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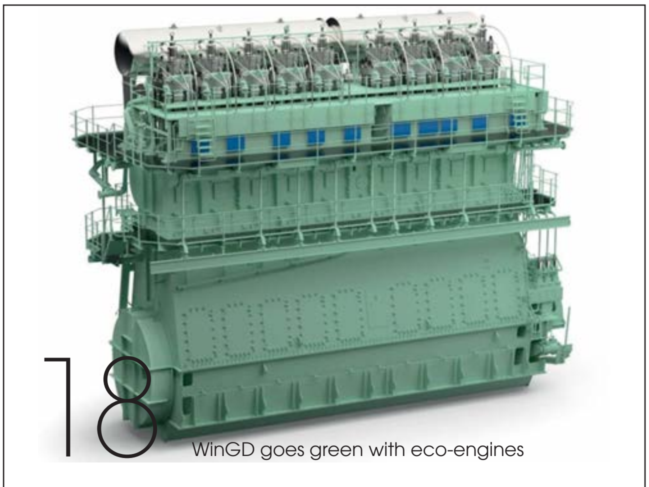
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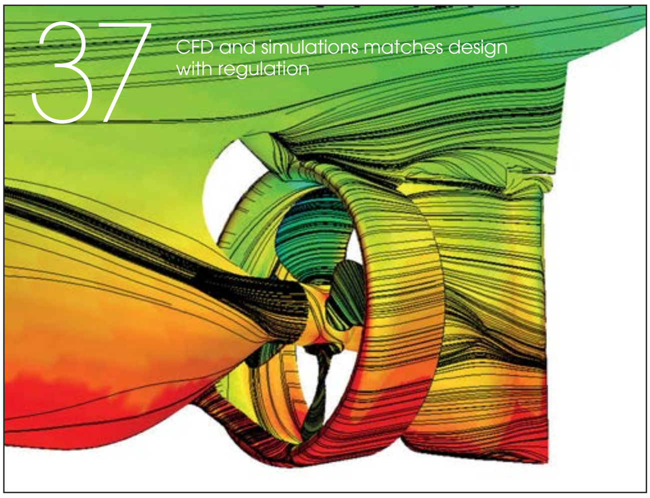

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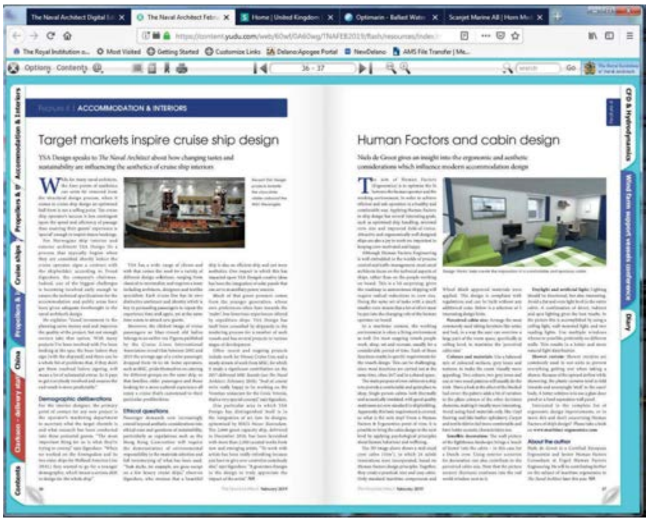


Forever blowing bubbles

William Hogarth's satirical take on the 'South Sea Scheme'

During the speculation frenzy of the South Sea Bubble in the early 18th century, there was the often-cited case of a joint-stock promotion that invited investors 'For an Undertaking which shall in due time to revealed'. Whether or not that offering attracted much or any interest doesn't appear to have been passed down through history, but it stands as the most egregious example of how opportunity (the South Sea Company had been granted a monopoly on British trade with South America) can become quickly mired in delusion.

There are plenty of others, of course, from the Tulipmania of a century earlier, to the 1929 Crash, through to more recent examples such as the Dot Com Bubble and the financial crisis of 2008. All have their equivalents of 'Importing a Number of large Jack Asses from Spain', 'Trading in Human Hair' or 'A Perpetual Motion Machine', to cite some of the other fantastic offerings from the South Sea enterprise.

Investing in marine technologies tends to be a far less alluring prospect, but while this isn't an endorsement of reckless speculation, one does wonder whether there might be something to be said for some of that old buccaneering spirit of adventure. That view might seem somewhat contrarian considering the attention this magazine gives to smart ships or alternative fuels, or startups exploring niche technologies, but there is a clear difference between small(er) scale investment in joint industry projects and the bigger commitments that will expedite significant progress.

A major theme at Nor-Shipping in 2017 was Disruption, one of those annoying buzzwords than can mean all things to all people. There was plenty of sagely head nodding at the panel discussions that 'something' was going to change, if not necessarily agreement about what that something was. Fast forward two years to the 2019 iteration, held last month, and the emphasis was far less about reinventing the concept of trade and shipping and more the exigencies of being efficient and profitable in a regulation focused world.

For some that means the convolutions and permutations of the sulphur cap (see News Analysis for more on that) while other companies were promoting their optimisation solutions. But the bigger doubts surrounded the IMO's greenhouse gas targets, or more specifically how to achieve the zero-carbon vessels that will need to enter service in little more than a decade if the net 50% reduction in emissions is to be achieved by 2050.

While there's not quite yet a sense of panic, I have attended a number of presentations and briefings that effectively gave the solution as a blank space to be filled by some nebulous 'future technology'. It was left for us to decide whether that was batteries, hydrogen, wind, biofuels, some combination thereof or something else entirely. Just... something… that will be presumably be 'in due time revealed'.

There's a certain irony, I think, that investment in renewable energies is booming while shipping financing remains in the doldrums, albeit these are land or offshore based technologies. In March, a report by Drewry Shipping Consultants posed the question whether IPOs were poised to make a comeback after a muted few years, suggesting that the situation would improve once a range of geopolitical issues – such as the US-China trade dispute, the global surplus in crude and Brexit – calmed down.

What's evident, however, is the reluctance to see beyond a model that has achieved a certain maturity and hitherto served global trade quite adequately. It would take vision to square the circle between ship financing and investing in technology research, although you could say that's the same for any industry. Regrettably the budget allocation, taxation and other levies used to channel money into R&D means progress will continue to be incremental, if not retarded, and there are few emboldened enough to stick their necks out in straitened, uncertain times.

In Letters to the Editor (p.48), Mr R.J.C. Dobson mentions in passing the expression 'economy of scale' in a letter regarding an article we published by maritime economist Dr. Martin Stopford in our *Future Ship 2050* supplement earlier this year, concerning the technical development of merchant shipping in the next 30 years. I feel it might be instructive to add some clarification since there's a difference between the term as it's used in engineering (e.g. the square-cube law, which obviously has a bearing upon volume), as Mr Dobson alludes to, and its use as first popularised by Adam Smith, as the basis of explaining how production increased through the division of labour.

Notwithstanding the repercussions of more, smaller ships and whether this would benefit or detract from efficiency (i.e. emissions), I do agree with Dr Stopford's response that the greatest gains will be achieved when shipping works with its cargo partners in identifying where the reductions can be made. Outside of its own bubble, if you will. *NA*

Tankers

HHI scores approval for eco-tanker design

A Hyundai Heavy Industries (HHI) design for a VLCC eco-tanker, outfitted with various emissions cutting technology, has received an Approval in Principle (AiP) from British classification society Lloyd's Register (LR).

The tanker will run on a combination of volatile organic compounds (VOC) mixed with LNG as fuel while using rotor sails to reduce consumption. The VOC recovery system developed by HHI will allow the VLCC to use fuel produced from naturally occurring vapor for the cargo tank during operation.

Presented with the AiP at Nor-Shipping 2019, the vessel design was developed through a collaborative project between HHI, LR and Norsepower. The AiP, which has been verified for interface and control logic stability with other systems, demonstrates the potential for reducing emissions in ship designs, said LR.

The impact of the installation of Norsepower's rotor sail solution, such as structural reinforcement and visibility calculation, was reviewed using computational fluid dynamics and confirmed that it has the potential of providing 5-7% fuel savings, depending on the operating route.

LR also presented Samsung Heavy Industries with an AiP for an LNG-fuelled VLCC equipped with Norsepower's rotor sails during Nor-Shipping week. The class society estimates that the vessel will emit around 25% less CO_2 compared with conventional VLCC designs.

HHI's new eco-tanker will be powered through a combination of LNG, VOC, and rotor sails

Bulk carriers

DNV GL and Oshima to collaborate on low-emissions bulk carrier

Class society DNV GL and Japanese shipbuilder Oshima Shipbuilding have teamed up to develop new green bulk carrier designs.

The partnership kicked-off with the presentation of their first design, the *Oshima Ultramax 2030*, at Nor-Shipping in Oslo last month. Developed with help from Wärtsilä, the 62,000dwt ship reduces the Energy Efficiency Design Index (EEDI) by 50%.

The ship maximises operational performance while minimising greenhouse gas (GHG) emissions by using LNG as fuel and taking advantage of an optimised hull shape as well as a hard sail for extra propulsion.

Additionally, the design is expected to offer low emissions in port by using solar panels and batteries to cover the hotel load during waiting times and port operations. According to DNV GL, it is one of the most efficient bulk carrier designs to date.

The pair signed a long-term strategic cooperation, with the aim of working together through to 2030 and developing a roadmap towards the IMO's zero-emissions goals, which will gradually be implemented through joint industry projects.

Autonomous systems

One Sea strengthens voice with new members

The autonomous shipping alliance One Sea has gained further momentum with the recruitment of three new international maritime members.

The global satellite group Inmarsat, NYK's research subsidiary Monohakobi Technology Institute (MTI), and The Royal Institution of Naval Architects have all committed to supporting the organisation's goal of promoting self-guided shipping. The latter has joined as an associate member while Inmarsat and Monohakobi have signed on as full members.

The Finnish collaboration was established in 2016 as a way of bringing members with different perspectives together in order to set out a roadmap and lead the way to an autonomous maritime ecosystem by 2025. It is financed by participating companies and Business Finland.

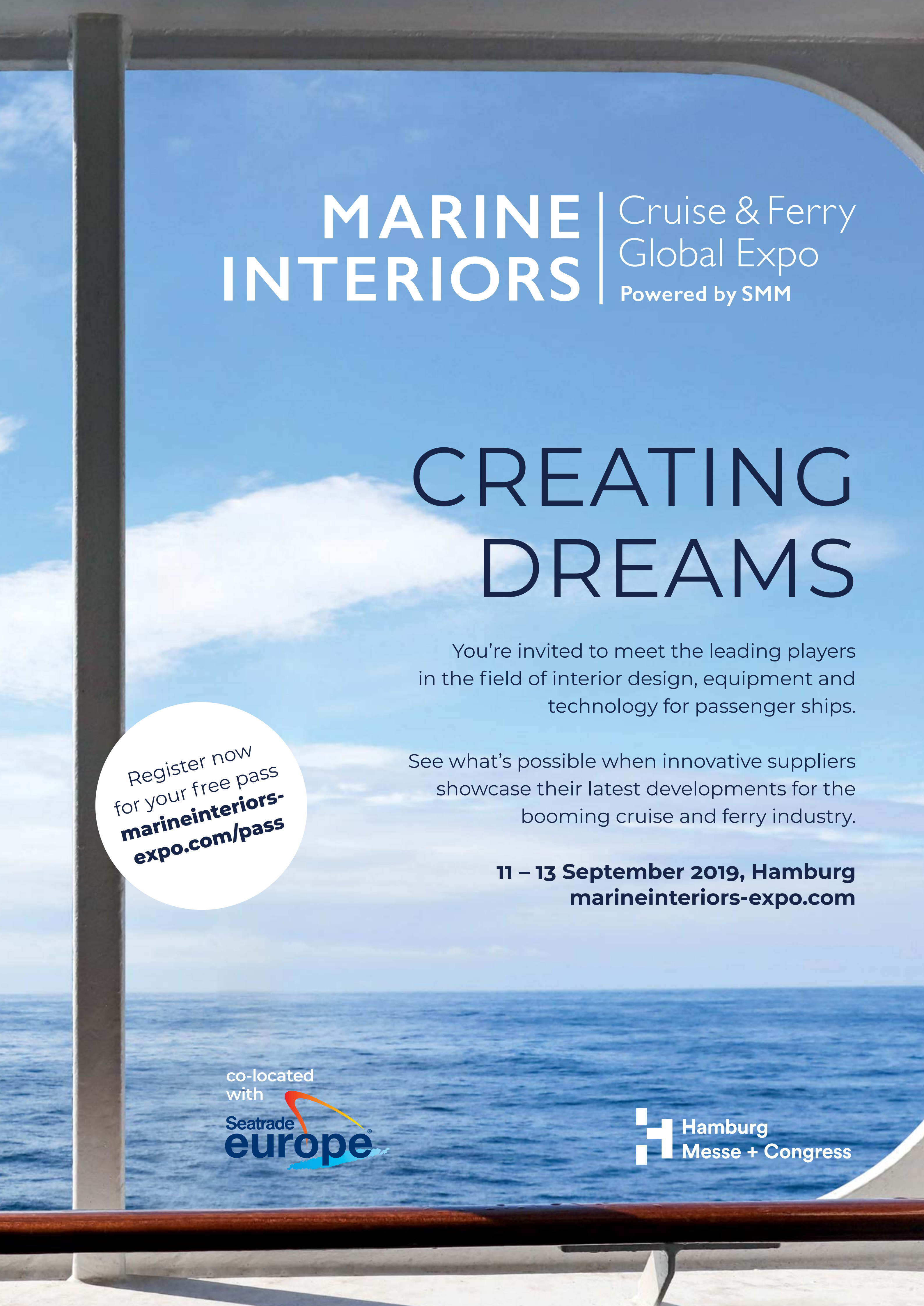
As the largest global provider of ship-to-shore connectivity, Inmarsat will play a key role in the alliance. MTI, which is the first member from Asia to join, have already been working with nautical instrument manufacturers to develop highly automated ship navigation technologies.

At the end of 2018, members including ABB, Kongsberg Maritime and Wärtsilä tested autonomous ships off the Finnish and Norwegian coasts. One Sea will also oversee future trials in Jaakonmeri, Finland, the world's first test area for autonomous ships.

Wind power

K Line sails towards zero emissions with kite system

Japanese shipowner K Line is set to install an AirSeas' SeaWing kite on one of its large bulk carriers in hopes of reducing the ship's emissions by 20%.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AirSeas will install a SeaWing kite on a K Line bulk carrier by 2021

The partners announced their 20-year agreement, which could see the technology rolled out across 50 ships if the first kite performs successfully, at this year's Nor-Shipping.

SeaWing is an automated parafoil kite developed by AirSeas, a spin-off of AirBus, which combines aeronautical concepts with maritime technology. The 500m^2 or 1,000m^2 kite is controlled by a single on/off switch that when pressed launches, operates and retrieves the kite automatically.

"The kite is a large piece of cloth, which is folded, will be lifted to the top of a 35m mast and is then unleashed. It is linked to a winch on the deck by a cable, 500m long, and then it will start doing a figure eight trajectory in order to produce a massive traction for the ship," said Vincent Bernatets, AirSeas' chief executive.

The SeaWing system collects and analyses meteorological data in real-time to propose an optimal route for the vessel and notifies the crew when the kite should be unfolded.

Bernatets said the deployment of the kite is dependent on weather conditions but is not limited by the distance it can be used for. It requires a windspeed of 8-40knots, although it cannot utilise a direct headwind into the bow.

"We have calculated the kites will be useable on at least 50% of journeys."

Financing

Top shipping banks join forces to boost decarbonisation

A group of global shipping banks have banded together to launch a framework for measuring the climate impact of banks' loan portfolios to the shipping sector.

The Poseidon Principles are a self-governing set of values established to help banks integrate climate-oriented goals into their lending decisions and, in turn, encourage shipowners to build more eco-friendly vessels. Shipping companies that ignore new environmental standards will be penalised with limited bank loans.

The 11 founding signatories, which includes Citi, Amsterdam Trade Bank, ING and Nordea, represent a bank loan portfolio of approximately US$100 billion and around 20% of global ship finance. Other major industry players, such as Cargill, Euronav and Lloyd's Register, collaborated with the banks to develop the framework.

The principles, which must be applied by signatories in any credit product, are based upon four key categories: assessment, accountability, enforcement and transparency. These align with the IMO's 2050 greenhouse gas strategy and create a common baseline for quantitatively assessing financial institutions' lending portfolios.

It is hoped that by linking shipping finance and environmental standards, environmental protection and responsible behaviour will be promoted throughout the entire value chain and help the industry transition towards a greener future.

Performance monitoring

Radar-based speed measurement tech gets shipowner approval

Ship operator BW Dry Cargo has given the thumbs up to a radar-based speed measurement technology, after a pilot project indicated it could contribute to significant gains in fuel efficiency.

As reported in last month's *The Naval Architect*, Miros Speed Through Water uses a secondary X-band radar above the waterline to determine a vessel's speed through water (STW). Following a successful six-month trial on the newbuild bulk carrier *BW Rye*, BW Dry Cargo managing director Christian Bonfils said that he estimated "up to 10% savings" could be achieved using the system, given its superior accuracy over acoustic speed logging.

