set
£26	£26	£26	£26	£85

IJME - is published in March, June, September & December. The IJME provides a forum for the reporting and discussion of technical and scientific issues associated with the design, construction and operation of marine vessels & offshore structures

International Journal of Small Craft Technology (IJSCT)

2019



Members Part Ref: IJSCT19 Set Ref: SS19

Part B1	Part B2	Set
£19	£19	£33

Non-Members Part Ref: IJSCT19 Set Ref: SS119

Part B1	Part B2	Set
£26	£26	£46

IJSCT - is published in June & December. The IJSCT provides a forum for the specialist reporting & discussion on technical & scientific issues associated with research & development of recreational & commercial small craft.

Each month RINA offers up to 50% discount on the normal price of its publications. Please visit the website at

www.rina.org.uk/bookshop-bargains

to see this month's specials.

Journals

THE NAVAL ARCHITECT

Published 10 times a year

- Providing up-to-date technical information on commercial ship design, construction and equipment.
- Regular reports on centres of shipbuilding activity worldwide.
- Comprehensive, technical descriptions of the latest newbuildings.
- News, views, rules & regulations, technology, CAD/CAM, innovations.

quarterly publication
OFFSHORE MARINE TECHNOLOGY
bi-monthly publication
WARSHIP TECHNOLOGY

2019 Subscription

12 months	Print only†	Digital Only*	Print + Digital
UK	£196	£196	£250
Rest of Europe	£205	£196	£258
Rest of World	£220	£196	£274

†Incudes p+p
*Inclusive of VAT

SHIP & BOAT INTERNATIONAL

Published 6 times a year

- In depth coverage of small craft/small ship design, building & technology.
- Specialist sections include: fast ferries, tugs, salvage & offshore, patrol & paramilitary craft, coastal & inland waterway vessels, pilot boats, propulsion and transmissions.
- Advances in construction materials, electronics, marine equipment.
- Contract news and the latest market developments.

2019 Subscription

12 months	Print only†	Digital Only*	Print + Digital
UK	£144	£144	£176
Rest of Europe	£152	£144	£185
Rest of World	£174	£144	£206

†Incudes p+p
*Inclusive of VAT

SHIPREPAIR & MAINTENANCE

Published Quarterly

- In depth coverage of all aspects of shiprepair and conversion work and comprehensive technical descriptions of major conversion projects.
- Regular regional surveys on the major shiprepair centres.
- Developments in shipboard and shipyard equipment technology.
- Contract news, appointments, industry views, new regulations.

2019 Subscription

12 months	Print only†	Digital Only*	Print + Digital
UK	£67	£67	£88
Rest of Europe	£73	£67	£95
Rest of World	£81	£67	£104

†Incudes p+p
*Inclusive of VAT

RINA publications

Conference Papers

If USB format is required please add USB after the reference number.

		Non-Members	*Members*
2019	**ICCAS 2019** Ref: ICCAS19	£140	£120
	International Conference on Wind Propulsion Ref: WIN19	£140	£120
	Power & Propulsion Alternatives for Ships 2019 Ref: PPA19	£140	£120
	Design & Operation of Wind Farm Support Vessels Ref: WFV19	£140	£120
	Propellers – Research, Design, Construction & Application Ref: PRO19	£140	£120
	Design & Operation of Passenger Ships Ref: PASS19	£140	£120
	Design & Construction of Super & Mega Yachts Ref: SMY19	£140	£120
	Warship 2019: Multi-Role Vessels Ref: WS19	£140	£120
2018	**Smart Ship Technology 2018** Ref: SST18	£135	£115
	SURV 9 - Surveillance, Search and Rescue Craft Ref: SURV918	£135	£115
	Damaged Ship IV 2018 Ref: DS18	£140	£120
	Warship 2018: Procurement of Future Surface Vessels Ref: WS18	£140	£120
	Human Factors 2018 Ref: HF18	£140	£120
	Full Scale Ship Performance Conference 2018 Ref: FSSP18	£140	£120
	International Conference on the Education & Professional Development of Engineers in the Maritime Industry 2018 Ref: EDU18	£140	£120
	Historic Ships 2018 Ref: HIST18	£140	£120
	Design, Construction & Operation of LNG/LPG Ships Ref: LNG18	£140	£120

For more information on previous conference proceedings or a publications catalogue, please contact the Publications department on: Tel: +44 (0) 20 7235 4622, Email: publications@rina.org.uk or Website: http://www.rina.org.uk

PRIVACY

Personal data held by RINA will only be used in connection with RINA activities, and will not be passed to third parties for other use. Full details of RINA's Privacy Policy are available online.

☐ I wish to receive information on technical developments in or related to the maritime industry and on future RINA events. I understand that I may stop receiving such information at any time.

Payment Details: Payments must be made in pounds sterling to **RINA** by sterling cheque drawn on a UK bank, International Money Order or Credit Card, we accept Visa, Mastercard, or AMEX.

I enclose a cheque for _____ payable to RINA.

