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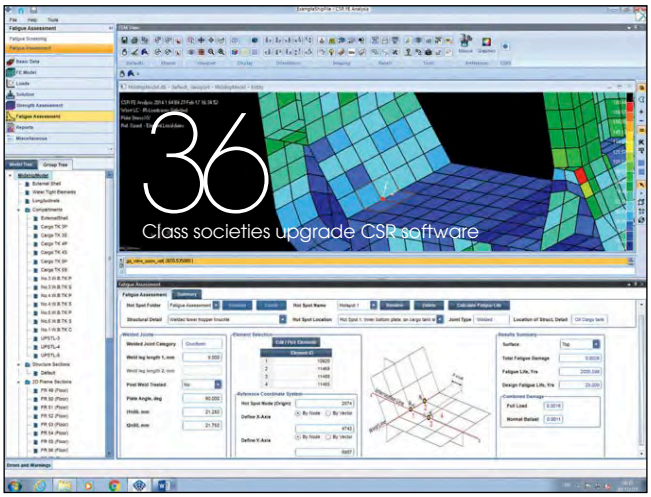

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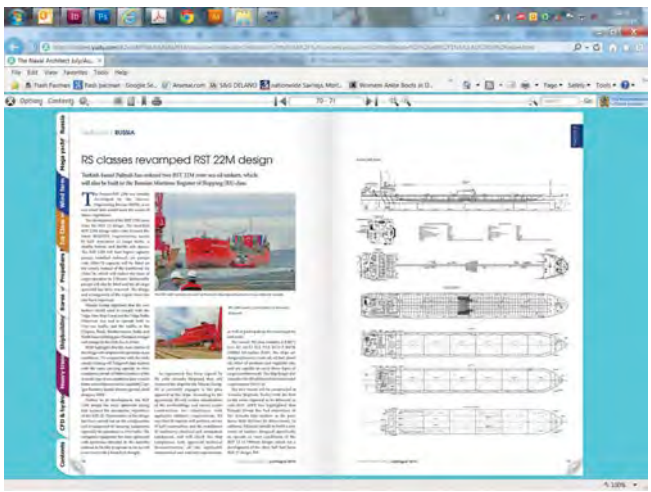

A bridge too far?

Concept illustration for Rolls-Royce's modular bridge and accommodation areas

Having served as the editor of a maritime safety magazine before joining *The Naval Architect*, I'm acutely aware of the suspicion with which the notion of unmanned vessels is viewed within some parts of the shipping community. Such wariness is hardly surprising; at the top of most major ship operators and maritime organisations is an executive who spent at least some of their formative years at sea. They know the kind of things that can and do go wrong, and while human error is frequently an underlying cause in an accident, human intervention can prove just as important in preventing them.

Of course, the reality is unmanned and autonomous ships are no more likely to appear overnight than did the Industrial Revolution or the pre-eminence of computing. Change will be incremental and pragmatic; influenced by market forces as much as the concerns of safety lobbyists or technophobes. Futurism is all well and good, but what really matters to shipowners is reducing costs and improving operational efficiency.

Rolls-Royce Marine thinks it's come up with a solution that's potentially both low-cost and future proof: modular vessels. What is needed, according to VP of innovation Oskar Levander, is more standardisation of ship types and systems. Standardisation, he believes, would make it easier to validate systems; predictive maintenance and determining reliability could draw upon performance trends rather than each vessel effectively being a 'prototype'.

In February, Rolls-Royce unveiled the concept design for *Electric Blue*, a 1,000TEU containership in which all components of a ship – with the exception of the hull and propellers – are held within container-sized units. Crew accommodation, engine gensets, fuel tanks and batteries would all be stored in their own interchanageable units, to be installed and removed according to the needs of the operator.

> "Futurism is all well and good, but what really matters to shipowners is reducing costs and improving operational efficiency"

Electric Blue features a number of innovations, including a ballast-free design achieved by widening the hull and a bow which extends down beneath the baseline. This means a deeper draught and for now it is unclear whether exactly the same principle could be applied on larger vessels, although Rolls-Royce is confident the overall modular concept can be scaled up without difficulty.

But the most notable, and perhaps contentious, aspect is the situating of the bridge module beneath the cargo deck (see illustration above). In other words the bridge team would have no direct view of what's in front of them, but instead navigate entirely using automatic detection tools and a fusion of sensors (see p.38 for the latest on Rolls-Royce's research into LIDAR). Formal approval is still required but Rolls-Royce is anticipating the point, potentially within 20 years, when even large oceangoing ships are remote controlled and the bridge becomes redundant.

The wider implications of modular shipping are manifold. At an operational level it would give owners increased flexibility and the modest initial capex required could see new players challenging the established oligarchies, much in the way that low-cost airlines have risen to prominence in the past two decades. In terms of design, it raises the possibility of suboptimal off-the-shelf hulls and a less holistic approach to naval architecture (at least in terms of cargo ships).

For now, the 'bridge-that-isn't' could prove a hard sell to shipowners and seafarers alike. The industry remains troubled by an officer shortfall and the various permutations of e-navigation, and both the immediate training needs and longer-term strategy are complicated problems to resolve. It could be that smaller remotely-controlled support vessels, such as those Rolls-Royce is simultaneously developing for offshore, might need to serve as a testing ground for a new generation of 'mariners' and demonstrate its viability - and safety - for bigger ships. *NA*

Technology

DNV GL launches Big Data platform

Three and a half years after its merger in September 2013, DNV GL's CEO Knut Ørbeck-Nilssen heralded a "new and exciting phase in our development" with the unveiling of Veracity, a new Big Data platform at a briefing in February.

Built using Microsoft's Azure cloud platform, Veracity is designed to cleanse and manage the data generated by onboard sensors and ship systems to create controlled-access data sets that shipowners and operators can share with DNV GL itself and other stakeholders. It estimates that with as many as 15,000 different sensors onboard advanced vessels, the permutations of different sets will create up to 36 billion separate records. The ultimate aim is to produce an automatic analytic system that can detect anomalies before they may be obvious and to remove the need for calendar-based inspections. Moreover, "individual data sets can be enriched with other industry-wide data sets, providing benchmarks, newer and richer insights and analytics," said Ørbeck-Nilssen.

DNV GL's Veracity utilises the enhanced connectivity of modern ships

The classification society revealed that 5% of its revenue is being invested in R&D, with half of that going into digital projects. An initiative closely aligned to Veracity is the digital twin, a "virtual image" of the vessel that brings together data in a user-friendly form. Other projects currently in the pilot stage include drone surveys, wearable camera systems and remote specialists providing support to on-site surveyors. Planned future developments include digital certification and using predictive analytics to advise the optimum time and place for booking new surveys.

With global newbuilding deliveries plummeting to just 18 million gross tonnes last year (against 83 million in 2015) and no immediate prospect of a revival, the classification society is acutely aware of the need to offer its customers enhanced products and to focus its energies on high-end growth markets.

Emissions

ICS chairman: CO_2 targets must be realistic

Esben Poulsson, chairman of the International Chamber of Shipping (ICS), has warned that the IMO needs to set out realistic long-term targets for shipping's CO_2 limits or risk its authority being undermined.

Speaking at the World Ocean Summit in Indonesia on 24 February, Poulsson said he was confident IMO can adopt an ambitious strategy that meets the spirit of the UN's Paris Agreement, but added: "IMO needs to agree a baseline year for peak CO_2 emissions from shipping, as well as setting out some serious long term aspirations for dramatically cutting the sector's total CO_2 by the middle of the century."

Poulsson said that ICS believes IMO's mechanism for delivering those CO_2 commitments should be in place by 2023, but that the objectives should cover shipping as a whole, rather than target individual vessels.

"Ambitious CO_2 reduction objectives will only be achievable with alternative marine fuels which do not yet exist, although we are very confident that they will be available in the not too distant future," he said. He added that widespread availability of renewable fuels, such as hydrogen or fuel cells, should not be expected for another 20-30 years.

Cruise

NCL orders new series of cruiseships

Norwegian Cruise Lines (NCL) has announced an agreement with Italian shipbuilder Fincantieri for the construction of four new passenger ships for delivery between 2022 and 2025; with an option for a further two ships.

The four 140,000gt vessels will each be capable of accommodating 3,300 guests, a slightly smaller scale than the current Breakaway-Plus series of ships which began with the *Norwegian Escape* (which holds 4,266 guests) in 2015. NCL said the new ships will feature a host of innovative designs and features but will prioritise energy efficiency. The vessels will each cost approximately €800 million (US$840 million).

"We are very proud of the innovative design of these ships: we developed it internally and we presented it to the shipowner, which appreciated it so much it ordered an entire class," explains Giuseppe Bono, CEO of Fincantieri. *NA*

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Emissions shakeup could lead to EEDI rethink

As the great and the good of the shipping industry descended on Brussels for European Shipping Week, CO_2 was high on the agenda after a vote in the European Parliament on the European Union Emissions Trading System (EU ETS) on February 15, writes *Sandra Speares*

Shipowners' trade associations came out fighting as MEPs backed reforms of the EU ETS that will aim to regulate international ship CO_2 emissions.

Environmental bodies like Transport & Environment welcomed the reforms as: "both a much needed first move to kick start maritime climate action and evidence that aircraft emissions will now be treated on a par with those of other ETS sectors". They called on EU governments to support the European Parliament's amendments to the ETS in upcoming negotiations.

Meanwhile there was disappointment but no surprise expressed by the International Chamber of Shipping with its Director of Policy & External Relations, Simon Bennett saying: "This vote for a unilateral, regional measure simply risks polarising debate among IMO member states which have already agreed to develop a strategy for reducing shipping's CO_2 emissions in line with the goals of the Paris Agreement on Climate Change". He added that the vote ignored progress on the issue already made by IMO.

The proposal is for shipowners to buy ETS allowances from 2023 onwards or pay an equivalent amount into a new Maritime Climate Fund. The fund will buy allowances on the sector's behalf and reinvest the revenues. The measure will only enter into effect if the IMO does not agree global action by 2023.

As IMO secretary general Kitack Lim pointed out at the MARENER 2017 conference in Malmo last month, IMO has approved a roadmap for developing a comprehensive strategy on reduction of GHG emissions from ships, which foresees an initial GHG strategy being adopted in 2018 and a revised strategy adopted in 2023.

"This again, sends a clear signal that IMO is ready to build on the existing technical and operational measures for ship energy efficiency to further address emissions from international shipping and collectively pave the way for further global action."

According to Dragos Rauta, technical director of Intertanko: "Like others, we believe that regional regulations on such a complex and global matter are totally wrong.

"The process starts with data collection from ships while, in parallel, considering the target and means for such additional measures.

"The timing agreed by IMO is fully harmonised with the process under the Paris Agreement."

While the shipping sector recognises the need for additional efforts, he says, the industry should also be given credit for being the sector that has made commitments mandating improved efficiency for new ships. Such new and more efficient ships are already in operation.

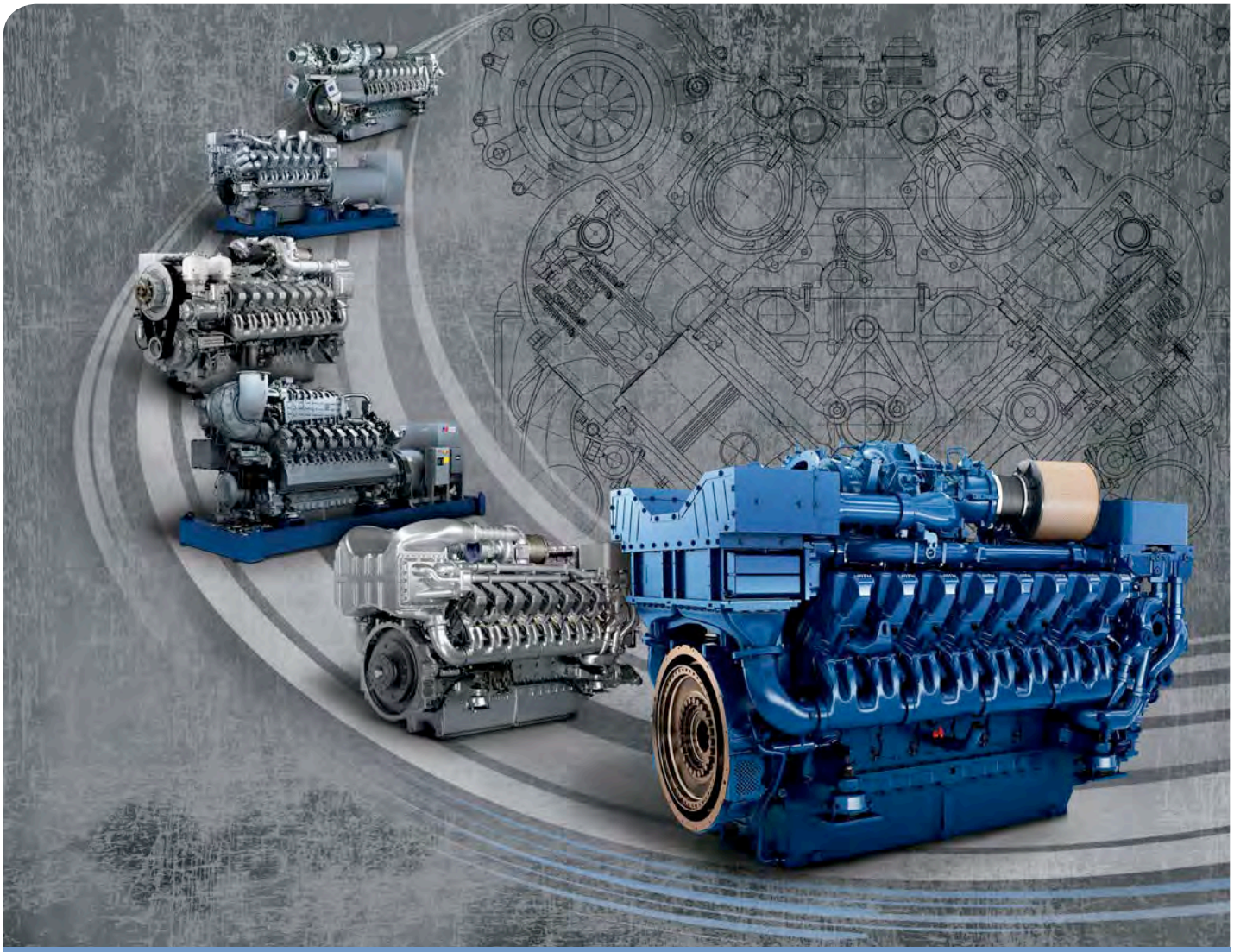
With regard to new buildings, the mandated Energy Efficiency Design Index (EEDI) has given ship designers more of a free hand to improve designs and hydrodynamics, Rauta says. "Unfortunately, the temptation is to use some quick fixes such as less installed power and lower design speed. However, these quick fixes have their own limits to further reduce the EEDI value."