"BW Dry Cargo have been a blast to work with," Miros CEO Andreas Brekke told *TNA* at Nor-Shipping. "They've allowed us to be very open with the collaboration."

Brekke said it was unknown when or if the full results from the BW trial will be published. However, he added that another Miros project, also involving ABB and its OCTOPUS performance management solution, together with Bureau Veritas, will hopefully be able to publish its own data later this year.

He added that BW have already said they plan to use Miros-derived STW data for bunker quality claims.

"For us, the next stage in our development is learning about the applications for this technology and understanding the hands-on optimisation challenges. There's still a steep learning curve ahead," he added.

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2,200~2,800 TEU	58
Total	148

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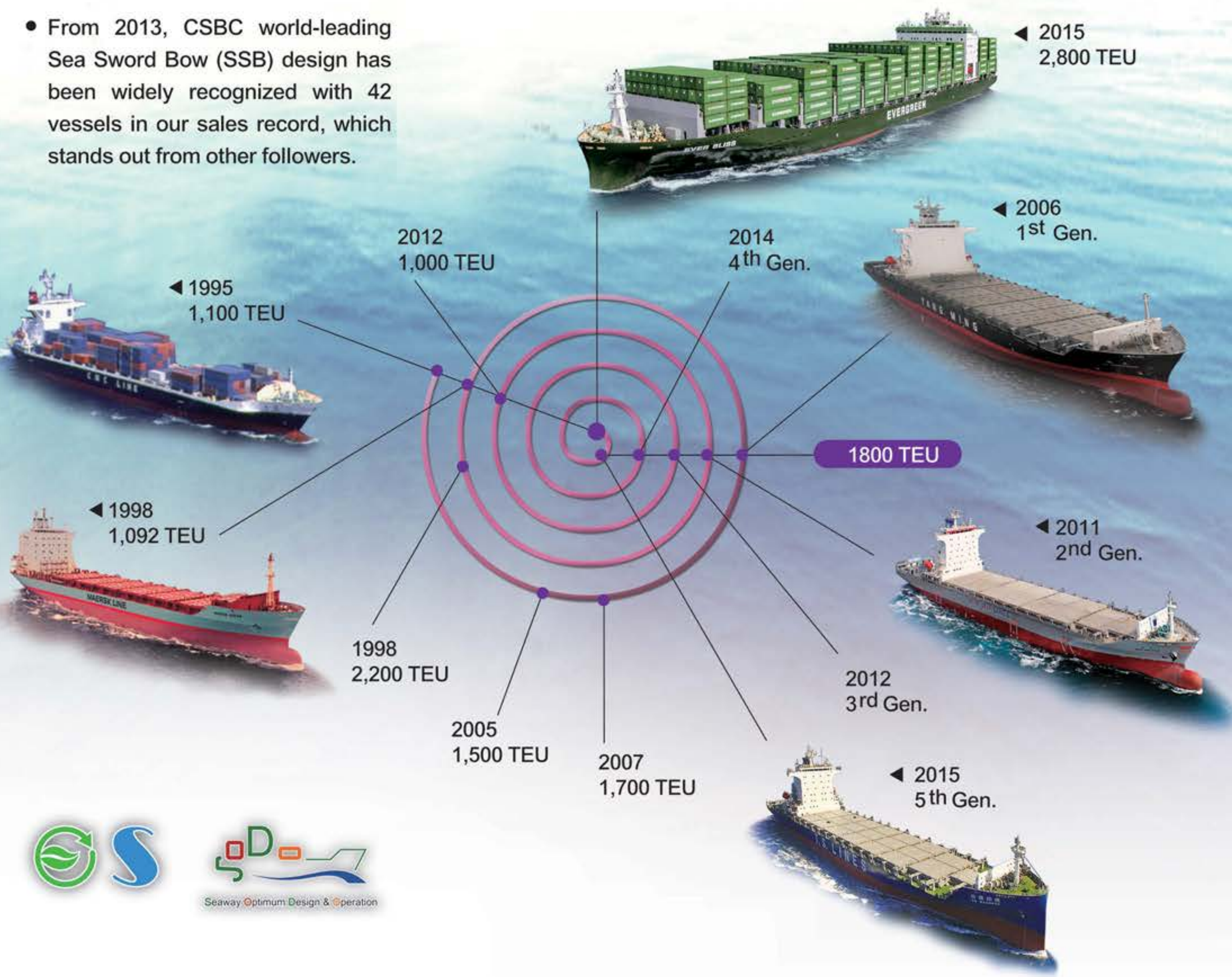

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Propulsion

LeanShips project reaps fuel savings with ESD

Finnish tech giant, Wärtsilä, along with the Netherlands-based Maritime Research Institute (MARIN) and Italian shipowner Grimaldi have designed an effective Energy Saving Device (ESD) for use with Controllable Pitch Propellers (CPPs).

Following sea trials with Grimaldi's *Grande Portogallo*, a 165m-long Pure Car and Truck Carrier, the pre-swirl stator ESD proved capable of optimising the inflow of water to the propeller and effectively reducing power loss. It was the first time that a pre-swirl stator was demonstrated to be suitable for use with CPPs.

The device, made of three fins connected by an outer ring to eliminate tip vortexes, reportedly confirmed fuel efficiency gains of 3.5% with CPPs. This translates into pay-back period of 1.3 years, according to Wärtsilä.

The development was carried out across four years under the LeanShips project, part of the European Union's Horizon 2020 framework project for research and innovation. Completed in April 2019, LeanShips aims to "demonstrate the effectiveness and reliability of technologies that offer energy saving and emission reductions on a large scale."

Effective ESDs adjust the swirl in the inflow or outflow of a propeller. Therefore, the technical challenge of producing this ESD was figuring out how to optimise the pre-swirl stator for the effects of a CPP's variable pitch on the swirl generated. *NA*

Grimaldi's *Grande Portogallo* was fitted with an Energy Saving Device that was successfully tested with CPPs

Correction

In a June news headline we incorrectly referred to emissions verification company Verifavia as 'Verufavia'. *TNA* apologises for any confusion caused.

2020 takes on new significance as time runs out

As the clock runs down to the 1 January 2020 deadline for the introduction of the global sulphur cap, more and more advice is being disseminated and issues continue to be raised, writes Malcolm Latarche

In spite of the current concerns, the IMO is adamant that there will be no changes to the sulphur cap regulation and no chance for any phase-in. The opportunity to change the wording of the regulation has passed, and under IMO procedures, it is already too late to do anything until the regulation is in place.

Without a doubt, there will be some ship operators who are unprepared for the forthcoming changes, even though the simplest – and probably costliest – route to compliance is merely to use a compliant fuel. That need not entail taking chances with any blended fuel that might be offered, as distillate fuels should meet the rules in any case. However, that does of course pre-suppose that there will be enough distillate fuel available.

This past June began with the Nor-Shipping exhibition in Norway, where 2020 was very much on the agenda. Even before the exhibition itself opened, DNV GL held a panel discussion with a wide variety of industry players expressing their points of view.

For those concerned about the potential for new compliant fuels to cause problems affecting safety and efficiency, the remarks by Rolf Thore Roppestad, the CEO of P&I and marine insurer Gard, could not have been very comforting. Roppestad said that Gard had already received more than 100 claims related to new generation fuels, some of which involved mechanical damage. He advised that segregation of fuels onboard is essential, but unless ships have tanks capable of doing this, operators will need to amend bunkering strategies accordingly.

Gard's experience would seem to add weight to the view that some new fuels might pose big problems. Something similar was experienced when the sulphur limit in ECAs and EU ports was reduced to 0.1%, with fires and engine breakdowns being the result. This time around many more vessels will be affected and compliant fuels will, in many instances, be something new with experience only garnered in a few test cases.

To mark the passing of the six-month point, the ICS has published a 40-page booklet providing advice on how to prepare for 2020 and the issues that may arise thereafter. It does not cover the alternatives such as scrubbers or alternative fuels but concentrates solely on what the bulk of ships will have to contend with.

The cost of compliant fuels has been another talking point, with sentiment hitherto suggesting that the trade war between the US and China would drive down demand for oil and thus the price differential between new fuels and regular HFO. Since the price for a barrel of crude had fallen from a high of near US$75 earlier in the year to under US$60 briefly in June, that view looked good for new fuels. However, the thawing of relationships at the recent G20 meeting had the immediate effect of OPEC extending its reduction in output, in the belief that both the demand and price of crude would rise again. On the first day after, oil prices did indeed jump a few dollars to over US$66, but how long that will last will depend on factors outside of shipping.

An expanding price differential will be music to the ears of those owners that have opted for scrubbers. What is less welcome to them has been the handful of ports that have banned or restricted the use of scrubbers. There is vigorous debate over whether scrubber use has a detrimental environmental impact with papers being produced by both sides. Japan has determined that wash water from open loop scrubbers does not threaten the oceans' ecosystems, but a new report from Sweden released at the end of June drew the opposite conclusion.

Despite the scientific doubts and indecision, scrubbers have proven to be more popular than many expected. Recently, the Exhaust Gas Cleaning Systems Association (EGCSA) launched a free to access global database on its website providing information on regulations concerning the operation of exhaust gas cleaning systems worldwide.

The announcement of the database also contained information suggesting that the number of ships likely to be fitted with scrubbers by January 2020 is set to be around 4,000. Since the majority are on larger vessels, EGCSA says that the ships will account for around 18% of all fuel used. In addition, analysts believe that scrubber installations will continue after 2020 and could relatively quickly double the figures quoted by EGCSA. If that does happen, it could well relieve some of the upward pressure on compliant fuel prices. *NA*


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Paints and coatings

Jotun scores deal with world's largest shipbuilder

Norwegian paints manufacturer Jotun have signed an agreement with Korean-based Hyundai Heavy Industries (HHI) to develop a new marine primer that reduces solvent emissions.

The memorandum of understanding outlines that Jotun will supply the shipbuilder with a new type of paint, which the company claims cuts solvent emissions by up to 90%. The corrosion-protective primer will reduce solvent VOC emissions into the air from approximately 250 grams per litre to nine grams litre.

As a result, HHI and other shipyards could potentially "save hundreds of millions of dollars by avoiding investments in plants related to the combustion of VOCs," according to Jotun. VOC combustion also leads to CO_2 emissions, meaning the paint will provide shipyards with an extra benefit.

It has taken Jotun 13 years to develop the new product. Besides helping shipowners and yards meet new environmental regulations, the company says it will provide better corrosion protection than previous primers.

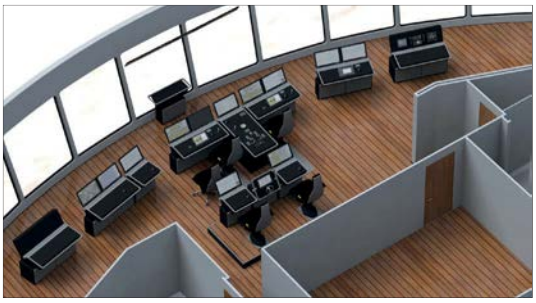
Bridge systems

Kongsberg steers the way for Seabourn newbuilds

The Norwegian marine systems provider Kongsberg will outfit Seabourn's two new expedition cruise ships with their K-Bridge Integrated Bridge System and K-Pos Dynamic Positioning.

The bridge system, which will form the operational foundation of the two ships, features multifunctional workstations, touch-sensitive control panels, joystick operation and large information displays. The set up will include K-Pos dynamic positioning solution, SN90 forward-looking, omnidirectional sonar and ECDIS functions, as well as mosaic enhanced 360° radar images and an ice radar.

The navigation and manoeuvring technology will help enable the vessels to operate in remote waters and polar regions.



Seabourn's two expedition cruise newbuilds will feature K-Bridge Integrated Bridge System

The polar classed cruise ships, owned by Carnival Corporation, are currently under construction at T.Mariotti year in Genova. The *Seabourn Venture* is scheduled to enter service in June 2021, while its yet unnamed sister ship is due for delivery in May of the following year.

Davits

Survitec introduces new davit range

The UK-based survival equipment manufacture Survitec has revealed a new array of davit systems, designed to increase safety and reduce corrosion.

The davit range includes different types for life rafts, rescue boats and fast rescue craft. It can be installed in or out of drydock and supplied as a fully tested and assembled unit.

Constructed from European marine grade stainless steel and covered in a three-coat paint system, the davit range is said to be capable of withstanding corrosion and harsh operating conditions. Designed and manufactured in Europe, key parts of the davits have been made from alloy, including the remote-control function, shackles, securing wires and cover plate.

The system will meet the upcoming amendments to the SOLAS rules relating to davit-launch safety equipment, which comes into force January 2020. Survitec is also offering annual and five-year inspections and load tests on the davits, along with the certification of lifeboats and hooks.

Turbochargers

ABB unveils compact turbochargers

Responding to the industry's thirst for turbochargers with greater power density, ABB Turbocharging has unveiled two new compact turbochargers for small and medium bore two-stroke engines.

According to the company, its new A255-L and A260-L turbochargers deliver high efficiency along with lower fuel consumption and reduced emissions. They incorporate the latest rotor component technologies and can maintain the high-power density produced by larger turbochargers in a smaller frame size.

Their compact design also means it's easier to mount the turbocharges in space-optimised engine rooms, making them particularly beneficial for vessels below 40,000dwt. Smaller merchant ships will see their energy efficiency design index lowered as a result.

The turbochargers can be used on low pressure dual-fuel engines and facilitate the utilisation of emission abatement technologies for NOx and SOx reduction as well.

In addition to their design advantages, the A255-L and A260-L lower maintenance costs. Compared with the previous TPL73-B model, first produced in 1999, ABB says the latest turbochargers will cut service costs by 30% and weight by 50%.

Engines

WinGD launches eco-engines for growing market

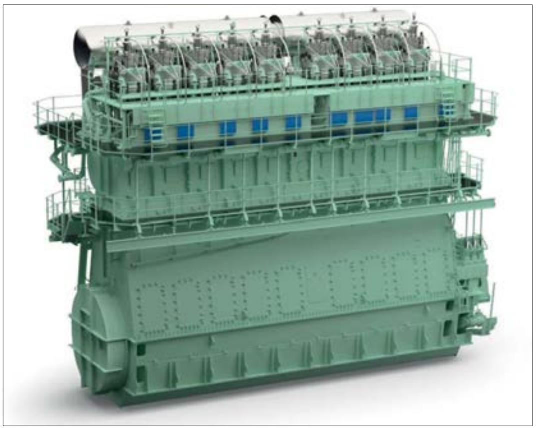
In efforts to answer the call for greener shipping, WinGD has announced the addition of three new two-stroke engines capable of running on low emissions fuel to its portfolio.

The Winterthur-based engine designer introduced its latest low-speed, two-stroke and dual-fuel engines at Nor-Shipping in June. Seeking to provide shipowners with a greater number of compliant choices, its new eco-engines include: the X40-DF for smaller vessels, the X82-D for larger vessels and the X82-DF dual-fuel engine.

In its standard configuration, the X40-DF is designed to run on LNG, making it the first two-stroke dual-engine for smaller vessels. It is available in five- to eight-cylinder configurations and covers a power range of 2,775kW to 7,480kW, at 104 to 146rpm. Given that the engine is already compliant with existing emissions regulations, its support system is reduced due to the lack of need for any exhaust-gas after-treatment system.

Both the X82-D and X82-DF engines are offered in a range of six to nine cylinders and possess a reduced engine length and weight due to a shortened cylinder distance. In addition, all cylinder configurations are possible with a one-piece crankshaft design, which further reduces engine length and will feature pistons fitted with two piston rings for reduced friction losses.

The WinGD X82-D engine for larger two-stroke vessels is dual-fuel



The X82-D, which will be supplied dual-fuel ready, has a covering a power output from 16,560kW at 58rpm to 49,500kW at 84rpm. According to the company, fuel savings amounting to US$1,170/day can be achieved for a VLCC running a X82-D engine at 90% power. This is achieved as a result of an increased firing pressure.

Although the X82-DF shares many of the same design concepts as the X82-D, one of the engine's specific advances is the replacement of the standalone as valve unit with an integrated gas pressure regulation unit (iGPR). The technology's low-pressure gas admission valves offer a high level of combustion stability while reducing emissions.

Digitalisation

Inmarsat furthers maritime connectivity with new digital service pack

Satellite telecommunications company Inmarsat and Hyundai Global Service (HGS) have signed a cooperation agreement to offer shipowners and managers a digital care package for newbuilds.

The agreement, which marks the first such step by a shipbuilder, will see HGS leverage Inmarsat's dedicated bandwidth services to expand its digital support solutions and provide after-sales services for the lifetime of a vessel.

This means Hyundai will now be able to deliver a ship fully fitted with dedicated bandwidth through Fleet Xpress or FleetBroadband services operating over Inmarsat's Global Xpress (GX) satellite network. Hyundai has signalled that it plans to retrofit existing vessels with the digital system in the future as well.

The contract also recognises HGS, a subsidiary of Hyundai Heavy Industries established in 2016, as a Certified Application Partner (CAP) within Inmarsat's digital ecosystem.

Prior to the signing of the agreement, the system was trialled onboard three ships over a three-month period, during which time various sensor-driven applications were tested. The tests included measuring voyage and equipment operating data, such as fuel consumption and vibration monitoring as well as HGS analytics and reporting services.

