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January 2021

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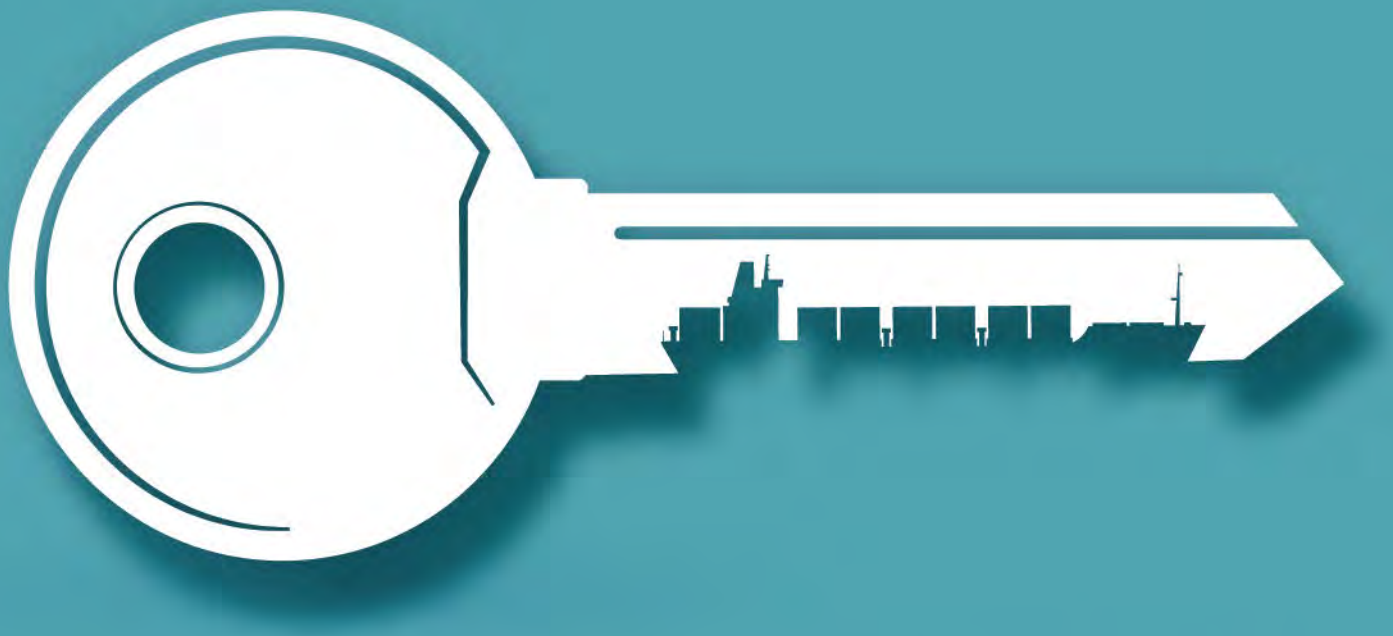

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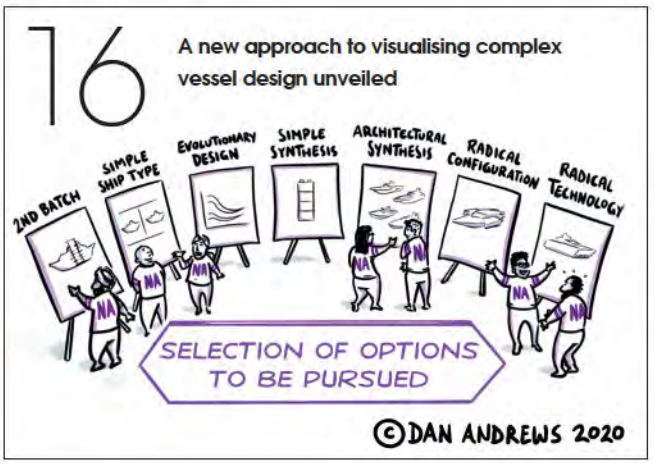

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2020

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Nominations should include a 750 word summary, describing the technological contribution made towards the advancement of maritime safety.

Nominations are open until the 31st January 2021.
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Is the 'low hanging fruit' being left to rot?

Accompanying this month's edition of *The Naval Architect* you will have found our *Green Shipping* supplement. In writing and commissioning its content we've attempted to paint a picture of merchant shipping's options and challenges in the drive towards more environmentally friendly shipping, both now and over the next few years.

In many respects, the drive towards efficiency and emissions control have become so ubiquitous in maritime that articles which aren't, even tangentially, related to those themes are becoming a rarity. That said, one person's 'green' is another's 'muddy brown', or any other shade in between. The increasingly irritating cliche that "there's no silver bullet" in shipping's mission to cut its GHG emissions is a well-intentioned acknowledgement that none of the proposed technologies and alternative fuels is without drawbacks or limitations, but it cannot be allowed to become a pretext for further prevarication.

The consequences were evident at MEPC 75 in November 2020, where familiar stalling tactics were employed yet again (see News Analysis). It seems the "low hanging fruit", to use another popular shipping cliche, can sometimes be left to rot. Apologists may point to the extraordinary times we're living in, that it's better to wait until the pressing crisis of Covid-19 is resolved and issues can be debated with some degree of normality. Well, one could immediately counter that argument by noting that if the pandemic has demonstrated anything it's that remedies can be found with unprecedented urgency, if there's the will.

Make no mistake, while the finer points of Ballast Water Management, and even NOx and SOx, may have passed over the heads of the general public, the same can't be said for global warming. With each delay comes the likelihood that the regulatory approach, and instruments such as carbon taxes, will become fragmented as regional enforcement is implemented.

George S. Patton said: "A good plan violently executed now is better than a perfect plan executed next week," and that surely holds true for shipping. There are technologies that could be implemented immediately and begin making a difference. Of course, there are going to be mistakes, that's part of the process of technological advancement, but also there's a growing body of evidence for some solutions. The challenge, if we're to move these technologies beyond the domain of trial projects undertaken by the elite operators, is making sure the regulatory framework is flexible enough to ensure that those shipowners willing to 'take one for the team' aren't penalised or disadvantaged retrospectively. That will require certain dispensations under any future carbon taxation, while also ensuring such a system isn't knowingly abused (as is sometimes claimed of EEDI).

Looking further ahead, there also needs to be pragmatism. While the proactive approach that the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping intends to take (see *Green Shipping* p.4-6) in fast-tracking some solutions is encouraging, upscaling some technologies simply because they offer a route to decarbonisation could have profound consequences. A fuel such as ammonia – arguably too dangerous to be safely used for coastal shipping, yet with an inferior energy density that would have significant design implications for deep-sea – risks leaving the shipowner with a stranded asset. If there's any consensus in the industry at the moment it's that a multi-fuel approach, matching horses for courses, represents the best approach, but perhaps we also need to be reconciled that for the largest ships there may not be viable alternatives until well beyond 2030.

I say that particularly with consideration of the promised land of Power-to-X (PtX), whereby surplus renewable electricity is used for the synthesis of chemical fuels. During a recent webinar, engine manufacturer Rolls-Royce MTU discussed its Green & High-Tech Program, a €500 million investment in eco-friendly technologies over the next 10 years, with a focus on PtX. Unsurprisingly, the company was keen to point out that it was perfectly feasible to create synthetic diesel that would be compatible with today's engines.

However, diesel synthesis has such a low conversion efficiency it would need to be sourced from areas rich in wind or solar energy, such as Patagonia or parts of northern Africa, and then transported to where it's needed by chemical tankers. Given the infrastructure requirements we're probably 10 to 20 years from such a model even being demonstrable, let alone scalable enough, to meet maritime's fuel demands. Even if the portion of the global fleet still requiring diesel or methane were stripped back to the absolutely essential, an overshoot of the 2050 targets would be inevitable.

Which probably means carbon capture and storage solutions (CCS), whether onboard or ashore, will need to be implemented. There's no shame in that, it's more a realistic acceptance of what shipping needs to fulfill its requirements, but it does demand serious investment in CCS projects over the next decade, as much, if not more so, than alternative fuels. Meanwhile, it really needs to start plucking some of that fruit before it's too late. *NA*

Alternative fuels

Joint industry project develops methanol-powered design

DNV GL has granted Approval in Principle (AiP) for the Low Emission Advanced Products tanker (LEAP) design, a concept designed to carry a range of cargoes and bunker methanol independently.

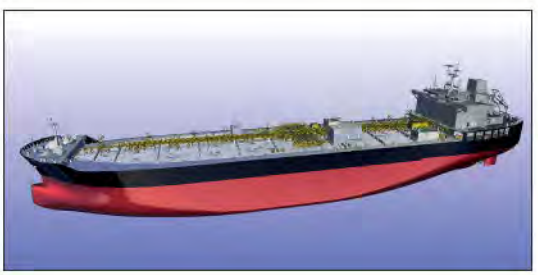
The LEAP design, operating at a service speed of 14.5knots, has an effective range of 17,400nm while operating on methanol as its primary fuel, and 21,900nm with VLSFO. It has a cargo capacity of 54,000m³, which according to the project is a reduction of just 300m³ in comparison to a diesel-only vessel.

Two 2,600m³ slop tanks for storage of methanol, protected by a cofferdam, are featured in the design, with a fuel supply system connecting to the engine room through an on-deck service tank. To provide operational flexibility, the design also includes tanks for VLSFO and MDO storage.

The plans originate from a joint industry project involving the Methanol Institute, DNV GL, MAN Energy Solutions and Hyundai Mipo Dockyard, which aims to enable product tanker charterers and shipowners to utilise methanol as fuel, regardless of the cargo carried.

Together, Hyundai Mipo Dockyard, MAN Energy Solutions and the Methanol Institute codeveloped the design in accordance with safety requirements but without compromising on cargo capacity and keeping additional build costs low. DNV GL provided technical advice and recommendations to enhance the design's development, as well as verifying and approving the design according to relevant rules and regulations, including IGF Code amendments for the use of methyl/alcohol fuels.

The project compares its design with existing vessels on the market, noting that where the capex for an LNG dual-fuel newbuild can be up to 22%, LEAP's additional newbuild costs are 10%. Comparing the design to that of a diesel-fuelled vessel, LEAP emits 54.7tonnes of CO_2 daily while operating at 14.5knots and using methanol as fuel, whereas a diesel-fuelled vessel emits 64.7tonnes. Further, LEAP should achieve around 6% improvement in EEDI Phase 5 rating compared to a diesel-only vessel.



General view of the LEAP product tanker design

Biofouling

IMO GloFouling Alliance appoints chairperson

IMO's Global Industry Alliance (GIA) has appointed Sonihull director Darren R. Jones as the founding chair of the GloFouling Alliance.

Launched in June 2020, the GIA aims to address the impact of biofouling on GHG emissions and the transfer of harmful aquatic species. Led by main partners GEF, UNDP and IMO, it brings together shipping industry stakeholders, the private sector and international regulations to take on the issue.

Jones comments that the task ahead is huge, as there are about 94,000 vessels in the global merchant fleet and a total capacity of around two billion dwt, with biofouling accounting for almost US$100 billion in extra fuel and remedial costs annually. "This does not account for the unseen costs of invasive species and climate change. By replacing existing antifouling systems and practices with available zero-harm technologies, marine industries can meet the economic and environmental challenges created by biofouling without restrictive capital costs, without unnecessary downtime and without leaving a toxic legacy."

He adds: "The shipping industry and the world's oceans are at a tipping point and it is essential that the marine industry comes together to share technology, ideas and legal frameworks to implement practical solutions to some of the world's most pressing environmental issues."

Alternative fuels

Danish partnership to develop hydrogen-powered ferry

A group of Danish companies has partnered up to develop a 100% hydrogen-powered ferry. *Europa Seaways* will be electrically powered through a hydrogen PEM fuel cell system capable of producing 23MW.

The partnership, comprising DFDS, ABB, Ballard Power Systems Europe, Hexagon Purus, Lloyd's Register, Knud E. Hansen, Ørsted and Danish Ship Finance, has applied for support from the EU Innovation fund. Torben Carlsen, CEO of DFDS, comments: "The largest fuel cell systems today produce only 1-5MW, and the development of such large-scale fuel cell installations for an electric ferry is a monumental task. We can only succeed in partnerships with companies that together can muster some of the globe's finest expertise in design, approval,

building, financing and operation of innovative vessels."

Europa Seaways' green hydrogen, used to power the vessel's fuel cell, will be produced at a planned offshore wind energy-powered electrolyser plant based in Greater Copenhagen, and the project partners will investigate how to optimally integrate with the local energy system.

Due to travel along DFDS's Oslo – Frederikshavn – Copenhagen route and anticipated to begin full operations in 2027, *Europa Seaways* will have capacity for 1,800 passengers, 120 lorries and 380 cars, and fuel tank capacity of 44tonnes. According to Knud. E. Hansen, the vessel is capable of 64,000tonnes of CO_2 emission avoidance annually, and its round-trip travel time and bunkering interval will each take 48 hours.

Classification

RS publishes cyber safety guidelines

The Russian Maritime Register of Shipping (RS) has issued its Guidelines on Cyber Safety, which entered into force on 1 January 2021.

The guidelines provide recommendations related to the design, manufacturing, maintenance and testing of shipboard computer-based systems, for vessels still in the design and construction stage contracted for construction from 1 January.

For ships already in operation, the guidelines include a requirement for maritime cyber risk management in safety management systems (SMS), which RS indicates should be taken into account no later than a year after verification of a Document of Compliance following the guidelines' implementation date.

A working group on cyber safety, which RS established in May 2020, developed the guidelines based on IMO resolution MSC.428(98) requirements, provisions of IMO circular MSC-FAL.1/Circ.3 'Guidelines on Maritime Cyber Risk Management', and IACS Recommendation No. 116 'Recommendation on Cyber Resilience'.

Vladimir Vikulin, departmental head at RS and chair of the working group, comments: "The development of the new guidelines is aimed at minimisation of a ship's vulnerability in terms of cyberattacks, malicious software, and, as a consequence, at the enhancement of the safety of shipping." *NA*

Debate ignites over proposed IMO regulations

Delayed MEPC 75 heralds new efficiency measures but upsets NGOs and some shipping sectors, writes Malcolm Latarche

Almost eight months after it was scheduled, MEPC 75 finally took place as another IMO virtual meeting in mid-November and predictably the outcomes seemed to satisfy very few of the industry stakeholders or NGOs.

There was, as expected, a ban on HFO as a fuel in Arctic waters, but exemptions are likely to mean that HFO can continue to be used through to mid-2029 and for some ships even longer. A new Regulation to MARPOL Annex I is likely to be adopted at MEPC 76 in 2021, which would ban the use of HFO after 1 July 2024 but there would be a five-year waiver for ships with protected bunker tanks.

Flag states with Arctic coastlines would also be allowed to exempt ships flying their flags and in territorial waters until 1 July 2029. Ships engaged in securing the safety of ships, or in search and rescue operations, and ships dedicated to oil spill preparedness and response would be exempted entirely.

Although environmental NGOs slammed the decision not to opt for an immediate ban, it was the proposals for reducing GHG emissions which drew the most criticism. An intersessional working group (ISWG) had been developing proposals for efficiency requirements for existing ships since MEPC 74 and came to the latest meeting with two proposals. One is the Energy Efficiency Existing ship Index (EEXI) and the other a Carbon Intensity Indicator (CII).

The new measures were detailed in late October and given approval at MEPC 75, although only after much discussion and an instruction for the working group to continue refining them for proposed adoption at MEPC 76 next year. If they are adopted then, they would likely be effective from January 2023.

The EEXI is, for all practical purposes, an extension of the EEDI rules to ships built before those rules came into effect in 2013. It is anticipated that in order to meet the requirements, ships will either have to undergo an engine derating or adopt some form of energy saving measures.

There have been a variety of reactions to the proposals with NGOs saying that because many ships are presently using slow steaming strategies and operating engines at below intended ratings, any derating needed to reach the EEXI requirements would not really mean any change to current practices. For them it is little more than an endorsement of 'business as usual'.

On the other hand, it has been estimated that around half of the world's fleet of larger trading ships will need to undergo some modification. The engine derating can be achieved without much expenditure but if there is a need to go beyond that, then costs will begin to mount.

The second measure of the CII has been criticised even more. It would apply to ships of 5,000gt and above and will use data collected under the IMO's DCS rules to determine the annual reduction factor needed to ensure continuous improvement of the ship's operational carbon intensity within a specific rating level.

The rating would be given on a scale – operational carbon intensity rating A, B, C, D or E – indicating a major superior, minor superior, moderate, minor inferior, or inferior performance level. The level would be recorded in the ship's Ship Energy Efficiency Management Plan (SEEMP). A ship rated D for three consecutive years, or E, would have to submit a corrective action plan, to show how the minimum C rating would be achieved. The IMO has called upon flag states and port operators to incentivise ships rated as A or B.

Criticisms of this concept included the fact that owners of inferior performing ships need only meet the rating once every three years to avoid taking any corrective measures and there would be no sanctions if they did not.

As to the combined impact of the schemes, some analysts have said it would lead to more scrapping and replacement of fleets, while others felt that the opposite could be true as owners just opted to derate engines. Another possible impact predicted by some is that there would be a move to regional regulation and away from the global level playing field that shipping has so long said was essential.

Reaction from within the shipping industry was remarkable for the polarisation of views. Even within Europe, which normally presents a united front, Maersk, Euronav and shipowner associations from Denmark and Norway expressed views siding with the NGOs whilst others were more satisfied. CIMAC, the global association of the Internal Combustion Engines Industry, believes the draft amendments are lacking ambition and long-term perspective.

