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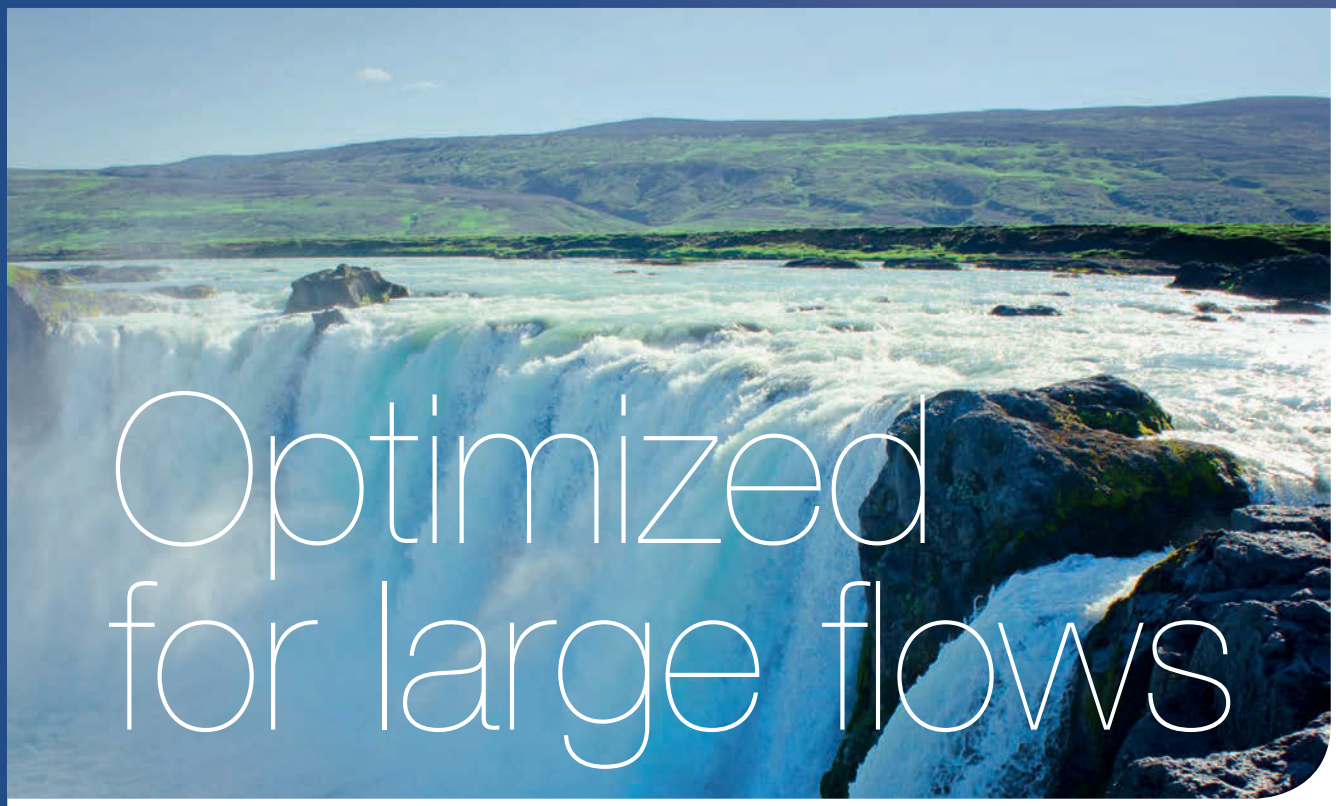

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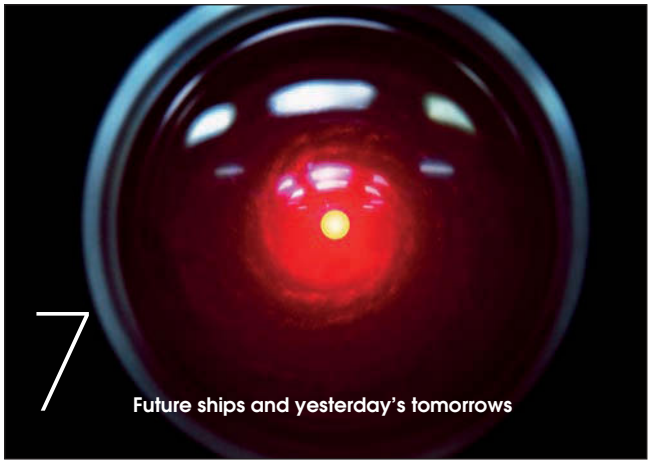