This announcement was made a week after Inmarsat stated it had contracted Airbus Defence and Space to build three new satellites in order to increase its GX network. The new technology will be compatible with existing GX terminals and be able to move around in order to deliver extra capacity to targeted areas with high demand.

Thanks to a serial production method that enables faster build times, the satellites are expected to be in orbit by 2023. *NA*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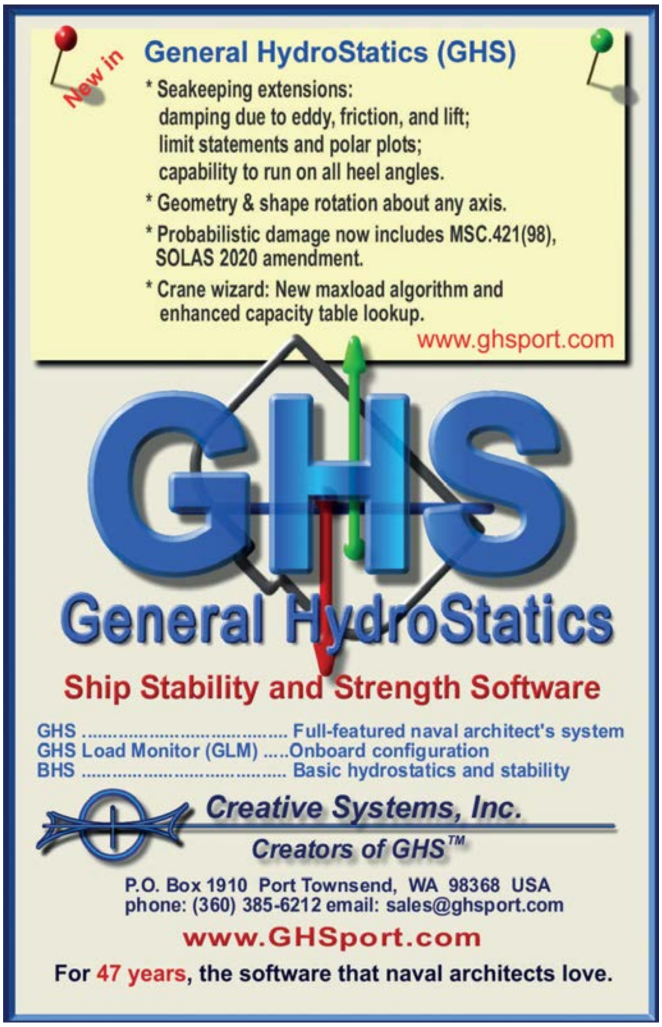
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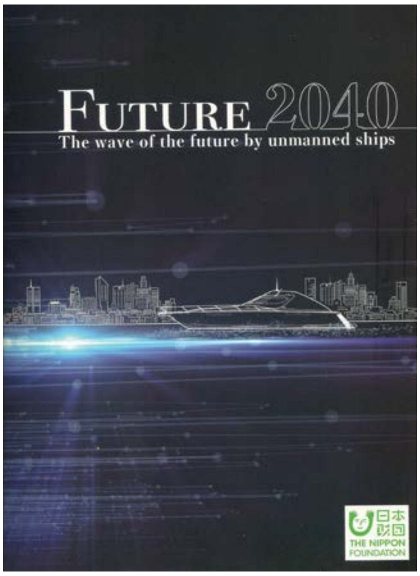
Could unmanned ships solve Japan's population crisis?

A recently published report by The Nippon Foundation makes the case for a technological overhaul of Japanese coastal shipping over the next 20 years

Japan, as is widely documented, has an ageing population and one of the sectors where it's being felt most acutely is maritime. Data published in 2015 revealed that 56% of Japan's 20,000 seafarers involved in domestic cargo shipping were aged 50 or over.

Last year, The Nippon Foundation, a privately funded Japanese philanthropic organisation that has been involved in maritime, as well as education and public welfare projects, for more than 50 years, began turning its attention towards autonomy. Conscious of the rapid progress being made within northern Europe – particularly Norway and Finland – a recently published report, *Future 2040*, argues for the widespread implementation of unmanned vessels as the ideal mid- to long-term solution with the hope of stimulating further action.



Japan's unmanned economy could be worth US$9 billion, The Nippon Foundation estimates

While there is already some ongoing research into ship autonomy being conducted in Japan, notably a joint industry project being overseen by the Ministry of Land, Infrastructure, Transportation and Tourism, the Nippon Foundation has focused upon understanding the social and economic impact unmanned ships could have upon domestic shipping.

Following in-depth discussions with an array of maritime experts and futurists around the world, it concluded the country's unmanned ship 'economy' could be worth US$9 billion per year by 2040 and account for 50% of Japanese coastal ships in service by that time.

Much of this total (US$5.1 billion) would be derived from domestic and inland shipping, to which the study gave particular emphasis. As a nation that includes numerous smaller, often remote islands and around 4,000 ports, unmanned ships create the possibility of both increasing the frequency of cargo ship calls and attracting more foreign tourism.

But the *Future 2040* report also foresees unmanned opportunities for larger cargo, such as petroleum products. 'Unmanned' in the Foundation's perception of the term will mean largely autonomous, although key decisions will be made remotely by onshore personnel.

The rapid increase of land-based specialists for both remote operations and maintenance, in effect a changing definition of what it means to be 'crew', is one of the eight industry changes the Foundation has identified. Among these are shipyards, which would become broad-based 'ecosystems' heavily dependent on automation, where traditional engineering roles will diminish while drawing more heavily upon IoT, cybersecurity and systems specialists.

Human resource development is seen as a key facet of the Foundation's proposed strategy, including women, older citizens and the younger generation Japanese maritime has struggled to attract. Moreover, increased importance of cyber would also give rise to a diversified range of insurance services.

Masanori Yoshida, chief advisor with The Nippon Foundation's office of offshore development, tells *The Naval Architect* that standardisation will be key to a successful transition. "This means that the ship machinery and equipment industry will need to merge and adapt, as well as the ship specific supply chain companies."

This standardisation would extend to information sharing and the Foundation is advocating the development of open source platforms in aspects such as the exchange of navigational data, similar to the EU's Sea Traffic Management (STM) initiative. Companies from different fields will be encouraged to collaborate on new ventures.

Yoshida says that it's widely acknowledged in Japan that cooperation with other countries developing autonomous technologies may be beneficial. "We need to consider internally what knowledge and skills we are lacking and what we should develop to keep our industry competitive. Finland, for example, already has experience with remote control and digitalisation. Dynamic positioning is maybe another technology where others have greater experience.

"Personally, I believe one of the biggest challenges will be propulsion systems because it's more difficult to operate diesel engines automatically, but electrical engines depend a lot on the development of batteries."

He adds that it is felt one of the most important things will be to make rapid progress, not only in proving the reliability of the technology in demonstration projects but working with governmental and local authorities in establishing test beds. This in turn extends to the development of legal and regulatory tools that permit unmanned operation.

There is certainly curiosity about autonomy in Japan, with Yoshida noting that a seminar held by the Foundation in Tokyo to coincide with the report's publication attracted more than 200 people from maritime, equipment and IT companies. "They are interested in this subject but I am not sure yet whether they are positive. Of course, with the government and industry alike, safety is the priority. But it's moving ahead fast," he says. *NA*

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Chinese shipbuilding enterprises promote the application of 5G technology

CMHI and CSSC are exploring ultra-high speed mobile communications as a means of augmenting and streamlining the ship construction process

On 15 May, Nantong Mobile Joint Investment Promotion Bureau Cruise Manufacturing Co., Ltd. and Ericsson (China) Communication Co., Ltd. successfully opened the 5G NSA Base Station at the Haimen facilities of China Merchants Heavy Industry (Jiangsu), realising the first coverage and application of 5G technology in the shipbuilding industry.

China Merchants Cruises, Nantong Mobile and Ericsson have completed the 5G network coverage of China Merchants Cruises Manufacturing Haimen Plant and plan to jointly explore 5G and Augmented Reality (AR) for auxiliary production applications based on smart ship design and maintenance. AR will be used to superimpose information for industrial intelligent applications such as remote device installation and maintenance, rapid inspection, and device interaction. Moreover, the three parties will jointly carry out research on the use of 5G-based unmanned aerial vehicles for the factory inspection plan, and further explore the needs of other manufacturing scenarios based on 5G technology.

The arrival of the 5G+ Shipbuilding project has greatly improved the industrial intelligence level of the shipbuilding industry and laid a solid foundation for the application and development of 5G technology in the field of intelligent manufacturing. In order to ensure the implementation of the project, the joint technical innovation team of the three parties completed the work of antenna foundation pouring, cable laying and equipment installation, all within just 10 days. Field tests have shown that the new network's speed is nearly 20 times that of the existing 4G network.

Based on the characteristics of mobile 5G ultra-high speed and ultra-low latency, the project team deployed a 4K HD camera and a live panoramic camera in the production facilities of China Merchants Cruise Line. This live 4K broadcast and panoramic video was relayed via cable to the showroom streaming media server. In the exhibition hall, users can view a large screen or use VR headsets to watch the block assembly and the shipyard docking process in real time. Through the deployment of VR panoramic live broadcast, China Merchants Cruise Management can monitor production progress and personnel safety in real time.

5G-empowered VR technology allow users to experience activity at China Merchants Cruise Line's shipyard in real time

After the experience, Wang Gong, a customer at the plant said: "At the shipyard, I wore a cloud VR helmet and I saw the dynamic picture of each production link in the factory. The picture was very smooth."

"A perfect VR experience is not only the same as the real scene but also smoother," said Gu Jun, a 5G technology expert at Nantong Mobile. "A few seconds of VR video, data traffic can reach several hundred megabytes. VR is extremely slow in transmission so the delay must be kept to milliseconds to alleviate the visual 'dizziness'. The high rate and low latency characteristics of 5G networks solve these problems."

Strategic agreement

In addition to China Merchants Heavy Industry, CSSC's shipyards are also actively promoting the application of 5G technology. On 24 April, its subsidiary Shanghai Waigaoqiao Shipbuilding Co., Ltd. (SWS) signed a 5G strategic cooperation agreement with China United Network Communications Group Co., Ltd at the Shanghai New International Expo Centre. According to the agreement, the two sides will actively explore a variety of innovative cooperation models to jointly promote the application of 5G in the shipbuilding industry.

According to reports, Waigaoqiao Shipbuilding and China Unicom Shanghai Company will together build a pilot demonstration of 5G-based industrial Internet applications in the marine industry. The two parties will use the 5G network to support the digitalisation and intelligentisation of the shipbuilding process. This innovative application research into the industrial Internet will look at the use of 5G and related

Shanghai Waigaoqiao Shipbuilding Co. and China United Network Communications Group signed a strategic cooperation agreement in April

technologies as a means of overcoming the bottlenecking that can occur during the production process.

In developing a concept known as 'SWS-Time', the project aims to achieve a breakthrough in the connection and sharing of "people, machine, material, method and ring" throughout the whole process of shipbuilding, design, application, supply chain management, on-site production, safety, quality, precision management and Big Data. It is hoped its application will improve the company's digital management level and promote the high-quality developments at Waigaoqiao Shipbuilding.

In addition, in the field of unmanned boats, at the Mobile World Congress 2019, held in Shanghai on 25 February, Zhuhai Yunzhou Intelligent Technology Co., Ltd. (Yunzhou Intelligent) presented the results of a joint project with Ericsson and China Mobile, where 5G technology has been used to build a 5G-enabled unmanned boat. The boat is equipped with high-definition cameras, water sampling equipment and online sensors. It can collect water information, automatically map water quality and generate sample test reports. *NA*

Demystifying zero-emission ships

Fuelling a zero-emissions future with hydrogen and renewables might sound intimidating but a new organisation is working to show it's entirely possible

A concept design for ZEM-Tech's zero-emission, zero-fuel vessel

For some time, the idea of using hydrogen and fuel cells to power ship fleets was viewed as a fanciful trend. As other green technologies picked up momentum, hydrogen was cast aside. But in the past couple of years, the abundant element has become a mainstream enterprise.

Why? Because it stands as one of the most promising zero-emission solutions. More and more hydrogen powered vessels are hitting the drawing boards as the consensus that hydrogen could be one of the best future fuels grows. This year, Hyundai Motor announced its plans to develop a ship powered by hydrogen fuel cells while GE and Nedstack partnered up to create a hydrogen fuel cell system for cruise ships. Taking a step forward early on, Viking Cruises revealed in 2017 it would construct what could become the world's first cruise ship powered by liquid hydrogen.

One young organisation that is trying to push hydrogen and zero-emission ships to the forefront is Zero Emissions Maritime Technology (ZEM-Tech). Established in November 2018 by Madadh MacLaine, who previously worked in the hydrogen sector at ITM Power, ZEM-Tech is working with partners to design zero-emission ships because, as MacLaine says, "to do anything else would be irresponsible".

The IMO's climate strategy aims to reduce the total greenhouse gas emissions by at least 50% by 2050 compared to 2008. Yet, as Tristan Smith, a reader at UCL's Energy Institute, has written: "It is likely this target will tighten further, but even with the lowest level of ambition, the shipping industry will require rapid technological changes to produce zero-emission ships, moving from fossil fuels, to a combination of electricity (batteries), renewable fuels derived from hydrogen, and potentially bioenergy." In order to reach the IMO's goal, zero-emission vessels need to enter service by 2030, if not sooner.

Many are both unconvinced that the shipping industry can be overhauled in such a short amount of time and sceptical of newer zero-emission technologies. "There are a lot of unknowns and a lot of mysteries that need to be unbaffled, people think of zero-emissions as science fiction but it's not," says MacLaine, who also founded the Zero Emissions Ship Technology Association, which works to facilitate the uptake of hydrogen and other zero-emission technologies.

Although hydrogen could meet 18% of the world's final energy demands by 2050, according to the Hydrogen Council, it's progress as a zero-emissions solution has suffered due to a lack of information and misconceptions.

"The biggest issues with hydrogen are a lack of available fuel, the cost and the volume that it takes up onboard a ship," says MacLaine. Additionally, how to produce sufficient amounts of the gas remains a major concern. Production through natural gas reforming is currently the most popular and cheapest option, however, it has a substantial carbon footprint. But ZEM-Tech is designing a solution to get around these hurdles: a zero-fuel ship. "What we mean by zero-fuel is that it's a ship that doesn't necessarily need to bunker. And the way it does that is that it produces its own fuel while underway through energy recuperation."

To achieve this, the company plans on using onboard electrolysis. The vessel will use wind as a means of propulsion and as a direct renewable. The excess energy produced will be captured and stored in batteries and then as hydrogen using proton exchange membrane (PEM) electrolysis, which will later generate electrical power for propulsion or hotel load. "When you start pulling together all these different zero-emission technology options, you start seeing the possibilities and how all these things can work together."

The technology to do this, MacLaine says, already exists. "We have a marinized electrolyser, it's just not to scale, and we have electrolysers to scale but they're just not marinized." She points to the *Energy Observer* – a race boat converted into a research vessel that runs on hydrogen, solar and wind power – as evidence of the industry's knowhow and ability to make a zero-emission, zero-fuel ship. ZEM-Tech is collaborating with various clients to design a full spectrum of zero-fuel ships and MacLaine believes the shipping industry could see the first zero-fuel VLCC by 2020.

What's the biggest holdup in evolving this concept? MacLaine believes it's regulation and investment into research and development. "Regulation will trigger investment, which will bring in the money required to bring things up to an economy of scale. If you just sprinkle a little bit of funding on that those innovations will grow until they're the sized required." *NA*

MacGregor foregrounds smarter cargo solutions

AI-based condition monitoring and container ship optimisation are the equipment supplier's focus as it takes a pragmatic approach to smart shipping

For many years now, MacGregor has been one of the stalwarts of marine equipment; it's estimated that every second vessel in the global fleet has some form of its cargo load handling solutions, lashing systems or hatch covers onboard. But the company, a subsidiary of Finland's Cargotec, is keen to emphasise these are just part of a portfolio of services.

"We're transforming the business at the moment," explains Robin Thuillier, MacGregor's director of communications. "Cargo handling equipment remains our core, but we're looking to introduce digitally enabled capability and that means becoming an intelligent cargo load handling provider."

Thuillier, however, is conscious of the cynicism such nebulous ambitions can provoke. "I have a view that the industry is largely fed up with 'intelligent this' and 'smart that' and want to see the tangibles, particularly in a depressed market where owners are struggling to make money with the cost of the sulphur cap and ballast water treatment systems."

MacGregor is therefore putting its emphasis on providing products and services that can offer a quick return on investment while enhancing its digital technology capability – with a little help from its friends. As part of Rainmaking Trade and Transport Impact, a global programme that sees established transportation and logistics companies joining forces with newer players, it has partnered with four startups on a range of projects.

Among these is Arundo, a US/Norwegian data analytics company that has collaborated in the development of MacGregor's OnWatch Scout, a digital service designed to help its customers predict component failure. It's an extension of MacGregor's existing OnWatch service, which uses sensors installed on equipment to relay information back to land-based monitoring systems. OnWatch is currently installed on approximately 140 offshore cranes worldwide but should be extended to merchant ships over the next 12-18 months.