Please charge my Credit Card No: _____

Expiry date: __/__/__ Security code: _____ Signature: _____

Print name: _____

Name: _____

Address: _____

Country: _____ Postcode: _____

Tel: _____ Fax: _____ Email: _____

Please allow 30 days for dispatch and delivery. Post to:

The Publications Department, RINA, 8-9 Northumberland Street, London WC2N 5DA, UK.

Tel: +44 (0)20 7235 4622 or **Fax: +44 (0)20 7259 5912.**

ORDER FORM

Please send me the following:

REF Nov 19

REFERENCE	QUANTITY	PRICE
	TOTAL:	

DIARY

November 19, 2019
Safety Techniques Workshop
Training conference,
London, UK
www.rina.org.uk/events_programme

November 19-21, 2019
METS Trade Show
International trade show,
Amsterdam,
Netherlands
www.metstrade.com/

November 21-23, 2019
Pacific Marine Expo
International exhibition,
Seattle, USA
www.pacificmarineexpo.com/

November 25-26, 2019
ICSOT Indonesia 2019
RINA conference,
Jakarta, Indonesia
www.rina.org.uk/ICSOT_Indonesia_2019.html

November 25-December 5, 2019
IMO Assembly
International conference,
IMO Headquarters,
London, UK
www.imo.org/en/MediaCentre

December 3-6, 2019
Marintec China
International exhibition,
Shanghai,
China
www.marintecchina.com

December 4-5, 2019
Cruise Ship Interiors Expo
International exhibition,
Barcelona, Spain
www.cruiseshipinteriors-europe.com/

January 15-16, 2020
Marine Design 2020
RINA conference,
Cadiz, Spain
www.rina.org.uk/Marine_Design_2020

January 22-23, 2020
NaviGate 2020
International exhibition,
Turku, Finland
www.turunmessukeskus.fi/en/event/navigate/

January 29-30, 2020
LNG/LPG and Alternative Fuel Ships
RINA conference,
London, UK
www.rina.org.uk/LNG_ALT2020.html

February 19-20, 2020
Human Factors
RINA conference,
London, UK
www.rina.org.uk/Human_Factors_2020.html

March 4, 2020
Sustainable and Safe Passenger Ships
RINA conference,
Athens, Greece
www.rina.org.uk/Sustainable_and_Safe_Passenger_Ships.html

March 11-12, 2020
Damaged Ship V
RINA conference,
London, UK
www.rina.org.uk/Damaged_Ship_V.html

March 11-13, 2020
Sea Japan
International exhibition,
Tokyo, Japan
www.seajapan.ne.jp

March 11-13, 2020
Australasian Oil & Gas (AOG)
International conference
Perth,
Australia
https://www.rina.org.uk/AOG%202020

March 11-20, 2020
Asia Pacific Maritime
International exhibition
Marina Bay Sands,
Singapore
www.apmaritime.com

April 1-2, 2020
Autonomous Ships
RINA conference,
London, UK
www.rina.org.uk/Autonomous_Ships.html

April 22-23, 2020
Influence of EEDI on Ship Design & Operation
RINA conference,
London, UK
www.rina.org.uk/EEDI_2020.html

May 2020
Ship and Berth Interfaces
RINA conference,
London, UK
www.rina.org.uk/events_programme

May 14, 2020
RINA Annual Dinner
RINA event
Royal Lancaster Hotel,
London, UK
www.rina.org.uk

June 1-5, 2020
Posidonia
International shipping exhibition,
Athens,
Greece
www.posidonia-events.com/

June 2-5, 2020
Basic Dry Dock Training Course
Training Course,
London, UK
www.rina.org.uk/events_programme

June 23-25, 2020
Autonomous Ship Symposium
International conference,
Amsterdam,
Netherlands
www.autonomousshipsymposium.com/en/

June 2020
Warship 2020
RINA conference,
UK
www.rina.org.uk/events_programme

September 8-11, 2020
SMM
International exhibition,
Hamburg,
Germany
www.smm-hamburg.com/en/

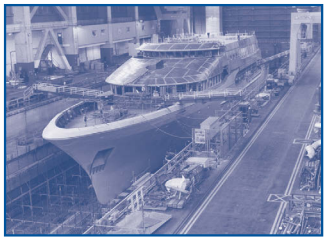
September 23-24, 2020
Full Scale Ship Performance
RINA conference,
London, UK
www.rina.org.uk/events_programme

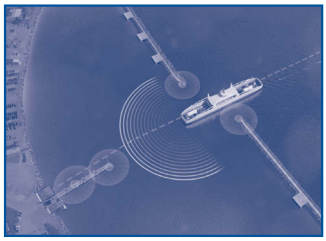
October 14-15, 2020
Smart Ship Technology
RINA conference,
London, UK
www.rina.org.uk/events_programme

The Royal Institution of Naval Architects

International Conference: Marine Design 2020 15-16 January 2020, Cadiz, Spain

UCA Universidad de Cádiz





Open for registration

Marine Design 2020 will return to provide a forum for reporting and discussing Marine Design practice and technical innovation, including Human Systems Integration. Marine Design is a holistic design process with a strong focus on the end users as well as stakeholders in the design process, based on the principles of Industrial Design.