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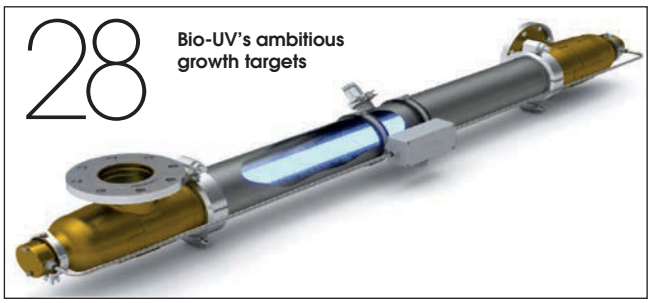

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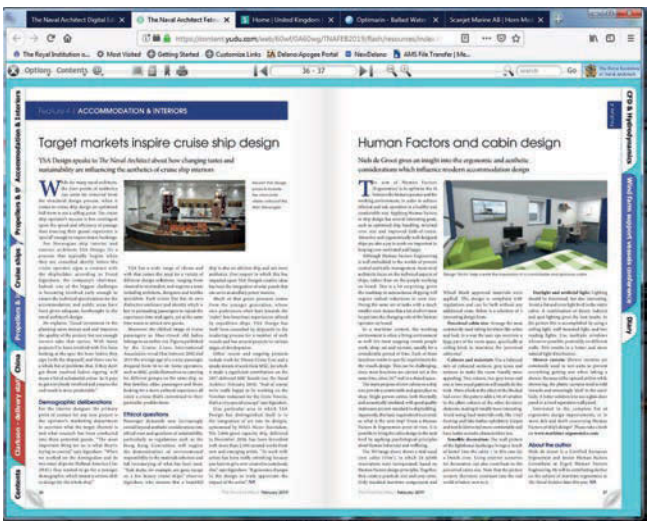

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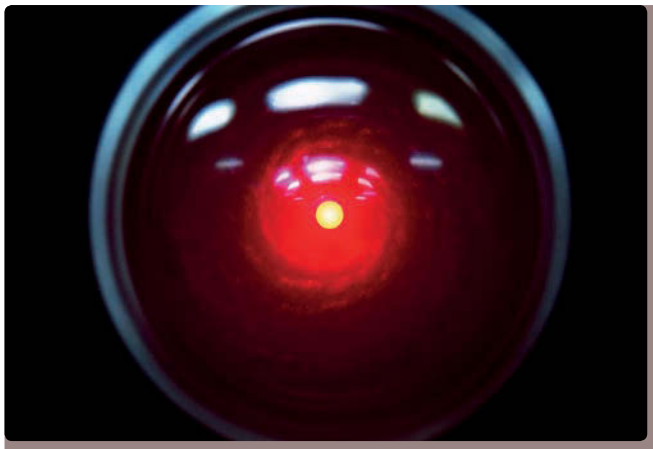

More future, less 'ism'

Sentient computers by 2001 turned out to be wide of the mark

Accompanying this month's edition of *The Naval Architect* you will have found a supplement with the somewhat grandiose title of *Future Ship 2050*. When this extra publication was originally conceived last year I wondered whether it might comprise all manner of futurist soothsaying about what the vessels of tomorrow might look like, yet as it evolved it became clear that we were actually compiling was a more measured and pragmatic look at how some the emerging technologies of today are being organised and developed into viable solutions.

I think there are several reasons for this. As regular *NA* contributor Volker Bertram wryly observes of Rolf Schönknecht's 1983 book *Ships and Shipping of Tomorrow*, yesterday's tomorrows have a tendency to be gloriously impractical, gravitating towards romantic ideas of what may be possible, much as Stanley Kubrick and Arthur C. Clarke imagined in 1968 that we might be undertaking a manned mission to Jupiter, assisted by a sentient computer, by 2001. But also, more seriously, the exigencies of climate change were hardening resolve that action needed to be taken even before IMO's declared goal of halving shipping's CO_2 emissions by 2050.

After all, how long is 30 years, really? In previous editions of this magazine it's been highlighted that if IMO's goals are going to be achieved the projections are that ships built by 2030 will need to be utilising fuels and efficiency measures that enable them to achieve, if not better, those 50% carbon reductions. While discussing its zero-carbon Super Eco Ship 2050 car carrier concept for the supplement, Japanese operator NYK Line told me that it expects ships being built next year could well be a part of its fleet by 2050 and is factoring that into its overall calculations.

The mainstream media has been recently been highlighting that March 2019 marks 30 years since CERN engineer Tim Berners-Lee's 'invention' of the World Wide Web and the birth of the Information Age, which some would argue represents as seismic a socio-cultural transformation as the Industrial Revolution.

Change can and sometimes does occur at a frightening speed; I'm reminded of a recent news item that compared two photographs of New York's 5th Avenue. In the first photo, taken in 1900, the traffic was almost exclusively horse-drawn carriages; yet by the second, taken only 13 years later, there was just one carriage amid a stream of cars. A similar transformation, the new story speculated, could soon happen with the emergence of self-driving cars that, in an Uber-style network, would remove any need for individual car ownership (and perhaps scupper the Super Eco Ship 2050's raison d'ètre).