Further reductions may require changes to the hull shape, block coefficient, or propulsion systems for example. "With regard to engines, these are passing through a period of extensive change in the design and technologies applied. Ships are equipped with early generations of electronically controlled engines which are designed to use different fuels and which need to run scrubbers and ballast water treatment systems. On top of this, there is the need to meet NOx Tier III emissions levels. More ships are now opting to use dual fuel engines. A rapidly increasing population still expects a lot of transportation at sea."

Rauta says: "Future solutions will require a complex, significant change through major breakthroughs in the nature of the fuel used, the combustion process and/or the entire propulsion system. This will not happen overnight but humans are inventive, particularly if they have to be."

The last IMO GHG Study concluded that the contribution from the shipping sector to global CO_2 emissions dropped in five years from 2.8% to 2.2%. "This change is significant because it means a 19% reduction to the global contribution but it also means the shipping sector has reduced its contribution faster than the other contributors", says Rauta.

Environmentalists, he adds, are quick to criticise shipping and give no credit for these achievements within the bigger picture: "The European Parliament decision to adopt amendments to include shipping into the EU ETS Directive is completely counter-productive and it comes to an unfortunate moment. It could disturb the goodwill at IMO to build up measures based on the roadmap adopted last October." *NA*



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Power systems

Hybrid chemical tanker for Stenersen

Finland's WE Tech Solutions has secured an order to install its battery-based Energy Storage Solution (ESS) on two 17,500dwt chemical tankers being built for Bergen-based Norwegian shipowner Rederiet Stenersen AS.

It will be the first time that an ESS has been deployed on vessels of this type. The tankers, which are being built at Chinese shipyard Taizhou Kouan Shipbuilding Co, will also be fitted with WE Tech's permanent magnet shaft generators. The hybrid technology, which will use Corvus Energy's Orca lithium ion batteries, provides an energy reserve at critical moments as well as back-up power in the event of a black-out.

One of the most significant benefits battery power offers is providing an effective back-up while a vessel manoeuvres. "Typically during manoeuvring you have two gen-sets running to ensure you do not get a blackout in case a gen-set stops. This means that these two gen-sets runs on low load and thus the fuel consumption is high per produced kWh of electrical power," says Martin Andtfolk, WE Tech's sales manager.

"With a battery you simply shut down one gen-set so only one is running at higher load. The battery is the spinning reserve so in case of a failure the battery kicks in to avoid a blackout. The battery only needs to supply power for a short time until another gen-set is up and running, typically below one minute."

The ESS can also be used for peak shaving to allow for a smoother load on the main engine during heavy weather conditions. Andtfolk says: "Excess power is stored when going down the wave and power is taken out of the storage when going through the wave. For this you need another hybrid solution, which is a shaft generator solution where the generator also works as a booster motor."

The two vessels, which each have a length of 146m and width of 22.5m, are due for delivery in 2018.

www.wetech.fi

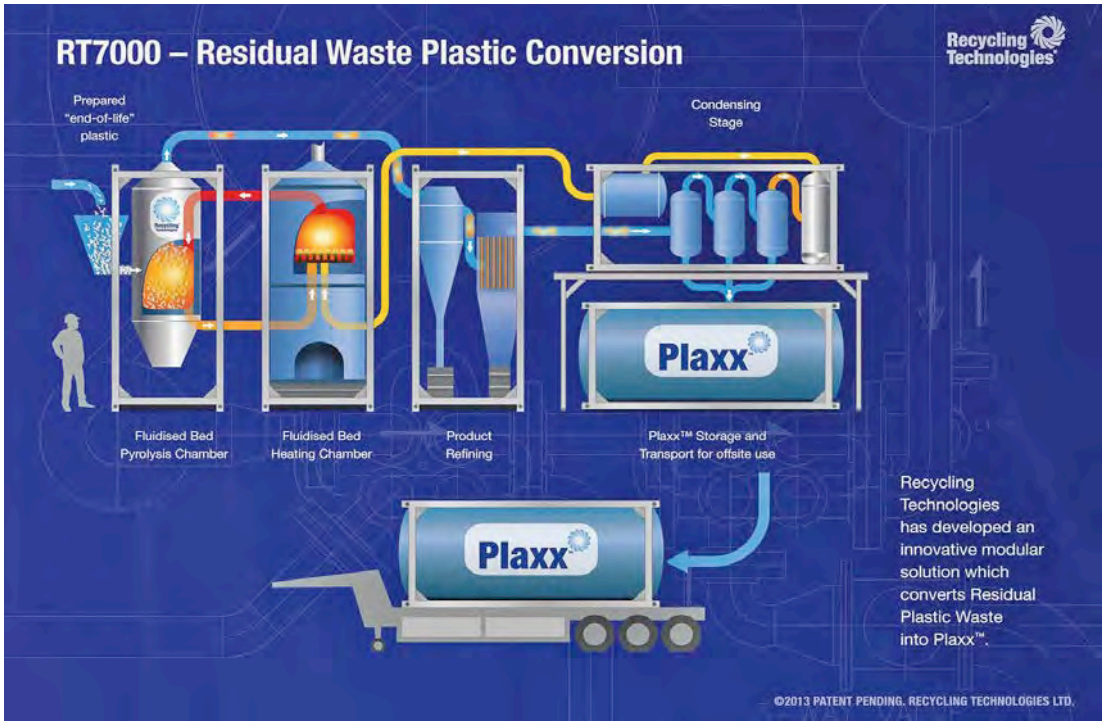
Fuels

Plastic-based marine fuel trialled

A MARPOL-standard marine fuel derived from the conversion of plastic is being trialled for its operational suitability. Developed by Recycling Technologies (RT) Ltd of Swindon, UK, it is hoped that the new fuel, named Plaxx, can significantly boost the recycling of plastic waste.

"The hub of the process is the RT7000 machine which converts the plastic waste into a clean and more sustainable ultra-low sulphur hydrocarbon

RT's plastic conversion process



substitute which can be used as an alternative for fossil-based Heavy Fuel Oil (HFO)," explained RT's sales and marketing director Adrian Haworth. Because there is little sulphur in plastic it comfortably meets the impending SOx emissions requirements.

RT has now built a large-scale plant for production of the fuel and the first commercial machine will be available later this year. The firm is now working with engineering firm Ricard Ltd, Lloyd's Register and others on a series of performance tests. From mid-2017 the fuel will be trialled and the firm is keen to hear from shipowners currently using HFO who would like to participate.

www.recyclingtechnologies.co.uk

Engines

Dual-fuel engine tested for large high-speed vessels

German engine and turbine management solutions specialists Heinzmann says it has successfully completed a series of tests on a high-speed diesel engine that has been converted for dual-fuel usage and is suitable for larger vessels.

The research, commissioned by ship operator Fred Olsen SA to explore the possibilities for fuel economy and emission reduction, adapted a Caterpillar 3618 engine. Powertrain experts AVL were also recruited to execute engine design, simulation and test-bed planning. Funding was co-financed by the EU's GAIN4SHIP INNOVATION project.

Heinzmann says the conversion was done in such a way that the engine's injection system was not modified, meaning that it remained capable of unrestricted diesel operation. Instead, a multi-point gas admission system was installed as an 'add-on'. After extensive performance and emissions testing the engine has been granted approval by DNV GL for installation.

Fred Olsen has announced that all four engines of its ferry *Bencomo Express* will be converted to the specifications in early 2018.

www.heinzmann.com

Get Smart!

The 16th International Conference on Computer and IT Applications in the Maritime Industries (COMPIT) will be held from 15–17 May 2017 in Cardiff, UK. Organiser Volker Bertram, Dept. Mechanical and Mechatronic Eng., Stellenbosch University, gives *The Naval Architect* a sneak peek

First held in 2000, COMPIT has established itself as a key conference in information technology (IT) for the maritime industries, bringing together software developers and users. Most participants come from industry, reflecting the practical relevance of the event.

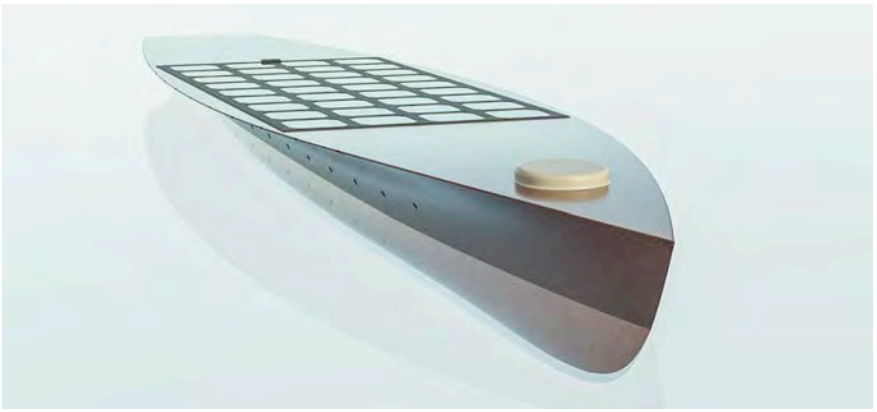
Selected papers for the upcoming COMPIT are discussed below, illustrating general trends in IT for the maritime industries. In short, the main trends are:

- Integrated design environments: Standalone solutions for simulation-based design give way to integrated solutions. "Simulation centres" handle data import, smart and user-friendly model generation and intuitive result display for design decisions.
- Shipyard 4.0: Yards get smart, too. The Internet of Things (IoT) and smart decision support systems play a key role here.
- Virtual Reality spreads: We have to thank our kids – the video game industry has provided cost-effective software and hardware solutions for Virtual Reality (VR) and Augmented Reality (AR). From training to hull inspection, from preparing nautical officers to shopfloor support in shipyards. VR and AR have arrived in our industry and are flourishing.

COMPIT covers three full days, each with four sessions:

- Day 1: Layout Design, Design Frameworks, Integrated Simulation-based Design, and Smart Yards
- Day 2: Autonomy I & II, Smart Wireless Ships, and Virtual & Augmented
- Day 3: Big Data as Game Changer, Smart Ship Operation, Routing 2.0, and Smart Communication

It is difficult to pick favourites. Best have a look at the complete program and pick your own winner(s).



Autonomous ships designed using simulation and optimisation – Compit connects people and technologies (source: aXatlantic)

Best-of-breed solutions

Despite numerous attempts, there is no single monolithic software program that is optimal for all tasks. However, design frameworks or simulation centres evolve. These house dedicated software codes reside in a larger framework with a common "same look and feel" user interface. The integration may be "hardwired" for a single vendor, but it may also, via a common integration surface calling different codes from different vendors, support the popular "best of breed" approach in design software. Data exchange in such frameworks is largely or fully automated, reducing both training time and project time. The framework trend is demonstrated in a variety of papers by several well-known vendors, many coming from joint industry projects.

Pawling & Andrews (UCL) point out the trend towards "Expanding the Scope of Early Stage Computer Aided Ship Design". Design, particularly for complex ship types, increasingly incorporates a wider range of aspects than straightforward numerical performance analyses. A whole session is dedicated to layout design, using an inside-out approach known as "Design Building Block", where UCL, TU Delft and the University of Michigan have evolved as key technology drivers. Pawling & Andrews also look into some interesting new developments, adapting techniques from other industries for the benefit of ship design. One example is "real options theory", a technique from financial market assessment that can be used for handling uncertainty in complex scenarios.

Mergers and alliances lead to consolidation in the software market and support the development of larger and more comprehensive design environments. The acquisition of CD-Adapco (CFD) and LMS (noise & vibration, fatigue strength and kinematics) by Siemens is a classic example of the general trend. Bundling assorted simulation competence under the Siemens umbrella is likely to lead to a new super-heavyweight in the maritime software market. Radosavljevic and Cardoen (Siemens) describe Siemens PLM Software's new solution for cross domain and multi-physics simulation in "Simcenter - Enabling Predictive Engineering Analytics", giving assorted simulation and optimisation applications.