It remains to be seen if the proposals will be much altered before MEPC 76, but it is certain that there will be more debate over them before then. *NA*

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Project courtesy of Wärtsilä Ship Design Norway AS

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Underwater noise

Strathclyde professors develop new URN measuring system

Professors Patrick Fitzsimmons and Mehmet Atlar's newly developed 'HyDrone' equipment measures a ship's underwater radiated noise (URN) using a unique configuration compared to traditional models.

HyDrone is a waterproof aerial drone fitted with a SoundTrap hydrophone recorder that is able to land on the sea, power off and float while suspending the recorder beneath it. According to the developers, this configuration minimises extraneous background noise from tidal current crossflow, which affects traditionally weighted line configurations where a suspended array of hydrophones are tethered to a buoy or support vessel.

Trials have been conducted off Blyth, UK, where the HyDrone made one short aerial trip coinciding with a passing run of *Princess Royal*. While in the trials, the HyDrone was launched and recovered to a support vessel, although in actual operations the system is suited to deployment from the target ship, thus eliminating the need for a support craft.

Results from the trial were tested against a standard vertical array of tethered hydrophones (RT systems). The findings confirmed HyDrone's ability to minimise background noise as, while floating in high seasonal current during the trial, minimal crossflow was experienced on the line between the drone and its 10m-immersed hydrophone.

Further trials are planned for 2021 in the Clyde Estuary, with the aim of gathering URN data on various vessels travelling at service speed, as well as at approach and departure speeds in both shallow and deeper waters.

The equipment, which will be made available for commercial hire, also features an onboard low-light camera augmented with a more deeply immersed lightweight camera, which aims to observe propeller tip vortex cavitation both over the rudder and at increasing distances behind the vessel. Data collected will then be used to validate advanced CFD simulations of cavitation induced noise. Other plans for the HyDrone include adapting it to measure wave motions, salinity and temperature.

Ballast water treatment

MPCC expands Alfa Laval BWTS installations

Operator MPC Container Ships (MPCC) plans to equip further Alfa Laval PureBallast 3 ballast water treatment systems (BWTS) with PureBallast Connect on its fleet, following successful installations on over 15 of its vessels.

Alfa Laval PureBallast connectivity

PureBallast Connect's secure online portal allows superintendents to support vessels by following parameters, conditions and alarms of connected BWTS'. Enabling them to validate system performance and, in the event of an incident, identify what action to take and utilise Alfa Laval's expertise.

Philipp Niesing, managing director at MPCC Verwaltungs GmbH, explains: "For new equipment like BWTS, the possibility to remotely access the systems provides several benefits. It was important for us from the start that Alfa Laval could access and troubleshoot the systems remotely, in order to avoid deploying service technicians to cater for small needs. We want to have our systems ready for use and compliant at all times, so as to prevent issues with port state officers and interruptions to our customers' routes and operations."

PureBallast Connect is a way to prevent downtime and reduce service costs and also benefits onboard crews, says Niesing: "The crews are well trained, but we want to facilitate immediate crew support to the extent possible. Crews are challenged to handle a range of sophisticated technologies onboard, and connectivity provides an opportunity for prompt support in troubleshooting."

Voyage optimisation

Swedish consortium develop AI-powered ship support system

Lean Marine, Molflow and Chalmers University of Technology have collaborated on Via Kaizen, a project aiming to develop an AI-powered, semi-autonomous system for planning and executing energy efficient voyages.

In the overall AI-powered ship operation support system, Lean Marine's propulsion automation system, FuelOpt, optimises the ship's propulsion in real-time,

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based on orders given by the AI system, which has been developed as part of the Via Kaizen project.

Further, data gathered by FuelOpt from both the AI system and other signals onboard the vessel is fed into the company's cloud-based performance management platform, Fleet Analytics, and shared with Slipstream, Molflow's vessel modelling system.

Joakim Möller, founder of AI-application developer Molflow, explains: "Slipstream will be trained on ship data available from Lean Marine's Fleet Analytics platform and will describe the vessel performance in different conditions with deep learning technologies. Our system will then be able to determine, given the constraints of the route and the ship, the most energy efficient voyage and calculate the commands that need to be set to reach the destination with the least possible amount of fuel consumed."

Researchers at the Chalmers University of Technology have developed new models and algorithms and the project, funded by the Swedish Transportation Administration, Trafikverket, already has three shipowners and operators involved. These include chemical/product tanker owner and operator Rederiet Stenersen and PCTC owner and operator UECC, which have offered up vessels to facilitate onboard testing, the results of which will be assessed as part of the ongoing project.

Engines

Wärtsilä 31DF engine gets power upgrade

Wärtsilä has upgraded its 31DF duel-fuel engine to increase its power output while maintaining its original dimensions.

The Wärtsilä 31 engine's power has been upgraded from its current range of 4.2-11MW to an increased 4.6-12MW, with 600kW per cylinder at 750rpm and 580kW at 720rpm. The company notes that the upgrade enables a typical ferry to reduce its GHG emissions by up to 750tonnes a year, the equivalent of the emissions output of 163 cars.

The Wärtsilä 31DF engine upgrade will increase its power output and lower the level of greenhouse gas emissions credit: Wärtsilä Corporation

Aside from a power upgrade, the company is improving the engine's already low level of exhaust gas emissions. Janne Klemola, general manager at Wärtsilä Marine, comments: "Getting more power from an engine that already delivers exceptional efficiency, low emissions, and fuel flexibility is a real benefit. Regardless of whether the engine is installed on ships for propulsion or in land-based power plants for electricity generation, achieving this upgrade with fewer cylinders lowers the lifecycle costs, while at the same time reducing both the installation and maintenance costs."

Since its launch in 2015, over 100 Wärtsilä 31 engines have been sold and accumulated over 60,000 field operating hours and the company states that its fuel flexible DF model, which can burn natural gas, marine light fuel oil and HFO, has been a popular choice among cruise ships, ferries, tankers and fishing vessels, and more.

Ballast water treatment

Optimarin achieves USCG filter approval

Norway-based Optimarin has received updated approval from the United States Coast Guard (USCG) for its ballast water treatment systems (BWTS), making it the only UV-system supplier with certification for a choice of two filters.

In Optimarin's BWTS, ballast water flows through a proprietary filter, removing organisms and particles, then continues through a UV chamber (killing or inactivating organisms) on route to the ballast tanks.

Filtrex and Boll filters are now both available options, thus Optimarin's entire range of BWTS components can be sourced from two suppliers, which the company says enables maximum availability and express delivery.

Further, the approved system has a holding time of two hours, allowing shipowners a short lead time in order to comply with the final deadline for IMO's Ballast Water Management Convention, extended for vessels delaying until their first renewed International Oil Pollution Survey due around 2024.

The company adds that it's anticipating a wave of industry orders, as Tore Andersen, Optimarin EVP, sales and marketing, comments: "The race for compliance is on, and we're focused on providing a seamless, high-quality supply chain for shipowners and operators to satisfy demand."

Emissions control

Scrubbers on 47% of newbuild dry bulkers, says BIMCO

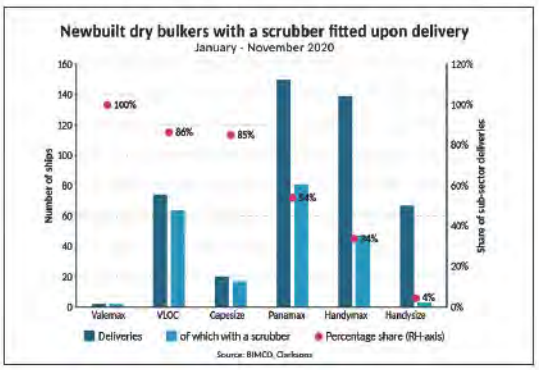
BIMCO has found that, as of December 2020, 47% of dry bulker newbuilds delivered in 2020 were fitted with a scrubber.

The association notes that 54% of scrubber-fitted bulkers delivered were Panamax vessels, taking up 81 units out of 150. Within the other large ship sub-sectors, including Capesize, Valemax and Very Large Ore Carriers (VLOC), the share of scrubber-fitted vessels varied between 85% to 100%.

BIMCO highlights a prevailing correlation where the bigger a ship's bulker fuel consumption, the more likely a shipowner will opt for a SOx scrubber over VLSFOs to comply with the sulphur cap. Notably, three newbuild Handysize bulkers delivered in 2020 were fitted with a scrubber, whereas of the Handymax bulkers delivered one in three had a scrubber installed.

In addition, the association comments that out of the 96 ships burning the most fuel, 13 opted for using VLSFO as opposed to investing in a scrubber.

Peter Sand, chief shipping analyst at BIMCO, comments on how the scrubber-fitted models are performing: "It is still worthwhile to mention that 2020 year-to-date average spot market earnings for a scrubber-fitted Capesize have exceeded that of a non-scrubber fitted Capesize by US$2,818 per day (+27%)." *NA*



Newbuilt dry bulkers with a scrubber fitted upon delivery Source. BIMCO, Clarksons

A new way to visualise the design process of complex vessels

Professor David Andrews and his son Dan, a graphic recording artist, outline their collaboration to find a new way of capturing and explaining the nature of the design process for complex vessels

The complexity of creating and designing physically large and complex (PL&C) systems is a subject that has occupied Professor David Andrews for much of his working life, both as senior naval ship and submarine designer for the UK Ministry of Defence and then, for the last two decades at University College London (UCL), both researching and teaching Masters students about complex ship and submarine design.

Last year, Andrews' expertise made him the recipient of RINA's highest award – the William Froude Medal – for his lifetime contribution to the field of ship design. Much of this contribution in challenging established practices was encapsulated in the first special edition of the *International Journal of Maritime Engineering* (*IJME*) featuring his 2018 paper 'The Sophistication of Early Stage Design of Complex Vessels'. As the title suggests, the paper captures the complexity of Early Stage Ship Design (ESSD) and was by necessity comprehensive.

But what if there was another way of communicating this information? Prof. Andrews has recently become aware of the of the possibilities of Graphic Recording, a field of illustration used to assist all sorts of businesses with strategic planning in complex environments, in which his son, Dan Andrews, also happens to work. Could such an approach, emerging from a series of discussions with experienced practitioners and current researchers in the design of complex vessels, produce a new representation of how we design?

This article outlines how the pair set about graphically capturing the crucial early stages of that design process. The aim was to see if such an approach would avoid a simplistic 'one size fits all' picture, which has the potential drawback of inhibiting creativity. Rather, might such an approach better reflect the complexity and multifaceted nature of sophisticated design practice with multiple pathways and multidisciplinary interactions?

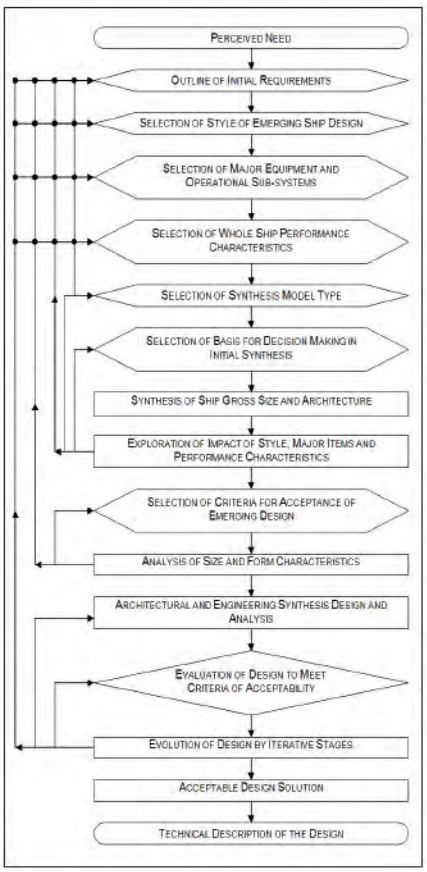


Figure 1: A Representation of the Ship Design Process Emphasising Key Decisions (from Andrews, 2018)

It is also hoped the resulting graphical representation can be used to help teach such a process, not just to the Master students at UCL but also to the wider profession, as an adjunct to the 2018 formal paper already commended to the profession at the Institution's 2020 AGM..

What is Graphic Recording?

Graphic Recording (GR, also known as 'scribing') has its origins in the work of innovative consultancies and training organisations operating in San Francisco in the early 1970s, who first brought visual documentation and synthesis techniques to their strategy workshops. Subsequently taken on as a tool of larger global consultancies in the 1990s, it has since spread around the world as a popular device for capturing valuable input, aiding collaboration, inclusion and insight, and helping participants at conferences, meetings and workshops find clarity from complexity.

The human mind is particularly disposed to processing imagery fast, and memorable visual cues can play a key role in helping people engage with complexity, think creatively and make connections between pieces of information. GR is often used in visioning workshops and strategic planning where disparate pieces of information, complex future scenarios, or the paths to them need to be explored and critically examined.

It is a particularly inclusive and 'democratic' format where the graphic recorder's lack of subject area knowledge enables them to capture what resonates in the conversation and the accessibility of the visual format allows participants to see a topic from new perspectives – gaining insight from being able to see the 'big picture' and discuss it with their peers and colleagues.

Why is some Early Stage Ship Design sophisticated?

It is obviously difficult to encapsulate such a complex and project specific process as ESSD, hence the exhaustiveness of the 2018 paper. Complex design has been described in other areas (such as urban planning and architecture) as a 'wicked problem'. While many designs (even for complex vessels) do not consciously follow all the decision steps Prof. Andrews identifies, for the purpose of introducing how GR has been used

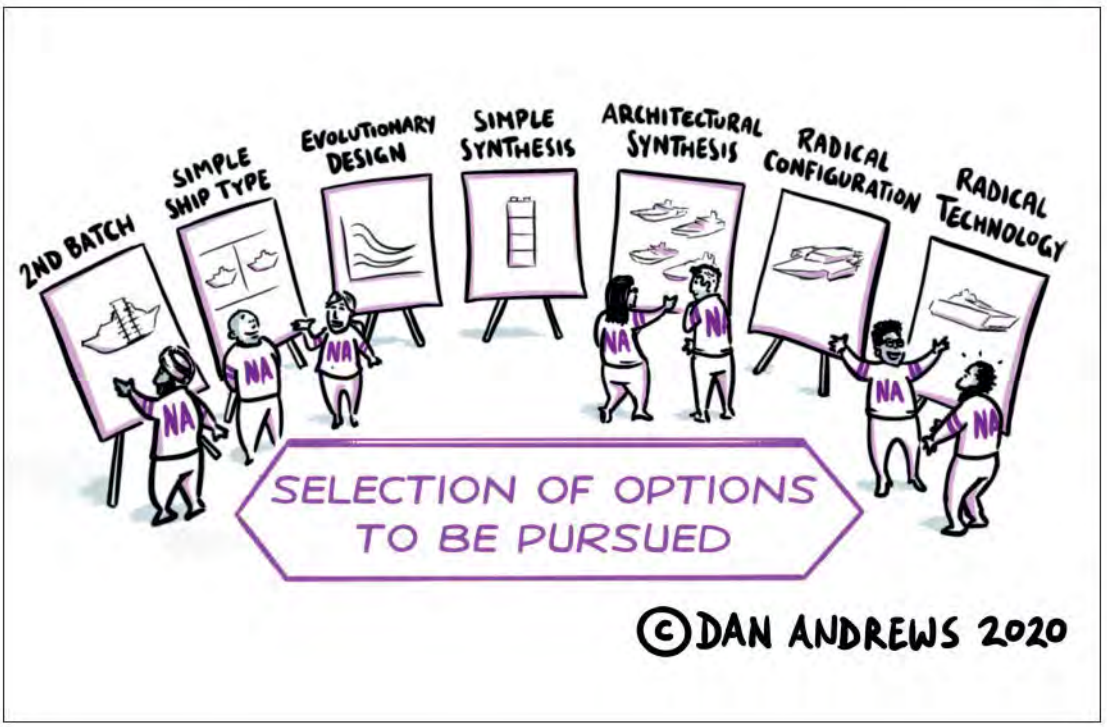


Figure 2: A highlight from the Rich Picture Graphic showing Option Types in terms of Design Novelty. Copyright: Dan Andrews

three key points from the 2018 description are worth highlighting.

Andrews coined the term "requirements elucidation" to capture what should be undertaken in the earliest phase of ship design, usually designated the "Concept Phase". Fully understanding the relationship between desired effectiveness and the cost and risk implications requires the designer to fully explore the solution space, and to do so in an interactive dialogue with the future operator over the nascent requirements and possible emergent solutions. The understanding, or elucidation, can only be obtained in the context of concept exploration of solutions so sufficient time and effort must be allocated to this critical part of the total ship design process. In design theory this is the 'wicked problem' of finding out what is really wanted (and achievable), which has to be resolved at the very beginning of the design process.

Secondly, for over 40 years Andrews has emphasised that there should be early consideration of space and geometry (or architecture) in evolving any new ship design. This has been demonstrated by his team at UCL using the Design Building Block approach, which uses advanced CAD alongside numerical balance of weight and space familiar to most ship designers. It differs from most approaches to ESSD in being an 'inside-out' approach to ship synthesis and provides an important perspective for the designer that traditional 'outside-in' design on its own cannot. This has proven essential not least in allowing human factors greater weight and enabling early assessment of naval ship survivability, not just vulnerability. Thus these and other factors, traditionally addressed after hydrostatic and hydrodynamics, have largely determined the emergent (underwater) hull design of any option being explored and can better influence the key ESSD decisions.

Finally, by highlighting the early choice of 'style' in any design option, Andrews has dealt with the old saw that form follows function. He argues there are many possible 'forms' and that designers, consciously or otherwise, select a given form through making a choice of style for each new design option. This then has to be checked to ensure it provides a set of desired functions. It's necessary to go beyond our naval architecture comfort zone to find many very important and, possibly, the best design solutions. This is not easy to do, but it must be done and must be done early with discipline, if we are to design satisfactory ships.