Effective Marine Design requires a multidisciplinary design team of Naval Architects, Industrial Designers, Human Factors specialists, Environmental Psychologists and Interior Designers. The start of the Marine Design process involves understanding the personas and needs of the end user.

The aim of Marine Design is to improve the aesthetics, human factors and functionality of a vessel or system, and its' marketability. Human Systems Integration provides a through-life, integrative framework with the potential both to enhance safety and increase performance while reducing through life costs.

Register your Interest | Sponsorship Opportunities

conference@rina.org.uk Tel: +44(0)20 7235 4622

www.rina.org.uk/Marine_Design_2020

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 invited for the 2019 Eily Keary Award.

The Award will be announced at the 2020 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

Nominations should arrive at RINA Headquarters by 31 Jan 2020.

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

CADMATIC

Marine Design Software

Visit us at Marintec 2019
Stand number N1C6A-07

Shanghai, China
3-6 December 2019

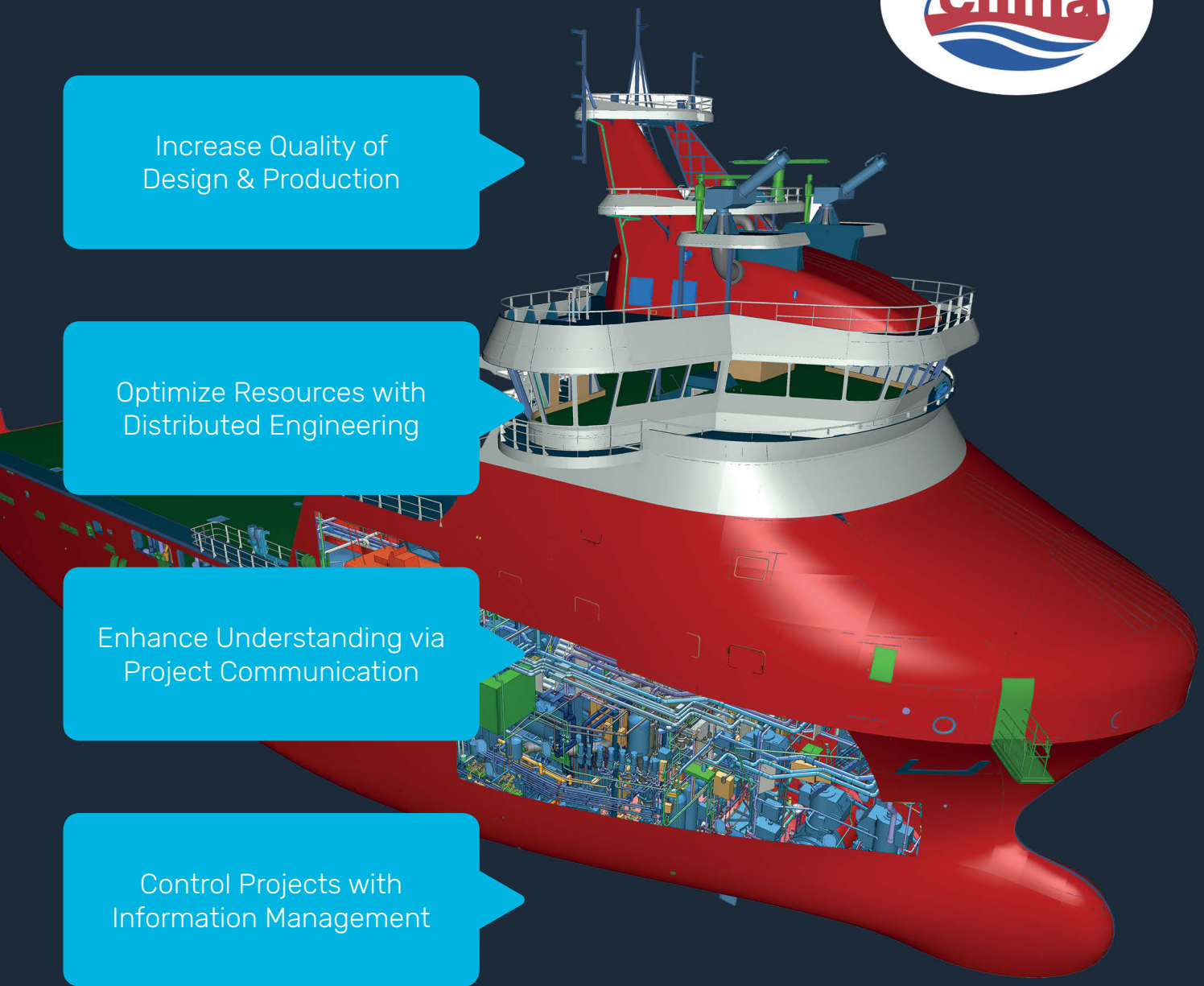
marintec China

Increase Quality of Design & Production

Optimize Resources with Distributed Engineering

Enhance Understanding via Project Communication

Control Projects with Information Management



Project courtesy of Wärtsilä Ship Design Norway AS

Feel Empowered

www.cadmatic.com