Korbetis et al. (BETA CAE Systems) present "EPILYSIS - A New Solver for Finite Element Analysis", which streamlines the processes further in CAE workflow of structural analyses. The paper illustrates how the focus in mature simulation

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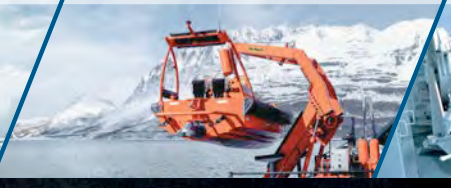

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techniques (strength and vibration, stability and CFD) lies increasingly on reducing time spent on model generation and data transfer between different software interfaces. The quest is not for new applications per se, but rather for new users, shifting simulations from dedicated simulation experts to the designer. The key is then making the software user-friendly and affordable. The solution is not rocket science, but common good engineering sense: re-use models wherever possible; offer macros for frequently performed operations; make the user interface more graphical and intuitive.

Grümmer et al. (aXatlantic, Friendship Systems, TU Berlin) are nicely 'cross domain' with their "Optimization of a Self-Righting Hull Design and Thruster Unit for an Autonomous Surface Vehicle". The project uses the design framework CAESES for hull generation and optimisation process management with MAXSURF Stability for volume and stability calculations to maximise the stability of a solar-powered, self-righting drone. The aXatlantic project aims for a world record with the first solar-powered and autonomous ocean crossing. This brings us to a theme that dominates the central day of COMPIT 2017: Autonomous ship technology.

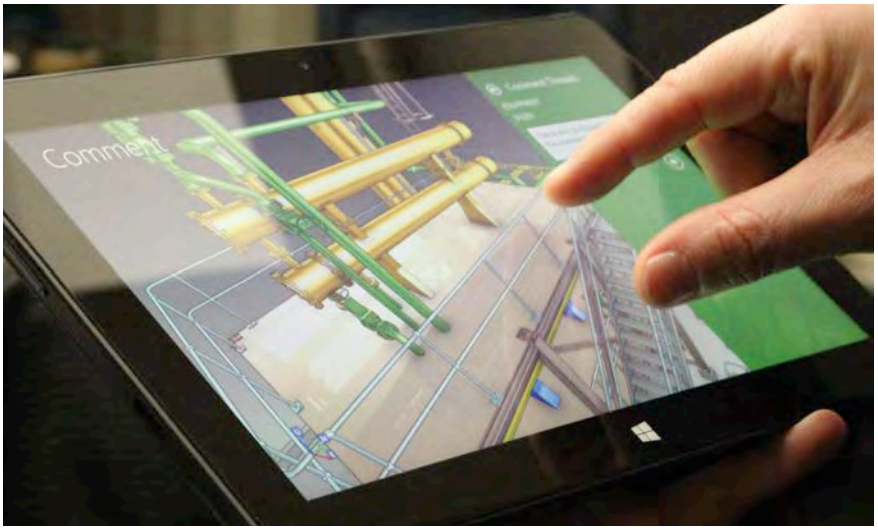
Autonomy now – or maybe later?

Autonomous, smart, unmanned – no shortage of buzzwords for a brave new world of ships and ship operation. But what is educated prediction and what is a marketing pipe dream? Media and public discussion are uncannily attracted to the latter. Autonomous means independent – systems perform some tasks independently that so far have been performed by humans. There are various levels of autonomy, e.g. independently coming up with a suggested path for collision avoidance is a lower level than independently performing the collision avoidance manoeuvre. Smart usually indicates large amounts of (sensor) data being processed typically with some local processing intelligence. Unmanned means no crew onboard, but could refer to a remotely controlled ship.

A key task in more or less autonomous navigation is path planning and execution of collision avoidance manoeuvres. The first field tests and commercial decision support systems date back to the 1990s, but work continues on higher autonomy, refined algorithms and preparation for an era where unmanned (and highly autonomous) ships may operate side by side in congested traffic with manned (and more or less autonomous/automated) ships – think fleets of Google cars mixing with many 'conventional' drivers in tomorrow's traffic on our streets. This era may come faster than some of us think. Various groups around the world are working on it. Daltry & Tripp (ASV Global) present "The Path to Real World Autonomy for ASVs", using a hierarchy of autonomous systems to plan collision avoidance efficiently and (hopefully) safely. Mediavilla et al. (Lloyd's Register, Rolls-Royce, et al.) work on the "MAXCMAS Project – Autonomous COLREGS Compliant Navigation". The MAXCMAS (MAchine eXecutable Collision regulations for Marine Autonomous Systems) project is developing a COLREGs compliant path planner for autonomous vessel guidance and control. The explicit and deterministic rules of the collision avoidance rules (COLREGs) are the easy part, but some COLREGs involve personal judgment, e.g. when to initiate emergency collision avoidance when the counterpart does not give way. Then rules for an expert system can be determined by observing human experts in similar situations, typically employing nautical simulators. Again, we see the power of combining advanced IT techniques (simulation, Augmented Reality, autonomous/robotic technology and Artificial Intelligence in this case). Totem Plus in Israel already offers a commercial collision avoidance system for unmanned ships without radio contact, as described in Rahav & Levy's "Totem Autonomous Navigation System".

Key technologies for future ship operation - whether smart, autonomous or unmanned - are Big Data and the Internet of Things (IoT). Mary Etienne (Dell EMC) sees "IoT: Maritime's Next Wave" already transforming the maritime industries from design to operation. As sensors become smaller, more robust and cheaper to acquire, we predict that they will be 'everywhere', in the hull, main engine, and auxiliary machinery and even small equipment items, gathering and collecting data for analysis. Whether ships and the equipment on them are operated locally or by remote control, operational decisions will be data-driven. Patrick Müller's (Siemens) "Marine 4.0: Condition Monitoring for the Future" illustrates the role of IoT and Big Data for the case of engine maintenance, seeing major cost savings in adopting the technologies.

However, Big Data and IoT require connected wireless IT systems. And these come with increased cyber risks. Patterson & Barton (Babcock) look in "Secure Wireless Options in the Smart Ship" at cyber-security. The paper assesses personal and local area wireless communication technologies,



Augmented reality offers intuitive instructions on the spot for assembly and retrofits (source: AVEVA)

particularly with respect to their potential utility in ships. They recommend operational and design considerations to limit exposure to threats.

A different VR game!

"Virtual Reality (VR) has gone from being science fiction, to being realised in the research lab, to being treated as a toy, to being used in practical applications, including shipbuilding," says Denis Morais (CTO of major ship CAD vendor SSI). SSI's state-of-the art description "The Evolution of Virtual Reality in Shipbuilding" gives a perfect introduction to the topic. It also predicts the future of VR by analysing the forces that have either hindered or promoted the implementation of virtual reality in ship design and construction. The diversity of applications is as fascinating as the level of realism achieved by CGI (computer generated imagery). Bertram & Plowman (DNV GL) review "Maritime Training in the 21st Century", envisaging increasingly digital maritime training. As an example, they describe a VR-based training tool for ship surveying where trainees can practice finding various deficiencies simulated in the virtual environment. Cabos & Wolf (DNV GL) also see VR playing a key role in actual surveys of the future. Upcoming inspection techniques such as drones and self-localising cameras potentially enable the full visual mapping of a tank's condition on a 3D ship model. Their paper "Virtual Reality Aided Remote Hull Inspection" explores the extent to which this could allow structural condition assessment to be performed remotely.

Sounds like science fiction? Maybe, but the future has already started. Helle et al. (University of Turku) give an overview of "Virtual and Augmented Reality Solutions to Industrial Applications" in Finland. Virtual reality is the complete modelling of virtual worlds in the computer, while augmented reality (AR) overlays computer information on real-world views (think Pokémon Go). While some industrial solutions have already been adopted, attitudes towards the new tools vary widely in the industry as the authors found in user interviews. Procee (NHL Hogeschool) gives us a glimpse of Captain Picard on future ships in "Effect of Augmented Reality on Human Performance in a Ship's Bridge Simulator". In his studies, AR helps the navigator in detecting dangerous targets by the overlay of a synthetic image, thus providing a visual cue over the real world outside the bridge window. A head mounted display is used to project the augmented image. The prototype system was tested in the controlled environment of a nautical simulator. The paper presents the first results of a larger program of empirical tests into the usability of AR in ships navigation.

The conference promises to be a highlight in this year's calendar for anyone interested in how IT is transforming the maritime industries. Get smart, join it and connect. For more information, visit www.compit.info. *NA*

Finnish companies continue to pioneer marine technology

A number of new concepts are being successfully promoted by companies in Finland, enabling them to win significant contracts for a variety of newbuild vessel types at home and abroad. Clive Woodbridge reports

The Finnish headquartered business, The Switch, specialises in the development and supply of drive train solutions. It believes that its permanent magnet (PM) and frequency converter technology, which is already widely used in the wind turbine sector, can have a major impact on marine applications.

The Switch manufactures PM systems that, in conjunction with frequency converters, convert mechanical energy into electric power that can be used for onboard systems and equipment. The company claims its PM systems offer scope to reduce energy costs by as much as 50% during slow steaming periods. In addition, The Switch says its frequency converters deliver reliable and accurate speed control, making them ideal for vessels operating in varying environments and speed ranges, such as ferries, cruiseships, ice breakers and tugs.

Mika Koli, business development manager, adds: "PM technology and frequency converters offer substantially lower operational costs for owners, while also ensuring that vessels can be future-proofed. They provide accessible, affordable and easily integrated energy, while lowering fuel consumption and emissions."

The company reports growing interest in its technology and has recently entered into an agreement with WE Tech to provide PM shaft generators for two Toll Shipping ro-ro vessels and a series of four Stena Ro-pax ferries being built in China.

Last November, The Switch acquired Wärtsilä Drives, a move which Koli describes as being "crucial". "This gives us competency in specialised power drives, as well as a test centre and manufacturing facilities in Norway," he says. "It means we are now a specialised provider of drive trains that are engineered specifically for the marine industry."

Tevo has introduced a new design of bronze propeller specifically to meet the needs of Arctic class vessels

Finland-based WE Tech, which is working with The Switch on both the Toll and Stena ro-ro ship projects, has also recently received an order for its Energy Storage Solution for two 17,500dwt chemical tankers being built for the Norwegian shipowner Rederiet Stenersen at Taizhou Kouan Shipbuilding in China. The newbuildings will also feature a PM shaft generation solution from WE Tech.

Finland's expertise in producing technical solutions for ice-class ships is world-renowned. Continuing this tradition, Tevo Oy has developed a new range of bronze propellers which it claims are well suited for extreme Arctic conditions and represent a cost effective alternative to steel propellers. The new generation bronze propellers, designed for 1A Super ice class ships, with optimised efficiency and noise characteristics, have been verified in full scale tests on the northernmost part of the Baltic Sea, including the Gulf of Bothnia.

In a three year development project, Tevo worked closely with Aker Arctic Technology and VTT Technical Research Centre of Finland. According to Tevo, based on material studies carried out in the course of the new product's development, it was able to prove that the bronze propeller material used by its propeller plant exceeds class requirements and makes it possible to use significantly better dimensioning parameters. This has in turn enabled Tevo to reduce the weight of its propeller construction, improving energy efficiency.

During tests in demanding ice conditions, the prototype propeller performed without damage and was able to demonstrate high levels of energy efficiency and low noise levels, adds Tevo.

Tevo is now targeting the Arctic shipping markets, and both newbuild

and retrofit projects, with its new bronze propeller designs. It has also developed an optimisation tool, allowing the company to design a propeller for ship operators that will perform well in open sea condition, as well as meeting class requirements regarding operations in one-year ice.

Propulsion systems for cargo and passenger vessels are another sector in which Finnish companies have a leading position. Wärtsilä has a significant market share, and continues to develop new solutions. Over the past year the company has introduced several new products, such as the 5,500-6,500kW retractable, underwater-mountable thruster, type WST-65RU, and the Wärtsilä EnergoProFin energy improvement device for Controllable Pitch propellers (CPP).

The WST-65RU is an innovative product that combines a number of features that are of significant benefit to shipowners and designers of large offshore vessels. The WST-65RU is a retractable with a power capability of 5,500-6,500kW, which makes it the highest powered thruster of its type in the world, Wärtsilä claims. The WST-65RU features an 8degs tilted gearbox driving the ducted propeller. By applying this tilted gearbox, which is also found on the Wärtsilä underwater-mountable series of thrusters, the propeller and nozzle are both tilted to redirect the propeller flow. This minimises thruster-to-thruster and thruster-to-hull interaction, without compromising propeller efficiency, unlike other thrusters in which only the nozzle is tilted.

The WST-65RU is the first retractable thruster of which the outboard part can be removed while the vessel is afloat without using a special habitat. This allows thruster exchange for maintenance on vessels that are too big to go into a drydock or which a local drydock is not available.

The Wärtsilä EnergoProFin is a specially designed propeller cap with hydrofoil section fins on the downstream side of the propeller. It is an energy saving device that can significantly reduce a vessel's fuel consumption as well as its emission levels. Wärtsilä's research and development work has succeeded in creating a product that offers vessels equipped with a CPP, as well as fixed pitch propellers, an opportunity to reduce energy consumption. This development work was a spin-off of an EU-funded collaborative project between Wärtsilä and nine other companies.