Figure 1, taken from Andrews' 2018 paper, served as the starting point in developing this first graphics visualisation of the ESSD process but immediately had to be extended to show more than one design option being initially progressed along the 'journey'.

How was GR used to model the SDP?

The members of Prof Andrews' Design Research Centre (DRC), including PhD students and UCL lecturers, along with Dan Andrews (who was without prior ship design knowledge), met online (this work taking place during the Covid pandemic) to facilitate discussion, using key elements of the 2018 paper. Over the course of three online sessions Dan presented iterations of his capturing of the 'ship design journey', culminating in the full picture revealed to the group in the final meeting and publicly unveiled for the first time in this article.

The GR artist interpreted what we ship designers felt describes a typical process for the crucial early stages of a major ship design project (in this case for a naval vessel). It was considered important to show the journey with multiple players (not just a single naval architect at a screen) as well as the paths of various options and the impacts of numerable disrupters.

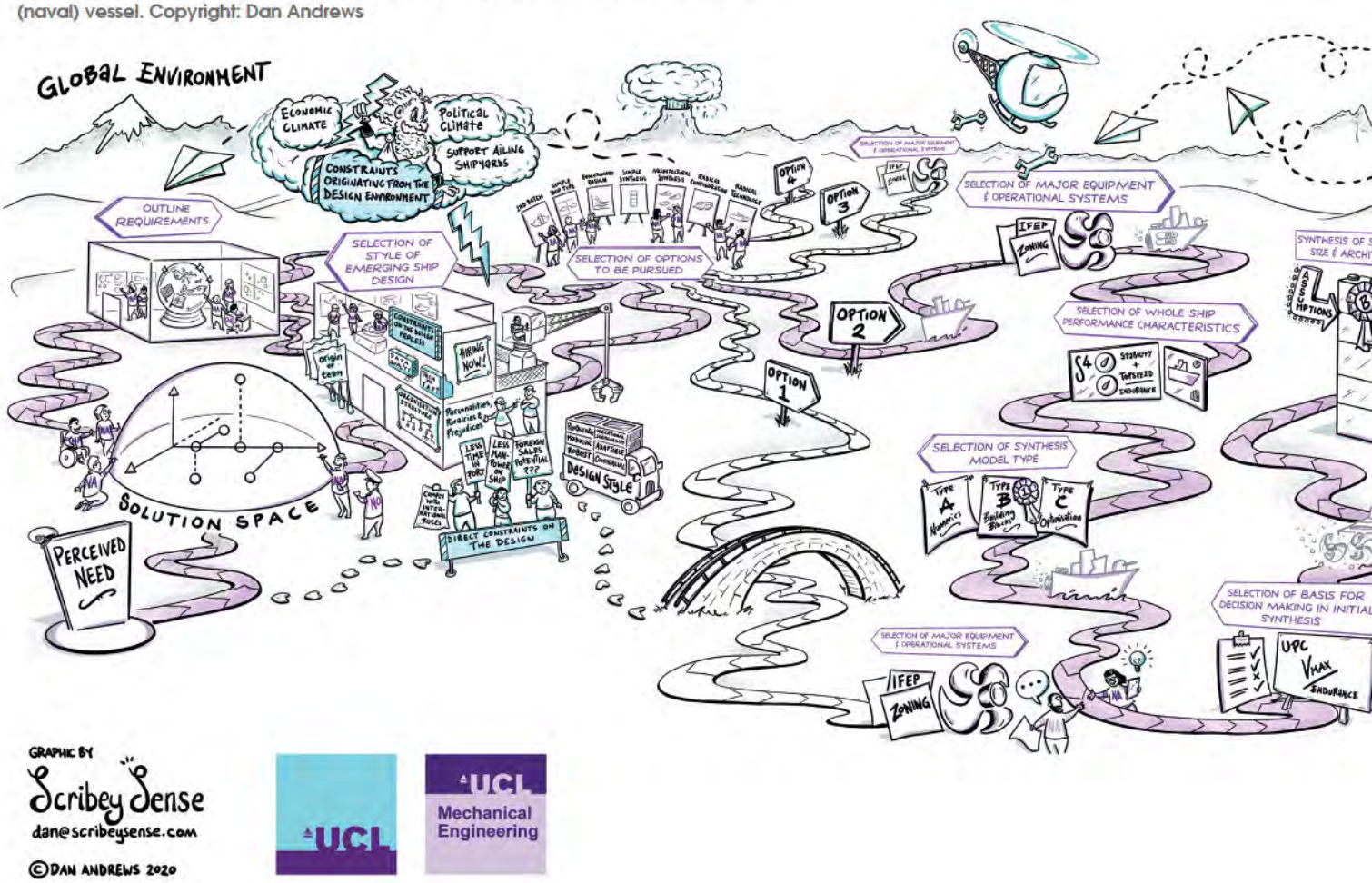
Dan Andrews comments: "GR is primarily about drawing live and in the moment, often with little subject knowledge, to capture the dialogue and insights that are made 'in the room'. The full piece is usually visible to participants as it takes shape and, bar some finessing that may happen after the meeting, the final piece is largely visible for participants to see as the meeting ends. However, at the initial stages of the project I quickly came to appreciate that, due to the complexity of the subject, the level of detail which participants would discuss both the design process and their personal experiences, as well as the need to visualise the interaction of various complex design approaches, this standard GR approach alone wouldn't be suitable.

"Instead, we took a different route that borrowed from both 'live' graphic recording and 'offline' Rich Picture illustration. My role was to synthesise the conversation and visually depict observations coming from the group, within the layout of a single cohesive image that represented the subject matter in all its richness and complexity. This made it possible to visually summarise a process that encompasses the various 'stages' of ship design, but also incorporated the 'human' and 'real-world' factors that directly impact on that process, which were revealed during the course of meeting with the group.

"These disruptive factors are impossible to highlight in a traditional summary of the stages of a ship design process (i.e. a step by step summary of design approaches with accompanying figures) but are possible to capture through graphic recording. Setting these observations and connections in the framework of a rich picture, using the visual metaphors and humour that's frequently found in graphic recording, mean that that final image could be an accessible, relatable and enjoyable tool for the end user to better understand the reality of this kind of ship design process."

This representation is in stark contrast to the somewhat unreal perfection of simplicities like the 'Design Spiral' or even process diagrams like Figure 1. Thus the journey mixes technical processes, very human dialogues and the evolving uncertainties arising from actual design environments, which are highly socially interactive. This social and open nature

Figure 3: Rich picture graphic depicting the Ship Design Process for a typical complex (naval) vessel. Copyright: Dan Andrews



also applies downstream with much larger multi-disciplinary teams, but was considered important to emphasise in the crucial early stages for complex vessels and shows them to be the very human activities they really are.

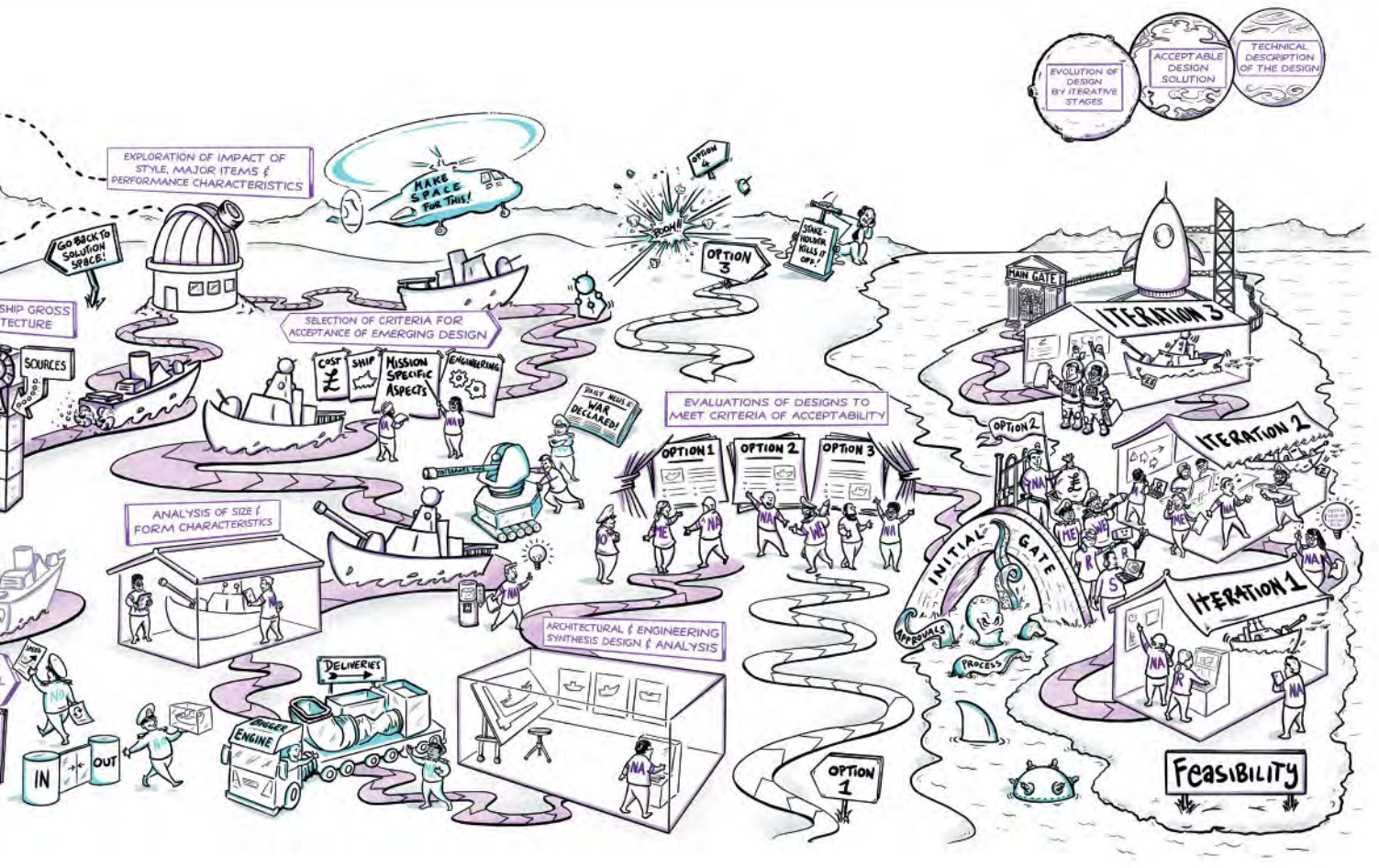
Is this a better way to understand a Complex Design Processes?

The question from this pilot study is whether it provides insights for ship designers, the wider design community and, also, students studying and coming to such processes for the first time. The UCL team and our graphics artist colleague would really like to hear views as to whether such a different presentation of a complex process helps all three sets of those involved in ship design.

Given this first brief presentation in *The Naval Architect* to the very widest field of those involved in ships and shipping, many will see this naval ship exposition as overly complex for most commercial ship design. However, by starting with the ESSD of these highly complex vessels, that Prof. Andrews has spent most of his career involved in designing, this representation is considered easier to reduce to a simpler journey than go the other way. It may also provide a basis for teaching ship design, by gradually building up the complexity.

However, Andrews is adamant that many of the decisions shown in the first diagram are actually made, albeit generally unconsciously, by all designers of PL&C products. What is not that common to the commercial world are the multiple option paths shown in the main diagram and quite the same degree of challenging the shipowners initial requirement or the issue of design assessment. For the latter, the commercial objective (with measures like Required Freight Rate) is much clearer than for service vessels and, furthermore, the business imperative often rapidly short-circuits (and ignores) the 'wicked problem'.

This intriguing and new way of picturing how we design ships is seen as at least an interesting development methodologically and in teaching complex ship design. It may well have applications to wider areas of design in the maritime sector and also beyond in the design of PL&C systems in other domains. *NA*



Covid-19 brings flexibility of cruise ship designs to the spotlight

Whether it's the more immediate implications of the pandemic or the longer-term transition towards low-carbon shipping, cruise shipowners increasingly have more than the whims of fashion to contend with. Kari Reinikainen reports

The Covid-19 pandemic has raised two questions about the flexibility of the designs of cruise ships. The first one relates to modifications that may be necessary to adapt existing vessels to operate in the new environment and the second one to possible effects of extended delivery times on the commercial and technical lifespan of newbuildings.

The Covid-19 pandemic forced the cruise industry to suspend guest operations and certain modifications onboard ships may become necessary before large-scale resumption of services becomes possible. Prior to the crisis, the orderbook of cruise ship newbuildings extended to 2027 and as some deliveries have been delayed, the question arises whether changes to designs may become necessary e.g. due to advances in technology.

As far as Covid-19 is concerned, the recent announcements related to likely and timely availability of vaccines will play a major role here, believes Tom Strang, SVP Maritime Affairs at Carnival Corporation & plc, the world's largest cruise shipping group. He adds: "However there may be some benefit to looking at changes to ventilation and air filtration – as you can see from announcements by different cruise lines – this may include use of different filter grades, UV treatment (ultra violet light) and reduction in air recycling for some areas."

"Apart from that there may some changes in internal layouts and space allocations regarding hand washing facilities, queuing space etc. to allow for social distancing and restricted access areas where necessary as well as other recommendations from the various public health and medical authorities."

Older ships are not necessarily more challenging in this respect. Strang continues: "For example, in some cases the latest designs which have significant energy saving devices in the HVAC (Heating, Ventilation, Air Conditioning) systems might be more difficult to modify."

Carnival Fantasy (ex *Fantasy*) and its sisters were retrofitted with balconies as passenger expectations changed

Three drivers of change

Looking further ahead, Strang says that advances in technology, changing consumer tastes and new regulations all influence the design of cruise ships. The use of LNG as fuel – the Carnival group is building a class of LNG powered ships of some 185,000gt, which will be used by four of its brands – posed such challenges as the fuel taking more space onboard than oil would do.

However, the large size of the vessels and an efficient design with close cooperation between Carnival, the shipyards that build these ships and equipment suppliers meant that the challenges were manageable. This, Strang says, can be expected to be the case when it comes to a possible adaption of other fuels to power ships in the future. From a technical point of view, incorporating such changes in an existing design is possible, but the question is how much money should be invested in achieving this, he concludes.

There is a lot of research into new technologies that could be used e.g. to power ships in the future: while some are at fairly early stages of development, others like hydrogen fuel cells are at a far more advanced stage.

Developments like these have the potential to change the face of shipping significantly over time, but this does not mean that the existing cruise ship orderbook would become obsolete, says Esa Jokioinen, director of sales and marketing at Deltamarin, the Finnish naval architects.

"They will not become fundamentally obsolete, although the development of new solutions does speed up: LNG has been used as marine fuel for 20 years, but it only now starts to become a true alternative for global operations," he tells *The Naval Architect*. Cruise ships are engaged in worldwide trading and for this reason, the owners need to look at the pros and cons of new developments against a broader background than, for example, ferry companies.

The established builders of cruise ships and the cruise lines that contract newbuildings have an understanding that not all technical details are agreed at the time a contract is signed. "These European yards are used to having flexibility in the design, so that the final details will be agreed with the owner as the design process moves ahead.

Ultimately, introducing any changes to the agreed plans is primarily a financial question," Jokioinen says. Switching to a different kind of fuel than what had been planned at first would incur such costs that it is not a viable option, but there are several lighter changes than can be made should need arise.

Against this background, the fact that the published orderbook for cruise ships was

Esa Jokioinen, Deltamarin

Tapio Karvonen, University of Turku

extended to 2027 already before the crisis and that the deliveries of some ships have been postponed does not pose a threat that ships will be significantly obsolete when they leave a shipyard.

All newbuilding options may not be taken up

"It is also possible that deliveries of some ships may be postponed further: this depends on how quickly operations are resumed and the ability of cruise lines to invest in the future. In light of the current situation I would look at the published orderbook and particularly the timelines with a certain degree of criticism," Jokioinen notes, adding that it would not surprise him if not all the options that are included in the orderbook were not eventually taken up.

It is possible that the long lead times to deliver the orderbook of cruise ships that may be stretched even further into the future as a result of Covid-19 can raise challenges due to advances in technology and changes in consumer behaviour, says Tapio Karvonen, senior researcher at the Centre for Maritime Studies at the University of Turku in Finland.

"The technical and equipment side of this question is much more complex. Some updates to existing designs can be done, but questions like at what cost and how does a change affect e.g. space utilisation onboard will emerge," he tells *The Naval Architect*.

"If massive changes are needed then you will lose the savings and efficiencies that the changes had been intended to achieve, so the economic advantage will be lost," he adds. As a result, owners of cruise ships and the yards that build this type of tonnage are likely to have in-depth discussions on how to adapt designs to meet the latest requirements should this become necessary.

Consumer related changes more critical

The passenger service side of designs plays a bigger role in determining the economic lifespan of a cruise ship than technical aspects. When what was Carnival Cruise Lines in 1987 ordered the first three Fantasy class vessels, cabins with balconies were rare and ones in significant numbers were limited almost entirely to suites on the higher end of the market lines than Carnival.

In the end, the series grew into eight ships, with the final unit delivered in 1998. By this time, balcony cabins were becoming a standard feature in all segments of the cruise market. Some cabins on a few ships of the class were retrofitted with additional balconies, but the project perhaps was not entirely successful as not all ships received the upgrade.

From a technical point of view, however, the Fantasy class, with its diesel electric power plant that used ABB's cyclo-converter technology, was modern: the last two units were fitted with Azipods, making them the first cruise liners with this technology. Yet it was the fact that the Fantasy class only offered a handful of balcony cabins – it was, from a commercial point of view, an enlarged version of *Holiday* that Carnival had built in Denmark in 1985 and its two Swedish built successors – that has condemned a number of Fantasy class ships to demolition in the aftermath of Covid-19 so far.