MacGregor's OnWatch Scout will use AI to predict component failure

"OnWatch is a reactive tool, so if an alarm goes off, we can advise how to correct it and send software patches. OnWatch Scout makes that proactive with algorithms and advanced learning, so we're able to predict component failure. That's where Arundo comes in as they're handling the data analytical work that's beyond our core expertise."

Daniel Lundberg, director of MacGregor's offshore business line, says one of the challenges is building up the system's artificial intelligence, which is by necessity a slow process. "As with all machine learning you have to train the models.

"First, it's about applying the base layers of these capabilities to show the asset health information, the operational KPIs and then building up the predictive warnings to create a hybrid of condition-based information. Then we can draw comparisons and establish the relationship between the different sensors."

Another service MacGregor offers, which Thuillier calls a "little-known secret" is Cargo Boost, where the company works directly with customers on existing containerships. "They may have changed their operations, so that the original design profile isn't optimal for what they want to do now. We work with the owner-operator to optimise the go-forward operating profile. Typically, that's planned six months ahead of a dry docking, and implemented at that stage, although smaller ones can be done while the ship is in service.

"We've done around 100 upgrades in the last three years and on average we can realise a 10-15% increase in container capacity. That can be achieved just by a redesign in the lashing system and the ability to stack 20ft containers on top of 40ft ones. Through that the owner gets increased cargo capacity and more efficiency. Hapag-Lloyd, UASC and MSC are some of the customers who've invested in it."

While the current focus is on finding smarter ways to help customers maintain and operate their equipment, the company is also actively exploring the future benefits of automation. As reported in *The Naval Architect* in November 2018, a joint project with ESL Shipping has seen the development of the world's first 'autonomous' cranes, albeit their self-discharging feature remains in the testing phase.

Meanwhile, in June, MacGregor announced it had entered into an agreement with Kongsberg Maritime to deliver an automated mooring system to the fully-electric Norwegian containership *Yara Birkeland*, which is scheduled for delivery later this year. Its fellow Cargotec subsidiary, Kalmar, is providing *Yara Birkeland*'s autonomous loading and unloading solution.

Cargotec is also in the final stages of closing its acquisition of the marine and offshore businesses of rival cargo handling equipment supplier TTS Group. "We're awaiting the Chinese competition authority approval but expect to get it this year," says Thuillier. *NA*


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International container design standards and regulations: how do they stack up?

While the adoption of ISO standards and the IMO's CSC has been fundamental to supporting the safe handling of containers, changes in stacking height on ships and higher cargo density is adding significantly to the load stresses on containers at sea. Dr Jeffrey Martin and Dr Sally Martin investigate the relationship between ISO standards and CSC regulations in the design of containers for safe stacking

			Container length				
Nominal length			10ft	2ft	30ft	40ft	45ft
Actual length			9ft 9¾in 2,991mm	19ft 10½in 6,058mm	29ft 11¼in 9,125mm	40ft 12,192mm	45ft 13,716mm
Height	<8ft	<2,438mm	**1DX** General purpose Tank Dry bulk	**1CX** General purpose Tank Dry bulk Platform	**1BX** General purpose Tank Dry bulk Platform	**1AX** General purpose Tank Dry bulk Platform	
Height	8ft	2,438mm	**1D** General purpose Thermal (reefer) Tank Dry bulk	**1C** General purpose Thermal (reefer) Tank Dry bulk Platform	**1B** General purpose Thermal (reefer) Tank Dry bulk Platform	**1A** General purpose Thermal (reefer) Tank Dry bulk Platform	
Height	8ft 6in	2,591mm		**1CC** General purpose Thermal (reefer) Tank Dry bulk Platform	**1BB** General purpose Thermal (reefer) Tank Dry bulk Platform	**1AA** General purpose Thermal (reefer) Tank Dry bulk Platform	**1EE** General purpose
Height	9ft 6in	2,896mm			**1BBB** General purpose Thermal (reefer) Tank Dry bulk Platform	**1AAA** General purpose Thermal (reefer) Tank Dry bulk Platform	**1EEE** General purpose

ISO designates (designate code in bold)

The first shipping lines to utilise containers in the 1950s each developed their own designs in relation to size, strength, maximum gross weight and securing methods. While significant benefits were achieved in terminal operations and ship turnaround times, a lack of standardisation hindered global adoption of this new technology. In 1961, the International Organization for Standardization (ISO) established technical committee ISO/TC 104 Freight Containers to develop standards with the aim of promoting the establishment of an exchangeable container, which today is commonly referred to as an ISO container.

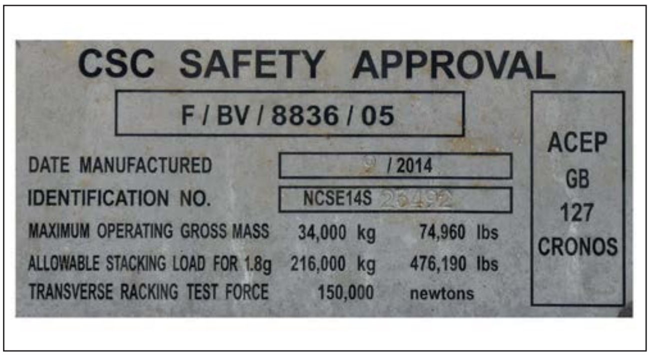
Parallel to the drive for international standards was a growing awareness that container technology did not fit within existing international maritime safety regulations. This led to the IMO's International Convention for Safe Containers (CSC), which required all containers from 6 September 1982 undertaking an international journey by sea or land involving at least one contracting country to display a CSC Safety Approval Plate (SAP). Currently, these regulations are enforceable in 83 countries whose ports represent over 75% of global container port traffic. In contrast to ISO standards, which act as guidelines to support efficient operational methods, the regulatory provisions of the CSC aim to ensure the safety of persons and property when in contact with a container.

The success of containerisation owes a lot to the work of the ISO and the IMO in developing an inter-operable unitised transport solution. Today, the container transport system consists of some 20 million container boxes and over 5,000 fully cellular container ships linking a global network of container terminals servicing inland locations. Since their introduction, the operating environment within which ISO standards and CSC regulations were first developed has radically changed. Not least, increases in ship size from first generation container ships of 1,000 TEU capacity in 1965 to ships today of over 21,000 TEU have seen the stacking height of containers above and below deck increase from four to over 10 containers high.

In a recent study, the authors examined the current ISO standards and CSC regulations to assess the extent of their alignment and to identify areas of inconsistency. During the study it was found that while the term ISO container is widely used in the industry, few practitioners can correctly define what an ISO container is and very few are aware of the role of the IMO and the CSC. The study also revealed that there is a surprisingly high number of non-ISO containers in circulation and that these are often mistakenly assumed by many operators to meet ISO standards.

Container strength

Practitioners and researchers generally refer to any stackable container featuring corner castings, an ISO container number and ISO size type code as an ISO container. This misconception leads to the incorrect assumption that the vast majority of containers are ISO containers and that they have common minimum strength, dimensions and design characteristics. For a container to be an ISO container, it must comply with all relevant ISO container



Example CSC plate, which includes information such as a container's stacking strength and racking strength

standards in existence at the time of production (ISO 830:1999 Section 3.2). As containers can have operational lives of up to 30 years and given ISO standards are reviewed and updated on a regular basis, there are different specifications and design characteristics even amongst ISO containers.

This is illustrated by the load strength of containers which ISO standards originally defined for all container types as a stacking strength of 192,000kg at 1.8g. This was updated for general purpose containers manufactured from 15 June 2005 (ISO 1496-1:1990/Amd 3:2005) and for thermal containers manufactured from 15 July 2008 (ISO 1496-2:2008) to 213,360kg at 1.8g. Currently the load strength for tank, dry bulk and platform type containers remains at 192,000kg at 1.8g.

The complexity of ISO container standards and a general lack of awareness of the existence of differing container strengths has been a contributing factor to a series of incidents, such as the well-publicised *Annabella* incident in 2007. In this instance, a less than ISO strength container stacked in the bottom tier below deck collapsed due to the weight of the containers stacked above it, which exceeded its load strength. Domestic containers and swapbodies represent a high-risk area, especially when their external appearance can lead them to be misidentified as an ISO container.

In response to accidents such as the *Annabella*, the IMO and the ISO developed a unified method to allow operators and planning staff to easily identify reduced strength containers. Under ISO standard 6346:1995/Amd 3:2012 the size type code, which is displayed on containers to show their type and external dimensions, was enhanced. The coding logic was amended so that the final character of the four digit code is always a numeric value for full strength containers and an alpha character for reduced strength containers. Full strength is defined as a container with an allowable strength equal to or higher than 192,000kg at 1.8g and a racking strength of 150kN or higher.

In the same year the CSC was amended to require all new and existing containers with a design strength of less than 192,000kg at 1.8g or a racking strength of less than 150kN to be clearly marked. The CSC amendment directly refers to the use of the size type code to distinguish between full and reduced strength containers as defined in the amendment to ISO 6346. Significantly the CSC made the use of this coding method retrospective, requiring new and existing containers of reduced strength to display the revised size type code. Thus, although the ISO standards are guidelines the new coding method was made mandatory and retrospective by their direct referencing within the amendment to the CSC.

Container design

The ISO standards define 15 height, length, width combinations which are given an ISO container designate code, although not all combinations apply to each container type. Nine combinations are applicable to thermal containers, 11 to platform containers, 13 for tanks and dry bulk and all 15 for general purpose type containers. So, a reefer container that complies with all other ISO standards but is not one of the nine applicable size designates for thermal containers is technically a non-ISO container. For example, 45ft long thermal containers are excluded from the ISO designate sizes and although there are 45ft long reefers in circulation that comply with all other relevant ISO standards, these are technically non-ISO containers. Likewise, the many pallet wide containers used in North Europe, which are wider than 8ft, are all non-ISO containers as the ISO designate sizes are all based on a width of 8ft.

The distinction between ISO and non-ISO container is further complicated by other design requirements and constraints within ISO standards. For example, ISO standards state that 45ft long general purpose containers should have a gooseneck tunnel (ISO 668:2013 Section 5.2.3.), but you will find 45ft containers in circulation without goosenecks. The standards also state that 30ft, 40ft and 45ft long containers should not have forklift pockets (ISO 1496-1:2013 Section 5.8.1.1.) and again such features can be found on containers. As there is no defined method or common certification process by which a container is validated as being an ISO container, it is extremely difficult for operators to know with certainty the extent to which a container complies with ISO standards nor the standards that applied at its time of construction. The one exception to this was the requirement made in 2012 by the IMO within the CSC for reduced stacking strength containers to display the revised size type code structure.

Container codification

The ISO standards have established common coding methods for containers which allows each container to be uniquely identified by its container number and its type, external dimensions and whether it is full stacking strength by means of its size type code. As well as defining the code structures, the standards also define where the codes should be displayed on a container and a minimum font size that allows operators to read them when in handling equipment cabins. These standards have been critical to the introduction of automated container recognition systems which with the use of Optical Character Recognition (OCR) technology are now commonly deployed at terminals, especially at the gate where containers are received or delivered by trucks.

In 2007, a stack of seven 30ft cargo containers collapsed on the *Annabella*, raising the alarm on container stowage practices

The display of other information such as a container's actual stacking strength, its ability to be used for one-door off operations and its maintenance regime and status are not detailed in ISO standards. Instead the display of this information on a container is a legal requirement under the CSC and is displayed on what is known as the CSC Plate. However, unlike the ISO container codes, which are large enough to be read by operators from some distance away, the size of the font required on the CSC Plate is too small to be read from any distance greater than 500mm. Consequently, the CSC Plate is rarely read by operators and cannot be read by automatic recognition technology during the gate in process. In 2016, BoxTech, a global database of container details administered by the Bureau International des Containers et du Transport Intermodal (BIC), was launched. The database includes container numbers, size type codes, weight and stacking strength for nearly 50% of the global container fleet and allows electronic access to data contained on the CSC Plate.

Closing remarks

To quantify the proportion of ISO to non-ISO containers the study analysed a yard inventory dataset of 9,000 containers stored in a European container terminal. By characterising containers based on their size type code, just over 20% of containers were found to have less than ISO stacking strength or did not comply with an ISO container designate. It was not practical to physically inspect every container but by observing containers passing through the gate, it was evident that some full strength containers complying with an ISO designate failed to comply with other ISO container standards. This suggests the analysis understates the proportion of non-ISO containers. The number of non-ISO containers handled will depend on the trade routes involved – less variation would be expected on deep sea services compared to short sea services.

The work of the ISO and IMO has been instrumental in fostering the adoption of the containers in international trade. Since their inception, the stresses and strains exerted on containers have significantly increased as stacking heights on ships have become higher and the gross weights of full containers has changed with new patterns of trade. The ability to introduce automated container handling methods has been dependent on the implementation of the voluntary guidelines documented in ISO standards. However, despite being a ubiquitous term there is a surprising lack of awareness of what an ISO container is and that there is a significant minority of non-ISO containers in circulation. The detailed results can be found in *Maritime Policy & Management Volume 46 Issue 2* (International container design regulations and ISO standards: are they fit for purpose? by S. Martin, J. Martin & P. Lai).

About the authors

Dr Jeffrey Martin and Dr Sally Martin are founders of J&S Maritime which delivers workshop and online training focused on the container industry. The training blends applied knowledge gained from 30 years of industry experience with operational research. Learners include apprentices, operators, frontline managers, software analysts and business consultants. For details visit https://nowlearn.net. *NA*

New ducted design is a boon for propulsive efficiency

Following several years of development, the Gate Rudder is demonstrating its benefits on the Japanese container ship *Shigenobu*

Why is a rudder placed behind a propeller at the stern when it could be placed outside of the propeller? There are several reasons, with the first being to keep the symmetry of the control surface. The second reason is to obtain additional rudder force at slower speeds when the ship needs frequent manoeuvring (for example during berthing). The latter reason is of concern for captains as they must get used to this operation in a port. However, when the rudder is located behind the propeller, it contributes to the ship's resistance.

Within this context, the main purpose of the Gate Rudder system is to remove this drag source and replace it with a thrust source (like a duct of a ducted propeller) in order to reduce the required main propeller thrust and hence, reduce the required main engine power. With this idea, the rudder may become an energy saving device (ESD) by being placed around the propeller, instead of behind the propeller, thus simulating the duct effect of a ducted propeller.

The Gate Rudder has two rudder blades with asymmetric sections, which are located around the propeller, and each blade can be controlled independently. The two rudder blades, encircling the propeller at the top and sides, provide additional thrust as opposed to the additional drag of a conventional rudder behind a propeller. Because of this additional thrust produced by the Gate Rudder, the required thrust of the propeller as a main propulsor can be reduced by more than 10%.

By introducing this ESD based on this simple idea, the interaction among propeller, hull and conventional rudder can be replaced by a completely different interaction scheme.

The Gate Rudder can be categorised as a new type of the ducted propeller; an 'Open Type Ducted Propeller', which is distinct from a conventional 'Closed Type Ducted Propeller' and a 'Front Type Ducted Propeller'. The Mewis Duct is a very familiar 'Front Type Ducted Propeller' as is the Sumitomo Integrated Lammeren Duct (SILD) and is the original of type of ESD.