In 2017, Wärtsilä plans to continue to release new propulsion products. Among the new releases will be retractable thrusters, transverse thrusters, marine gearboxes, controllable pitch propellers and energy saving devices.

Another Finnish company, Steeprop, has launched the CRP ECO LM propulsor with an integrated PM motor. This has

Fincantieri group has installed Pemamek technology at a number of its yards

been designed to be both more compact and cost effective, improving fuel efficiency, but also lowering vibration and noise levels.

Development of the CRP ECO LM began in 2015, with the idea of integrating a vertical electric motor on the propulsor, replacing the upper gear and the separate electric motor. The objective was to combine the hydrodynamic properties of the existing CRP Eco propulsor with a compact electric motor.

The new Steeprop ECO LM consists of a mechanical azimuth propulsor, electric motor and shaft line with flexible coupling. The integrated PM motor, auxiliary electric systems and instrumentation are located inside the vessel's hull, above the waterline, facilitating service access and space inside the hull.

There is no requirement for a separate foundation for the PM motor, and the shaft line and flexible couplings are inbuilt with no need for separate shaft alignment during the installation phase. The propulsor's cooling motors and lubrication pumps are frequency converter controlled, optimising auxiliary system power usage and enhancing overall propulsor efficiency.

Software update

Finland is also one of the leaders in supplying computerised ship design, operations and construction technology. Recently, Helsinki-based NAPA announced that Hyundai Heavy Industries (HHI) is implementing NAPA Steel's 3D model based ship structure design tool across its business.

NAPA Steel provides an interactive three-dimensional modelling interface for ship designers. Once a model is created for the whole vessel this can be used throughout the design process, including classification society rule checks, plan approval drawings, finite element model generation and other calculations.

Following the introduction of NAPA Steel, HHI says it expects that design time will be shortened with the amount of man hours involved in the design process reduced by around 30%. Juha Heikinheimo, president of NAPA, says: "The adoption of NAPA Steel by HHI demonstrates that our work to bring 3D modelling to ship structural design has been a success. NAPA Steel will be a paradigm shift in increasing competitive advantage and productivity, creating cost savings for all our customers." In particular, the company believes that NAPA Steel represents an agile, fast-to-learn and user friendly design tool that meets the needs of new 'digital natives' entering the industry.

ABB's Octopus marine software is also gaining ground and has been selected for installation on three new Torvald Klaveness combination carriers, to be built at China's YZJ Shipyard, to help them meet new emissions regulations. Octopus gathers information from onboard sensors and gives the operator a better insight into key performance parameters, including fuel efficiency. The vessels will also feature ABB's recently launched Torductor Marine. This torque measurement system optimises engine and fuel efficiency, with contactless sensors mounted facing the propeller shaft. This sends information to the Octopus system which then visualises the data.

Shipbuilding technology

Pemamek is achieving success with its robotised welding solution for shipbuilding applications, and continues to enhance the system's capabilities. Recent innovations include one-sided laser hybrid arc welding (LHAW) integrated with milling to ensure distortion free panels for further processing as well as the robot-based welding of micro panels and open flat blocks through its WeldControl 200 software. Yards using the Pemamek system include Fincantieri, STX France, Senesco and Irving Shipbuilding. Most recently, it has entered into an agreement with Vard Shipyard in Romania to deliver a 12m thin plate panel line. The solution is designed to ensure high-quality production of thin plate panels used in building various types of vessels, including special cruiseships. A similar agreement was signed last year with Werften in Rostock, Germany, to supply a 16m laser-hybrid thin plate panel line for cruiseship building.

The delivery to Vard Tulcea will be equipped with web mounting and welding as well as a hydraulic one-sided welding facility, and a panel cutting, blasting and marking station. Additionally, an integrated stiffener mounting and welding system will be included in the solution.

Furthermore, the panel line includes a robotised welding station specifically designed to weld pre-assembled T-beams, as well as other secondary structures, onto the panels. The robots are equipped with Lincoln PowerWave power sources and are programmed with Pemamek's WeldControl 200 Create software.

The panel line and robotic welding station will be built in Pemamek's recently expanded production premises in Finland. The system is scheduled to be installed at the Romanian yard during the summer of 2017. *NA*

Maritime cluster targets passenger ship sector

As Meyer Turku shipyard continues to pick up orders for technically innovative cruise and ferry designs, other companies from Finland's maritime sector are similarly targeting passenger vessel contracts, writes Clive Woodbridge

Finland is justifiably proud of its maritime cluster, which spans expertise in many different technology segments. However, it is perhaps within the passenger shipping sector where this cluster is most proving its worth at the present time, with Meyer Turku shipyard at the epicentre of much activity.

The yard now has an all-time high workload stretching forward to 2024, following its success in securing contracts from Royal Caribbean Cruises Limited (RCCL), Carnival Cruises and TUI Cruises over the past year. The most technically advanced of the cruiseships on its order book are a pair ordered in 2016 by RCCL for delivery in 2022 and 2024. These 200,000gt, Icon-class ships represent the first of a new generation of LNG-powered cruise vessels and will feature several groundbreaking features, such as fuel cells for power generation.

According to Jan Meyer, chief executive of Meyer Turku: "The eight-year long horizon creates a unique opportunity for Turku shipyard and the entire Finnish maritime cluster to invest and develop their capabilities with a long-term strategy and achieve new leaps in technology." The lengthy, high value order book is further enabling the company to modernise and upgrade the shipyard, with planned investments in excess of €75 million (US$79 million).

Meyer Turku is also working with TUI Cruises on the new *Mein Schiff 1* and *2*, which represent an evolution of the original six-strong Mein Schiff series. The keel-laying of the first of the new design cruise liners took place in January, while the 295m long, 2,534 passenger capacity *Mein Schiff 6*, the last in the earlier series, is now being outfitted alongside and is due for delivery later this year. The new *Mein Schiff 1* and *2*, which will be longer at 315m and able to accommodate 2,894 passengers, will be delivered in Spring 2018 and 2019 respectively.

Construction begins of the new *Mein Schiff 1* at Meyer Turku yard

The upturn in cruise orders at Meyer Turku, as well as at yards in Germany and France, has created significant opportunities for the Finnish marine technology sector, which has responded proactively through the development of new products and systems.

Wärtsilä has, for example, introduced its new WTT-40 transverse thruster, which is specifically designed to meet cruise lines' need for greater thrust levels. The first WTT-40 units are now being constructed and will be installed on a currently unnamed cruise vessel newbuilding to be delivered later this year. Enhanced manoeuvrability is one of the main improvements claimed by Wärtsilä, along with reduced noise and vibration.

One of the biggest cruise projects for Wärtsilä in recent times was RCI's *Harmony of the Seas*, which entered service last year. This features four Wärtsilä 5,500kW CT3500 transverse thrusters, the largest of their type in the world. *Harmony of the Seas* also features Wärtsilä 46F 12-cylinder engines,

propulsion equipment, exhaust scrubbers, Wärtsilä NACOS Platinum navigation and dynamic positioning systems, as well as Wärtsilä CCTV and various electrical and automation solutions.

Another key player within the country's marine cluster, ABB - which manufactures Azipod propulsion systems in Finland - is also achieving good levels of success in the cruise sector. ABB Azipod's have built up a significant market share of the cruise market and it is estimated that approximately two thirds of the modern large cruiseships are fitted with this technology.

The company recently announced an order to provide propulsion systems for five new cruise vessels being built by the German Werften yard for Genting Hong Kong brands, Crystal Cruises and Star Cruises. All five contracted vessels will feature a comprehensive ABB propulsion system, electric power plant, automation and marine software. Three of the ships will be powered by two Azipod D units each, enabling the ships to navigate polar conditions, while the other two newbuildings will each be installed with three Azipod XO thrusters. All of the vessels will feature ABB's automation and intelligent manoeuvring technology as well as its OCTOPUS marine software designed to optimise onboard management.

In addition, ABB Azipod propulsion was also recently selected for Scenic Cruises' *Scenic Eclipse*, the world's first passenger vessel to be constructed explicitly to Polar Code standards. With a PC6 notation, this 'discovery yacht' is currently under construction at the Uljanik Shipyard in Croatia and is set to launch in August 2018.

Another well-established Finland-based group, Evac Oy, is also going to be engaged in the Genting newbuilld project at Werften. The company is supplying Complete CleanTech solutions for two vessels building for Genting Hong Kong's Star Line. The vessels will feature Evac vacuum waste collection, vacuum toilets, wastewater treatment, dry and wet waste treatments and freshwater generation by reverse osmosis.

Langh Tech's scrubber and water treatment systems have been ordered for 11 cruiseships

Ferry newbuildings are also generating activity for Evac. Its Complete CleanTech Solution can be found on the Tallinn *Megastar* ferry which started operating between Helsinki and Tallinn in January this year, after delivery from Meyer Turku shipyard. The LNG-powered vessel is designed to meet stricter emissions levels within ECA areas, including the Baltic. Technology provided by Evac includes vacuum collection systems, wastewater treatment, dry and wet waste treatment system, fresh water generation and automation systems.

The Langh Group is also targeting opportunities in the cruise sector. The Langh Tech scrubber system was originally developed for cargo vessels where there was limited space for machinery installations. As cruise operators have become more interested in installing scrubber systems, the Finnish company has recently responded by reducing the size of the scrubber tower to fit into the narrow engine casings in cruise vessels.

Laura Langh-Lagerlöf, commercial director, Langh Tech, says: "Our new, smaller scrubber system is more cost effective and environmentally friendly than before, and is ready to meet the global sulphur emissions cap of 0.5% coming into effect in 2020. The small amount of dry sludge that is produced in the process is easy to dispose of ashore while our solutions are flexible and can be individually tailored to the layout of each ship."

Langh Tech scrubbers and water treatment systems have already been ordered for 11 different cruiseships. Four of these have already been fully commissioned; four have been delivered and will be commissioned over the next 12 months; while three more will be delivered between 2017 and 2019. The contracts, for newbuildings and retrofits, have been placed by Norwegian Cruise Line and RCCL.

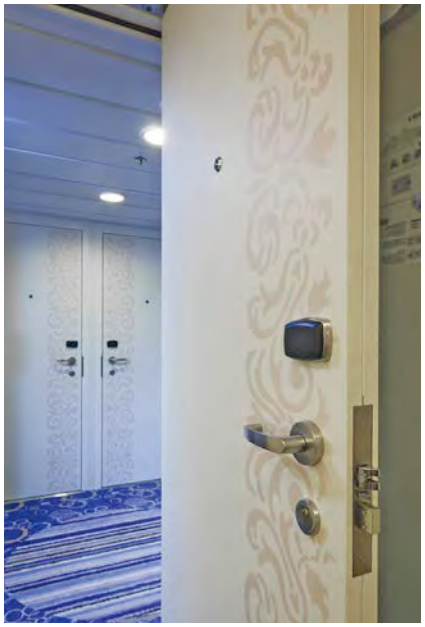
Langh Tech scrubbers are hybrid solutions, which mean they can operate both in open and closed loop mode. Langh-Lagerlöf adds: "We think, however, that the closed loop mode will become the most popular. It is the most environmentally friendly solution, since it not only washes particles from the exhaust gas, but also the water used in the washing process."

Finnish companies are delivering internal outfitting solutions to cruiseships, with Almaco recently announcing that it has been contracted to build the catering areas onboard the first Saga Cruises newbuilding at Meyer Werft in Germany. Almaco's scope of work includes the complete galley and pantry equipment and visual turnkey installation.

Almaco has worked closely with Saga Cruises since the pre-contact stage, assisting with the design and equipment selection for the main galley, crew galley, pantries, counters and refrigeration equipment for the catering areas. Erik Schobesberger, group vice president, newbuilding sales, says: "We understand the need for owners to optimise the design at the earliest stages of the process and, by working side by side with Meyer Werft and Saga, we were able to deliver a customised and efficient design."

Antti Marine has been chosen as the cabin door supplier for a number of high profile cruiseship projects, with

ongoing work including TUI Cruises' new *Mein Schiff 1* and Dream Cruises' *World Dream*. Projects completed in 2016 include *Mein Schiff 6*, *Norwegian Joy* and *Genting Dream*, as well as Tallink's *Megastar* ferry. The scope of supply for these vessels included passenger and crew cabin doors, as well as communication and internal access doors.



Antti Marine is offering doors with printed designs, which the company believes offers interesting potential for interior designers

Markko Takkinen, commercial director, says: "We have done a lot of development work, especially with regard to door sound reduction issues. As a result we are now able to offer sound reductions doors from Rw 35 dB up to Rw 48dB."

The company has plans to further develop its product range and manufacturing processes. "We are preparing to upscale our activities and we have already started to make some investments," says Takkinen. "We are for example preparing a new fire test for a B-class fire door and [we] are looking at the scope for harnessing digitalisation to move to a higher level of automation."

The company is also promoting a concept called Antti Decorative Print Design, which gives interior designers greater scope to enhance the visual impact of shipboard doors through printing on a visual effect or a visualisation of a well-known landmark, for example. Takkinen suggests: "The advantage of the print design method is that it offers a wide range of options, starting costs are low and it can be used in a wide range of projects, from small ferries to large cruise ships."