Luckily, as far as the future is concerned, it seems that meeting the changing tastes and requirements of cruise passengers will not require such massive challenges as was the case with balcony cabins and the Fantasy class. Many of the alternations that are introduced onboard cruise ships are based on IT. An example of this is Ocean Medallion, a small wearable device, with an app offering faster boarding, the ability to open you cabin door, pay for purchases onboard and the possibility to locate friends onboard.

It is much easier to incorporate such technology to existing designs – or indeed, existing ships – than innovations, which are essentially physical changes to them. The cost of the introduction of these technologies is also lower, Karvonen points out.

Open questions, changing landscapes

Cruise ships are among the most expensive merchant vessels and, at least until the present crisis, they have often enjoyed lifespans far longer than the usual 30-year depreciation time of newbuildings. This was due to the fact that the industry had also been highly profitable and earnings were far less volatile than in commodity shipping businesses. These factors have given owners more flexibility when it comes to investments.

The pace, extent and longevity of recovery from the present crisis will, quite likely, play a significant role in whether or not the industry will continue to enjoy the same situation in the future. At the present time, there is not enough visibility to say with anything like certainty whether or not this will be the case.

Prior to the crisis, the sector's strength meant that some first generation cruise ships built in the early 1970s were still in service. Even with an optimistic view on the industry's prospects, it is difficult to believe that ships currently in service would enjoy a lifespan of almost 50 years.

Newbuildings are unlikely to emerge as obsolete from shipyards, but an accelerating technological development that Jokioinen mentions combined with the emergence of Millennials and Generation Z as the most important groups of consumers, instead of the Baby Boomers that for so long have filled cruise ships, could bring the lifespan of cruise ships closer to the 30-year depreciation time. *NA*

Safe Return to Port gets an ASSIST

Italian research and consultancy Cetena, in collaboration with Lloyd's Register, has developed a next generation solution designed to support SRtP scenarios

Authors

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Seven Seas Splendor Image: Fincantieri

ASSIST, or the Shipboard Operator Smart Assistant for Safe Return to Port (SRtP), is the next generation guide for operators and other stakeholders, designed to actively assist crew in performing complex team tasks during an SRtP emergency. The equivalent to the hardcopy SRtP Operations Manual required by the International Convention for the Safety of Life at Sea (SOLAS) Regulations II-1/21 and 22, ASSIST is the first digital SRtP application that meets SOLAS requirements in a modern and effective way.

The fully independent software solution reduces potential for errors during ship recovery situations and the environmental footprint associated with paper manuals, while ensuring that any changes are immediately updated to the central database. This is the first time such technology has been approved by a major Flag State administration for use onboard a ship, supported by the approval of Lloyd's Register (LR). The first installation of the SRtP ASSIST system was performed by Cetena SpA with the support of Fincantieri during the construction of Regent's *Seven Seas Splendor* at the Ancona Fincantieri Shipyard.

The regulations available in SOLAS and the related IMO MSC publications govern the SRtP requirements, applicable to passenger ships whose keel has been laid from 1 July 2010 onwards, whereby the ship needs to be designed and built in such a way so it is able to perform a SRtP, even in the event of a fire or flooding within certain thresholds, thus making the ship its own best lifeboat. To do this, it is necessary to perform some restoration operations (also known as 'manual operations' as they are carried out by the crew manually) on essential systems; these are described in the operating manuals which must always be physically available onboard.

For all the damage scenarios specified by the IMO rules, the correct sequences of manual actions that onboard operators must perform need to be defined. This activity is carried out during the design phase through a detailed Failure Mode and Effect Analysis (FMEA) of all essential systems directly and indirectly involved in the damage. The results of these analyses are available onboard in paper format, which are referenced by crew following an injury to determine the correct set of manual actions to be performed. This process can be stressful, lengthy and could be a source of error, particularly if crew members are not properly trained and familiar with onboard systems.

To facilitate SRtP activities, the builder provides a specific manual for each possible SOLAS damage scenario, containing the essential information to carry out the ship recovery procedures. To meet the resilience requirement (a key concept of the SRtP), two copies of the operational manuals are carefully stored in separate rooms onboard the ship, in order to preserve the documents from deterioration which may occur from use in the marine environment, and to avoid the risk of losing the manual necessary for its recovery after the damage.

The restoration of the ship functionality through the essential systems is implemented by a series of manual actions that must be performed by an experienced and trained crew member in a limited period of time. Cetena has been working to meet IMO requirements for damage scenarios through relevant design activities since legislation was introduced in 2010, with activities developed for more than 30 ships to date, 15 of which are prototypes. Depending on the size of the ship, approximately 600 to 1,000 operational manuals are prepared to determine how much work is needed to restore a ship following a specific damage scenario.

Each manual contains the details of all the physical actions that a team of onboard operators must carry out to reconfigure the ship following that specific fire or flooding damage scenario. Teams can consist of 10 to 25 crew, trained to intervene on each possible scenario. Storing paper manuals onboard must also be a consideration for operators as it requires the need to find the necessary space – occupying more than 10 cabinets, potentially weighing several tonnes, and limited flexibility means it cannot be moved – often impractical onboard a passenger ship, for example, where space is a precious resource.

Easing the paper weight

The existing use of paper manuals, in addition to being bulky, is expensive and characterised by a significant environmental impact. Furthermore, in the event that the ship undergoes changes, in terms of the

Digital support for onboard operators Image: Cetena

layout and/or essential systems, a large number of manuals may need to be updated or replaced, which means having to reprint and replace them. This is inevitable for paper manuals and represents a significant and avoidable impact on the environment. Finally, the limitations of paper format must also be considered with regards to the ability to quickly access and effectively represent information during operational scenarios that take place under potentially stressful conditions. So, it is no surprise that the industry has looked to identify innovative solutions to improve manual storage, becoming more of a priority in recent years.

Utilising experience gained over the years around SRtP and exploring the possibility of using new digital technologies onboard, Cetena developed and implement the ASSIST tool, which can overcome many of the critical issues related to the use of paper manuals, facilitating and simplifying the intervention of the operator onboard if an SRtP scenario occurs.

Cetena's digital solution was certified with the support of LR, approved by many flag administrations, and received its inaugural installation last year onboard *Seven Seas Splendor*, the second vessel in the RSS Explorer class built by Fincantieri for Regent Seven Seas Cruises. It represents an important moment in the history of SRtP, marking the transition from traditional paper to the digital solution, aiming to reduce the amount of paper stored onboard, and importantly, help operators and associated activities that must be carried out in case of emergency situations, minimising potential human error and improving the reliability of operations.

Portable devices

ASSIST is based on a set of portable devices that interact with each other, providing onboard operators with all the information necessary to carry out the sequences of operations relating to the various possible damage scenarios.

The tablets keep track of all the actions that each operator performs, highlighting the sequence and recording the successful execution of the necessary manual actions. The interface has been designed from an ergonomic point of view to be easily interpreted and performed by the operators in order to reduce human errors and fatigue.

In fact, the previously used paper support required a compromise between the completeness of the information and the compactness of the manual. In addition, the information available on paper is static, meaning that it does not allow the operator to deepen the level of detail as needed. This could be a problem, as the lack of completeness of some information could generate stress factors for the crew and errors, compromising in some cases the safety of the ship and the people onboard.

The ASSIST portable device solution lets crew members collect the information necessary for the operator, allowing them to also view the General Arrangement plan of the ship and explore it, in order to better understand the actions it will be necessary to perform and view other useful information quickly and simply, including the best route to follow to get to the intervention site or photos and videos.

Verification and certification

The certification process of ASSIST, performed by LR, was carried out through hardware and software verification. Starting with the Software Conformity Assessment (SCA), an independent certification that allows LR experts to assess the quality of the software, ensuring its compliance with the pre-established development criteria in the reference standards.

Subsequently, a verification of the outcome provided by the system was carried out in order to ensure that there were no deviations from the data contained in the paper format. All this was performed while also evaluating ergonomic and human-centred design aspects aimed at ensuring a user-friendly environment. Finally, it was verified that the results provided by the ASSIST system through use of the tablet were aligned with the previously approved paper version and the master console updates accordingly, depending on the progress of the SRtP actions, generated by the single tablet.

The work carried out in close co-operation with LR to achieve the

ASSIST utilises an ergonomic interface to reduce human error and fatigue. Image: Cetena

ASSIST system installed on the *Seven Seas Explorer*. Image: Cetena

ASSIST certification is part of a broader activity of studies imposed by the SOLAS regulations aimed at increasing the safety of passengers and crew onboard passenger ships. These studies aim to enrich the safety culture by crew and to develop the necessary awareness of the risk factors in which they may find themselves operating. The installation of ASSIST onboard *Seven Seas Splendor* was carried out by Cetena in collaboration with the flag State administration of Marshall Islands (RMI), Fincantieri and LR.

Training tool

ASSIST can be used for the training of onboard personnel; in fact, the continuous turnover of crews from one ship to another poses another challenge relating to their knowledge of the ship and the procedures associated with it. By using ASSIST, the teams called to operate in possible emergency situations can carry out targeted training in advance, using the devices to familiarise themselves with the ship's systems and train to move inside the unit with the procedures that they will have to carry out if an event occurs. This means the complexity of ship systems, high number of components and spaces involved, and the heterogeneity of the skills required (electrical, mechanical, HVAC, IT, etc.) can be dealt with more effectively through new training approaches using the ASSIST solution.

All the devices (including tablets) onboard are in communication with each other, thus having the capability of synchronising. Moreover, operators can enrich the contents of the devices with material such as photos or annotations/notes/remarks which, once approved, can become an integral part of the contents of the devices available to other operators. In the near future, the devices may have a close interaction with the ship's essential systems, integrating technologies such as Wi-Fi by exchanging information with the ship's automation in real-time, or using QR code technology and Augmented Reality to have a deeper interaction with the ship. *NA*

Project Hygiea assessment for a safe return to cruising

Last year, Foreship unveiled its 'Project Hygiea' Covid-19 action plan to enable a safe restart for the cruise industry. With its first implementation complete and more under way, the initiative is restoring confidence in a sector hit harder than most says Mattias Jörgensen, Foreship's VP for business development

Following the recent decision by the U.S. Centres for Disease Control and Prevention (CDC) to lift the No-Sail Order, the cruise industry has been allowed – since 1 November 2020 – to begin a phased return to operations in the United States. As part of its 'framework for conditional sailing', the CDC sets out a series of stringent health and safety requirements for cruise lines to follow, such as providing testing for passengers and crew at embarkation and disembarkation.

The CDC's announcement arrives just weeks after IMO issued its own advice on the resumption of cruise ship operations. Drawing on guidance developed jointly by the European Maritime Safety Agency and the European Centre for Disease Prevention and Control, an IMO Circular (4204/Add. 26) targets ships registered to or calling at European Union or European Economic Area member states. It prescribes minimum safety and sanitation protocols to protect passengers and crew, based on comprehensive risk assessments of shipboard operations and third-party verification of any resulting modifications and procedural changes.

Foreship can thoroughly recommend the approach taken – not least because it completely aligns with Project Hygiea, the risk assessment-based service launched by the company almost as soon as the impact of Covid-19 on our cruise customers became apparent. Hygiea is part of a portfolio of new Advisory Services developed by Foreship that use the rigour of engineering to address changing client challenges.

Already, Project Hygiea has been applied to a real and working cruise ship, with the job fully approved by classification society Bureau Veritas (BV). The approach begins with a hazard and operability (HAZOP) study, through which Foreship collaborates with a 'HAZOP group' of vessel stakeholders to identify risk areas and develop solutions specific to their ship. A subsequent feasibility study determines how these solutions

manifest themselves onboard and in port, paving the way for engineering work, installation, commissioning and finally, verification by a third-party surveyor.

A step-by-step approach

While Covid-19 has undoubtedly done significant harm to the cruise industry, the situation is far from being irreparable; with the right approach, passenger ship operators can provide a safe and enjoyable experience for guests and help to rebuild public trust in this most popular form of holiday.

Unfortunately, there is no silver bullet for eradicating Covid-19 on cruise vessels. In the absence of such a solution, Project Hygiea tackles the threat on multiple fronts. The strategy combines Foreship's expertise in marine engineering, architecture, interior design and HVAC (heating, ventilation and air conditioning) with knowledge contributed by company partners and medical professionals. It seeks to minimise the presence, transmission and potential impact of the novel coronavirus and other pathogens on vessels by way of a four-step plan, as outlined below.

Stage 1: Interception

As the first line of defence against shipboard outbreaks, ports are designed for efficient interception, with technology installed for testing and measuring body temperature. Should a vaccine be made widely available at some point in the future, passengers will be screened for proof of vaccination before gaining entry to the vessel. The aim is to stop the virus from reaching the ship altogether.

Stage 2: Prevention

While the measures employed in Stage 1 can decrease the risk of an outbreak onboard the ship, there is no guarantee that they will prove 100% effective. Therefore, steps must be taken to control the spread of infection among passengers and crew. Spaces and routes are optimised to enable individuals and parties to maintain a safe distance, while technology is contactless and automated where possible to reduce transmission via surfaces. Hygiene – always a priority on cruise vessels – is given special attention, and crew are trained in sanitation, physical distancing and the proper use of personal protective equipment.

Stage 3: Mitigation

Preparations are made to mitigate the impact of Covid-19 if detected onboard. Decontamination procedures are carried out while infected passengers are quarantined in pre-designated, specially designed zones. Air treatment systems limit the flow of air between public spaces and thereby decrease the risk of aerial transmission. Facilities converted from unused cabins allow medical staff to test passengers and treat confirmed cases.

Stage 4: Evacuation

Contingency plans are established as a fallback in the event of an uncontainable outbreak. Evacuation protocols are put in place, with routes through the ship designed for speedy extraction, while emergency suits, capsules and craft are made available for worst-case scenarios.

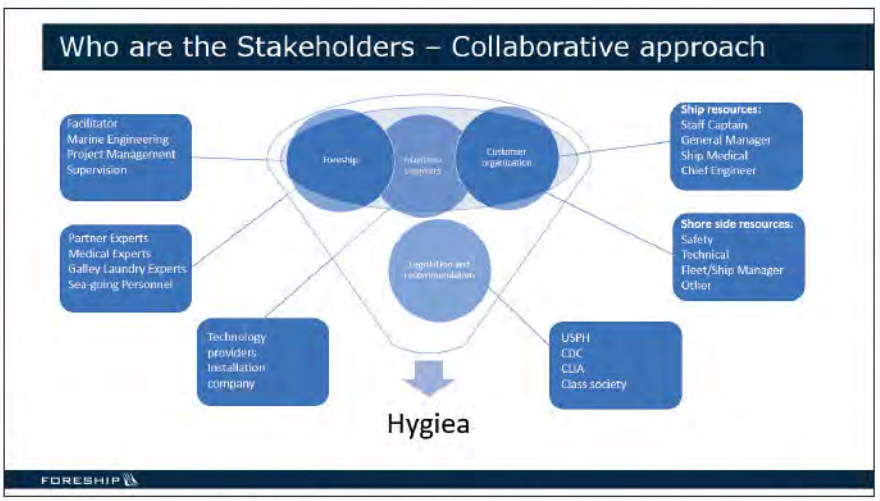
Successful debut, promising future

Approximately three months on from its launch, Project Hygiea has been deployed for the first time on an undisclosed cruise ship in preparation for its return to market. BV gave the vessel the green light following a thorough evaluation to determine how effectively the four-step response plan had been executed.

BV, whose comprehensive risk assessment strategy included HAZOP studies based on IEC (International Electrotechnical Commission) International Standard 61882, found the application of all four stages of Project Hygiea to be in fulfilment of its strict requirements.

With new advice from the IMO promoting the use of strategies like Hygiea, BV's verification represents a further endorsement of the initiative. The recently completed implementation project also gives Foreship its first experience in deploying the action plan on a large cruise vessel – and this will serve the company well as demand steadily increases.

Already, we are collaborating with other classification societies on a number of projects in the passenger ship segment. By incorporating the knowledge and experience of expert surveyors, Project Hygiea will continue to evolve and grow in scope, allowing it to better serve the sector in resuming operations and restoring public faith. If shipowners apply the right tools and planning, the outlook for the cruise industry will look far brighter than many might have predicted. *NA*



A hazard and operability (HAZOP) group brings together the stakeholders to identify the risks

Better ship connectivity is going to be a building process

The challenges of Covid-19 have proven the ideal test for remote connectivity, but many shipyards have some catching up to do, believes KVH Industries' senior IoT director

While the past year has raised all manner of complications for the maritime industry, it's fair to say that it has also represented an opportunity for digital services to not only prove their worth, but also highlight that there might actually be a better way of doing things. As much by necessity, services such as remote maintenance, surveys, inspections, performance optimisation and the support provided to seafarers have undergone irrevocable change.

For a company like KVH Industries, a leader in maritime satellite communications, the effects have been dramatic. "The pandemic has been a business trigger and there are certainly downsides," Sven-Eric Brooks, KVH's senior director for Internet of Things (IoT) business development, tells *The Naval Architect*. "We're also a content provider; we have a mobile connectivity business where we provide movies and music to the crew for their wellbeing, so we care greatly for the people onboard."

"But in other areas, such as IoT, Covid has challenged shipping companies in how to trade their assets remotely and monitor them. So it has moved from a rather optimistic way of accessing a vessel to more or less the standard modus operandi."