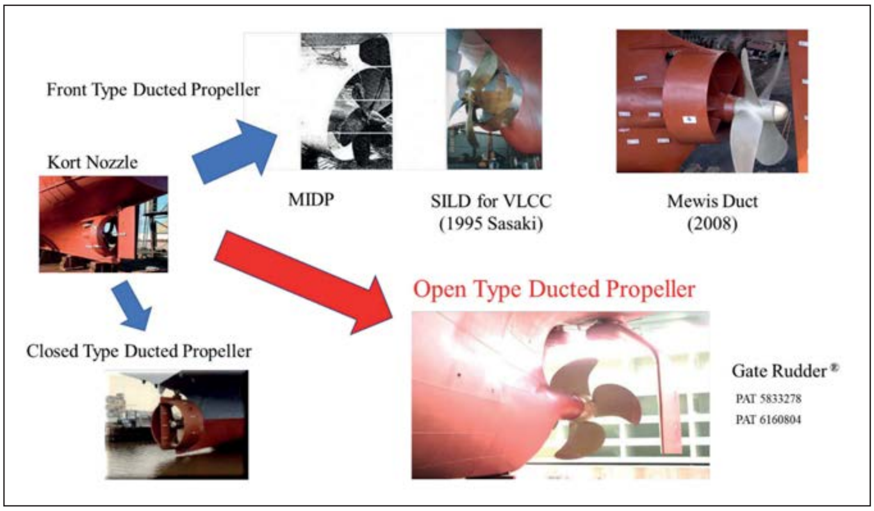


Figure 1: The evolution of ducted propellers

Huge ducted propeller optimised by Elementary Propulsive Efficiency

It is well established that the bottom part of the front type duct shows inferior performance compared with the upper part. Sometimes this part shows negative thrust (resistance) due to the adverse flow for the duct section. By opening this part and moving it to the side of the propeller, this invention has a rudder function and can avoid the risks for cavitation erosion which may occur on the inner surface of the duct. It is also well understood that a minimum clearance between the propeller tip and the inner surface of the duct guarantees the best open water efficiency of the ducted propeller system because it minimises the tip vortex strength which normally introduces 2-3% energy loss. However, the Gate Rudder revealed that the duct (rudder blades) located in the high wake zone behind the ship shows best propulsive efficiency instead of the best open water efficiency. This means the minimum clearance between the

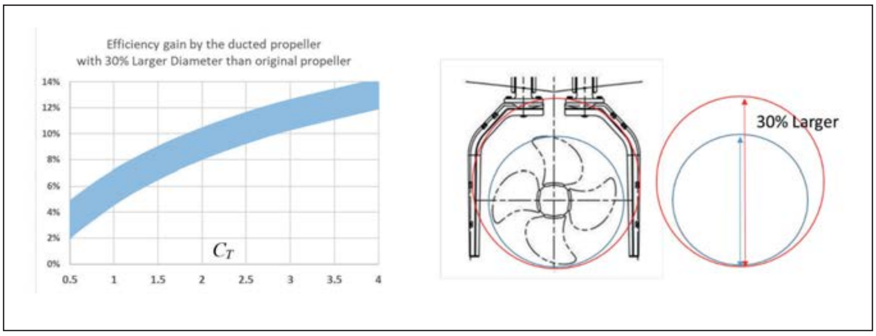


Figure 2: The Gate Rudder is a huge ducted propeller and its efficiency gain can be estimated based on the propeller loading factors C_T (T_P / 1/2 ρ V^2 S_P). Here, T_P, V, S_p is propeller thrust, ship speed and propeller disc area respectively

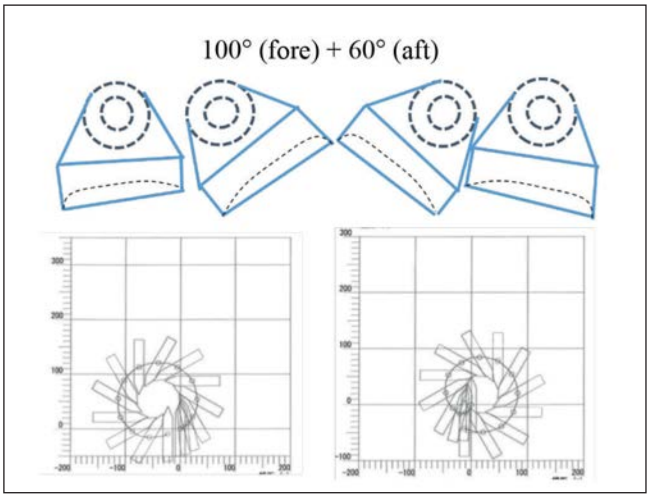


Figure 3: Different rudder control modes

Figure 4: Vessel in crabbing mode

propeller tip and the inner rudder surface is not required to establish the best propulsion system. This new concept is termed 'Elementary Propulsive Efficiency'.

Huge stern thruster

As shown in Figure 3, two different rudder control modes can be obtained by using the Gate Rudder's independent twin rudder system at its slow speed. When the Gate Rudder is used with a bow thruster, crabbing mode can be established (Figure 4), which is very useful for positioning a ship in any direction by a combination of the bow thrust and the Gate Rudder propulsion system.

By replacing the stern thruster and conventional rudder system with the Gate Rudder system, a vessel's design capability will improve from a cost and operational perspective, improving its Energy Efficiency Design Index (EEDI) and Energy Efficiency Operational Indicator (EEOI) performance and lifecycle cost.

Speed trial and navigation data

The first full scale Gate Rudder was manufactured with support from The Nippon Foundation and utilised all of the technologies developed by University of Strathclyde, Key Seven Co., Yamanaka Zosen Co. Ltd., and Kamome Propeller from 2012. The speed trial of the world's first container ship, *Shigenobu*, equipped with a Gate Rudder system was conducted on 12-13 November 2017. The results were compared with a sister ship *Sakura*, which was delivered in August 2016. These two vessels have the same hull form and the same engine but their rudder systems and propellers differ. A 14% difference of speed performance was found during these speed trials based on both raw and corrected data.

Figure 5: A comparison of the rudder systems of the Gate Rudder-equipped *Shigenobu* (right) and its 'sister' *Sakura*. Image: The Nippon Foundation

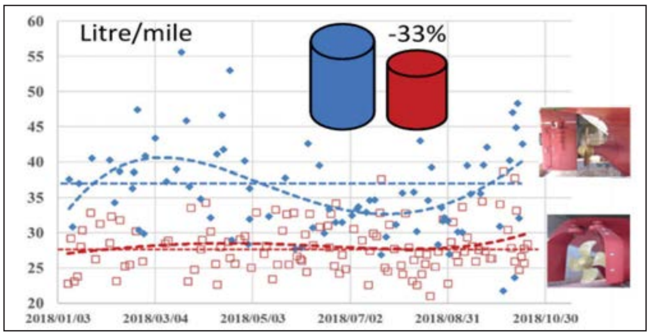


Figure 6: Speed trial comparison of *Sakura* (blue) and *Shigenobu* (red)

Minus sea margin?

Both the *Shigenobu* and *Sakura* sailed along the same coastal route on the same day. This enabled us to evaluate the ships' performances without effects from different routes, which could have introduced differences in weather and current. Around 30% fuel saving was found from the voyage data reported from both vessels every day using the same monitoring system installed on each vessel.

The voyage data was compared with the predicted power curve obtained from the tank test. The averaged power curve of the *Shigenobu* predicted from the voyage data indicates a lower (even negative) sea margin while the *Sakura* shows 25%, which is normal for a coastal vessel running a north-east coast route.

Mechanism

The propeller of the Gate Rudder system requires a much smaller propeller thrust than that of the conventional rudder system because the rudder is changed

from a resistance device to a thrust-generating device. This also reduces the hull interaction drag force, known as the thrust deduction factor.

A second factor is also at play: the Gate Rudder works like the sails of a sailing ship in the water. The propeller increases this sail performance using the so-called Upper Surface Blowing (USB) technology, which is like an aeroplane wing. Meanwhile, the conventional rudder works in the deflected flow of a propeller slipstream, which deteriorates the sail performance. The same effect of the Gate Rudder on rolling motion can be expected.

Energy efficient with safety under adverse weather conditions

Recently, it was also reavealed that a Gate Rudder can improve the course keeping ability for the vessel with unstable characteristics, which can be seen in beamy ships or slender ships with extremely flat and wide stern. The modern energy saving container has a large open stern and high superstructure for visibility, hence it can easily sacrifice the course keeping ability.

The Gate Rudder is so effective that the manoeuvrability of such kind of ships in adverse conditions can be improved remarkably by supporting the above-mentioned functions. There are serious concerns regarding the sufficiency of propulsion power and steering devices to maintain manoeuvrability of ships in adverse conditions, hence regarding the safety of ships, if the EEDI requirements are achieved by simply reducing the installed engine power. The gate rudder is the most efficient measure for this conflict between EEDI and Minimum Power Requirement (MPR).

Why did nobody think of it before?

It seems that conventional modelling techniques were unsuited to unconventional propeller-rudder configurations. It is not easy to say, but it strongly relates to the model test technology and the analysis procedure. The Gate Rudder is not within the scope of the existing model testing and scaling technology. For example, the resistance of the Gate Rudder measured in the towing tank is quite high and 5-10 times, relatively, compared to full scale (scale effect). This will provide the model test with the wrong conclusion.

Another reason for this may be the fact that very few people take the propeller hull interaction seriously. The propeller increases the hull resistance by 25-30% with its strong suction force. This is called thrust deduction factor. For a long time, this fact has been regarded as a consumer tax which everybody must pay. The increment of the resistance is proportional to the propeller thrust as the constant tax rate. The Gate Rudder system succeeded in reducing this tax considerably by reducing the propeller thrust itself and distributing the remaining thrust to the rudder blades where the tax rate is extremely low. This is a main difference from conventional ducted propellers.

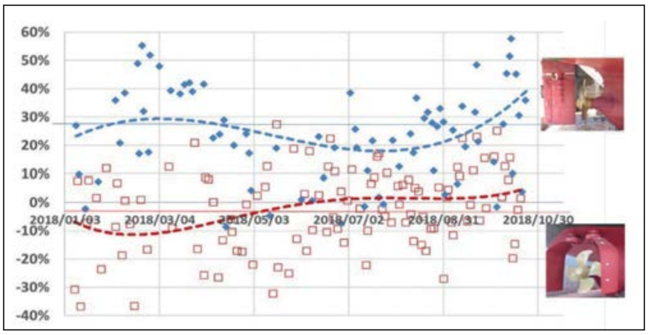


Figure 7: *Shigenobu* performed 30% better on the same route

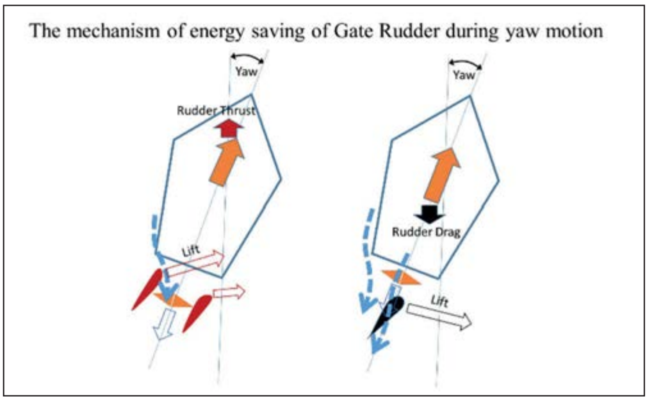


Figure 8: The Gate Rudder's energy-saving mechanism during yaw motion

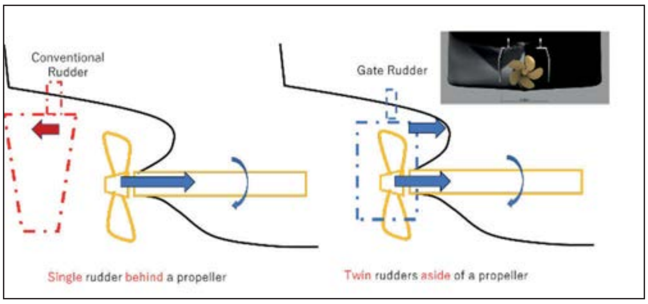


Figure 9: Twin rudders provide additional thrust, instead of drag

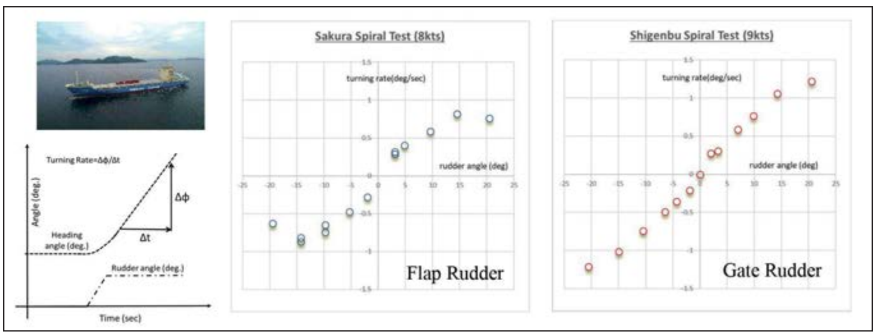


Figure 10: Improved manoeuvrability

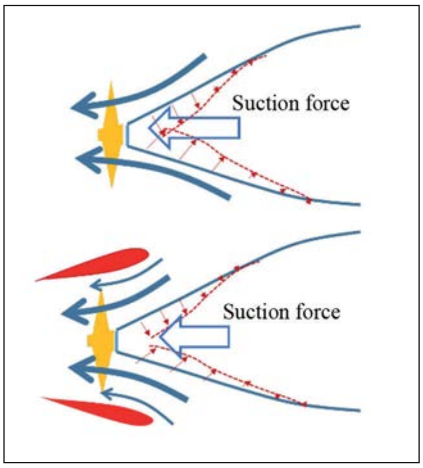


Figure 11: There are significant savings to the thrust deduction

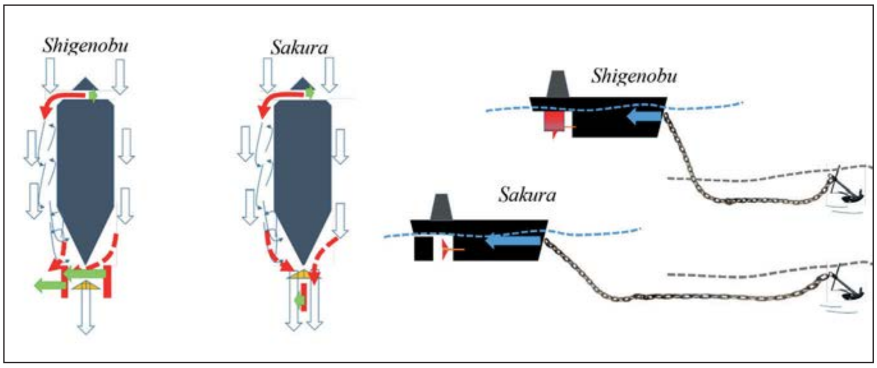


Figure 12: Bow thrust introduces different inflow angles to the Gate Rudder (left), while also minimising the risk of running anchor

Unexpected results

After the delivery of the *Shigenobu* many interesting stories were reported by its captain, Captain Tachibana. Some were very reasonable and expected, but others were anomalous and had not been anticipated.

The first comment from the captain was that the *Shigenobu* is faster than the *Sakura* by 0.7 to 1.0 knots.

These values corresponds to 16-22% power reduction. This comment implies that *Shigenobu* is showing better in-service performance than predicted by the sea trial records (14% power reduction). In reality, however, the voyage data shows more than a 30% power reduction over the winter period and around a 15% reduction in the summer. The captain also said that the Gate Rudder is superb at head sea conditions and the ship is able to keep its speed against wind and waves. These comments can be expected as the performance of *Shigenobu* during its sea trials shows the same feature, while the sea trial weather conditions for *Shigenobu* were more severe than that of *Sakura*. Interestingly, the ship speed also increased at the start of the 10° zig zag motion test. This was quite an unusual phenomena.

The first curious incident was reported in January 2019 by Captain Tachibana. He stated that the bow thruster can be used at up to 10knots while *Sakura* is less than 5knots. This is quite unbelievable because the specification of bow thrust on both vessels is exactly the same as is the design of the bow shape. We finally concluded that this was a result from the difference of the rudder systems. The bow thrust can change the flow near the hull surface and introduce different inflow angles to the Gate Rudder, however, the flow angle of the flap rudder is hardly affected by this perturbation due to the propeller flow straightening function. This difference may affect the efficiency of berthing and leaving the port.

The second unexpected result was reported at the same time by the captain. He said that the risk of running anchor can be minimised by the Gate Rudder. He explained the difference of the number of chains using anchoring. The *Shigenobu* only has seven chains while the *Sakura* obviously needs longer chain to protect the running of the anchor. The captain explained that the reason for this difference was caused by the Gate Rudder, but why? Because, as he said, of a "very strong rudder".

Further research

The recent study, 'Analysis of the Gate Rudder on a catamaran', aimed to provide a set of validated data that proves the Gate Rudder reduces resistance, delivers power and increases the propulsive efficiency of a catamaran. The Gate Rudder consists of two asymmetric twin foils added beside the propeller acting as an accelerating duct. The foils produce lift, which contributes to the overall thrust of the propeller. Power savings of up to 15% were obtained.

The project tests the *Princess Royal*, a displacement type Deep-V catamaran with symmetric demi-hulls, using the Computational Fluid Dynamics software StarCCM+. First, the catamaran was tested with the conventional rudder and once the results were validated against towing tank tests, the Gate Rudder was implemented. Seven different speeds were tested, from 10 to 20knots. The comparison of results shows that the Gate Rudder is capable of 9% total resistance reduction, 6.5% delivered power reduction and up to 12% propulsive efficiency increase, compared to the conventional rudder.

The necessity to explore, improve and implement the Gate Rudder, could not be more relevant in today's world, where climate change, energy efficiency and emissions are of growing importance. *NA*

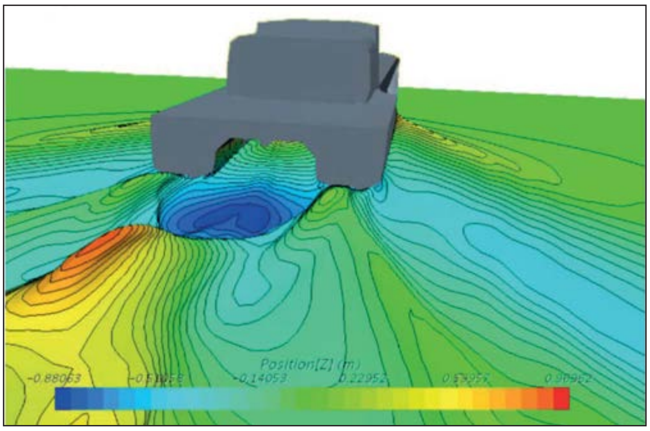


Figure 13: Recently CFD analysis using StarCCM+ has indicated significant potential efficiency improvements for a catamaran

Usage of digital tools for optimum propeller design

Combining full-scale CFD and system simulations can bring accurate results fit for today's more exacting market conditions and stringent regulations, says Norbert Bulten of Wärtsilä, The Netherlands

The usage of more sophisticated design and analysis tools have become prevalent in all industries. In order to get the true value out of these numerical tools, the actual design requirements need to be defined properly and in general, this leads to the question of how to find the right balance between conflicting requirements.