Antti Marine's print system has been certified by DNV GL and is compliant with fire safety regulations for surface decorations. "We think the print system opens up opportunities to create something new within door designs as part of cabin area visualisations," he adds. *NA*

Where are we now?

Cases of mild to moderate disorientation/frustration follow in the Ballast Water Convention's wake. *The Naval Architect* reviews the industry's current position as the charge of the Convention makes for 8 September 2017, 13 years after its adoption

The rapid implementation of the Convention poses difficulties for some manufacturers and shipowners yet to hedge their bets, but one can understand why IMO has been compelled to get the show on the road and to wrestle some of its reluctant members into line as quickly as possible. Without this it is quite possible the Convention could have been delayed by many more years.

At MEPC 70, support to extend the Convention compliance deadline fell short of a majority vote, however another discussion and vote is scheduled for MEPC 71 this July. If passed, this vote could extend the compliance deadline by as much as two years, according to Tom Perlich, founder and president of Ecochlor.

Perlich lays the scene: "As shipowners have started to operate IMO Type Approved BWTS, a growing concern is that the IMO test procedures were not explicit enough to ensure that IMO Type Approved systems would function properly and meet discharge standards. Currently, USCG test protocols are generally perceived as more rigorous, standardized and transparent than IMO Type Approval. However, Revised G8 Guidelines are being finalised to address this discrepancy."

These guidelines aim to "provide the technical specifications and the approval and certification procedures to be used by the [Flag] Administration when granting Type Approval," according to IMO, and their revision will likely bring the originals into line with the USCG type approval process – widely regarded to be more rigorous.

The timing of these revisions, however, is problematic. Submitted to MEPC 70 in October, they were approved, but will be further "reviewed and revised into a mandatory Code at a subsequent session of the Committee," according to class society ABS. Understandably, this regulatory flux, as well as the slight hope requests for an extension might be successful, is creating confusion for manufacturers and shipowners yet to take the plunge with ballast water treatment systems.

USCG testing (pictured above) is pushing a more stringent global approach to compliance

In a summary of developments from MEPC 70, ABS points out that two proposed schemes will be considered at MEPC 71 for vessels built before the above date:

1. Compliance with D-2 (see box) at the first International Oil Pollution Prevention (IOPP) renewal survey after 8 September 2017
2. Compliance with D-2 at the first IOPP renewal survey completed after 8 September 2017, unless that survey is completed prior to 8 September 2019, in which case compliance is at the first IOPP renewal survey completed after 8 September 2019

As a result, there is much confusion. "MEPC 70 did not bring any definitive answers, only more questions," says Perlich. These, he continues, regard:

- The compliance date for D-2 (after the ship's first IOPP renewal) is non-specific and [will] be discussed again at the next MEPC meeting (71). The compliance date could change by as much as two years.
- Revision[s] of [the] G8 Standard are accepted but have not been made public yet
- Whether there will be 'Experience Building' time with no penalisation for noncompliance
- Contingency measures
- Defining strategies on 'same risk' areas
- And further guidance on sampling and analysis, as well as Port State Control (administrative fines; compliance control; enforcement).

Expanding on the need to check effectiveness at different ports and

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maintaining standards, which could prove to be difficult in practice, Perlich reveals that MEPC 71 will be addressing this at their next meeting and that the committee is currently researching sampling and analysis products on the market.

"The next MEPC meeting will also discuss and hopefully define guidelines for Port State Control in regard to administrative fines, compliance control and enforcement as well as penalties for non-compliance," he adds.

As of 2 February this year, the USCG initiated civil penalty proceedings against the operator of the bulk carrier *Vega Mars*, Hamburg-based Vega Reederei, for discharging ballast water from the vessel without the use of a USCG approved ballast water management system or other approved means. This carries a maximum penalty of US$38,175 for violating the National Invasive Species Act.

Only three ballast water systems have received USCG Type Approval so far:

1. Optimarin's OBS/OBS Ex
2. Alfa Laval's PureBallast 3, capacities 150-3,000m^3/h – where only models using Idefix and Obelix reactors are approved
3. OceanSaver's BWTS MKII, capacities 200-7,200m^3/h – where models and operational ranges shall be in accordance with the Range Table provided in the OceanSaver Operation, Maintenance, and Safety Manual

Many others are still in the throes of their application. Both Ecochlor and De Nora, for example, are aiming to secure it this year; Ecochlor anticipates submitting an application in Q1 this year, while De Nora's BALPURE system is progressing through USCG testing for full approval according to the company.

Susanna Wyllie, global proposals manager – BALPURE, De Nora Water Technologies, also feels that the Convention has lacked clarity.

"One example is that the Convention links the implementation of the requirements to the International Oil Pollution Prevention (IOPP) and the majority of the class societies have allowed these IOPP dates to be de-harmonised from the vessel dry docking dates," she says. "This means that owners can delay installing a ballast system for another five years."

"While it is understandable that some ship owners have decided to complete their IOPP renewal survey ahead of schedule to postpone the deadline to install a system when the legislation finally comes into force, the knock on effect of this is that we're likely to see a peak requirement in 2022. This in turn will have an effect on dry dock capacity and the manufacturer's ability to supply....meaning long waiting lists for BWTS installation and owners risk having to accept a sub-standard solution other than their first choice in order to achieve compliance."

To avoid this, Wyllie suggests that owners should think ahead and be wary of repercussions that may occur with making the decision to de-harmonise. Those that delay may find themselves in a worse position. "Although it may seem the easy solution now, they are likely to be dealing with exactly the same issues further down the line," she explains. "All the 'get out of jail free' cards will have been used up, as at that point they're likely to be held responsible for both IMO and USCG requirements without any real flexibility on extensions or allowances."

Long-term compliance

Questions of long-term compliance still remain, as it ultimately falls to the shipowner/operator to make sure that the system they have onboard is compliant and fully-functional while the vessel is in operation. However, as far as system capabilities are concerned, the stringent testing enforced by USCG and the Revised G8 Guidelines will show any system's efficacy in test results, according to Perlich. After all, the USCG Type Approval process includes onboard and land-based testing with an independent laboratory, the rigorous definition of operating limits regarding water salinity, temperature and turbidity, as well as power requirements and requirements for the crew to operate the system.

Regrowth has circulated as a potential hazard, but well-designed systems will have considered in-tank regrowth from the outset, says Wyllie. "They must be able to demonstrate that at deballasting they are still able to ensure that organisms that are churned up during the voyage are killed and the D-2 standards are achieved. This is an important discharge standard and something that owners should be asking about when investigating ballast water treatment solutions."

"BALPURE was designed to address the issue of in-tank regrowth in its initial design stages. We demonstrate compliance on deballasting by having some hypochlorite left in the tank which is measured on de-ballasting and then neutralised to ensure compliance with the G9 requirements. In our view, if the vessel is deballasting with some hypochlorite then there is no organic requirement for additional hypochlorite - meaning you've continued to kill all the organisms throughout the voyage."

Ecochlor's system prevents regrowth in its own unique way, using one of the chemical features of chlorine dioxide, which its treatment process relies on. According to the company, this chemical possesses a superior ability to remove slimy films of bacteria that adhere to surfaces of water storage tanks, known as biofilm. Perlich says: "In land-based operations [where the chemical is already used], small cooling towers (frequently contaminated by food products or by-products) have tremendous biofilm forming potential and chlorine dioxide has achieved widespread usage in such systems, due to its excellent biofilm dispersing/ bacterial disinfecting properties." *NA*

IMO's Regulation D-2 Ballast Water Performance Standard

"Ships conducting ballast water management shall discharge less than 10 viable organisms per cubic metre greater than or equal to 50 micrometres in minimum dimension and less than 10 viable organisms per millilitre less than 50 micrometres in minimum dimension and greater than or equal to 10 micrometres in minimum dimension; and discharge of the indicator microbes shall not exceed the specified concentrations."

Winthertur shapes a new two-stroke generation

Notwithstanding the fact that the large two-stroke, low-speed marine engine market is the province of just three licensors, competition is intense and subject to considerable pressures from outside as well as within the industry. This is driving innovation, reports David Tinsley

Two-stroke engine production is characterised by a high degree of customisation, reflecting both the variety of vessel applications involved and the constantly evolving nature of client requirements. Ally to that the volatility of the shipping business and a circumspect approach to technological progression is demanded.

The overarching, and growing influence of international moves to decelerate global warming, expressed in more stringent, ever-widening emissions legislation, continues to shape R&D endeavours in the sector, as do rising expectations among users for greater plant efficiency, performance and reliability. Fuel consumption and multi-fuel compatibility are also essential medium to long-term considerations in R&D, despite the recent, protracted spell of low crude oil prices—which are now on an upward trend again.

MAN Diesel & Turbo, straddling both the marine and stationary power markets, ploughs more than 5% of its annual sales revenue back into R&D, with an expanding portfolio of two-stroke and four-stroke engines, turbomachinery and exhaust treatment solutions. Likewise, Wärtsilä Corporation has in recent years allocated some 2.5-3% of net sales for R&D across its diverse offering of machinery and equipment, although the sale to China of the group's remaining stake in the two-stroke domain shifts the resourcing of that area of engine development.

Long-term investment

Having purchased Wärtsilä's 30% shareholding in Winterthur Gas & Diesel (WinGD) last June, China State Shipbuilding Corporation (CSSC) became the 100% owner of the Swiss-based two-stroke engine design and technology specialist. CSSC has indicated that WinGD will be the beneficiary of a long-term investment strategy focussed on R&D, and that the company will retain its separate corporate structure and headquarters in Switzerland.

Winterthur Gas & Diesel's Andreas Kyrtatos, general manager of the R&D project management office

In a presentation to last year's CIMAC Congress in Helsinki, WinGD's project manager, Andreas Kyrtatos, considered that the next generation of two-stroke marine diesel engines could be expected to include the following features:

- Multi-fuel capability;
- Higher fuel injection pressures;
- Higher firing pressures;
- Combined emission control mechanisms integrated on the engine;
- Condition based management(CBM);
- Big Data: vessel/engine variables acquisition, transmission and statistical processing in order to optimise ship performance;
- Remote data connection, allowing problem diagnostics, software downloads, and engine performance optimisation.

Unlike IMO Tier II NOx limits, which can be fulfilled through internal optimisation measures with electronically-controlled engines, obviating any significant increase in specific fuel consumption (SFC), the Tier III standard is hard to achieve by just adjusting combustion and injection-relevant control parameters without sustaining a substantial fuel consumption penalty.

Accordingly, WinGD has focussed on exhaust gas aftertreatment, exhaust gas recirculation(EGR), and low-pressure dual-fuel (DF) technology, so as to provide more cost-effective solutions.

Kyrtatos observed that aftertreatment based on selective catalytic reduction (SCR) technology was regarded by the company as technically the most advanced, proven and cost-efficient way of meeting the Tier III edict on NOx with diesel engines, although systems require certain temperature levels so as to avoid the formation of deposits and ensure efficacious conversion of NOx.

In the low-pressure SCR system, the reactor is placed downstream of the turbocharger, necessitating only minor modifications on the basic diesel engine. "However, the LP SCR has the disadvantage of the lower temperatures, pressure and density of the exhaust gases at the catalyst (which thus requires a different composition and/or heating of the exhaust gas)," according to Kyrtatos. "This leads to large reactor volumes and the risk of formation of ammonia sulphates, in particular for operation with high-sulphur fuels."

In the high-pressure SCR alternative, the greater density of the gas allows for a more compact SCR arrangement

and reduced reactor and mixing device volumes, although more significant modifications on the engine are needed as the reactor is between the exhaust gas receiver and turbine. The higher temperatures before the turbo put less onus on the engine process and control to keep temperatures above the dew point of ammonia bi-sulphate.

Kyrtatos noted an important attribute in that: "The SCR system can be bypassed in order to enable the operator to switch between Tier II and Tier III modes when entering or leaving an ECA (Emission Control Area)."

WinGD is at an advanced stage of development for a fully-integrated HP SCR system, whereby the catalyst and all reactant injection and mixing equipment and flow control valves are mounted on the engine. This configuration presents obvious space and arrangement challenges, as the reactor and mixing pipe need to be extremely compact in order to be placed below the exhaust manifold. An integrated, compact arrangement must be viewed as positive in the light of feedback from shipowners and shipyards which indicated that a major concern with NOx aftertreatment on two-stroke engines is the extra space generally required.

Another technology used by WinGD to decrease NOx is high-pressure exhaust gas recirculation (HP-EGR). By recirculating exhaust gas into the combustion chamber, the heat capacity of the gas in the cylinder is increased and the oxygen concentration is decreased, so reducing combustion temperatures and NOx formation. The system requires a scrubber to clean the exhaust gas before it is mixed with fresh charge air.

A simpler version of EGR can also be used to increase power output and/or decrease specific fuel consumption in dual-fuel engines, where no scrubber is needed as long as the EGR is only run in gas mode.

WinGD gas leveraged longstanding experience from its Wärtsilä days in the field of low-pressure dual-fuel technology on four-stroke engines for the development of two-stroke DF machinery that is inherently compliant in gas mode with the most stringent emission standards governing SOx, NOx and particulate matter (PM). The company now offers the DF-ready option across its entire diesel portfolio. The 15,000dwt oil/chemical products carrier *Ternsund*, which entered the North European distributive traffic last August, provided the first installation of a DF low-speed engine employing WinGD's low-pressure X-DF gas admission technology.