Even before Covid-19, the past couple of years have seen some significant advances for IoT technology, whether on land or at sea. The adoption of Message Queuing Telemetry Transport (MQTT), a network protocol for machine-to-machine communication, has played a key role in that progress. "The nice thing about MQTT is that it's bi-directional, lossless and easy to use. It has become the standard protocol for any type of IoT device, even in the land-based sector. Generally it's now being used everywhere, including the manufacturing and automotive industries, and it makes life much easier," says Brooks.

High throughput, backward compatible cables, such as the Category 7 class, are what's really required for effective onboard connectivity

Ensuring that the right information arrives at the right time, in the right format, to the right destination, is particularly important as the marine communications sector seeks to standardise its practices. KVH is among the members of the Smart Maritime Network, which is developing an updated, standardised noon report that draws upon the wealth of additional data it's now possible to send back to shore.

"KVH is committed to supporting the ISO 19848 standard, which is a naming convention, in order to identify sensor data within a given pool or link. By offering that standard it's easier to retrieve that data and fill in any type of report for any type of third-party system that needs to retrieve data from this data link. It makes it much easier to hand over and share information between different parties."

Learning from construction

But when it comes to ship design, there are additional challenges to the implementation of the connected ship that shipyards and naval architects must contend with in transporting data around the vessel. The steel of the hull and bulkheads can lead to electromagnetic interference and frequently there are either too few wireless access points or too many, which can lead to noise.

Added to that, retrieving sensor information from an older vessel creates huge challenges with the technology itself, given that little thought was given back then to providing open interfaces or ensuring the data was accessible.

Brooks believes that many vessels built today are still not being designed with network connectivity and communication in mind. In many cases, the IoT that has been implemented via retrofit is confined to limited areas of the vessel, where wireless connectivity is viable, because a wired solution is cost prohibitive.

Newbuilding design offers the opportunity to integrate IoT from the outset and he thinks maritime can learn a lot from land-based architecture. "If you look at buildings, there has been a rapid change from the standard office block to one which is connected and automated. Whereas in the past they used to be based on simple Cat 4 or Cat 5 cables we now need to look at other options such as Cat 7 or fibre optic cables, because they're the ones which provide the data throughput that's required for high-end users, which vessels are."

Although system integration should, by rights, be at the heart of modern ship design, less than 10% of shipyards currently include service as part of their shipbuilding contracts. While being a tried and tested business model, it contrasts with the growing emphasis in other sectors on the total cost of ownership with built-in service plans. When it comes to delivering the 'IoT ready' vessel increasingly demanded by a growing number of shipowners, providing a completely networked system, with the servicing commitment that might entail, requires a more holistic approach.

KVH launched its connectivity-as-service platform, KVH Watch, last year

Brooks says: "When you look at a vessel from a data perspective you find there are various subsets. There's the navigation bubble, the automation bubble, the power and propulsion systems, and the environmentals (e.g. ballast water treatment and scrubbers). Each of these areas is dominated by large suppliers that provide a completely self-contained networked system.

"But these systems need to be connected and then the question arises whether you're going to do that wired or wirelessly. When you look at the amount of data, plus the need in many areas now for video support, the real way to do this is a wired solution.

"[In the future] we might see shipyards building up their own services capabilities, where the yard takes a more active role either throughout the warranty period or even beyond. The shipyard is obviously the authority, understanding what piece of equipment was built where and having access to all the drawings and wiring diagrams. They're sitting on a wealth of information that they can make available to their end customers. This could create entirely new business models and lead to some interesting opportunities."

KVH Watch

KVH already advises shipyards on how to develop an IoT ready approach and they are increasingly among those most interested in receiving data via KVH Watch, the connectivity-as-service IoT platform the company launched last year (see also *TNA*, September 2019). KVH Watch acts as a core hub, collecting the IoT data from the vessel and subsystems and delivering it to any number of stakeholders according to their particular requirements.

As an independent dedicated maritime IoT terminal, KVH Watch avoids the common issue of trying to cram all a vessel's network solutions in the existing satcom terminal and the problem of so many different services – from machine-to-machine data transfer to crew accessing social media – contesting for space. Typically, the solution is to manage the network using firewalling and best practice for maritime cybersecurity, segregating information technology (IT) from operational technology (OT) as recommended by organisations such as IMO and BIMCO.

"IT is really emails and web access, but it's the OT where you have the engines, radars and everything you can think of in terms of machinery onboard a vessel. With KVH Watch we're splitting that in the most cyber secure fashion by having them air gapped on a segregated terminal and using dedicated channels for each manufacturer and user."

The service was further enhanced in June last year with the introduction of Remote Expert Intervention, a video collaboration application that allows equipment manufacturers to give real-time advice to onboard crew.

"There are a lot of brand agnostic service providers which service multiple brands, whether that's in the wheelhouse or below deck, and their core business is to attend to vessels and service equipment onboard," explains Brooks. "Now, with Covid, you can't just show up. Providing them with an opportunity to reach the vessels remotely, retrieve vital information from the equipment onboard, but being able to liaise with the crew to resolve problems in the middle of the ocean, has been transformational."

Aside from the cost saving (a typical callout for vessel equipment can cost US$5,000), because such work can be conducted while at sea it saves time when the vessel is at port and the work of cargo handling, inspections and documentation takes priority. "By removing those tasks from all those operations during port approach and when berthed, allowing technical issues to be resolved in the comfort of their own time, it's a game changer and we've heard a lot of positive feedback from the technicians onboard."

While remote servicing isn't IoT per se it's indicative of the push towards higher connectivity, something which Brooks, unsurprisingly, thinks will ever increase over the next few years as the evolution towards smart ships continues. "As an enabler we see a lot of drivers on the navigation side and the automation side to aggregate sensor information and make it easier to monitor vessels from afar, and I think that's where the journey will go." *NA*

Virtual Personal Assistant helps tame shipping's data monster

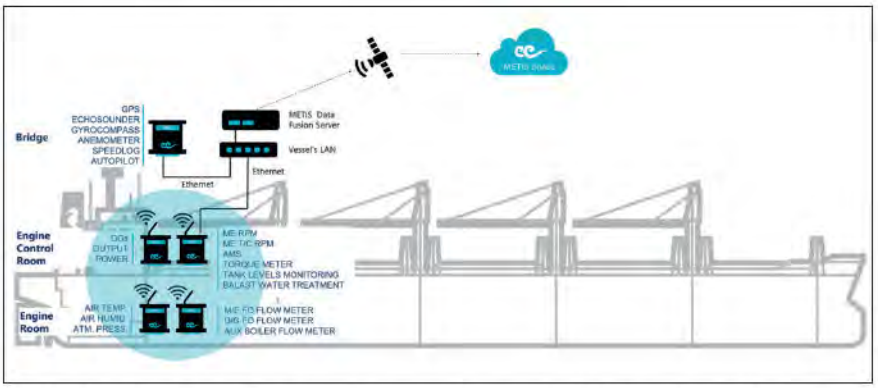
Big Data produced by ships can improve safety, efficiency and competitiveness but decision-makers must be equipped to interpret and act on results, writes Mike Konstantinidis, CEO of METIS Cybertechnology

Shipping has struggled to get to grips with data, but the tide is turning. The advent of reliable, high-speed, high-throughput satellite connectivity at sea means transferring vast quantities of data is no longer the problem it once was. The challenge today is sifting data for insights that can make vessels safer and more fuel efficient.

Shipowners and managers are also contending with a rapidly evolving regulatory landscape – particularly in terms of environmental performance – and vetting requirements from charters and cargo owners that are ever more demanding.

Fortunately, the advances seen in Artificial Intelligence, machine learning and related analytic techniques are now as available to shipping as any other industry.

At METIS, these technologies have been deployed to create a platform for capturing, processing and analysing data, with particular attention paid to making the outcomes of most relevance easily accessible to those using them. The user benefits from shipping's first Virtual Personal Assistant, an 'agent' powered by Artificial Intelligence which – like a seafaring Siri or Alexa – can help seafarers, shore-side technical colleagues and executives alike to perform their day-to-day tasks.



Wireless Intelligent Collectors around the vessel are meshed into a network which relays data back to METIS Space, a cloud-based hub

Data capture

Creating such a powerful solution relies on addressing a major obstacle facing digitalisation in shipping that does not block the route of other industries: lack of standardisation, in terms of equipment specifications and configurations onboard.

Stepping onto any modern vessel one will find equipment from innumerable manufacturers, most of which opt for proprietary interfaces. The situation contrasts starkly with aviation, where airlines largely choose between just two manufacturers. Shipping's apparent abundance of choice has, in reality, hampered integration efforts.

Finding a way to deliver this data that can be pooled, accessed and manipulated for multiple purposes as Big Data has become something of a 'Holy Grail' for maritime digitalisation.

The METIS solution is to deploy a collection of smart devices, called Wireless Intelligent Collectors (WICs), which are meshed in a robust wireless network. The data collected is transmitted back to a cloud-based hub, where it is stored securely alongside information from other sources, like weather providers and traffic monitoring services including AIS, as well as corporate resource and maintenance planning. Everything is immediately available to the micro-services and 'agents' providing functionality and interacting with end-users.

The ability to gather data around the clock provides a much richer, high-resolution picture of vessel performance than would be possible through trying to join the dots using incomplete, patchy datasets obtained from noon reports or manual readings.

WICs don't just function as a dumb relay, forwarding data unchanged as it arrives. They contain embedded processing power to carry out local pre-processing, cleansing and preliminary analysis of incoming data before it is transmitted back to the hub. By intelligently removing unimportant 'background noise', the architecture also reduces the load on the hub and improves overall system resilience and reliability.

This supports 'data-driven decision-making', helping staff to generate various operational scenarios quickly and easily. Based on the current condition of the vessel and dynamic parameters such as speed, ETA, draught, etc., METIS can help shipping companies choose the optimal course of action, without captains/superintendents having to resort to guesswork.

This qualitative approach contrasts markedly from the one-size-fits-all model previously seen in the maritime space, where unfiltered data has left manipulation or interpretation up to the individual user.

Recently, we had a case of a real vessel faced with heavy weather on a passage from Malaga, Spain to Rotterdam, the Netherlands. The normal course of action is to slow the vessel down and let the storm pass before proceeding; running multiple scenarios on METIS indicated – conversely – that less fuel would be burned by outrunning the weather.

Intelligent agents

Against this background, agents can be created to perform specific tasks: including

weather analysis, monitoring hull fouling, measuring fuel oil consumption, quantifying onboard energy usage, or tracking main engine operating efficiency. Agents can also adapt intelligently to their immediate environment, selecting the best available data source for the job at hand – whether from equipment sensors, manual readings or external information.

Because no two ships are identical, agents are also highly configurable and can be set up to detect and act on events based on vessel-specific thresholds. They have both diagnostic capabilities that can help engineers pin down the likely cause of an anomaly, and prognostic capabilities for predicting future outcomes so that corrective actions can be planned in advance.

Thanks to their predictive capabilities, agents can forewarn crew of potential impacts on vessel operation caused by changes in equipment status or forecast for the external environment. This helps to schedule maintenance tasks and aid voyage planning, also monitoring and evaluating machinery performance for optimisation purposes. The ability to intervene before an issue escalates offers benefits for safety, as well as the bottom line.

In exceptional cases where more rigorous investigative work is necessary to diagnose the root cause of a problem or make a decision, METIS can prepare and provide data in a format suitable for tools like Tableau, Power BI and MATLAB.

Virtual assistance

The way in which agents convey information to vessel crew and shore-based staff also represents a sharp break with industry norms. Instead of requiring another standalone application that complicates existing workflows, the default output channel for METIS is through the shipping company's existing collaboration platform – think Microsoft Teams, Skype or Slack.

If necessary, the Virtual Personal Assistant can reach personnel more directly by sending text messages to alert them to critical events. Such updates and alerts are presented in plain English as opposed to indecipherable error codes. Crucially, METIS won't spam everyone in the organisation about, say, a broken fuel pump. It knows who needs to know what, and, depending on the event's seriousness, when they need to know.

What is more, communication with the agent is interactive: recipients can respond, requesting more information or selecting a course of action – again in natural English, in much the same way they would chat with a human colleague. In short, anyone can now use data in their work without having to undergo training on how to code or query a database. This should enhance collaboration between different teams within a shipping company.

In this way, agents also assume the role of an extra pair of eyes for personnel in the engine room or PA for staff tasked with preparing regular performance reports. Against a backdrop of shrinking crews and growing administrative burden on those who are left, the value of such additional 'helpers' quietly and tirelessly supporting seafarers cannot be understated. *NA*

Why maritime companies are turning to digital technologies to aid business recovery post Covid-19

Shipping companies are increasingly demanding reliable and stable internet connections to enable them to transform how they do business post Covid-19, writes Alexander Buchmann, managing director, Hanseaticsoft

A recent report highlighted that satcom specialist IEC Telecom[i] had seen demand of remote high-speed connectivity onboard maritime leisure vessels boom as the sector reacted to the crisis.

IEC Telecom[ii] also noted earlier in the year that the demand for digital technology has risen tenfold as maritime businesses embrace new ways of working during the Covid-19 pandemic. Better connectivity is enabling shipping companies to turn to digital technologies, such as cloud technology, in order to radically change how they operate.

This wasn't always the case. Traditionally, shipping has been an industry that has lagged behind when it comes to adopting digital technologies. A whitepaper from Vodafone[iii] in 2019 pointed out that in shipping the sharing of information and data between companies and their customers – and even within companies – has been rare.

They say that situation has been exacerbated by the historical expense and complexity of deep-sea connectivity. However, with the advent of new high throughput satellite systems, coastal connectivity including 4G and soon 5G, the gateway to the digital economy is now opening for shipping.

This is enabling shipping companies to play catch up with other industries and make use of available technology to improve how they work post pandemic.

Another study, by McKinsey[iv], highlighted that responses to Covid-19 have sped up the adoption of digital technologies by several years and suggests many of these changes could be here for the long haul.

The study with C-level executives and senior managers across a number of sectors found that their companies have accelerated digitisation of their customer and supply-chain interactions as well as their internal operations by three to four years; and the share of digital, or digitally enabled products, in their portfolios by seven years.

Shipping companies can now start to follow suit and in light of the rapid pace of technological change and the economic fallout from the pandemic, utilise modern software solutions to help navigate the challenges ahead.

Whilst they may be unable to control external factors, we are seeing shipping companies focus on improving their internal operations to strengthen their business.

Investing in innovative digital technologies can help companies reduce their costs, reclaim time and manage operational and management processes more efficiently. It can also assist them in becoming more competitive, something that will be needed in a challenging economic environment.

Alexander Buchmann

How the cloud can modernise shipping

In 2017, McKinsey found that nearly half of executives ranked cost savings as one of the most important priorities for their digital strategies. In 2020, they say only 10% view technology in the same way.

While it stays true that the use of innovative technology increases efficiency, streamlines processes and this way saves costs, more than half of respondents now see technology's core value in modernising their capabilities and in gaining the competitive advantage.

One area where cloud technology is having a significant impact is the way in which shipping companies handle, store and access data. The core value is simplicity. As data is centrally stored in the cloud, all that is needed to access relevant information is an internet connection, regardless of time or location.

This enables users to work more effectively without having to request anything from colleagues or IT, ideal for employees that are working remotely. In the past, accessing data and accurate information was a big challenge that often wasted time and resources.

Without the cloud, different teams would be inputting and storing data in different systems and information may not have been accessible, accurate or shared effectively with others. Having accurate and up-to-date business critical information in one place and accessible to staff on or offshore is key to improving communication and collaboration between crew members.

Management decision making is also improved. With one source of true data, operators have a complete 360-degree overview of their fleet and entire operations, which means they can react immediately and confidently to information and their decisions are based on accurate information.

Cloud-based solutions help companies reduce their IT spend too. Instead of buying hardware and managing servers, the software vendor handles all of that and capex is reduced significantly. A centralised pool of information also makes it easier to evaluate data and calculate KPIs, either by exporting data to software solutions or using advanced solutions that do it automatically.

As the world moves beyond the pandemic, we expect more shipping companies will be using cloud-based digital technology to automate processes and create connected workplaces that support strategic business goals. This can help them transform their business and get ready for the journey ahead. *NA*

For more information visit:
www.hanseaticsoft.com

Cloud computing allows crew to access critical information, wherever they may be

i https://spacewatch.global/2020/09/iec-telecom-sees-connectivity-boom-on-leisure-vessels-in-the-crisis/
ii https://www.thedigitalship.com/download-digital-ship/send/18-2020/2673-digital-ship-142-june-july-2020
iii https://www.vodafone.com/content/dam/vodcom/images/maritime/Near-Shore-Connectivity-Whitepaper.pdf
iv https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/how-covid-19-has-pushed-companies-over-the-technology-tipping-point-and-transformed-business-forever

Clouds on the horizon for shipping's digital journey?

A full embrace of digitalisation will require new approaches to overcoming latency and greater use of standardised systems, says Tore Morten Olsen, President, Maritime, Marlink

We know that digitalisation will have a transformative effect on the maritime industry and that it has the potential to improve everything from operational safety and port call optimisation to environmental performance.

What is not always appreciated is that it is difficult to achieve a revolution in the way that people, assets and data are managed using the technology of a decade ago. Just as Moore's Law has been superseded with ever more powerful processing, communications technology has also evolved.

As if we need reminding, maritime communication is 'different' to terrestrial communications, principally because of its inherent latency, or delay between data being sent and its arrival. All networks have challenges of how to terminate the traffic with as low latency as possible and an increase in throughput does not by itself solve the latency issue because the journey is still into space and back. How we overcome this challenge requires a combination of engineering, hardware and software expertise.