More feedback on the performance of a design can be obtained through numerical simulations within the design evaluation phase and with digital data collection tools in the operational phase. With the implementation of CFD simulations in the design cycle, unforeseen deviations with model testing campaigns and actual full-scale sea trials has reduced, and collection of actual vessel operational data, in combination with a system simulation approach generates further insight in the actual operation, which can be used to further fine-tune the design philosophy.

The requirements for propeller designs are becoming even more stringent due to changing market circumstances and legislation. In order to limit emissions as much as possible, there is a clear focus on the propulsive efficiency. Yet, crew and passenger comfort as well as underwater noise levels are also considered to be part of the critical design criteria nowadays. Establishing the target design criteria for a propeller is one important aspect of the design cycle, however, the method (or the range) of evaluation conducted for the design is equally significant.

Before CFD simulations became commonplace, this evaluation was limited to experimental model scale testing of performance and cavitation behaviour. Today, the developments in numerical flow simulations (CFD) have reached a level where they can be adopted within the evaluation and feedback cycle, such as those in [1-4]. Despite the developments in both numerical and experimental evaluation methods, the final truth is found during sea trials, where the ship's speed, noise and vibration levels are determined. Overall, there are three different possible feedback loops in the evaluation of the actual propeller design, as shown in Figure 1.

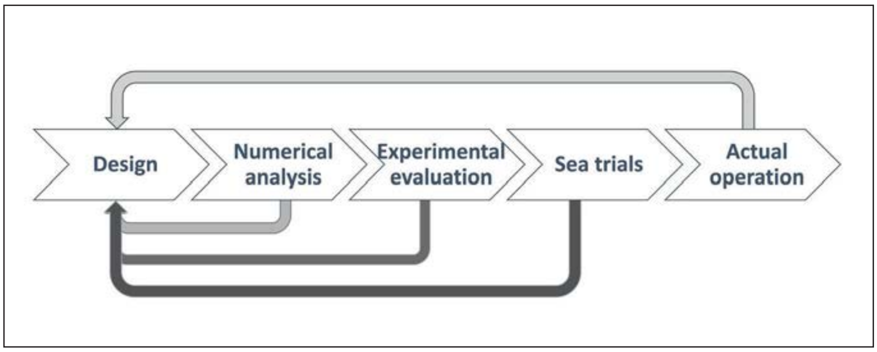


Figure 1: Propeller design process and (possible) feedback-loops

The key-elements in feedback loops are the accuracy of the evaluation and the required time to obtain that feedback. Changes in design are more costly after sea trials, in comparison to changes during the drawing phase. Despite ongoing discussions regarding the accuracy of CFD simulations, value can be found in the shorter runtime of various simulations, when compared to that of a model test campaign and furthermore, when considering the cost impact in comparison to full sea trials.

So far, optimum propeller design is based on meeting the outlined targets during sea trials. It should be acknowledged that the actual operation of the vessel will differ significantly from the defined sea trial condition. This is also related to whether the design is made for the shipowner or shipyard, since the owner will operate the vessel for many years and will regard the

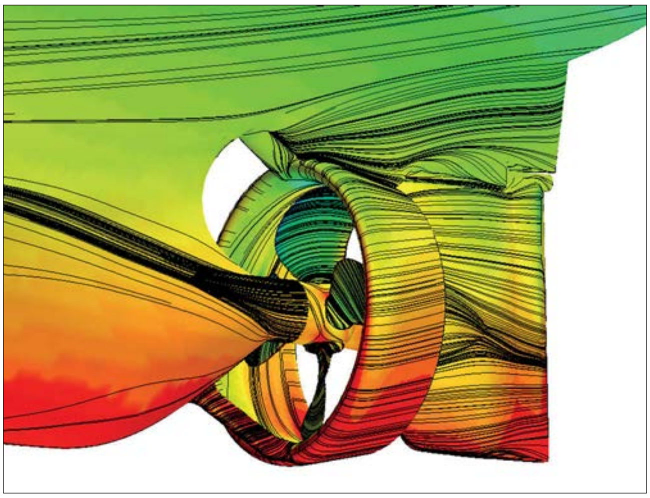


Figure 2: CFD simulation of propeller in behind ship condition in self-propulsion condition

impact on fuel consumption as paramount. For such reasons, the feedback from vessel monitoring/data-collection systems can and will provide valuable insights into the actual performance of the vessel and propulsion system, which can be used to make a fourth additional feedback loop in the design cycle. When the step is made from a single design point to an operational profile, use of dynamic system simulations come into play. Examples of usage of both full scale CFD simulations and dynamic system simulations will be discussed.

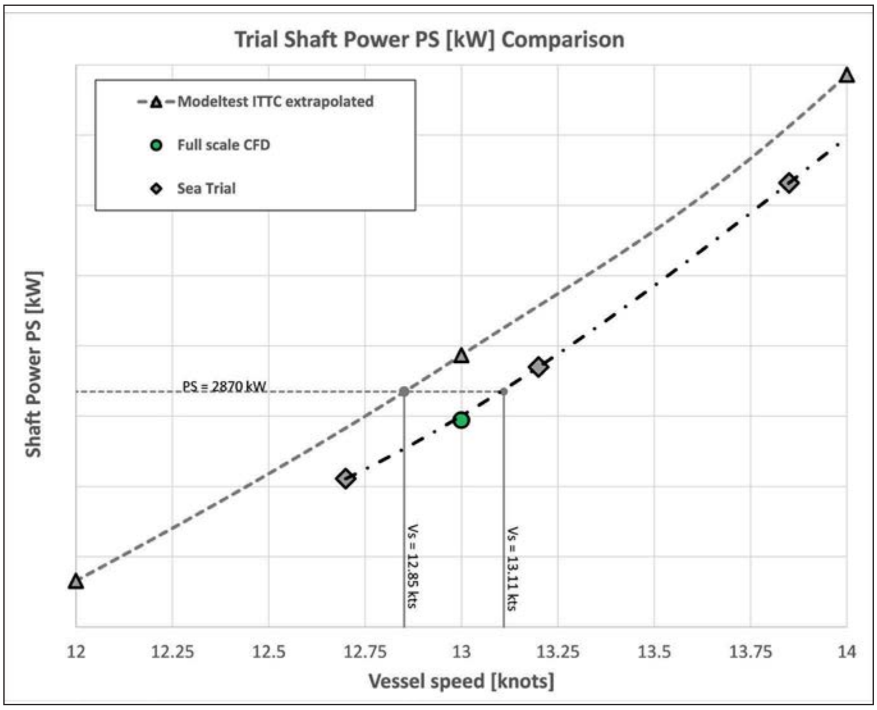


Figure 3: Speed-power results from model test, full scale CFD simulations and sea trials

Design for sea trial

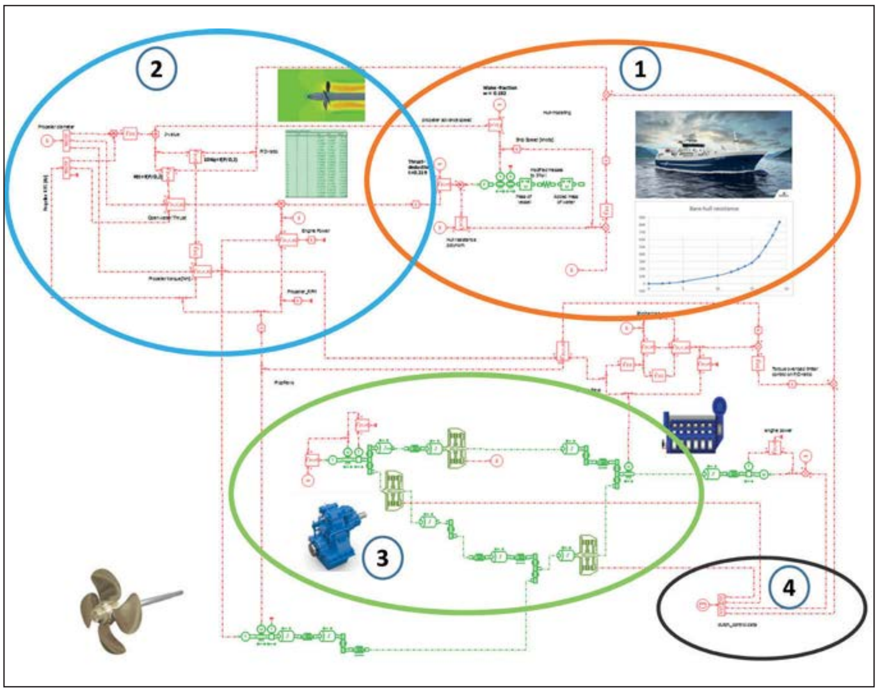
Full-scale performance CFD simulations have been made for a tanker with ducted propeller. The simulations include the rudder as well as the free surface effects and dynamic sinkage and trim. The target speed is 13knots, for which the required power level has been calculated. The results are shown in Figure 3. Agreement between the sea trials and the CFD results is good, certainly when compared to the prediction based on model scale tests. The gap between sea trial performance and the estimate based on model scale measurements is caused by the shortcomings in the extrapolation method. Decades ago, an extrapolation method was developed based on a large number of vessels with open propellers (ITTC'78). With aid of CFD simulations it has been proven that the applied Reynolds-number corrections for ducted propellers differ significantly from the open propellers. The physical concepts behind the Reynolds scaling effects have been discussed before [5]. The current results clearly indicate the weakness of the commonly applied extrapolation methods in case the propulsion configuration differs from a conventional open propeller.

From sea trial to actual operation

The drawback of the full-scale CFD simulations of the complete vessel is the required computational power. As shown in Figure 3, the design condition has been brought back to one single operating condition which is often not representative of the actual operation of the vessel for many years. If a range of operating conditions needs to be analysed, a quicker calculation method must be applied. In order to obtain a greater insight on the actual operating conditions of a propulsion system, the system simulation approach is adopted. In such numerical models, the performance characteristics of the main components are modelled and the dynamic interaction between the different components is calculated.

A simple sketch of a system simulation model, as built in SimCenter Amesim, is shown in Figure 4. In this model a number of main components are coupled with each other to determine the impact of the interaction.

Figure 4: Example of system simulation set-up for dynamic event simulations



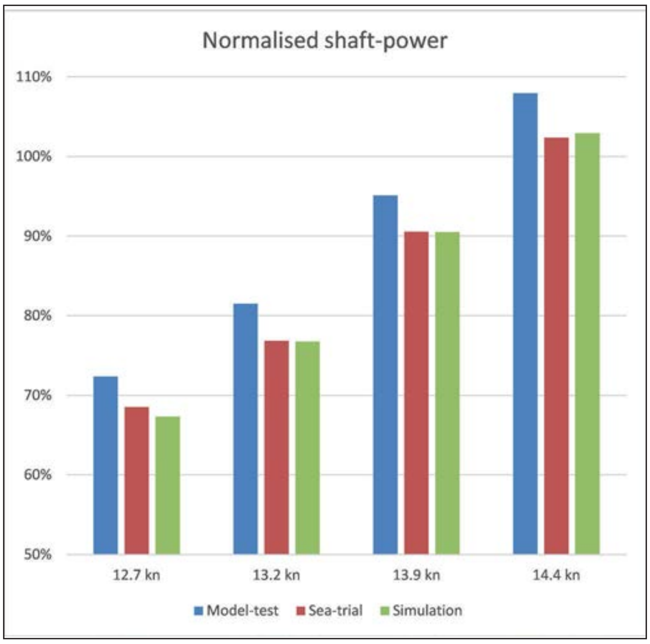


Figure 5: Normalised shaft power prediction of tanker based on system simulation approach for different trial conditions

The main components in this system are:
1. Hull resistance and inertia
2. Controllable pitch propeller performance response surface for thrust and torque as a function of inflow speed, propeller pitch setting and propeller RPM
3. Drive-line layout with the option to model a 2-speed gearbox and simplified 4-stroke engine
4. Operation/controls input channel

The hull resistance will be balanced with the propeller thrust to reach the steady-state sailing speed. The impact of the vessel inertia is taken into account, which gives a clear delay on the response of the vessel in case the thrust is changed.

The performance data of the propeller is based on a set of CFD simulations of the propeller in an open water set-up for different pitch angles. The dimensionless thrust and torque data are translated into a mathematical response surface representation, where the propeller thrust can be determined as a function of ship speed and propeller pitch ratio, including the propeller-hull interaction factors for wake and thrust deduction. The propeller operating point will gradually change in the start-up phase until the target ship speed has been reached. The required torque will be based on that operating condition.

The system simulation approach has been used to calculate all measured sea trail conditions of the tanker. The results of the system simulations, shown in Figure 5, are within 2% for the different points. The prediction, derived from the model scale performance prediction, gives a larger difference with sea trials for all measured conditions.

Once the system simulation model has been set-up and the input parameters for hull resistance and propeller performance have been imported, the actual calculation time of the speed-power prediction is reduced to a few seconds. This is a huge difference compared to the full scale, detailed CFD simulation.

The dynamic simulation model now allows for analyses of various operational scenarios. For a controllable pitch propeller, the optimum combination of pitch and RPM for certain vessel speed can be found. A set of these pitch-RPM combinations (combinatory-curve) can be used to define the handle positions on the bridge. The modern propulsion control systems allow for a number of combinatory-curves, which are tailored to specific vessel operating conditions.

Conclusions

Today's demanding market and stringent regulations has increased the need for more accurate and efficient tools during the design and evaluation process. With a combination of detailed full-scale CFD simulations and system simulations, a good performance estimate can be made. The strength of the system simulations lies in the speed of calculation, whereas the model can be fed and calibrated with the results of the detailed CFD simulations. Nowadays, hull-resistance and propeller open water performance calculations are well-established calculations in maritime industry. The speed-power prediction in sea trial conditions can be made with proper accuracy as well. Further fine-tuning of both methods will be based on monitoring data from sailing fleets. *NA*

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Space tech takes the weight off LNG

Marine consultancy group Ocean Finance, together with Cimarron Composites and ABS, is fusing aerospace technology with maritime knowhow on SpaceTech4Sea, an innovative project that uses composite tanks to eliminate the biggest barriers to adopting LNG as a marine fuel

SpaceTech4Sea introduces ultra-lightweight aerospace fuel tanks to LNG-powered ships

Even though LNG has fuelled a variety of ships since 2000, its appeal and primary use has centred on large energy-demanding vessels. Car and passenger ferries make up the greatest number of LNG vessels while cruise and containerships have the highest number of LNG vessels on order.

This pigeonholing is, in part, due to the weight of LNG tanks and the space they require. As class society DNV GL states, LNG tanks "typically occupy three to four times the volume of an equivalent amount of energy stored in the form of fuel oil".

The inefficiency of heavy and expensive LNG tanks has deterred some shipowners from investing in LNG-powered newbuilds or retrofitting older vessels. But a new project, which erases the loss of payload and transportation capacity usually necessitated by the installation of traditional tanks, may make LNG a more compelling choice.

Dubbed SpaceTech4Sea, the project involves the adoption of aerospace technology and "novel shipbuilding techniques" to develop an ultralight LNG fuel tank.

Headed by the Athens-based marine consultancy Ocean Finance in partnership with the American Bureau of Shipping (ABS) and Cimarron Composites, it aims to introduce LNG as marine fuel across a wider spectrum of vessels. Last year, it was awarded a grant of €1.1 million from the European Commission as part of a push to boost the Blue Economy.

Made of all composite carbon fibre and wrapped in an advanced resin, the cylindrical tank can withstand the cryogenic temperatures required to store LNG. Unlike a metallic tank, it is non-corrosive, won't microcrack and is incredibly lightweight.

"We are saving almost 85-90% of the weight" compared with the average LNG tank of the same net volume, says Panayotis Zacharioudakis, the director of the Ocean Finance. "So, the weight is only the weight of the fuel, not of the tank."

The concept for the project arose in 2016, during which time the consultancy group was trying to design a high-speed catamaran powered by LNG. However, upon realising the LNG equipment would account for 20% of the vessel's total weight, a new plan had to be devised. The team turned to the most weight sensitive industry they could think of for ideas – the aerospace industry, where, as Zacharioudakis says, "every gram counts".

"The advantages of this technology are that by having less weight, it is much easier to locate the tank in other places compared to standard metallic tanks the market is currently offering. You also don't need to reinforce the substructure of the vessel that is going to hold the tank."

The space-ready technology has been downgraded for use in the marine environment, as it does not have to endure such extreme conditions at sea as it does in space. Additionally, the tank has been tested for use with liquid oxygen and liquid hydrogen, which have much lower storage temperatures than LNG.

The tank will eventually be validated for liquid hydrogen and slush hydrogen. This will help future-proof the technology if LNG – which is often cited as a transition fuel on the road to decarbonisation – finds itself overshadowed by zero-emissions fuels like hydrogen and ammonia.

Although the technology may sound incredibly costly, "there is no huge difference on the price tag compared to a metallic tank," says Zacharioudakis. There is a slight premium, but he expects it to become more competitive if they automate the production process in the future.

At the moment, Cimarron – a composite developer based in Huntsville, Alabama – manufactures and owns the property rights to the technology while Ocean Finance has a commercial agreement for its commercial exploitation in Europe. Cimarron will later make a technology transfer to the consultancy group to marinise the project and, depending on market demand, help set up a production facility in Greece from a respective joint venture.