Whereas high-pressure gas injection two-stroke engines operate on the Diesel cycle, the low-pressure X-DF series works on the lean-burn Otto cycle when in gas mode. The Swiss firm advocates that low pressure gas compression makes for greater simplicity and lower costs relative to alternative gas engine solutions.

MAN, though, is wedded to the high-pressure concept. Its high-pressure, dual-fuel ME-GI two-stroke design range has found particular market receptivity in the LNG carrier segment, and has also attracted a breakthrough order in the bulk carrier propulsion field. The licensor anticipates significant future opportunities as concerns increase across the board about CO_2 emissions as well as SOx and NOx.

Since Diesel-cycle DF engines require pilot injection of fuel coil for combustion, they can never be said to run entirely on LNG when in gas mode. However, MAN and other proponents of the technology contend that the system ensures that as much of the methane is burned in the detonation as possible, resulting in negligible 'methane slip', consequently adding very little to the so-called greenhouse effect. Furthermore, the Diesel combustion principle leaves no emissions of formaldehyde, a carcinogen.

In the meantime, WinGD has also been investigating the concept of a fuel-sharing mode on DF two-stroke engines. Tests were set in train last November on a WinGD W-X72DF engine onboard an LNG carrier. The aim of the system is to allow cargo boil-off gas to be supplemented (not replaced) with fuel oil, so that the ship operator can balance evaporated gas usage with actual power demands. WinGD already has a system known as dynamic combustion control, which enables liquid fuel to be added to boil-off gas for combustion in certain circumstances; where gas is of low quality, or in adverse ambient conditions. *NA*

A six-cylinder W-X62DF dual-fuel engine on the South Korean licensee's testbed

Tier III diesel power for Norwegian double-enders

Elegant powering solutions have come to characterise newbuild projects for Norwegian fjord ferries since the seminal, gas-engined *Glutra* was commissioned in 2000, writes David Tinsley

In addition to fostering the adoption of LNG, advocated for its cleaner-burning, environmental properties and as a growing Norwegian energy resource, the sector is increasingly championing electric drive technologies and hybrid solutions, notably including battery power. The overarching influence of the authorities, as exerted through emission edicts and ferry service operating licences, sets key parameters in fleet modernisation schemes, resulting in the advanced and often innovative arrangements adopted.

Now, this vibrant segment of the Norwegian maritime industries has embraced a new direction in pure diesel technology by opting for US-developed medium-speed machinery that meets the exacting requirements of the IMO Tier III limit on NOx emissions through engine-internal measures, without the need for selective catalytic reduction (SCR) exhaust aftertreatment plant.

On the strength of a new, 10-year concession to maintain the intensively-utilised Horten/Moss ferry connection across Oslofjord, Bastø Fosen is introducing three large double-enders contracted from Turkish yards. The newbuilds have each been specified with diesel mechanical drives based on two eight-cylinder GE Marine engines of the 250 MDC type, achieving the Tier III standard while burning diesel oil but eliminating the requirement for a separate SCR system and associated urea storage tanks.

Rated at 2,250kW apiece, the engines are installed at each end of the vessel, driving respective Rolls-Royce Azipull azimuthing thrusters. Based on the MM139FD design drawn up by Multi Maritime, the ferries also have the distinction of being the longest in the Norwegian domestic fleet, at approximately 143m overall. The length is a consequence of the operator's stipulation of a single ro-ro deck, so as to better ensure the rapid turnaround times of the schedule, notwithstanding the substantial increase in capacity to 200 cars, and provision for 24 articulated trucks, compared with a maximum of around 112 cars offered hitherto.

The 7,700gt *Bastø VI* opened the programme, making her debut on the Horten/Moss run on 1 January 2017 following delivery by Cemre Shipyard. The handover of *Bastø VI* was quickly followed by the completion of *Bastø IV* at the nearby premises of Sefine Shipyard, which has the last of the trio, *Bastø V,* in hand.

In marine engineering terms, the die was cast when Bastø Fosen repowered two 1997-built ferries with 16-cylinder vee-form versions of the IMO Tier III engine. The first of the pair, *Bastø I*, was brought back into service during April 2016 following conversion at Fiskerstrand Verft, and opened a new chapter for the ferry industry worldwide by employing diesel power that accords with Tier III requirements without the use of a urea-based catalytic converter.

The space savings realised through having no SCR installation and urea dosing storage tanks has enabled ro-ro capacity to be optimised in the new series from Turkey. As a means of fulfilling environmental criteria, the nomination of GE diesel power was also seen as a less expensive option than an LNG-fuelled system.

GE's emissions abatement technology encapsulated in the 250 MDC-series features exhaust gas recirculation (EGR), plus an advanced Miller thermodynamic cycle in conjunction with high-pressure common-rail fuel injection and increased peak cylinder pressure enabled by a dual-stage turbocharger.

EGR reduces NOx by addressing its formation within the engine's combustion chamber. A portion of the exhaust gas is cooled and re-routed back to the engine charge air stream. Since the specific heat capacities of the exhaust gas components are higher than

New Norwegian fjord ferry *Bastø VI* is installed with Tier III-compliant diesels from GE

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that of air, this results in a reduced combustion temperature and consequently less NOx formation. In addition, due to a reduction of the oxygen level in the combustion chamber, less oxygen is available to combine with nitrogen to form NOx.

Aside from the space, weight and capital cost implications of SCR technology, GE asserts that SCR systems require tight control of the exhaust gas temperature to avoid clogging of the catalyst from the ammonium hydrogen sulphate that issues at lower temperatures. "Other challenges include the process complexity associated with handling urea on board the vessel, controlling ammonia slip, the incremental operational cost for consuming urea, and additional maintenance scope," contends the US company.

The latest Bastø ferries' dual propulsion and auxiliary power systems and split location fore and aft confer full redundancy. In the event of an individual fault or damage, at least 50% of propulsive power should still be available.

GE Marine's L250 and V250 MDC engines achieve US Environmental Protection Agency (EPA) Tier 4 certification as well as IMO Tier III compliance, and reduce NOx by 70%-plus without urea-based aftertreatment.

The EPA Tier 4 standard, achieved while maintaining fuel efficiency and with a 12% higher maximum continuous rating than the Tier 3-compliant predecessors, has attracted a series of orders for the new generation of GE diesels on the US market. This has included the 12V250 MDC installation in Harvey Gulf's deepwater field support ship *Harvey Stone*, delivered in 2016. A prestigious new application entails five models of the 12V250MDC as the main genset drives in the 108m, US-flag inspection, maintenance and inspection (IMR) vessel *Ocean Evolution*, due to enter service this year. *NA*

Inward investors bolster Chinese production

With several new ventures involving European and American marques starting or ramping up marine engine production in 2017, China's ascendancy in the sector is set to receive a further boost, writes David Tinsley

The year began with the official opening of Lingang plant of CSSC Wärtsilä Engine Co (CWEC), near Shanghai, followed by the commencement of marine engine and genset manufacture at Caterpillar Tianjin. Also to be realised this year is the joint undertaking between Rolls-Royce Power Systems and China Yuchai International to produce MTU diesels in Yulin.

As the joint endeavour of China State Shipbuilding Corporation(CSSC) and Wärtsilä, with respective 51% and 49% shareholdings, CWEC has created a 20,000m^2 centre equipped to turn out up to 180 engines per annum, of the Wärtsilä 26, 32, 34DF, 46F and 46DF types, for both propulsion and marine auxiliary applications.

Although Wärtsilä has engine manufacturing joint ventures in China with other local partners, the CWEC initiative gives considerable added dimension to Chinese collaboration through the establishment of the first engine factory in the country to manufacture large-bore, medium-speed engines and also medium-bore, dual-fuel models. China's designation of emission control areas encompassing major spheres of shipping activity can be expected to create a substantial domestic demand for LNG-fuelled machinery.

By the time of the inauguration ceremony at Lingang on 9 January, CWEC had already made its first delivery and logged total orders for more than 70 engines. As a consequence of a market analysis conducted by the two partners, the joint venture is targeting LNG carrier, large container vessel, ferry, cruise ship, offshore and special-purpose vessel construction projects, primarily at CSSC Group yards but also throughout the Chinese shipbuilding industry.

CWEC's managing director Hannu Mantymaa said that it had been agreed under the joint venture that Wärtsilä would control the production, quality and supply chain. "A strong principle that we will always observe is that the design, quality and features of the products that we (CWEC) are manufacturing are 100% the same as that from any other Wärtsilä production facility."

Meanwhile, Caterpillar's plant at Tianjin is gearing up for volume output of 3500-series four-stroke, high-speed diesels for the marine market, complementing the factory's production of engines for the power generation and oil and gas sectors. Wholly-owned by the US group, and constituting its single largest investment in the Asia Pacific region, the US$300 million Caterpillar Tianjin factory is located in the Tianjin Airport Economic Area and will be Caterpillar's second dedicated site worldwide producing the 3500 family in its marine versions.

Tianjin will primarily serve customers in China and the wider Asia Pacific region. Together with the parent Lafayette Engine Center in Indianapolis, USA, it will also jointly supply markets in the Middle East, CIS (Commonwealth of Independent States) and Europe. Caterpillar said that it had embedded its world class quality processes from the outset at Tianjin to ensure there would be no material differences in engines assembled across the two sites. An Engine Learning Center is also planned, supporting and fostering the development of specialist engine technicians in China.

As one of the most prestigious brands in the high-speed, four-stroke domain, encapsulating German engineering technology, MTU will soon have a Chinese production dimension. The joint venture between MTU Friedrichshafen, owned by Rolls-Royce Power Systems, and Guangxi Yuchai Machinery Company, the main operating subsidiary of China Yuchai International, has been licensed to produce the versatile MTU Series 4000. Engines compliant with China's Tier 3 emission standards in the 1,400-3,490kW band will be manufactured at Guangxi Yuchai's Yulin City complex in Guangxi province.

From 2020 onwards, the aim is to extend the partnership company's sales territory beyond China to South East Asian countries. R&D activities may also be embraced in the years to come. *NA*

Integrated top end for new breed

Two new technologies developed by MAN Diesel & Turbo are central to the company's Mk 10 two-stroke low-speed engine platform, which offers a higher power-to-weight concentration than its predecessor, writes David Tinsley

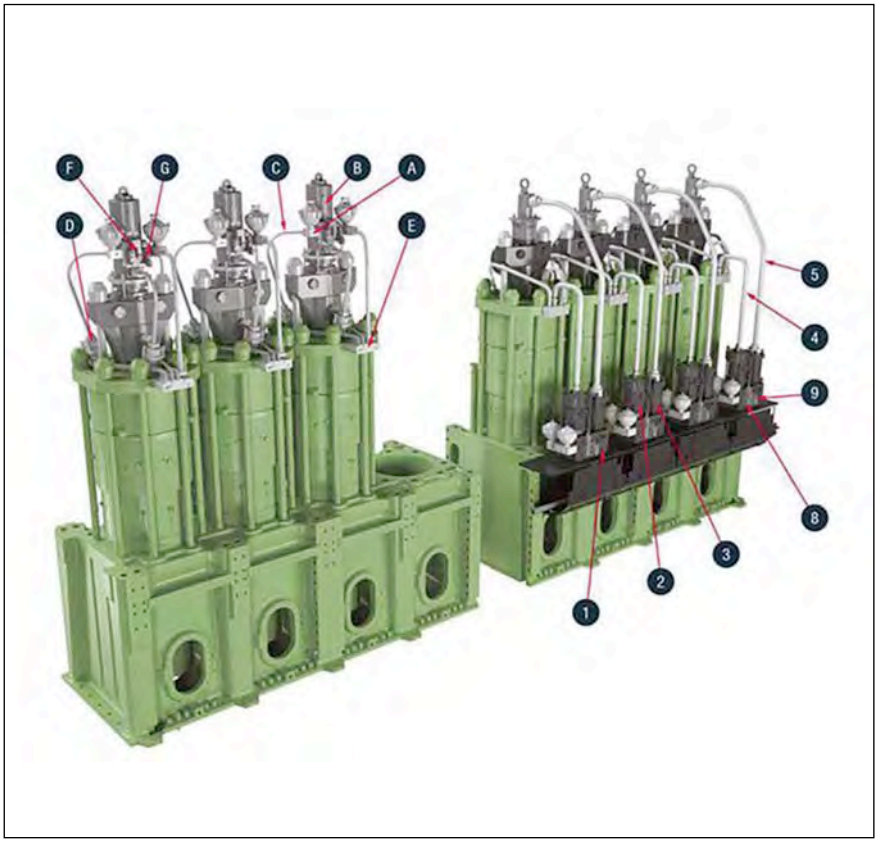
MAN's top controlled exhaust valve (TCEV) and fuel booster injection valve (FBIV) have been conceived to lessen the complexity of the hydraulic system, reduce componentry and increase the performance of the new generation of weight-optimised, wide-bore machinery. In addition, an innovative design of connecting rod, the Flex Rod, gives improved bearing load distribution and facilitates reduced engine dimensions.

The Mk 10 portfolio currently comprises the G90ME-C10, the S70ME-C10, and S60ME-C10. These are to be followed by a Mk 10 version of the G95ME-C type, the most potent MAN two-stroke. All S- and G-engines will eventually be upgraded to the Mk 10 platform.