The trend in data analytics is once again moving inexorably towards the cloud. But maritime satellite services operate with a level of latency that makes cloud-based computing and applications challenging. Even the use of LEO constellations does not eliminate the problem, because even though the distance between earth and satellites is smaller, the journey from the vessel across the network to an end point is still long compared to terrestrial services.

Our experience in smart hybrid networks suggests there are mitigations, including a form of buffering that smooths out the end-user experience by manipulating the journey of the data to enable it to be delivered as a complete package even if the process is interrupted.

Network performance can be impacted for better or worse by a number of factors; orbital spread of the available satellites, the likelihood of congestion and the number of overlapping beams in areas of the densest traffic. One-off problems such as blockages to the signal from ship superstructure are a fact of life but shouldn't be a reason to incur higher costs or sacrifice performance.


Tore Morten Olsen

For vessel operators, getting the service they require will mean comparing their options in detail and creating a benchmark that gives them the certainty they need. The absolute amount of combinations of satellites may not be decisive above a certain number, but the orbital spread and number of overlapping beams makes a critical difference to service quality.

The core differentiator is whether they are using a guaranteed service or one that provides 'best effort'. For some low level application usage, best effort will perform adequately but when communications become critical, an uptime and throughput guarantee will be required as the industry moves towards more complex solutions.

There are different categories of urgency and owners need to plan and prioritise the traffic in a particular data stream. Some OT systems may only need to ping once in 24 hours, others will send more frequent updates and systems must also be able to cope with unforeseen events that need to take bandwidth priority.

Achieving a new level of operational efficiency, certainty and security on the basis of "this has worked until now" may not be enough for the new technologies coming into play. A long term connectivity partner will need to do more than join one user to the other; value added services go well beyond basic user applications from backbone systems such as automatic updating to more emergent technologies like routing data around software-defined networks.

The trend towards cloud-based computing and applications also suggests that the industry can only take full advantage of digitalisation by moving towards the use of standardised software tools rather than the traditional maritime-specific systems that have emerged independently over time. This is particularly true of cloud services, which tend to employ disparate standards; these need to converge for the maritime cloud to work to its full potential.

The software, monitoring and performance tools that shipping has used until now can continue to be used over hybrid networks. This challenge lies ahead if more demand for cloud computing pushes latency further up the agenda. Being able to connect to shore and transmit data should be considered 'business as usual'; storing and processing data in cloud-based corporate systems will require us to think differently.

These challenges must be considered as part of the digitalisation story, and the shipping industry needs to understand the limitations and challenges in coming closer to an 'onshore experience' in the near future.

The physics of satellite connectivity might be against standard shore-based offerings for applications like Microsoft Office 365 or Citrix to maritime users, but with proper expertise and considerations, we can optimise every possible parameter to build a good user experience, making standardised tools work within the framework of maritime communications market. *NA*

Data that fuels shipbuilding – the role of CAD/CAM in data-driven shipbuilding

Slowly but surely the design process is evolving from a narrow focus on the end product to digital information flows and universal digital twins that can serve for the ship's entire life cycle, believes Cadmatic marketing director Ludmila Seppälä

Advances in VR, like Cadmatic's eShare for HoloLens, are helping take 3D modelling to the next level

Shipbuilding has a rich history that spans centuries. Traditionally, it is considered an industry that requires a lot of intelligence and science. Vessel design requires extensive knowledge about stability, shapes, structural strength, engines, equipment, materials strength, and much more.

Modern ships are complicated autonomous floating storages and transporters, power generators, refineries, living quarters, and leisure facilities. It takes years to design and construct modern vessels: the joint effort and coordination of numerous designers and engineers, meticulously organised work in materials and equipment procurement, assembly lines, workshop floors, and shipyard process management. Months of testing and adjustments are needed to ensure operational stability, train the crew, and set up maintenance schedules.

Shipbuilding as a data flow process

Looking at the shipbuilding process from a data flow perspective is fascinating. From concept and basic design up to shop floor and operations – a massive amount of data is created and used for various needs. Calculations performed for stability and flotation are critical in the initial stages, but not needed in production. Planning of production and work breakdown sequences can be prepared after the detailed 3D model is complete. The grouping of engineering, design, procurement, and production processes is non-linear and often simultaneous; the same can be said about data flows.

One might think – CAD/CAM/CAE packages take care of the whole cycle from the beginning of the project to the very end. However, a closer look reveals that shipbuilding's digitalisation process is fragmented and often too narrowly focused. There are many types of data that originate and evolve during the shipbuilding process: engineering and calculations, 3D geometrical and meta-data, logistical sequencing, work breakdown information, and production data generated according to specific machinery needs.

Shipbuilding's intense design focus and use of AI

The shipbuilding industry is distinctively different from other industrial sectors due to the intense focus on design. The so-called CAD-centric approach emphasises the 3D model and its role in shipbuilding as the single truth source.

The other significant trend is the use of AI and machine learning technologies. Machine learning mechanisms can assist in design decisions made by engineers and naval architects. Regulations and best practices are embedded in CAD/CAM systems to

help and act as a reliable knowledge storing facility. This process is not novel, as the first specification-driven features date back to the origin of CAD/CAM systems, but new technologies, such as neural networks and algorithms for the use of big data, have opened up new possibilities.

It is true that for shipbuilding, the 3D model and related documentation extracted from it constitute a foundation. However, this leaves the shipyard processes uncovered. As a result, a functional gap was created between design data and PLM/PDM/ERP needs to manage the shipyard operations.

Digital twins are the hub of ship information model

A common trend in modern CAx solutions is to look beyond creating the 3D model and extraction of production information. Incremental digital twin creation places the 3D model as the hub of the information model, adding layers of integrated non-centralised data. Essentially, this can be any data from any system that has an application in the shipbuilding process. This approach aims to resolve the information gap and directly link the design and PLM-related data.

The role of the CAD/CAM solution changes – instead of a tool for engineering and design, it takes on a universal 3D dashboard position. Adding information on top of the 3D model resolves the linking of data and information perception. Instead of looking through datasheets, users can see a 3D rendering of the end model and manipulate the data on a 3D dashboard. Advancements in computing power and new technologies take this even further – the data is available in any format and on any device – up to life-sized holograms in physical locations with AR/VR/MR/XR technologies and wearable devices.

The next gap

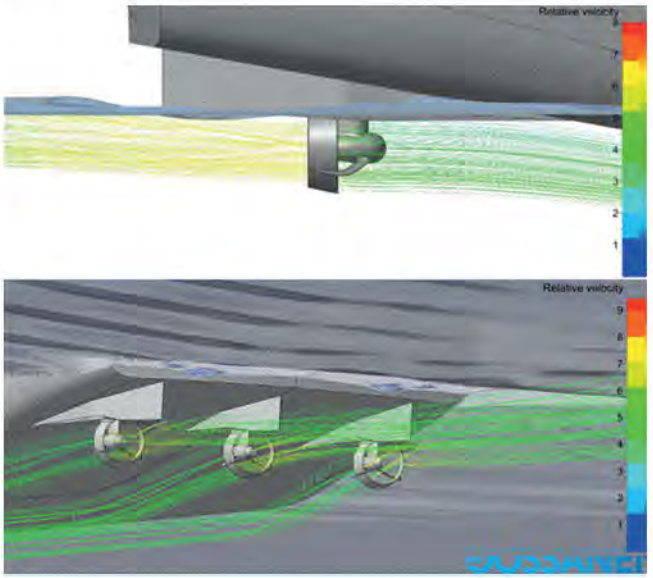
The future development of CAD/CAD trends emphasises the role of digital information flows and the process of digital twin creation. However, for the time being, it remains focused on the end product of a shipyard, the vessel that is delivered to the shipowner. The next gap in the digitalisation process is between shipbuilding data and operation, maintenance, and shipping. Creating specialised digital twins for each stage of the vessel's life cycle seems to be a cumbersome and ineffective approach. Developing and facilitating a universal digital twin requires a broader perspective on digitalisation and data flows, in which the interests of shipyards and shipowners are aligned. *NA*

Customer focus propels Veth onward

Veth Propulsion's technical director talks to *The Naval Architect* about the world's most compact azimuth thrusters, and the innovative solution it helped develop for operating in shallow inland waterways

Considering that this year it celebrates 70 years of involvement with the maritime sector, it's safe to say that Veth Propulsion by Twin Disc can claim to know a thing or two about marine propulsion. The Papendrecht, Netherlands-based firm has grown into a global player, but it prides itself on remaining true to its origins where meeting the customer's (service) expectations and the personal touch are key elements.

"Besides developing new thrusters, we are doing repairs and overhauls. Nowadays it's only a small part of our company," explains Marco Huisman, Veth's technical director. "We started developing products because customers were asking us. The man who founded our company (Mr. Jan Veth) was able to think in terms of solutions and developed certain types of bow thrusters, then in 1987 came our first rudder propeller. But we came from a service company, it's in our DNA. We like to try on the shoes of the customer and see what he's going through and offer him solutions he would like to use and solve issues quickly."



L-drives were mounted in troughs to optimise shallow draught performance

Integrated L-drive

With that customer focus comes the ability to adapt to their changing requirements, not least of which is the demand for electrical propulsion solutions. In 2017, it launched its Integrated L-drive, an azimuth thruster solution available with power ranging from 265kW to 2,350kW. Described as the world's most compact propulsion system, with extremely low mounting space requirements, it is attracting interest as a solution for inland barges, tugs and superyachts. Notably, it represented the first Veth system to use permanent magnet (PM) which is partly built inside the thruster, rather than asynchronous, motors, while the absence of gears inside the ship also means it generates less noise.

Huisman explains that the development process began a few years earlier, when it started exploring the feasibility of using the smaller, lighter PM motors. He says: "In the beginning there wasn't much interest, nobody was asking for a super compact thruster. Our innovations are often based on (scientific) market analysis and the latent needs of our customers. Then we had a project where the client required a very compact unit and decided to take that opportunity.

"So we designed a slightly different L-drive thruster. We found increasing the diameter of the slew ring, which is for steering, gave space to mount the electric motor inside the inner diameter of this slew ring, which enabled us to make everything much lower than the existing L-drive in our portfolio. We also mounted the elastic coupling partly inside the motor, which allowed us to lower the motor so half of it was inside the thruster."

PM motors offer excellent efficiency at full load, but Huisman says it is particularly at half load that a PM motor performs better than asynchronous motors. Nor is the price of PM motors such a deterrent; especially bigger motors (in excess of 1,000kW) are at the more specialised end of the market and will always come at a premium due to lower production volumes. The price of water-cooled asynchronous motors and PM motors are in the same magnitude. Up to 2,000kW, in particular superyachts and ferries desiring low noise production, there is also the option of including a contra-rotating propeller. In collaboration with Promarin, Veth's contra-rotating solution features a patented asymmetric 'shark tail' design that's said to ensure an optimal flow of water toward the second propeller.

According to Huisman, the Integrated L-drive is a "game changer" for the superyacht market. "Because our thrusters are extremely compact, it gives them design opportunities that they didn't have before. Superyacht designers often want to include an infinity pool or beach bar, which requires some space that would normally be occupied by engine exhaust systems. It's very beneficial to them that they can use our thruster with

diesel electric propulsion, which can be positioned much more easily than conventional diesel propulsion with a long shaft line."

Shallow draught

Beyond the Integrated L-drive, Veth Propulsion is continuing to find other converts to its propulsion solutions. One recent project of which Huisman is particularly proud of is the stern optimisation achieved with the tank barges *Oranje Nassau V* and *Oranje Nassau VI*. The shipowners, Oudcomb BV, were receptive to the idea of using rudder propellers for inland tankers, which is traditionally quite a conservative market. However, there was an additional demand that made it more challenging because they wanted to use the vessel on a very low draft. The effects of climate change mean that the water levels of many European rivers have declined dramatically in recent years and the capability to operate in shallow waters is increasingly vital, otherwise vessels may be unable to operate on their usual routes during the summer months.

Huisman explains: "Normally a rudder propeller has a disadvantage in low draughts because you need a certain amount of space for the 360-degree steering, so you need some extra space between the bottom side of the vessel and the top side tunnel construction of the hull. Also, with a low draught, because of the drag, it's less efficient to use a tunnel as you might with a conventional vessel. What we have done is identify a solution

The nozzled Integrated L-drive

that has the same benefits, using smaller propeller diameters but maximising the available space and creating a sort of small tunnel underneath sleek gondolas for every rudder propeller, to achieve the same effect. The hull resistance is much lower than vessels using a tunnel to be able to sail on low draught."

Working with our and the project's naval architects, the aft hull was designed so that it was capable of sailing at a very low draught. Most notably, three L-drives were each mounted inside gondola-shaped mouldings, each with a shallow tunnel, or trough (see image), thus enabling it to operate at a reduced resistance despite the smaller under keel clearance.

There were also some surprising efficiency gains. "When the customer compared his new vessels with his old [conventionally propelled] one he found they had 26% lower fuel consumption, despite the old one being smaller. So it was quite an achievement to realise the two most important demands: sailing with only 1.45m of water depth and without the disadvantages of such low draughts with required tunnels when fully loaded."

The future

With Veth's acquisition by power transmission manufacturer and distributor Twin Disc in 2018, Huisman believes there are now opportunities to expand the company's reach. "However, what we are finding, from talking to our partners in the United States, is that outside of western Europe many shipyards don't work with system integrators with knowledge of diesel electric propulsion. So, we need to be able to supply a complete package with generators, battery banks, power management, frequency drives and a monitoring system.

"So now we are able to work together with our Twin Disc partners to globally offer a complete package and enable them to go from the old-fashioned method of propulsion – diesel engine, gearbox and propeller shaft – to more modern vessels. We will set base on the trend of electrification and will offer shipyards the opportunity to go to a more sustainable solution and build new vessels with the energy transition in mind. In Western Europe this energy transition already started, and other continents will follow shortly after." *NA*

Extending the interdocking periods for berth-connected non-propelled ships and floating facilities

Recently updated requirements published by the Russian Maritime Register of Shipping allow for a number of different methods to avoid drydocking, explains Vladimir Shurpyak

Drydocking has always been one of the shipowner's major expenditures as regards ship operation. Traditionally, drydocking was carried out in order to remove biofouling from the hull and to coat the underwater portion, thus ensuring reduced hydraulic resistance to ship movement and fuel economy.

With the wider application of antifouling coatings, drydocking is still required for the service, repair and technical maintenance of the underwater parts of the hull, bottom and side valves, rudder and steering arrangements, shafting, propulsion and active means of the ship's steering (AMSS), as well as the underwater parts of the navigation equipment. The requirement is based on the Regulation 10/I of SOLAS, which stipulates at least two surveys of underwater portions of the hull within a five-year period for dry cargo ships (Regulation 10-v, Part I of SOLAS).

However, berth-connected ships constitute a special group and are subject to their first docking only after 15 years (according to the Russian Maritime Register of Shipping (RS) rules) and then every 10 years, as they do not need to check technical condition of shafting and rudder, steering gears and navigational equipment.

There still remains a range of facilities, e.g. floating power stations (including nuclear), floating docks, large oil and gas production units, floating oil/gas storage facilities and other offshore installations that do not provide a docking opportunity within the entire service life due to their dimensions or specific location. When designing this type of item, the designer will anticipate a long service life without service in dock. Therefore, in response to the needs of the industry, RS has developed special requirements for berth-connected non-propelled ships, ensuring 40-50 years of operation without docking.

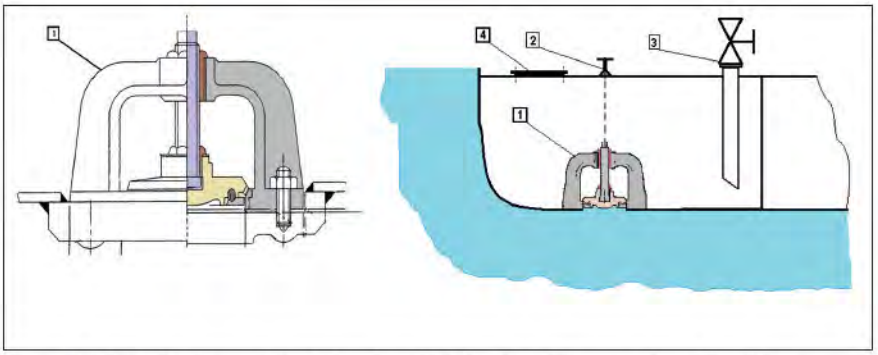


Figure.1 Inlet valve for sea chest. 1 - closed inlet valve of the sea chest; 2 - distance drive with bulkhead seal penetration; 3 - bottom or side valves; 4 – bolted cover of manhole to the see chest

Thus, if RS, at the design stage, approves technical solutions providing for the operation without docking within a required period, it is then indicated upon survey results in the documents and is considered during arrangement of further periodical surveys of ships in service. The particular technical solutions may vary depending on the project. Due to this fact, RS has implemented minimum criteria for these ships stated in Section 20, Part XVIII of the rules.