In terms of scalability, Zacharioudakis says that there is no reason they shouldn't be able to manufacture higher volume tanks for larger ships. The hurdle of creating them will be to modify the construction tooling, so that it can wrap large diameter tanks with the resin. Currently, Cimarron can produce a tank that is approximately 16m long and 2m in diameter – a tank that is considered very big in the aerospace industry.

SpaceTech4Sea is expecting Approval in Principle from ABS' Global Ship Systems Centre in Greece for the product shortly. The class society will provide the rules, regulations and standards of approval for the technology in marine applications. A pilot project to test out the tank is also underway with an unnamed Greek shipping company. *NA*


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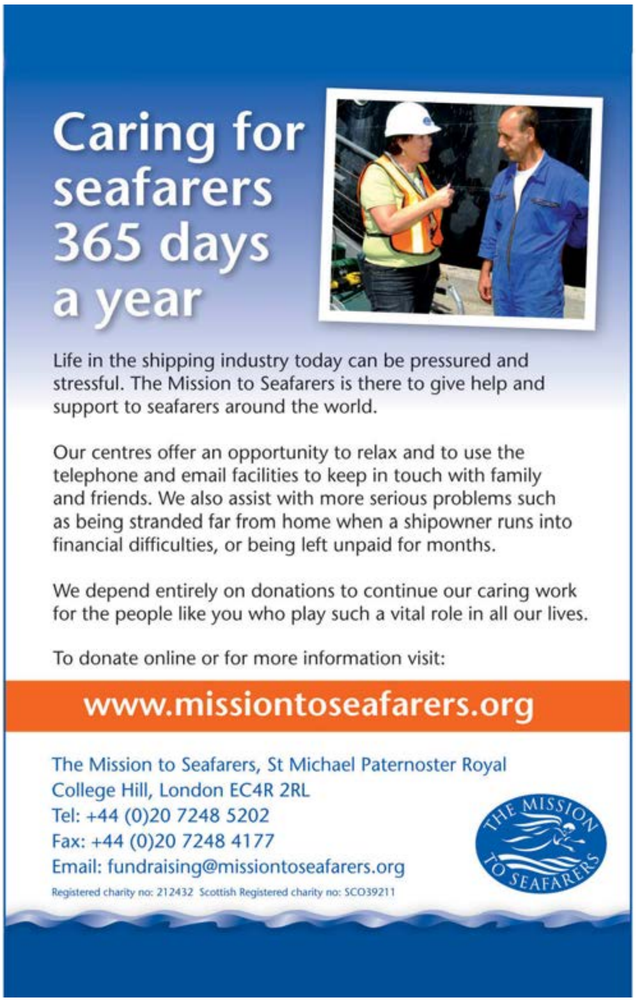
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THE MISSION TO SEAFARERS


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Digital dynamics

For fleet owners and shipbuilders, commercial and economic pressures mean keeping on top of vessel performance. Mark Jones of PSM Instrumentation looks at how advances in tank gauging equipment are helping to address these multiple needs

Tank gauging systems play a vital part in the safety and operation of modern vessels. Monitoring fluid, temperature and pressure levels in cargo holds, storage tanks and other spaces is essential to optimising ship performance, preventing fuel theft and avoiding potentially disastrous consequences due to undetected changes.

The advent of larger vessel sizes has added to risk levels, as the increased burden on time-constrained crews leaves them less time for monitoring and maintenance. The introduction of digital tank gauging solutions has helped alleviate pressure by removing the need for manual checking.

Modern tank gauging systems are designed to be flexible and capable of handling process control across the full range of shipboard fluid types, from fuel oil and lubricants to ballast water. Intelligent sensors collect real-time data from all onboard storage tanks, including anti-rolling tanks, and measurement of the ship's draught and trim, as well cargo tanks and water ingress detection.

The sensors and transmitters are networked via an onboard system that uses distributed termination modules to acquire the data collected and relay it to a centralised graphic display unit, which provides content indication and alarm status for all tanks. A key objective for PSM has been to maximise 'view on deck' opportunities. Repeater displays can be installed to provide function-critical information at additional locations to enable crews to access information directly.

Supplied pre-configured to suit individual applications, the onboard system also outputs to other shipboard systems such as the Vessel Management System or loading computers, enabling the wider integration and automation of ship systems.

Making the numbers work

Uncertain market conditions call for design flexibility to meet new emerging industry needs. For the bulk sector, this has led to a marked trend towards smaller bulk carriers among other industry changes. ATEX certified and marine approved digital tank gauging systems are now an increasing requirement for shipping organisations. Furthermore, they ensure regulatory compliance, providing additional drivers for refit programmes.

For shipyards and shipbuilders, staying competitive also means ensuring a quick turn-round in the shipyard for refits and fast-tracking of new builds. Minimising downtime for vessels in service by shortening the time in drydock is essential for fleet owners. Easily integrated at a component level, the latest digital tang gauging systems offer a cost-effective route for repair and replacement. Increased compatibility and interchangeability provide a solution where existing systems are found to be inoperable or where obsolescence occurs due to component suppliers exiting the market.

For newbuild contracts and major upgrade projects, pre-configuration by the supplier of all operational parameters means that whole systems can be quickly supplied and installed without the need for costly local engineering expertise.

Unlike traditional analogue systems, which require a signal cable and barrier fitted to each sensor with multiple converters, digital systems like PSM's require only a single multi-drop power and communications cable. This eliminates the need for multiple barriers and analog-to-digital converters, which can reduce installation time and materials cost by up to 60%.

Taking digitalisation to the next level

In order to help shipowners maintain profitability, improve efficiency and safety, manufacturers and suppliers continue to support the digitalisation process in the move towards 'smart' ships.

For PSM this means applying the latest thinking and technology to deliver on innovation. Equally key is simplicity of design for easier use, cost-effective installation and reliability.

The configurable remote Tank Level Display of PSM's VPM system

Currently in final development and testing with a view to launch this summer is VPM, a new type of transmitter and display package that aims to make digital measurement even more accessible.

The new VPM intelligent tank gauging package is based on the next generation intelligent transmitter, which may be configured prior to delivery with all parameters specific to the intended application. Installers can connect the system and set to work immediately while retaining the ability to fine-tune settings on the spot using a laptop computer. No specialist knowledge or test equipment is required. Should replacement at sea be needed, the smart technology behind the new system allows the crew to drop the new transmitter into place and instruct it what to do within minutes.

The VPM system is scalable from a dedicated compact integral display panel mount unit for smaller vessels to larger PC based solutions with multiple repeater stations for larger vessels.

The bottom line

Often a lesser consideration in the context of ship architecture, smarter sensors hold the key to reducing lifetime vessel costs while building in more flexibility and control. *NA*

Smarter means cyber

Bureau Veritas hopes to ensure that smart shipping doesn't compromise safety and security

The era of the smart shipping is upon us, impacting not only ship operations but also the way they are inspected and audited. IMO is currently occupied with its scoping exercise of Maritime Autonomous Surface Ships (MASS), a generic term for smart ships, ranging from 'simple' decision support tools through to unmanned fully autonomous ships. An update of current progress in the exercise was reported at June's meeting of the Maritime Safety Committee (MSC) with the final report due next year.

But for technology providers and the classification societies who are called upon for their input and approval of increasingly advanced solutions, this is simply a technicality. Earlier this year, Bureau Veritas Marine & Offshore (BV) conducted the first digital survey using Kongsberg Maritime's DP Digital Survey solution onboard an offshore support vessel (OSV) operated by Bourbon. The system, which takes data directly from the ship's control system and sends it to auditors securely via the cloud, allows for what BV describes as an "unprecedented" consistency in system verification, rather than merely visual confirmation.

Further trials of the system are expected later this year and according to Najmeh Masoudi Dionne, BV's Global Technology Leader for Smart Ships, feedback from the industry is very positive. "Digital inspection offers greater flexibility; you don't have to survey it three months before or after the anniversary of a certificate. It gives the possibility for crew to conduct the trials while the surveyor onshore could monitor what they're doing."

Critical to that has been ensuring that cyber resilience is at the very heart of the system. "What's important is that the data is accurate and can't be tampered with. The way we test the system is to try and break it. In addition to data integrity analysis and certifying the system as cyber secure, we thirdly check if the device performs to the technical specifications we have outlined."

Najmeh Masoudi Dionne, Bureau Veritas

BV has been among the most proactive of the class societies in quantifying the challenges of digitally enabled vessels and doing its best to ensure both the vessels and their owner/operators are adequately equipped. It launched its smart ships programme in 2016 and late the following year published its document *Guidelines for Autonomous Shipping* (NI641). "It helps our clients understand what a smart ship is and determine at what level, and which aspects of operations, should be smart. Theoretically, if you're a billionaire you could have everything automated, but you need to know what is practical."

BV breaks down the requirements of smart ships into three core areas: cyber safety and cybersecurity (both which fall under cyber resilience), and smart performance. Cyber safety relates to the durability and integrity of that software and system, which might be compromised by numerous different factors, such as an error in coding or a lack of testing, the failure of mechanical parts or a combination of any or all of these.

Cybersecurity refers to the threat of a third party gaining access to that system or introducing malware or a virus into it for malicious purposes. "That could be activists gaining access to an oil platform, competitors trying to damage a reputation, teenage hackers trying to test their skills or even a state. Organised cybercrime is becoming a lot more common," says Masoudi Dionne.

"Smart Performance – or as some are calling it, 'cyber performance' – means any solution based on digital technology, onboard or ashore, to enhance the health and performance of the asset. However, maritime keeps forgetting that to ensure smart performance, it needs to put it into the perspective of cyber resilience. This is often neglected by both those responsible for buying the software and integrating it into a single system and owners."

Cybersecurity survey

Notwithstanding a handful of high-profile cases, such as Maersk's 2017 NotPetya malware attack, operators are understandably coy in revealing whether they have been victims of cybercrime. Nor, for that matter, is there any confidential reporting mechanism for incidents. However, Masoudi Dionne points to a 2018 Maritime Cybersecurity Survey conducted by legal firm Jones Walker LLP, which included some illuminating results.

The survey analysed the responses of 126 senior executives, IT officers, non-executive security and compliance leaders, and key managers from US-based maritime companies. It found that 78% of large companies believed they had suffered some form of cyber breach in the preceding 12 months, whereas 83% of small companies did not believe they had been targeted.

Large companies were also more likely to perceive the cybersecurity threat coming from outside their organisation, with 100% saying their greatest vulnerability concern was external attacks such as ransomware and malware. By contrast, among small companies, 61% felt the greatest risk came from internal negligence.

But the starkest statistics were with regard to cyber attack preparedness. While 73% of companies that had been breached were confident they were prepared if it should happen again, 86% of companies that had not reported a breach admitted to being unprepared. Furthermore, while the majority of all companies were now implementing secure-IT solutions, such as keeping an inventory of applications and diagnostics tools, most lacked advanced systems like encrypted ship-to-shore communications.

The results reflect Masoudi Dionne's belief that maritime is failing to adequately address cybersecurity because of a prevailing attitude that preventative measures are simply unnecessary, despite the growing sophistication and integration of the equipment their vessels rely upon. "Most owners just want to get their ship from A to B. The offshore industry is far more advanced because of the complexity of their systems."

Moreover, cybersecurity is a moving target, with new risks from viruses and malware constantly emerging. "It's important to understand it's not like an engine that can keep running for 40 years. The vessel's systems need to be checked on a regular basis by the antivirus software and the operator's IT technicians. The system should also be upgraded regularly. This represents CAPEX, of course, but if you don't it will become your OPEX later."

It's not uncommon for operators, be it at sea or ashore, to be using long-outdated operating systems, reaching as far back as Windows 98 or XP. Moreover, patches issued to prevent the exploitation of security flaws are frequently not installed. Another problem, says Masoudi Dionne, is new software and devices being added on top the existing infrastructure without any risk analysis or compatibility checks.

Some sectors are, of course, more forward-looking than others and with the more advanced vessels cybersecurity begins at the shipyard. "Cruise ship and yacht owners are very concerned about cybersecurity because people going onboard such vessels expect to be able to do the same things that would at home or the office, so designers are very keen to take on class insight. LNG carriers and containerships also demand cybersecurity at the yards. Ultimately it's up to the owner who decides to apply "voluntary" cybersecurity class requirements which class is assigned to the ship as a notation, so if they choose BV then, of course, the shipyard's IT team will have the support of our expert to deliver a secure network on-board."

Notations and regulations

BV has developed a portfolio of cybersecurity services to help its clients mitigate the risks. For newbuilds equipped with in-depth automated cybersecurity onboard and ashore that fulfils the requirements, there is BV's Cyber SECURE notation. Meanwhile, for in service vessels that are undergoing regular checks, with appropriate procedures and training in place, there is the Cyber MANAGED notation.

The class society was also instrumental in the formation of a dedicated Cyber panel within IACS, leading to the implementation of the Unified Requirement (UR) E22 – 'On Board Use and Application of Computer Based Systems' – which set down minimum requirements for computerised based systems onboard a ship and became applicable to all newbuilds contracted on and after 1 July 2017 (BV created its SW-Registry notation to certify compliance with this standard for ships in operation).

"We should not forget that cybersecurity measures need to be implemented at the system and solution level. We have developed a type approval scheme for equipment, certification scheme for cybersecurity solution and remote access providers," says Masoudi Dionne.

IMO has also been actively engaging with cyber. In 2018, it adopted MSC.428(98), which affirms that "an approved safety management system should take into account cyber risk management in accordance with the objectives and functional requirements of the ISM Code" and that this should come into effect no later than the first annual verification of the ship operating company's (i.e. the technical manager of the vessel) Document of Compliance after 1 January 2021.

The full implications won't be known for some time but given that the safety management system (SMS) is an exhaustive documenting of best practice for all safety scenarios, covering all eventualities for cyber failure will pose a challenge. "Normally the captain or the master onboard has some IT and network knowledge but may not be profound, normally the crew will call shore for help. But with operational systems sometimes it's too complex and many will not have remote assistance capabilities. So, they need to request an engineer from the OEM, to either fly onboard or get it fixed at the next port," says Masoudi Dionne.

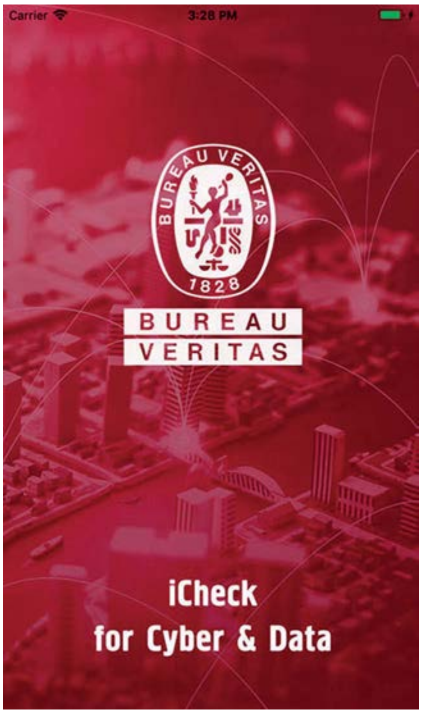
Digital surveys, like the one recently conducted on the DP system for the OSV *Bourbon Explorer 508*, could soon make the transition to merchant ships

"At the moment we don't have the experience to see what will happen with the SMS when [cyber risk management] becomes mandatory in 2021. We've developed guidelines to help our clients be compliant but as the requirements in IMO does not address how to do the risk analysis and what should include, it's a bit of a grey area."

Self-assessment app

Cybersecurity, Masoudi Dionne notes, has become a real challenge for operators to know just how prepared they really are. To assist them BV has developed a web-based self-assessment application: iCheck for Cyber Vessel. "It's high level but I'm sure a lot of ship managers, owners, designers and OEMs will appreciate it. There will be some terms they're not familiar with but that's a good thing because they'll need to ask their IT department what it means.

BV's iCheck for Cyber & Data is available through its website or as a downloadable smartphone app



"The assessment is based on three areas: technical aspect, management, testing and audit. When they have completed it, they will receive an immediate report, a simple risk analysis, where they can see whether they are in the green, orange or red zone (red being the most vulnerable) and what they should do to mitigate. It shows our goodwill towards the industry and may help bring some new words to this sector that didn't exist before." *NA*

To try the app visit: *https://marine-offshore.bureauveritas.com/digital/your-applications/icheck-cyber-vessel*

In-depth | PERFORMANCE MONITORING

Managing data through the lifecycle using relations and 3D representations

3D models can offer enormous gains to shipowners and operators, says Marcel Veldhuizen

Change is the only constant when discussing maintenance of a fleet of ships. Often each ship is specifically fitted for certain missions or, during the build process, has already incorporated changes compared to the first in class, either due to lessons learned or the availability of components. Another important aspect in the lifecycle of a ship is that these modifications often require detailed study and planning to determine their true impact.