The design initiative as a whole results in specific weight reductions of up to 10% per kilowatt and also allows a higher maximum pressure (Pmax), contributing to lower fuel consumption. The Mk 10 engines are not only lighter, but of reduced overall length, width and height compared to the equivalent Mk 9 models. The G95ME-C10 is forecast to offer a weight saving of about two tonnes per cylinder by incorporating TCEV/FBIV rather than the traditional hydraulic cylinder unit (HCU) arrangement.

The TCEV integrates the exhaust actuator, the hydraulic push rod and the control block into the exhaust valve. The integration of the FBIV and TCEV eliminates the HCU base plate, pressure booster, and the long, high-pressure pipes between the actuators and the fuel and exhaust valves. The dynamic behaviour of the engine is improved by dispensing with the long hydraulic push rod.

With the FBIV and TCEV combined on the engine's cylinder cover, the control of the valves for fuel injection is separated from the control of the exhaust valve by using the well-proven, electronic fuel injection (ELFI) valve and the new, proportional exhaust valve actuator (PEVA).



MAN Mk 10 engine's TCEV/FBIV concept (left), compared with the conventional hydraulic cylinder unit (HCU), actuator and exhaust valve configuration (right)

The Flex Rod conrod achieves better bearing load distribution and oil film performance, allowing narrower bearings and a shorter distance between cylinders. It makes a signal contribution to the Mk 10's reduced componentry and build dimensions.

The simpler design and lower component count of the Mk 10 platform offers benefits alike for shipowners, designers and licensee manufacturers.

TCEV and FBIV were originally developed in parallel. However, it became apparent that a significant weight reduction could be realised by combining the two as an integrated system. Extensive tests in service conditions have been conducted using a 500m-bore ME engine.

The Mk 10 portfolio to date is as follows:

- G90ME-C10: delivers 6,240kW per cylinder; maximum power range 31,200-74,880kW;
- S70ME-C10: delivers 3,430kW per cylinder; maximum power range 17,150-27,440kW;
- S60ME-C10: delivers 2,490kW per cylinder; maximum power range 12,450-19,920kW.

At the uppermost end of the range, the current G95ME-C9 (Mk 9) engine produces 6,870kW/cyl at nominal maximum continuous rating, providing coverage at MCR from 34,350kW to 82,440kW. *NA*

Arctic ice baptism for new medium-speed type

Designed to set a new standard in medium-speed marine engine efficiency, the Wärtsilä 31 will cut its teeth as the main machinery for Atomflot's nascent icebreaker, a vessel destined to serve the Yamal LNG project in the Russian Arctic. David Tinsley reports

The gensets central to the diesel-electric power and propulsion system in the 90m newbuild, reckoned to be the world's most advanced port icebreaker, will be driven by three eight-cylinder models of the 310mm-bore, four-stroke, vee-form engine. The vessel's technical outfit is also distinguished by the adoption of four azimuthing propulsion thrusters, two in the stern and two in the bow, and by the use of ABB's Onboard DC Grid energy distribution system.

Laid down at Vyborg Shipyard, located on the Gulf of Finland about 130km northwest of St Petersburg, the newbuild is due for completion towards the end of 2018. Under a port fleet services contract awarded by the Yamal LNG consortium to Atomflot, the vessel will replace the existing icebreaker at Sabetta, mainly to escort LNG carriers through the approach channel and assist with manoeuvring and berthing.

Through the multiple Azipod installation and specially-crafted hull form, the icebreaker will be capable of navigating and ice-forcing in both bow-ahead and astern modes, and will be effective in coping with thick brash ice formation in Sabetta harbour.

Although Vyborg Shipyard, part of Russia's United Shipbuilding Corporation, has predominantly ordered Wärtsilä engines for newbuilds over many years, the choice of the as-yet-untried W31 type for the Atomflot icebreaker is said to have been at the shipowner's insistence. "Our main purpose is to meet the customer's requirements, and the Wärtsilä 31 engine is at the moment the No. 1 engine in the world, especially when it comes to complex, modern vessels," asserted the yard's general director Alexander Solovyev.

Atomflot's Alexander Degterev, in charge of the diesel-electric newbuild programme, highlighted the facility for connecting the machinery to the proprietary condition-based maintenance system as a factor favouring the choice of engine. "It is an advantage to us that Wärtsilä can monitor the engine operation on-line and, if necessary, provide us with instant advice," he said.

As the icebreaker is intended to be in operation through the entire winter period, which effectively spans most of the year, availability and dependability are fundamental considerations when selecting equipment, machinery and shipboard systems. A characteristic of the W31 engine is the most circumspect approach to maintenance. The first major service will be necessitated only after 8,000 running hours. By comparison, engines of similar output typically require service after about 2,000 runners. In addition, the TBO (time between overhaul) for cylinder head and pistons, and injection pumps, has been much extended to 32,000hours.

The Wärtsilä 31 medium-speed design has been specified for Atomflot's nascent diesel-electric icebreaker

This improvement cuts maintenance costs and increases vessel uptime. Furthermore, the modular design of the engine and correspondingly lower component count simplifies servicing by shifting from dismantling and overhauling individual parts to exchanging whole assemblies.

Besides performance attributes, Atomflot identified the long maintenance intervals promised by the Wärtsilä prime movers as one of the distinct attractions of the design.

The shipset of engines was shipped from the Vaasa factory in Finland to Vyborg around the turn of the year. So as to minimise handling and its attendant risks, the Finnish group arranged for direct delivery of the engines to the shipyard rather than routing through ports.

The W31, which has subsequently attracted orders in ferry and deep-sea fishing vessel applications, has been developed exclusively as a vee-form engine, a factor which underpins the modular build strategy. It is exceptional in providing a concurrent design platform for distinct diesel, dual-fuel and gas-only variants.

In its diesel version, the maximum continuous rating is 610kW per cylinder. The nominal MCR output of each of the engines in the future Sabetta icebreaker is accordingly 4,880kW, making for an overall installation of 14,640kW. Each of the four Azipod propulsors is equipped with a 3MW electric motor.

In 2015, Guinness World Records rated the W31 as the "most efficient four-stroke diesel engine", adding credibility to the manufacturer's claims for its new product.

The longstanding Finnish technological involvement with Russian icebreakers also finds expression in the Atomflot newbuild through the engagement of Aker Arctic for the development of the ship's design, the type ARC 124.

The Onboard DC Grid augments the efficiency gains promised by the diesel machinery. The system allows the main diesel generators to run at variable speed rather than fixed speed, reducing overall fuel consumption and emissions when the power plant operates at partial load. The ability to have the diesels working at variable speed for maximum fuel efficiency at each load level is a compelling advantage when managing ice conditions.

The grid also permits the harbour genset to run in parallel with the main engines without limitation. Furthermore, the reduction in overall componentry and footprint yields benefits from a ship design standpoint. *NA*

Class societies update CSR software suites

As controversial as they may have been at the time, common structural rules (CSR) have been a part of new ship design and construction now for around a decade, writes Malcolm Latarche

Although the original CSRs were developed separately for oil tankers and bulk carriers by two different working groups, it was soon recognised by IACS that there was a need to harmonise the two sets into a single version. That work was completed in 2013 and the new harmonised common structural rules adopted in December that year took effect in July 2015.

The rules are applicable to all IACS members and with the advent of the common rules, class societies developed software to check and compare newbuilding designs against the requirements of the rules. However, despite the concept of common rules having been devised to address the issue of individual classification societies competing on lowered standards, there were still many who did not believe that the rules would be applied equally.

Two class societies – ABS and LR – have tried to dispel this idea by jointly establishing Common Structural Rules Software LLC (CSRS) to provide industry with a validated and verified suite of software tools for CSR. It was the joint venture's hope that other societies would recognise the value of the suite and consider adopting it, but so far that has not happened and ClassNK and DNV GL both operate using their own software.

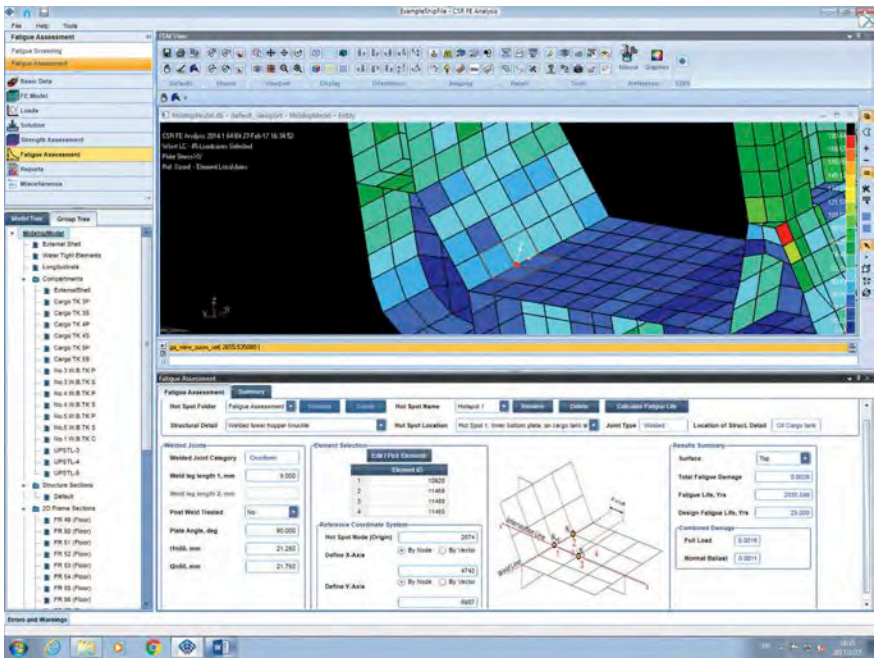
Last May, at MSC 96, the IMO recognised that the harmonised CSR met the goals and functional requirements of the organisation's own Goal-based Ship Construction Standards. Later in the year IACS made some changes to the CSR resulting in a new version that takes effect in July this year.

In response, both CSRS and ClassNK have updated their software to incorporate the changes. The joint venture's version 2.5 of the CSR Prescriptive Analysis (PA) and CSR Finite Element Analysis (FEA) software allows assessment of whole vessel structures – including new bulk carrier and oil tanker designs using either the 2015 or the 2017 versions of the common rules.

Both applications PA and FEA are standalone desktop applications that can be downloaded from the company website. Upgrading to the new software is straightforward. A user uninstalls the previous version and then downloads the new version from the website. All existing projects work seamlessly with the new revised release. Detailed instructions on how to install the new version of the software are available on the CSRS website in the User Guide and Release Notes provided with the software. At the moment, the software does not interface with CAD programmes, but this feature is on the CSRS PA and FEA roadmaps, and there are plans to implement an interface in later releases.

The PA application is used to assess hull girder ultimate strength and hull local scantlings while the FEA app uses a Finite Element Analysis approach for strength and fatigue assessment on different tanker and bulk carrier structures. The current PA and FEA releases have multi-rule year capability, which allows users to evaluate ships for both 2017 and 2015 IACS rules. The 2015 IACS rules are in force today.

The updated CSR Prescriptive Analysis software requires only that the user input the appropriate data. All of the outputs are claimed as being clear, straightforward and easy to read. A summary report provides required and offered scantlings with graphic representation of any deficiencies.

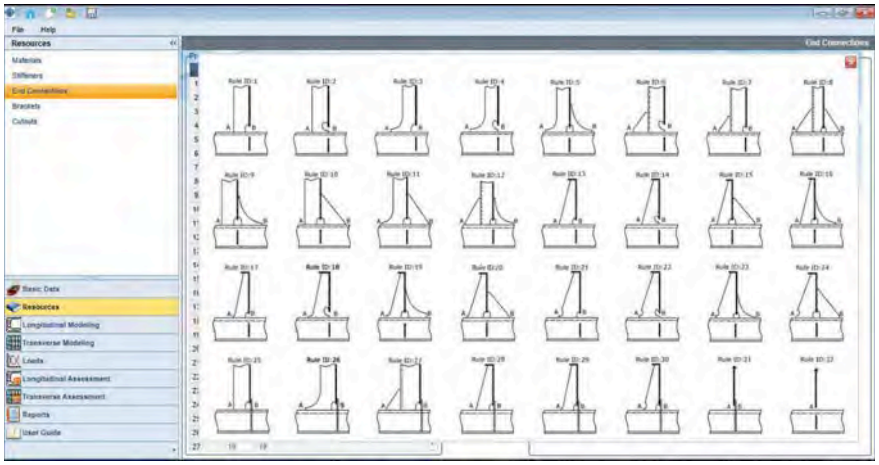


Screenshot of a fatigue assessment in Lloyd's Register's CSR software

An intermediate report summarises dominant criteria for each structure and a detailed report provides data for every parameter value. In conjunction with CSR FE Analysis, this complete tool makes verifying compliance with CSR possible with minimal effort.

ClassNK also released a new version of its software in February. PrimeShip-HULL (HCSR) Ver.4.0.0 incorporates the 2017 rule amendments and offers a new function to preview reports in the direct strength assessment software, improving overall performance and usability. In the prescriptive calculation software the calculation time has been reduced and the initial design function for quick sectional evaluation can now link with other sectional data in order to automatically extract longitudinal parameters, reducing the potential for inputting errors. There is also an enhanced data linkage function with 3D-CAD software NAPA Steel. This enhanced function now makes it possible for 3D model data of NAPA Steel to be imported into the initial design function and members' data modified in the fullship design function to be imported back to NAPA Steel, a feature which is expected to significantly reduce the man hours required for structural evaluations in NAPA Steel. *NA*

Lloyd's Register's CSR Resource Module enables users to choose from a list of pre-defined industry standard material/stiffeners/end connections, etc. or create new ones



'Ship sight' envisages safer operations

A new autonomous ship system emerges for use onboard today's vessels. The Naval Architect exclusively reports

The increasing presence of sensory technology is changing the way crew and indeed vessels themselves perceive their local environment. Technology now has the power to see and relay the environment it beholds, further enhancing the sensory resources at a bridge team's disposal.