The special distinguishing mark UWILD or UWILD(S) added to the class notation may be assigned to ships constructed according to new requirements. Mark assignment is not mandatory and is carried out as desired by the shipowner of the berth-connected ship in case they have decided to avoid

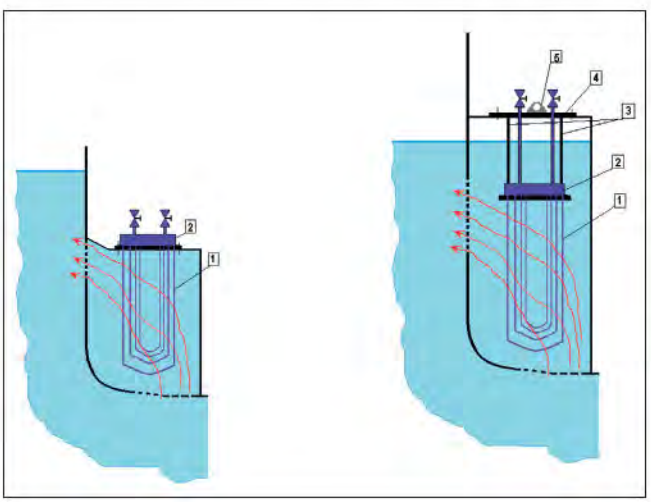


Figure.2 Mounting design and location of the boxcooler of an ordinary ship (left) and of a vessel intended for service without docking (right). 1 - tube part of the boxcooler; 2 - cover of the boxcooler; 3 – brackets; 4 - bolted cover; 5 - lug for boxcooler lifting

docking. Briefly, the requirements may be divided in two groups:

1. Additional requirements to maintain hull strength and watertightness. It can be obtained by increasing thickness of hull members (by increasing the corrosion allowance) and reducing the corrosion rate. These measures include protection of shell plating by applying a protective coating and electrochemical protection. In addition, any structural member of shell plating shall be accessible from the inside to perform measurements.
2. Provision of technical maintenance of bottom and side valves installed on the shell plating. From the real-life survey experience of RS, there are several ways of achieving that, as described below.

The simplest way to perform surveys of bottom and side valves, widely applied for river ships without docking, is the use of inlet valves for the sea chest. It is usually a disc valve without body but with a long stem. (Figure.1) However, due to their low reliability these valves are not used on seagoing ships and floating facilities. In addition, the more powerful the engines are, the larger valves are required, but the valve sizes are limited.

The most radical way to fulfil these requirements is to exclude sea water usage. For this purpose, the cooling systems are one-circuit with sea water coolers. Thus the design of the sea water cooler should be non-standard and able to dismantle tubes from the cooler to carry out technical maintenance, cleaning and repair without docking (Figure.2).

The significant restriction for this method is the power of the unit because the heat flow provided by natural water circulation is not intensive enough. Thus, this method is not suitable for powerful consumers with high water consumption needed for cooling (for example, floating power stations). Besides, numerous systems (for example, water-based firefighting systems or systems for process needs) mandatorily require water intake, otherwise their operation is technically impossible.

Another method is to apply external individual flange plugs for each valve or water-tight closing of sea chests (Figure 3). These provisional closures and plugs shall be provided on the shell plating to carry out service of bottom and side valves located below the waterline and may be installed by divers.

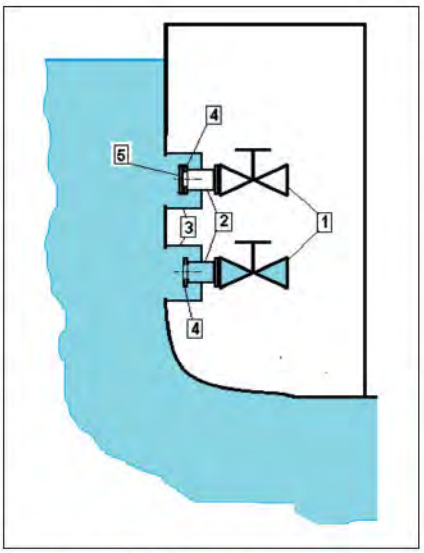


Figure. 3 . Installation of temporary flange plugs on the side board nozzles. 1- bottom or side valves; 2 - side board nozzles; 3 - side board nozzles recess; 4 - outer side board nozzles flanges; 5 - divers bolted flange plug

One more method is through a penetration trunk in the ship structure where all discharge and inlet valves are installed. Thereby providing the possibility for its closing and drainage to perform service works on the bottom and side valves. The trunk may be closed with a provisional plug from the outside by divers or from the inside on the top of trunk by cover as shown on Figure 4.

If submersible pumps are used in the trunk, closing and drainage of this trunk may not be provided, but the extraction of submersible pumps for technical maintenance should be possible. The examples of submersible pump use for water-based fire-fighting systems installed and extracted for maintenance may be found on several MODU and other offshore installations.

New requirements of the RS rules implement two distinguishing marks – UWILD and UWILD(S). The difference is that on the berth-connected ships with the UWILD(S) mark, all systems and machinery with disabled bottom and side valves shall remain in serviceable condition with redundancy of sea water systems. Herewith, it will be possible to carry out any type of technical maintenance and survey without interrupting the operation of power unit and normal operation of the berth-connected ship as intended.

About the author

Vladimir Shurpyak Ph.D., is deputy head of the Russian Maritime Register of Shipping's Machinery Department *NA*

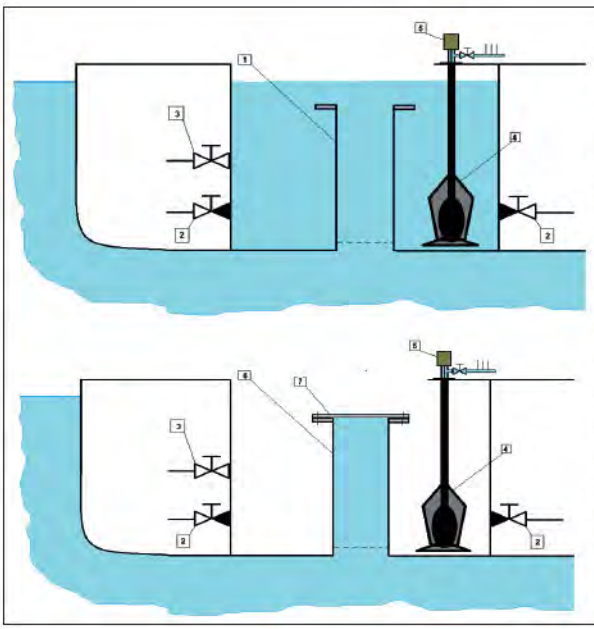


Figure.4 The principle of operation of the cooling system using the water intake through the closable receiving trunk: at the top - during operation, below - during maintenance mode. 1 - water intake trunk with open cover; 2 - discharge valve; 3 - suction valve; 4 - submersible pump; 5 - submersible pump drive; 6 - receiving water intake trunk with closed cover; 7 - receiving water intake trunk with open cover

Localised stress and failure on bulk carriers and OBOs

As a complement to his previous article on hull-girder loading (*TNA*, June 2020), Dennis Barber considers how localised loading forces contribute to bending and, in the worst cases, structural failure

In my experience of managing a wide variance of ocean-going cargo vessels it was the dry bulk trade that introduced perhaps the most significant challenges on localised stresses. Bulk carriers and oil-bulk-ore (OBO) carriers were always grouped together when in dry mode. OBOs may have enjoyed stronger internal structures and significantly greater pumping capacity when managing ballast but, particularly when alternating between wet and dry cargoes, they were extremely hard worked and highly stressed vessels. The question was always, did this project them towards the failures more to be expected in pure bulk carriers? I was always taught there is no such thing as a free lunch.

It is this combined group of vessels that this article concerns, but other vessel types may have similar issues.

Bulk carriers were and are still subjected to the carriage of dense cargos, frequently loaded at very high speeds. Those with which I worked often suffered structural failures that were localised. It is possible this relatively insignificant damage may be considered inconvenient rather than hazardous to the more global strength of the hull. Like the more catastrophic failures of side shell or decks, these localised internal failures could be attributed to the heavy loads imposed on the hull structure.

Localised Bending

During bulk loading the ship is responsible for matching the loading rate with a de-ballasting rate and pattern aimed at controlling the stresses on the hull within acceptable limits. This is not an easy task for the chief officer, or the officer of the watch on deck. In my own experience, the ballast spaces often had longitudinal centres of gravity that did not align with the cargo compartments they were intended to balance. More recent designs tend to have ballast tanks positioned with separations in line with cargo compartments.

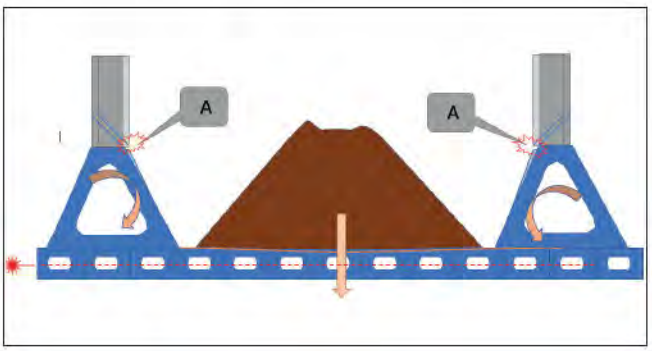


Figure 1: Athwartship section of hold loaded with ore

This is probably mainly for environmental management of ballast at sea but it also enables reduced longitudinal stresses during loading operations. The avoidance of the large shear forces that, in older designs, would very quickly arise during fast loading, could be key to also avoiding the type of failures described below. The only limits to which the ship's staff can refer are those applicable to global longitudinal shear force and bending moments, imposed by Class. These limits have traditionally formed the basis of any loading plan.

In the 90's our Capesize fleet were fitted with Hull Stress Monitoring (HSM)[1]. The HSM gauges provided meaningful outputs and could be seen reacting globally to the loading of the hull. It was found to be a useful tool when seeking cooperation from terminal staff in controlling the influences on hull stress. HSM however made no reference to localised bending, such as might occur when one compartment was loaded with 5,000tonnes or more when adjacent compartments remained empty. This condition was frequently encountered during loading and remained that way if a vessel sailed in a part-loaded condition, to top up in another port possibly on the other side of the first ocean to be crossed. In such part-loaded conditions the load differential between adjacent compartments could be in excess of 15,000tonnes. In a heavy ballast condition the same could apply in way of a ballasted hold.

Did any distortion result in these circumstances? Could it be measured? In as much as the ship's structure is itself a crude form of strain gauge, there were failures that should have alerted structural specialists to the possibility of localised stress causing deformation that incrementally differed from the global pattern assumed by HSM and the Class imposed stress limits.

1. Hull Stress Monitoring primarily involved a set of strain gauges at critical positions on the deck as well as at least one accelerometer forward for measuring vertical accelerations (due to slamming).

Localised bulkhead failures: lower sections

In Figure 1, the extract from a profile section illustrates the typical loading of a heavy ore in a conventional bulk carrier. The conical form of the load, in the heavier ores, rarely mounts the side hoppers or lower stools to any significant depth, such is its density. This means that the entire load is taken on the tank top.

Also depicted in the duct keel area is a laser, representing observations made on a particular Capesize class of ships. The aim initially was to detect distortions of the hulls causing double deflection longitudinally – simultaneously hogging and sagging at different positions – which affected the results of draught surveys.

The observations also provided useful data when fractures were consistently occurring in the double bottoms (referred to in my article 'Hull Girder Loading' in *TNA*, June 2020). Whilst all observations were made in ballasted conditions to ensure that the forces from known weights could be assessed more accurately, the local loadings were similar to those imposed by ore cargo (typically 15-18,000tonnes in single hold of a Capesize). The observations revealed localised sagging over a single hold length of between 1-2cm in the direction of the arrow in Figure 1. Failures in bottom longitudinals corresponded to these zones of deflection.

Figure 1 also depicts the lower stools rotating inwards towards the load. It was not possible to measure any such deflection but the failures that occurred, together with the known bias of weights, suggested this as a likely distortion. The cargo, being too dense to mount the lower stools or side hoppers to any significant depth, does not offer any support to the bulkhead. If any reader thinks otherwise, think again, this depicts the real world of dense cargo. The bulkhead itself (grey in the diagram) is usually a corrugated single layer sheet of steel. The corrugations are, in the larger vessels, aligned vertically. They attach to the lower stools by a welded joint onto a flat top plate of the trapezoidal stool (blue in diagram). The top edge of the bulkhead connects to the upper stool, or in some cases, underside of deck using a similar but inverted version of the joint.

An additional sloping plate, known to ship's staff as the 'shedder plate', is shown as the sloping blue lines at the base of each recess formed by the corrugated bulkhead. Similar plates are fitted in alternate corrugations sloping in the opposite direction in similar recesses in the adjacent hold (left out for clarity in subject hold). These shedder plates enclose a triangular space at the join, a potential corrosion trap but also, initially at least, creating greater rigidity in the area. Their top sloping surface enables cargo residues to be 'shed' into the hold and avoid clingage in places where accessibility for cleaning is restricted. They also provide a smoothing of stresses from the vertical to the sloping surfaces. The illustration shows the bulkheads and the shedder attachments in two positions due to the inward rotation of the lower stools on which they stand (exaggerated for clarity).

A failure often seen in service was a fracture of the weld at this joint – 'A' in the Figure 1. The fractures usually occurred at the weld between the corrugated bulkhead and the top side of the stool. This suggests strain in the structural elements due to the rotation of the stools towards the load in the direction shown. The lower stool, being more rigidly attached to the tank top plate, would concentrate strain at its joint with the corrugated bulkhead, which retained its vertical rigidity.

The underside of the tank top was observed to deflect in sag relative to the load above it. Observations also confirmed that in a seaway the forces acting in this area would oscillate due to longitudinal whipping of the hull and the repetitive nature of the oscillations would surely impose fatigue in the welded joints, which could result in failure where flexibility met with rigidity.

Onboard it was never known to what extent these failures weakened the bulkhead, but if carrying hold ballast, or worse still, oil cargo on the OBOs, the otherwise difficult to detect fractures would be quickly revealed. Further exacerbation was then often imposed when repairers simply welded the fracture, thereby introducing further stress as the weld cooled. The repairs were usually done in an empty hold when the deformation due to rotation had been relieved, returning the stool to its original alignment but with the possibility of a new weld retaining the stress from cooling.

I was taught by a chief engineer, who had a background in the nuclear industry, that welding often created stresses as the joint cooled that were worse than the original condition, hence such failures often recurred after repair.

Baseline Assumptions

What the above observations and those in the double bottoms[2] seem to suggest is an assumption of load distribution that may be incorrect. If the load were distributed more evenly the intensity of bending moment acting in the centre of the tank top would be reduced, but this is not the reality of fast loading in the heavy ore trade. Once loaded, the terminals have no facility capable of trimming the cargo. Furthermore, has the resistance to bending of the bulkhead assumed support from the cargo, which in denser cargoes is impossible?

It should be noted, however, that the deflections in the bottom structure were taken under a water ballast load, which is the ultimate in even distribution, so this points to flexibility of bottom structure that exacerbates the joint with the vertical structure. Should the bottom structure be further stiffened? If these assumptions need addressing it might, in the interim, be an idea to engage with the trade and the operators. This might be better than an assumption of heavy handling in a seaway.

Torsion

There was no reference in any onboard documentation to torsional stress, and yet the loaders could be placing cargo in a variety of positions laterally. Many ships had bridge front heel indicators displaying to the cargo deck. Loader operators could monitor these indicators to maintain the ship in an upright condition. Unfortunately lapses in attention could allow a heel to develop. If not corrected in time for the

2. *TNA*, June 2020, Hull Girder Loading

end of the cargo pour in the hold being served, the situation might lead to an attempt to correct the heel in the next pour, which typically would be in a hold at the other end of the cargo deck. The result would be torsional stress in the hull between those holds. In older OBOs this was visibly detectable because midship hose handling derricks, stowed athwartship, could, when viewed from forward, be seen misaligned with the windows on the accommodation block! It was something I always checked as each pour moved into its second half.

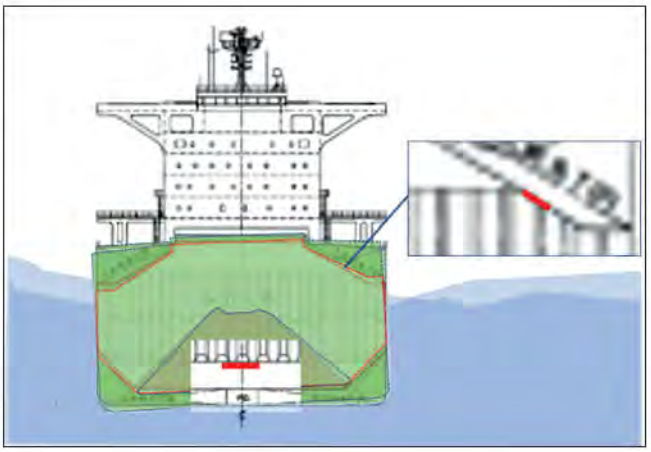


Figure 2: Sections superimposed (exaggerated for clarity). Effects of quartering swells on hull

Localised bulkhead failures: upper sections

Failures could occur at the tops of bulkheads adjoining the topside tanks (see Figure 2 inset). These failures could go unnoticed unless the holds concerned were filled with water ballast or in the case of OBOs, oil cargo, when the resulting cascade should have alerted the ship's staff to the problem. It is not surprising that a fracture in an inaccessible overhang some 20m above the tank top goes unnoticed but it is worrying that this joint, which surely is a key part of the hull's rigidity, should fail.

Bulkheads can collapse – it happened to me on a final voyage to the scrap yard. It causes sudden and alarming reactions in the hull and may test the mariner's ingenuity in reducing the longitudinal stress that can occur as a result.

Torsion stresses do not remain static in a seaway. Distortions due to torsion were identified from output of HSM fitted to the fleet in which I worked. The two midship strain gauge outputs (port and starboard) would oscillate, indicating in opposite senses (one in sag, one in hog). Furthermore, during such conditions the output would offset towards sag in the starboard gauge. This corresponded to resistance to the large propeller, creating kick-back in the after section of the hull[3].

Mariners are familiar with loud grinding noises from hatch cover movements when quartering seas are encountered. The movement is caused by the hatchway being forced "out of square". It is another indicator of torsion and is recognised in increased deck plating thickness in way of the hatchway aperture corners. But what about other (under-deck) parts of the structure?