The benefits and value of data represented in the form of 3D models from the engineering contractor, to improve engineering quality and efficiency, are

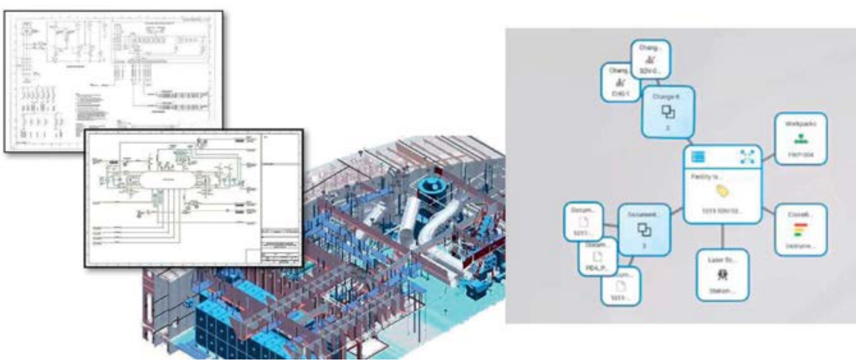


Figure 1: Infomap with data relationships to model and drawings

well-documented and are no longer a subject of dispute in the industries. The benefits and value of this data for the owner operator, however, are less established. It is all about representing the data as closely as possible to the physical world so that people can easily identify themselves with the data. 3D models are a prime example on how this can be achieved, in combination with relations displayed through info maps to show related data/information to that physical object.

It is apparent that owners are starting to make increased use of data shown in 3D models. A growing number of owner operators request the 3D model to be included in the scope of project deliverables. There is also a higher prevalence of laser scanning of existing facilities.

Availability of up-to-date integrated 3D models can help reduce time and cost for ship modifications and the ship's life extensions, as well as serve as a useful tool for several day-to-day tasks during the operation and maintenance of the asset. This is shown in the summary below:

The increased intelligence in data shown through 3D models opens new possibilities and increases the value of the 3D model. For example, the solution can highlight where the design is misaligned with regulatory authority requirements, such as where the number of risers in a flight of stairs without a landing is exceeded or where headroom in escape-ways is restricted. However, the engineering industries can be typified into three main groups with each having a distinct capability of delivering the data:

- Those that have an integrated common data source, with a 3D and other representation of the data
- Those that have a non-integrated data set, but with a 3D mode
- No data and no 3D model available (this is often the case in legacy projects)

However, going from three to two, or two to one, requires manual interventions. Currently tools are available to leverage the available information without performing costly conversions. These abilities, combined with the lower cost of maintaining 3D models, is driving increased recognition that 3D models reflecting the current 'as-built' status of a ship are prerequisites for operational excellence. Laser scanning, point cloud integration and the lower cost of converting legacy 3D CAD models have also lowered the barrier to adopting intelligent 3D solutions.

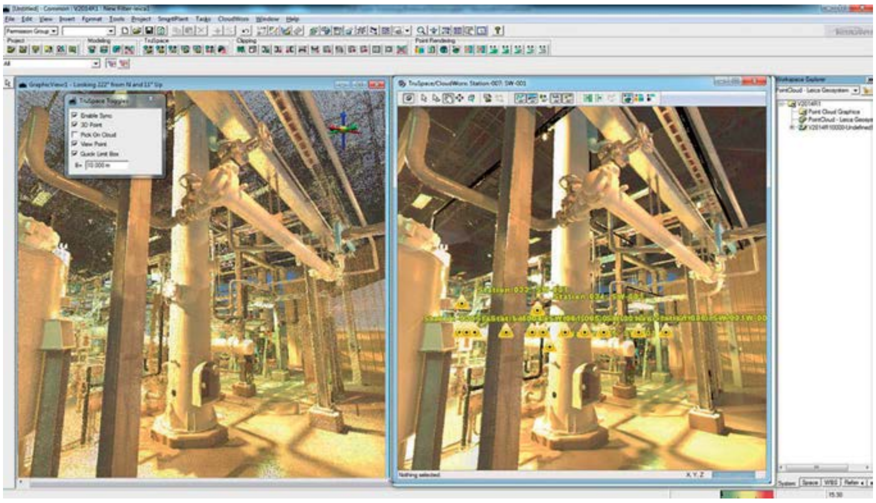


Figure 2: Laser Scans and TrueView images

All these aspects have something in common: the more data you have in that change process the better you can manage the eventual change itself. This is easily quantified through examples where the preparation of a modification is executed before the ship arrives at the drydock, so that upon arrival the work can start right away instead of investigating what the ship actually looks like. A 30% time reduction is common and therefore immediately impacts the time at sea.

Knowing the design in general accounts for 90 to 95% of the data already, it is therefore imperative to conserve that information throughout the complete lifecycle of the ship in an as-build situation.

Another important aspect is the economy of scale within a project that comes from a multitude of efforts. These are more process and organisation-focused instead of 3D related:

- Purchasing identical components (project as well as spare parts)
- Identifying components that are interchangeable

This can be achieved by having a catalogue system that is linked to the design tools and capable of:

- Being able to uniquely identify the item
- Based on continuously progressing insight of technical aspects that will identify the item (for example, at P&ID level you know you have a pump with certain technical capabilities, in the initial 3D model you have an initial horizontal pump, replacement of the final pump upon vendor selection in the 3D model to have the accurate nozzle orientations)

This also ties into the timely replacement of ships and equipment; a process that requires the ability to predict asset lifecycles based on costing information, utilisation, and asset age. Funding requirements are also an issue because many organisations, especially governments, purchase ships with cash. The ad hoc nature and traditional low funding levels with cash has put many operations in an ageing fleet. This lack of adequate funding for replacements can also result in higher maintenance costs due to ageing ships.

The combination of the aspects mentioned previously leads to unique ships within the fleet, and they should, from an engineering and data perspective, be managed as such.

All of this has an impact on the overall lifecycle costs of a ship. A conservative estimate on a US$10 billion program could equate to a US$50 million saving from an effectively instantiated digital twin and a well-architected digital thread. *NA*

About the author

Marcel Veldhuizen, AMRINA, is managing director of fabrication solutions software supplier NESTIX Oy, part of Hexagon PPM

Design, development and decision making

Dear Sir,

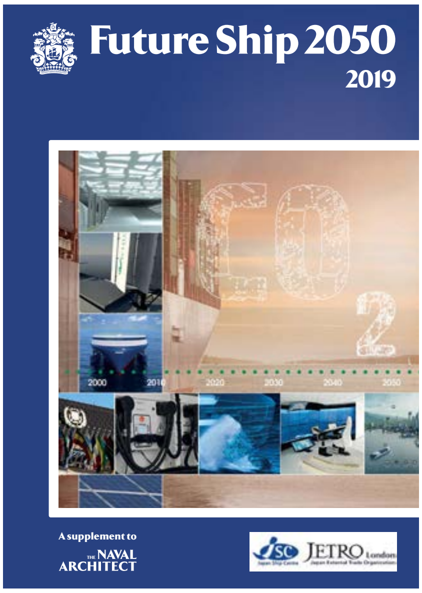
I read with great interest the articles in February's *Future Ships 2050* supplement, in particular the article by Dr. Martin Stopford, 'A working agenda for merchant shipping's technical development?' I accept all the numbers which helped the author to produce his figures, but I find his action plans puzzling.

In Step 1, the proposition to reduce the trade volume without reducing value added does not lie within the purview of shipping companies. It is the producer of the goods that has to decide, in compliance with its country's regulations, whether the goods should be moved or not. Shipping companies react to demands and may assist the decision making by providing their estimated carbon footprint of ships in their fleet or, if necessary, by a specially designed ship fit to carry a special type of cargo.

Perhaps it was on this basis that China decided to open a new Silk Road and buy the port of Piraeus to reduce the need for a long sea trade route. Nevertheless, raw materials such as iron ore, oil etc., will always need specially designed ships to carry them. For instance, the UK imports £400 million of LNG per month to satisfy its power needs at present, and oil is not only used for burning, but also as a raw material for the manufacture of different products such as nylon, for instance.

Steps 2 and 3 are clearly falling within the ship owners' ambit and fine-tuning designs to a particular trade is constantly going on, hence the variety of ships' type now sailing. However, the "economy of scale" and the speed of ships do not stand on their own. They are interconnected. A ship earns its living while at sea, carrying the cargo for which it is designed. Its time spent in in ports is loss making. Therefore, its size and speed should be determined by the distance between ports and the port facilities it finds at either end.

The growth of oil tankers, introducing the expression economy of scale, was caused by the [1967-75] closure of the Suez Canal, increasing the distance of the trade route around the Cape. It was interesting



to note that during the [1973-74] oil crisis, when fuel rationing was introduced in the UK, the tankers started slow steaming to avoid waiting in port for the oil reservoirs to empty. Another development in the container trade was the building of special container ports in Tilbury and Rotterdam to accommodate the growth and speed of container ships.

Another item which needs to be considered is the size of the fleet to service a trade route. Adding a ship to the fleet would tend to reduce the economic size and speed of the ships, while reducing the fleet by one ship will tend to increase the economic size of the ships and their speed.

The cumulative effect of these factors can be evaluated by detailed analysis resulting in the economic size and speed for a particular trade route (1) of ships. In my view, no overall generalised advice can be given in the design of ships except the word fine tuning.

Step 4 is obviously a given. It is here that all efforts should be concentrated to meet the target set. Judging by the many articles appearing in *The Naval Architect*, this effort is well underway.

Shipowners, like land hauliers, are all goal based, i.e. to carry goods from A to B in good order and on time. But whereas a heavy goods vehicle can be sent on its way with a driver plus spare driver(s) to comply with the law on long hauls, ships require a captain and his crew of deck officers, boatswain and matlows, engineers and motormen etc. to enable the ship to be independent of the land for days on end. Ships are not mini business units or transport factories. Their officers are highly educated and trained, and of necessity a strict discipline is maintained. Their logbooks are kept by the captain and the chief engineer. The companies' administration is kept ashore and there is a technical department of superintendents which provides support, if necessary by also consulting classification societies, in the event of emergencies or during dry docking.

I do not believe that autonomous ships without a crew will ever come into being. There are too many scenarios which make it disastrous, from a yachtswoman who needs to be rescued in the South Atlantic, who will not know how to climb on board her rescuer, to pilots who have to guide a ship into port who will not know which button to press or know the capabilities of the ship such as its stopping distance or its turning circle. I am convinced that intergovernmental regulations will prevent it.

Yours truly,
R. J. C. Dobson FRINA
Senior Principal Surveyor (Retired), Lloyd's Register

Martin Stopford responds

I read Mr Dobson's letter commenting on my article with great interest. I am grateful for his comments.

There is one point I would like to clarify. Mr. Dobson says that "the proposition to reduce trade volume without reducing value-added does not lie within the purview of shipping companies". Of course, this is true. But it is not the reality facing shipping companies today. IMO's strategy on GHG emissions makes international shipping companies responsible for reducing their annual carbon emissions to below 500 million tons by 2050, regardless of cargo volume.

As I demonstrated in my article, future cargo growth is the most important variable in the carbon emissions model, so shipping companies should not ignore it.

It is easier to highlight this problem than to deal with it. Perhaps if shipping companies work with cargo owners, they could find ways reduce cargo ton-miles. The industry moved about 60 billion tonne miles of cargo in 2018, so better informed decisions about voyage emissions would be a good starting point. For example, each tonne of iron ore transported from Tubarao to Qingdao in China requires 11,640 tonne miles of transport, whilst the same cargo from Dampier in Australia requires only 3,900 tonne miles. The iron ore which arrives in Qingdao is much the same, wherever it comes from, so sourcing iron ore from Australia would cut ton-miles and carbon emissions by two thirds. There must be many decisions like this buried in 60 billion tonne-miles of cargo. Today, carbon emissions are not explicitly considered in the cargo contract, but in future they must be.

Developments in digital technology can help improve the millions of cargo decisions made each year. For example, if shipping companies could provide cargo owners with a carbon estimate for their transport (e.g. based on distance, the carbon efficiency of the ship and planned voyage management), as part of the freight negotiation, the cargo owners could make decisions which take emissions into account. Similarly, retail products with the transport emissions printed on the packaging would help consumers choose carbon efficient products. In both cases the right decision is only possible if the right information is available.

Developing systems that produce this transport emissions information quickly, reliably and cheaply must lie within the purview of shipping companies – who else can do it? Smart ships may be part of the solution, but so are smart people to develop the shipping company information systems needed to improve freight decisions – millions of them, every year! *NA*

Yours sincerely,
Martin Stopford,
President, Clarkson Research

(1) Prof. R. Spronck, University of Liege: 'Chaix de la vitesse et de la portee utile les plus avantageuses pour un trafic determine; Probleme d'exploitation des navires', CiDiN: Ostende 1951

Hochschule Bremen
City University of Applied Sciences

HSB

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Subject to the release of funds, we have the following professorship to be filled as soon as possible:

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for the field of

"Ship Design, Ship Systems Engineering and Information Technology"

Ref.: Fk5- SM 1/18

Your future task
In the Faculty of Nature and Engineering you will participate in the development of teaching and research in the accredited study programmes "Naval Architecture and Ocean Engineering B.Eng. and M.Eng.". You will be expected to participate actively in the relevant research clusters embedded at the Hochschule Bremen as well as in the development of the teaching and research area "Blue Sciences". This also includes the supervision of the lab for CAE and ship design.

Duties include teaching the basic and advanced modules of the above-mentioned subject area in the bachelor's programme and the consecutive master's. In particular, it is expected that you will develop profile modules for the teaching area of "Blue Sciences".

Your profile
In addition to having completed a relevant engineering degree in the context of naval architecture and ocean engineering as well as a doctorate, you have several years of practical experience in the design of ships and maritime systems as well as the integration of ship systems. Ideally, you will also have applied and further developed IT processes in these areas. You have comprehensive knowledge in the application of ship design systems and experience with their integration into the holistic design and optimization process.

The statutory recruitment requirements resulting from Section 116 (1) to (5) of the Bremen Civil Servants Act shall apply. The prerequisites as well as explanatory notes can be found under

www.hs-bremen.de/internet/de/hsb/struktur/dezernate/d1/stellenausschreibungen/professuren

Moreover, you will be expected to
1. teach basic and advanced courses in bachelor's and master's degree programmes and expand the range of course offerings; these duties will include the supervision of students studying abroad and in their practical semester as well as the supervision of final theses,
2. work in interdisciplinary projects and participate actively in their further development, particularly in the teaching and research area of "Blue Sciences",
3. acquire and implement research and development projects and to actively shape the technology transfer of the Hochschule Bremen,
4. further develop the international relations of the Faculty,
5. actively participate in the university's self-governing bodies,
6. actively participate in the university's research clusters,
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In addition, experience in the general organisation of research and teaching as well as science management is an advantage.

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The Hochschule Bremen is committed to increasing the share of women among its professors to 35% by the year 2022. We therefore especially welcome applications from women. The office of the Central Women's Representative, telephone ++ (0) 421-5905 4866, will be happy to provide further information.

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for the field of

"Structural Analysis and Design of Ships and Offshore Systems"

Ref.: Fk5-SM 2/18

Your future task
In the Faculty of Nature and Engineering you will participate in the development of teaching and research in the accredited degree programmes "Naval Architecture and Ocean Engineering B.Eng. and M.Eng." You will be expected to participate actively in the relevant research clusters embedded at the Hochschule Bremen as well as in the development of the teaching and research area "Blue Sciences". This includes supervision of the lab for the applied analysis and design of offshore systems.
Duties include teaching the basic and advanced modules of the above-mentioned subject area in the bachelor's programme and the consecutive master's. In particular, it is expected that you will develop interdisciplinary profile modules for the teaching area of "Blue Sciences".

Your profile
In addition to having completed a relevant engineering degree in the context of naval architecture and ocean engineering as well as a doctorate, you have several years of practical experience in the structural analysis and design of ships and offshore systems. You have comprehensive knowledge in the application of CAE systems, finite element methods and manufacturing processes, ideally in the field of innovative materials and lightweight construction.

The statutory recruitment requirements resulting from Section 116 (1) to (5) of the Bremen Civil Servants Act shall apply. The prerequisites as well as explanatory notes can be found under

www.hs-bremen.de/internet/de/hsb/struktur/dezernate/d1/stellenausschreibungen/professuren

Moreover, you will be expected to
1. teach basic and advanced courses in bachelor's and master's degree programmes and expand the range of course offerings; these duties will include the supervision of students studying abroad and in their practical semester as well as the supervision of final theses,
2. contribute to interdisciplinary projects and participate actively in their further development, particularly in the teaching and research area of "Blue Sciences",
3. acquire and implement research and development projects and to actively shape the technology transfer of the Hochschule Bremen,
4. further develop the international relations of the Faculty,
5. actively participate in the university's self-governing bodies,
6. actively participate in the university's research clusters,
7. offer courses in German and English, and
8. establish Bremen or its immediate surroundings as your place of residence.

A sound knowledge in the general organisation of research and teaching as well as science management is an additional advantage.

Application
The Hochschule Bremen is committed to increasing the share of women among its professors to 35% by the year 2022. We therefore especially welcome applications from women. The office of the Central Women's Representative, telephone ++ (0) 421-5905 4866, will be happy to provide further information.

Staff diversity in science is enrichment, and priority will be given to applicants with severe disabilities who have essentially the same professional and personal aptitude.

Applications from people with a migration background are also welcome.

Please email your application and supporting documents in a single PDF file stating the above **reference** number no later than **15.09.2019** to **sabine.topp@hs-bremen.de** (HR Department).

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