Such developments have the potential to improve the safety of currently operating vessels, but also re-open the discussion of an autonomous future – a future that seems increasingly feasible (at least technologically).

Rolls-Royce has made a name for itself within the maritime industry for innovations in the field of ship autonomy. Its Advanced Autonomous Waterborne Applications Initiative (AAWA) project set out with the aim of having a remote-controlled ship in commercial use by the end of this decade, and products based on the project's developments are percolating to market.

Last year an automatic crossing system was delivered to Norwegian ferry company Fjord1, and now a new commercial product emerges from the project.

Following more than six months of testing on AAWA's test vessel Stella (a 65m ferry owned by Finferries), an Intelligent Awareness System (IAS) for vessels of any type is set to be launched; the first of its kind according to the company.

The system functions as an advisory tool that empowers decision-makers with a greater understanding of a ship's surrounding environment. Its application is particularly aimed at the safe navigation of busy ports, for example a large cruiseship navigating the port of Shanghai, or operations in challenging environments, such as the dense fog experienced in Houston's shipping channels.

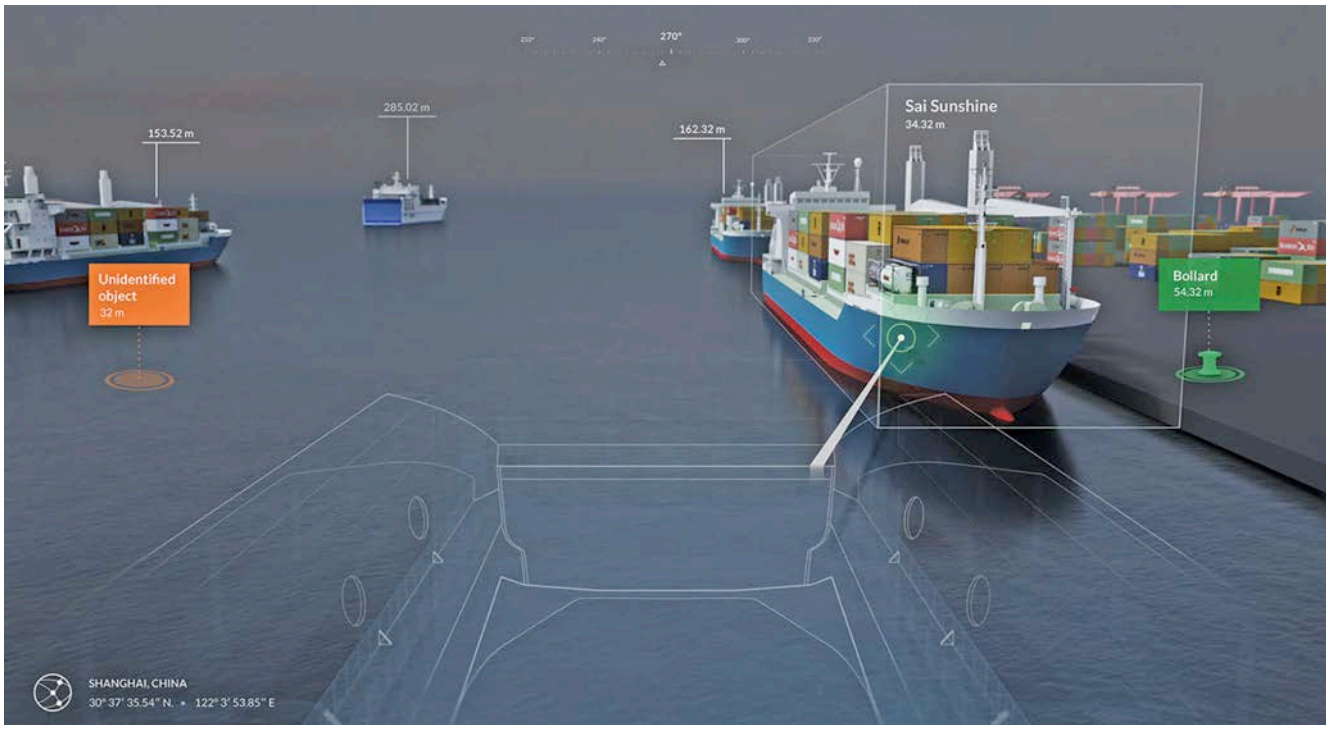
Fundamentally, the system opens the eyes of operators to a wider range of perspectives based on a ship's sensor technologies. Using the information it perceives, the system then informs operators of risks and can offer a unique bird's-eye view of the environment – this is something that could be particularly useful in docking operations and Rolls-Royce reveals that work on an automated docking system is ongoing.

Iiro Lindborg, general manager of remote and autonomous operations, Rolls-Royce, explains that the system is based upon the use of multiple different kinds of sensors, including high definition cameras, night vision, radar, LIDARs and AIS data, and functions through the efficient integration of different data sets, what he calls "data fusion". In addition, IAS also has the unique benefit of fog horn detection – a recent innovation that can map the distance between two vessels based on acoustic information.

This fusion allows for interchangeable layers of insight i.e. where an operator can view either a 3D map rendered by LIDAR, a radar overlay or a topography that shows the ocean bed.

Already deployed in the first autonomous cars, LIDARs are making their way to the maritime industry,

'AI-Spy': Rolls-Royce's Intelligent Awareness System can perceive objects/hazards and relay their presence to crew



creating 3D environments that can be mapped with GPS points and used to perceive what the human eye cannot when operating a ship. LIDARs are a particularly useful component, offering a view that is in principle four times better than the human eye in foggy conditions according to Lindborg. The technology is based on the creation of a point cloud, firing beams of light from a laser and then measuring when a beam is reflected. Roll-Royce says approximately 300,000 beams are pulsed to render a 3D map of the world around a vessel. In this way a vessel is able to map its environment and provide new insight for those on the bridge.

The way the system processes a ship's surrounding environment and any objects, how its 'brain' works for want of a better description, is particularly innovative. It uses an artificial intelligence (AI)-based object classification solution that can independently detect and track objects. Onboard cameras classify approaching vessels or objects and, after some time, will be able to determine vessel characteristics i.e. how fast a vessel can travel or stop.

A process known as 'labelling' establishes what a vessel's cameras 'see'. This involves drawing boundaries around pictures containing two vessels and teaching the AI the difference between each boundary field, as well as any associated characteristics for each field/vessel. Rolls-Royce has amassed two million pictures for 'labelling' so far and the system on offer contains 100 different categories and can detect objects including lighthouses.

The potential is obviously expansive and improves with the amount of data the AI is able to leverage. At its most basic, it detects a vessel and whether the vessel is moving. Rolls-Royce controls the templates the system functions on and will improve the service offered based on its constantly growing data pool.

Tomorrow's solutions today

Lindborg stresses that while the system will help to facilitate an autonomous future, the project aims to help existing crew. It is therefore increasing the usability of readily available data, not necessarily creating more data, he says.

With this in mind, there is not much extra equipment to install onboard. The cut and thrust is to improve the use of existing tech, integrating LIDARs and cameras. Asked about the cost, Lindborg says any solution can be different and will be the product of a co-development process with the owner. In other words, a system or a version of the system is tailored to each ship's needs based on the requirements of the shipowner. The process, Lindborg explains, will begin by looking at a vessel's current capabilities before moving on to discussions of future improvements and establishing a proof of concept.

Initial interest has been received from cruiseship owners, but owners of other ship types including cargo vessels have discussed the new system with Rolls-Royce. To this end, Lindborg is keen to point out that studies have ranged to represent the requirements of different vessel types. *NA*

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SHIP ECONOMY & TRADE

Smart manufacturing needed

China's shipping industry has entered a new phase, dominated by slowed growth rates, structural adjustments and the rebuilding of advantageous sectors, writes Liu Zhiliang

Only 112 out of 633 active players in shipbuilding and offshore enterprises have firm orders, according to statistics from the China Shipping Industry Economic and Market Research Center.

Guo Dacheng, chairman of China Association of National Shipbuilding Industry (CANSI), points out that there are many uncertain factors that will influence future global economic growth currently. The global problem of overcapacity in shipping and manufacturing cannot be solved within a short time. The contradiction between oversupply and limited demand is to exist for a long time in the future and the shipping market is still in the adjustment phase. It is predicted that in the "Thirteenth–five-year Plan" period, the annual global orderbook will approximately total 80 million deadweight tonnes.

Chen Yingtao, a researcher from the equipment division of the Ministry of Industry and Information Technology says: "This year is the first year of the 13th - Five-year-plan period and it's also the most difficult year for the shipping enterprises since the international financial crisis began. The shipping enterprises should abandon the [delusion] of [a] next boom…and be prepared to confront the long-term harsh condition and struggle."

Zhang Jing, assistant for the director of China Shipping Industry Economic and Market Research Center, also believes that 2016 has been the most challenging year for the shipping industry to date, clearing-out uncompetitive players. However, this is just the beginning of the bottoming process and the Chinese shipping industry should be prepared for worse.

Market survival

With such a downturn, but also new technological revolutions, there is a pressing need to focus on innovation and to accelerate the 'smart development' of China's shipping industry.

Smart manufacturing is needed if the Chinese shipping industry is to compete on the construction and manufacture of high-tech vessels and equipment. Picture from GE Resource

After years of development, China's shipping and offshore equipment manufacturing competencies are quite advanced. Yet its core areas such as high-tech vessels and deep-sea offshore equipment manufacturing are still lagging behind the developments of overseas peers.

In terms of core technology, intellectual property rights and the operation of such technologies, there is still great room for improvement. And in such a slow market, China's shipping enterprises must value the role of technological innovation in propelling the industry.

As early as 2013, in the report "Suggestion on the Prominence of Tech-Innovation and Comprehensive Enhancement of Enterprises' Innovation Competence", the General Office of the State Council clearly stated that such tech-innovation systems should have been established by 2015. Guo Dacheng believes the shipping enterprises should change their philosophy and abandon the old emphasis on manufacturing and ignorance on R&D. "A new philosophy of viewing the enterprises as the entity of innovation should be established. We should encourage the enterprises that have enough competence to establish their individual innovation centre or join their efforts in establishing [a] collaborative innovation centre. They should work out the full potential of innovation, developing the products which most satisfy the demands of customers. At the same time, we should fully integrate the competence of academic institutions, exerting [a] positive influence on the whole industry, especially in terms of R&D and quality of the parts products which [have] bottle-neck issues in exportation."

Mr. Guo called for greater attention to the academic research guidance from the national government. In early August, the State Council issued New National Tech-Innovation Planning for the 13th Five-year-plan, which focuses on global technology frontier issues. At the same time, the State Council also issued a Specific Guideline for Promoting Manufacturing Industry Quality and Brand-name, which emphasises five major projects: the construction of manufacturing innovation centres construction, strong industrial bases, smart manufacturing, green

manufacturing and high-end equipment innovation – all of which the shipping industry should be concerned with and participate in.

Chen Yingtao agrees with Guo on the above. He says the Ministry of Industry and Information Technology will further improve the management of the high-tech vessel research system and that of major industry projects this year. The ministry is also to tighten its management of the industry's major projects by making specialised rules. In July last year, the High-tech Vessel Research Projects Guideline 2016 Version was officially issued in order to drive better planned R&D activities and the study of new IMO standards and rules.

Drivers

Smart manufacturing is at the centre of plans to develop China's shipbuilding and equipment manufacturing capabilities, with such techniques promising shorter R&D and manufacturing cycles.

Smart manufacturing and smart yards are becoming increasingly prevalent across the industry globally, and China's shipping industry is also transitioning to utilise the production efficiencies and improvements in product quality that this approach can offer. This new round of techno-industrial revolution is set to create opportunities for the country's shipping industry, propelling it towards smart designing, smart products, fine management and information integration. Smart manufacturing is consequently seen as a way for China to compete internationally.

In 2015, the Ministry of Industry and Information Technology announced its pilot projects list. The only demonstration model for the shipping industry was a smart workshop for NACKS. In an update on its progress, Qiu Ting, general manager, says that NACKS is currently moving towards having robot applications and an automatic production line in answer to the government's call for technological development. Based on automation, a smart production line and an assembly line, the plant is to construct a smart workshop, with the long-term objective of building a preliminary-stage smart shipyard.

More yards are following suit. Jinhai Heavy Industry is currently focussed on building a smart shipyard and plans to invest RMB3 billion (US$436 million) within 3-5 years. The shipyard is to be built to Industry 4.0 Standards, transforming current infrastructure and equipment while introducing new robots and auto-assembly and welding. The shipyard will also introduce suitable equipment to meet the construction requirements of high-end vessels. New measures include a smart logistics management system, a smart production management system, s smart digital workshop and a smart shipyard, all of which are to lead the shipyard into the premier tier of global smart maintenance and manufacturing centres. *NA*

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