Bulkhead detachment with the topside tank and the hatch cover movements could have their origin in long term and repetitive torsional stresses

Data may not be readily available. Class reports on repairs may well house records that could relate to these questions. Unfortunately, such records are owned by a variety of interests necessitating privacy which prevents their ready availability.

Conclusion

When failures of the types described do occur, the engineer superintendent might accuse the Master of pushing the ship too hard. The Master might plead that he is responding to pressure from the chartering department not to default on the charter speed. It would be worth saying, however, that in all the instruction manuals available to the Master I never found a single word relating to optimum speed and reduction of flexing or torsion. In relation to whipping, – repetitive flexing of the hull along the logitudinal axis – Masters will respond to excessive movements but could use more scientific verification to assist their decisions.

When carrying ore cargoes, it is well known that bulk carriers are probably some of, if not the highest stressed commercial hulls afloat. Is there a need for more research on in-service dynamic loads imposed by the conditions in the big, full-scale testing tank? There may be a case for further education of mariners as to how far they can push their ships. At least some written instruction would give the Master grounds for arguing back with the charterer, something that is rather scant to date. There may even be a need to improve awareness of these stresses and the practicalities of loading among those responsible for design and survey of hull structures.

I experienced a shocking wake up when on sea trials of a large Capesize bulk carrier newbuild. I was on the bridge with a naval architect who went rather pale as he looked forward through the windows. The ship was flexing in a way familiar to the mariners present, none of whom were particularly concerned. I concluded he may be feeling seasick as landlubbers (and seafarers) often do in such motions. I therefore enquired politely after his wellbeing. He quickly denied any nausea but pointed hesitantly out of the window at the very visible flexing, stating categorically that he never thought it could be visible!

My belief was shattered – that the design process was robust. I thought it was not considered necessary to impose restrictions on speed or wave interception angles during flexing. I had believed these stresses were understood and the reactions known about. Were they? Are they? *NA*

3. *TNA*, June 2020, Hull Girder Loading

ABS helps Tananger Offshore navigate path to Polar Code certification

Norwegian shipowner achieved compliance by leveraging class society's dedicated tools and services, writes Dan Oldford, Principal Engineer, ABS

When the IMO Polar Code was adopted in 2017, it was a new type of regulation. Designed around goal-based standards, where a high-level target is set and functional requirements are given to achieve the goals, then semi-prescriptive regulations to meet the functional requirements.

In general terms, the functional requirements of the Polar Code are applicable where a specific hazard is relevant to the intended vessel operation. This means that compliance with a goal-based standard is based on thresholds for rule application. Recognising these thresholds can be a significant challenge for a shipowner or operator.

Among the misconceptions about the Polar Code is that it will necessarily require major modification of the vessels concerned.

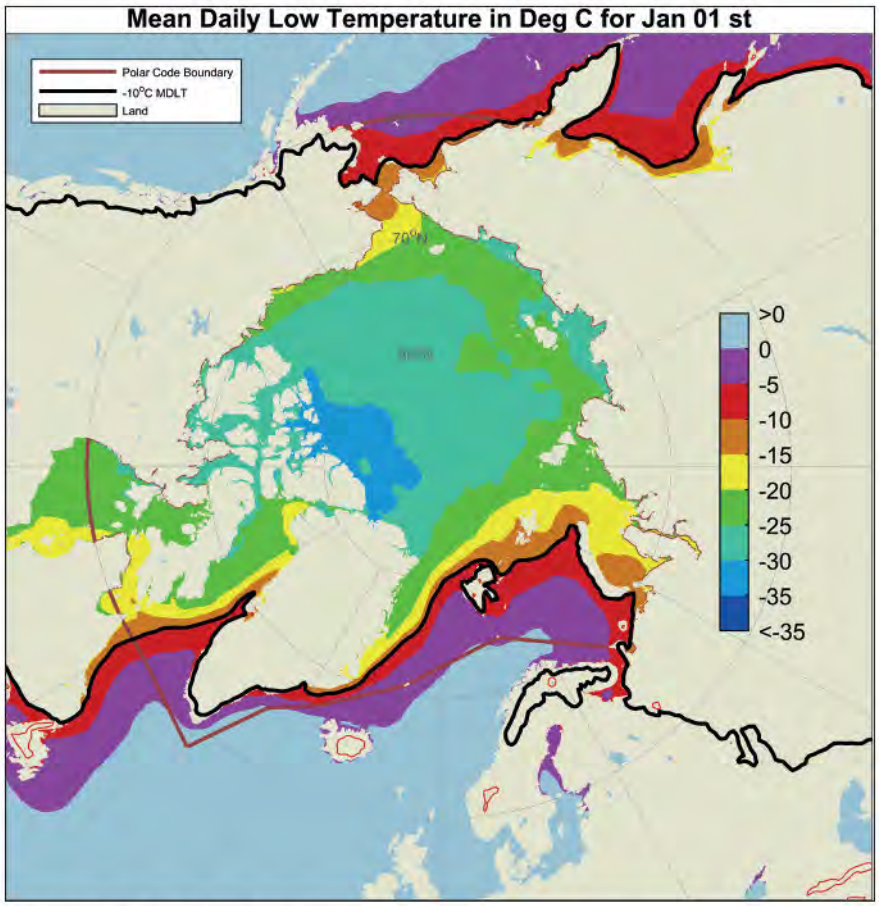
Obtaining certification does not require the vessel to be certified as ice class; rather it is a process of developing procedures in the company and onboard the vessel that demonstrate an understanding of the hazards and their mitigations. Critical to obtaining certification is that shipowners correctly identify and address risks and provide required information in the correct format to the inspecting authority.

In order to help industry with these requirements, the ABS Harsh Environment Technology Centre (HETC) has developed a suite of unique tools and services to calculate the data required for an accurate assessment and present it in a user-friendly way.

Based at Memorial University in St. John's, NL. Canada, HETC has unrivalled experience with the Polar Code. HETC engineers took part during the development of the code, chaired the IACS Expert Group Polar Code and assisted various flag administrations around the world to implement the code into their regulations.

Tools and services

To support clients in the compliance process, ABS provides dedicated solutions to help them understand and mitigate the risks. The ABS Polar Suite is an in-house software tool that inspects datasets such as seasonal sea ice and provides output in the form of easy to interpret charts of predicted ice conditions at the times and locations of the intended vessel operation.



The ABS Polar Suite tool can be used to help determine many of the hazards associated with harsh environment conditions, such as the air temperature shown here

The derived data can be used to support decisions for voyage planning in accordance with Polar Code Part I-A/11.3.4. The Polar Suite can also serve to fulfil the requirement for owners and operators to examine statistical sea ice and temperature data in former years by processing multiple year data for output.

A key aspect of Polar Code compliance is the Operational Assessment (OA). This is a process where the regulations are examined, operational hazards are identified and risk assessments for each are conducted, Risk Control Measures (RCMs) are decided and operational limitations defined.

The outcomes of the OA feed directly into the Polar Water Operational Manual (PWOM), making it critical that the OA is an effective and representative process. The relevant hazards must be considered together with their control measures, all in the context of the code's regulations. The HETC nominates a polar Subject Matter Expert (SME) to facilitate the OA, walking the owner or operator through a series of formal risk assessments.

These assessments address the hazards noted in the code plus any additional issues

identified by the group. If any of the risks are found as being outside the company's risk acceptance level, RCMs are developed to address the specific risks. A thorough examination of the regulations and the ship's systems and equipment is conducted to ensure all risks are addressed.

An OA report is then produced that serves as a companion document to the PWOM during the review process and also as the basis for any future or further Polar Operational Assessments.

In preparing for the OA, it is possible for owners to over or under compensate for perceived risks, usually based on the level of understanding of that hazard. During the OA process, the ABS polar SME will provide guidance to identify realistic, practical, cost effective and functional control measures.

Practical owner assistance

Based in Hafrsfjord, Norway, Tananger Offshore has a long history of safe offshore operations including seismic support in polar waters. Among its fleet is the ABS-classed *Guard Celena*, a 2008-built OSV which engages in worldwide operations.

With the Polar Code in force, Tananger Offshore and ABS worked together through the process which ultimately led to *Guard Celena* being issued a Polar Ship Certificate. ABS provided guidance to blend Tananger's operational experience with the code's goal-based approach and facilitate compliance with the code.

Tananger contracted ABS to support with the OA, but due to the Covid-19 pandemic it was necessary to design a modified process that could be performed remotely, requiring Tananger to perform the OA without the polar SME expert in the room.

To overcome this challenge ABS produced a pre-OA report, which gave Tanager guidance on how to work through all of the hazards as they pertained specifically to *Guard Celena*'s polar operations.

Combining the pre-OA report and its extensive safe polar waters operational experience, Tananger was able to quickly and easily progress through the OA; ABS reviewed the report to ensure all issues were addressed before Tananger developed its PWOM.

Tananger's PWOM and OA report were submitted for review and were approved with only minor comments. Upon completion, an ABS surveyor attended *Guard Celena*, conducted a survey and issued the vessel its Polar Ship Certificate.

At the successful conclusion of the process, Nancy Shen, QHSE Manager at Tananger Offshore commented: "The Polar Code represents a very specific set of challenges in terms of procedures for compliance and ABS provided the support that we needed every step of the way, including providing us with the guidance we needed ahead of time to address issues in the OA and Polar Waters Operations Manual." *NA*

HIPER 2020 keeps it real

Nick Danese reports on proceedings at the 2020 conference for HIgh-PERformance marine vehicles, where grounded futurism dominated the socially distanced discussion

Excellence deserves favour and while our new best friend Covid-19 did manage to impair travel for some, the conference itself was definitely left unscathed. The variety of high-quality, inspirational papers did justice to HIPER's name. As hoped, the house chef concocted true Italian, nonna-grade marvels which the sommelier honoured exactly and, new to HIPER, panels were held at the end of each day on topics spanning from how to promote evolution in ship building to whether academia is a better suited research lab than industry.

HIPER 2020 went back to the basics of high performance and explored its roots as opposed to keeping with the discrete examples trend of past years. In essence, high performance starts with the smallest, simplest component of any process, without which the superior hull shape, engine, propeller or complex process will not come to be. The ability to identify, isolate and act upon the crucial components of a given problem are also key to high performance in our era of Big Data and Digital Twins. The Industry 4.0 paradigm provides the perfect environment to develop high performance by definition and, at last, misleading hype is fading and pseudo-"solutions" are being exposed.

Keeping in theme, pragmatic and realistic looks at the future from today's standpoint took centre stage around questions like 'what is environmental protection really?', 'how can the professional and social worlds be protected from a pandemic and adjust with least disruption?', 'how to manage large groups of people in lockdown or in the presence of a suddenly explosive infection rate?', 'how to even tell what's going on?', etc.

October's event took place in Cortona, Italy

AI hopes

Considerations about Artificial Intelligence opened the three days of work, with Bertram pointing out that from an engineering standpoint the "misnomer 'Artificial Intelligence' is a set of tools that may do jobs better or handle tasks we could not handle at all in the past", and that ". . . in its broadest sense, AI is concerned with the investigation and simulation of human intelligence with the ambition to replicate the processes in machines".

Recent news suggests a contradiction between spacecraft bringing back asteroid samples after a three-year voyage (how did it actually get to that little rock, and to land on it . . .) and the mechanical failures in several Vendée Globe racing machines designed and built for the worst punishment possible under sail. Both endeavours started with powerful computers and smart programming (by humans) sorting through Big Data in otherwise impossible ways, but the results are not quite the same. And, despite its computational power, AI cannot predict the unpredictable, create, have ethics or develop desire… at least not yet. Perez then sharply noted that ". . . AI cannot be a solution in itself". AI and people are one and while AI will increasingly be required for (human) success, its application in the marine industry is slow (due to the human presence).

At the same time, how to deal with confinement and what to do about how limited tools and perception are in protecting today's digitally oriented world? Plowman discussed how gaming, Virtual Reality and social media concepts now apply to human interaction, not just technology, although these are not per-se the answer. Video calls have been become common, even the norm, only since March 2020 though they have been readily available for years.

Looking from a fresh angle, Matsuo *et al* proposed "developing a deductive vision of the future as an extension of current social and technological trends" and "focused on fundamental problems and ideal images". This allows formulation of "a strategic hypothesis based on the attitude of the future image . . . to create", implementing it and organising "the technology to achieve it". Pragmatically, Soncini pointed out that IMO tries to keep up, too, by establishing four degrees of ship autonomy in its strategic planning but economics hamper what should be a totally impartial and neutral process. Technology and industry progress faster than regulatory bodies and insurers are

left behind. Will 'progress' have to be slowed in order to ensure, regulate, and possibly enforce what is best for everyone?

Practical solutions

Back to the drawing board, two "inventions" stood out for their simplicity and effectiveness. Odetti *et al* designed, built and field-proved a portable Autonomous Surface Vehicle (ASV) equipped with interchangeable sensors and a true engineering masterpiece in its radio-axial pump for operation in very shallow waters. The sensors are housed in plug and play receptacles and connected to the radio transmitter by a micro-LAN.

Claneros *et al* deal with water and air pollution from hydrocarbon spills by deploying highly oleophilic yet hydrophobic sponges that can absorb 30 times their mass in fluid (periodic squeezing required), flanked by oil-degrading, smell removing allogenic bacteria innocuous for people. Both are reusable. Still in the green-sea zone, discussion of alternative fuels from LNG to hydrogen foreseeably resulted in observing, that with the exception of wind and solar, all power sources involve some undesirable by-product.

More crucially Musio *et al* addressed contagious disease outbreaks at sea. Cruise ships, war ship and, very likely if unknown, submarine operations have been crippled by the Covid-19 pandemic. Lazarettes have disappeared and ship crowding has soared, forcing a deep rethink of sick-bays; requiring the ability to segregate whole areas of the ship, distribute air treatment circuits into closed loops accordingly, provide for food and hygiene services capable of supporting scores of people, etc. What a puzzle that is for designers, yards and operators when considering the already signed contracts for ships to be delivered in coming years.

Taking a fresh look back, multi-hulls were rediscovered and found to offer significant advantages especially in specialised applications. Another finding based on (not so) Big Data is that 20% of ship maintenance is unplanned, considerable given that maintenance represents 40% of ship operation costs.

A fresh look ahead, Yang *et al* considered a Virtual-Real Interaction Testing for Functions of Intelligent Ships: how to leave "dependence on human intrinsic knowledge" aside in testing "autonomous" functions? Their thought flow is very pertinent: "cognitive capabilities derived from perception, decision-making capabilities derived from cognition, optimisation capabilities derived from decision-making, control capabilities derived from optimisation, execution capabilities derived from control, and repair capabilities derived from fault". Are humans are too subjective to design tests for AI-type machines (should we ask HAL 9000 ?).

Twin talk

Modular Conceptual Synthesis, effectively a Lego-type collection of 'building block' Digital Twins, was introduced by Lagemann *et al.*, preface to discussing the misconception of the Digital Twin (DT) itself. Finally accepted, DTs are an ever-present, arguably conjunctive tissue of modern engineering and technology. They are synthesised, operational, predictive and then some, essentially each person, process, machine, etc. has a bespoke Digital Twin, be it used or not.

Looking at the world of design, construction and operation of marine vessels, Danese indicated that Industry 4.0 principles provide the infrastructure needed by bespoke DTs to feed the data and information sharing that is required to compose a truly collaborative, distributed process. Panel discussions pointed to Industry 4.0 remaining unaccomplished in Big Industry, which Danese deemed unlikely to change unless currently market standard monolithic / paralytic pseudo-solutions are not challenged more vigorously. For this there exist many common tools and processes already in place or available out-of-the-box, perfectly capable to generate and maintain bespoke DTs and directly and better support the still infant PLM paradigm.

Back to the water, antifouling DTs are not common, forcing empirical testing with relatively short-term conclusive evaluations. UV emitting LEDs embedded in a transparent layer might soon coat many hulls and possibly be painted on. Wireless energy transmission, neural meshing of the LEDs and 3D printing nanotechnology are options, too, and power could come from wind, sun and ship motions.

Time for IIoT?

Last but not least, HIPER and Industry 4.0 find their bond in the Industrial Internet of Things (IIoT) which connects, hence encompasses, and wraps everything up: position predicting, Machine Learning, testing of intelligent ships, etc. – all depend on both instant and Big Data at once, something that is possible only via solid IIoT. Despite its usefulness, edge computing is not as commonly employed as it should be. In fact, IIoT itself is largely ignored due to lack of understanding and vision among those who would most benefit from taking advantage of it.

Vannas & Danese lamented the Big Industry closed IoT systems suffocating Industry 4.0. Vannas' Library of Things paradigm was identified as one immediate remedy: "communications are established with the drivers and controllers of devices, not with devices themselves, rendering the solution ubiquitous and unlimitedly extensible. This allows multi-directional channels, supports hack-stopping segregated networks and provides a "remarkably low cost connectivity in multi-player system architecture thanks to a novel business model based on the supply of free 'drivers' and communications channels through a network of gateways, rendering customers autonomous and freeing them from dependence on the IIoT supplier".

HIPER 2020 was the light at the end of the tunnel: it showed that people are getting off bandwagons and pursuing pragmatic goals while maintaining a vision and that a number of our industry players have finally embraced or are moving towards Industry 4.0 : HIghPERformance!

For more information visit:
www.hiper-conf.info

About the author

Nick Danese, the founder of Nick Danese Applied Research (NDAR) and of SYRRKLE, holds Naval Architecture and Marine Engineering degrees. NDAR is a consultancy specialising in composing and delivering software solutions for the design and building of marine vessels. SYRRKLE specialises in plug & play IIoT and IIIoT&S systems for the marine and other industries. *NA*

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