But with both cars and the internet, one probably needs to differentiate between the technology itself and how its exploitation as a commodity can become a cultural catalyst. Forms of computer internetworking were already in use by the late 1960's, likewise the internal combustion engine had (after a fashion) existed for 70 years before it became basis for the motor car.

What this probably tells us is that it's nigh-impossible that any radically new technology is going to transform maritime transportation by 2050. But whereas the aforementioned cultural catalysts have been driven by the confluence of technological readiness and market forces, environmentalism is not as such (yet) driven by the same ethos. Shipping has been compelled to re-contextualise 'efficiency' as more than just saving money on resources; the opex now includes the planet itself and eventually it's probable this will be translated into literal carbon taxes.

There are certain recurrent themes throughout the supplement but two in particular stand out. Firstly, that whatever future fuels are in use come 2050 – and the smart money is on a mix of different solutions, even onboard the same vessel – as much depends on the ability of the land-based infrastructure to supply clean, renewable energy. Second, that it's facile and reductive not to take a holistic approach to the entire supply chain, irrespective of how fragmented that might currently be.

Thirdly, much as CERN's decision to release the source code for Berners-Lee's World Wide Web project into the public domain allowed it to become the de facto standard, so too standardisation needs to be embraced by shipping. To what extent this can be achieved in shipbuilding itself remains open to question, but there is already ample evidence of its growing importance to e-navigation and the implementation strategies being developed for remote and automated shipping.

With regard to autonomous shipping itself the prevailing sentiment remains highly positive, but as companies such as Rolls-Royce Commercial Marine (who may or may not have been formally integrated into Kongsberg by the time you read this) now well underway with product development for these AI solutions, regulatory hurdles notwithstanding it's evident the application of autonomy will most likely be localised for the foreseeable future. *NA*

Research & development

C-Job representatives to join ISSC committee

The International Ship and Offshore Structures Congress (ISSC) has appointed two members of the team at Netherlands-based C-Job Naval Architects to serve as representatives on its 2018-2021 committees.

Mark Slagmolen will serve on ISSC's 'Design Methods' technical committee, while Claudia Loureiro Garcia will be joining the ISSC's 'Special Vessels' specialist committee.

The ISSC is a forum for the facilitation and evaluation and dissemination of marine structural research results in order to make recommendations for standard design procedures and criteria, and encourage international collaboration in furthering these areas. In total, it has 16 committees consisting of international experts from universities, research institutions, class societies, shipyards and naval architects.

Of his appointment, Mark Slagmolen said: "C-Job Naval Architects has a strong focus on research and development and is always looking for new ways to improve and be innovative with both its designs as well as in the creation of these designs. It's an honour to have been chosen by ISSC to share C-Job's knowledge and work together with international experts on the 'Design Methods' committee."

Last year, C-Job earned a Maritime Designer Award 2018 nomination for its Accelerated Concept Design R&D project (see *The Naval Architect*, November 2018). It has also recently launched its C-Job Buckling Tool, which allows ship structures to be optimised at the earliest stages of Concept Design, while promoting a better understanding of plated structures in the Basic and Detail Design stages.

Shipbuilding

Foreign suitors linked to bankrupt Philippines shipyard

South Korea's Hyundai Heavy Industries (HHI), as well as several Chinese and European shipyards, are among those being linked to a takeover of operations at the Hanjin Heavy Industries and Construction Philippines (HHIC-Phil) shipyard in Subic Bay, Philippines, according to media reports.

HHIC-Phil, the largest shipyard in Southeast Asia, filed for bankruptcy in January, despite having an orderbook full to the end of 2020, after defaulting on US$412 million owed to several Filipino banks and a further US$900 million to South Korean lenders. The yard, which opened in 2008 and at peak production employed more than 10,000 people, is a subsidiary of Hanjin Heavy Industries.

Among other shipbuilders being linked to a takeover are Netherlands-based Damen, which already operates 36 shipbuilding and repair yards around the world, and unnamed shipbuilders from both the United States and China.

However, for political reasons a Chinese takeover is generally felt to be unlikely. Another possibility is that the Filipino government itself will acquire the site for naval production or alternatively become a minority stakeholder in a takeover package.

Between 2008 and 2018 the HHIC-Phil yard built 123 vessels, including oil tankers and 20,000TEU container ships.

Alternative fuels

Dutch companies announce methanol fuel project

A consortium of Netherlands-based companies is to collaborate on a two-year project to explore the feasibility of methanol as a sustainable alternative fuel for the maritime industry.

Endorsed by IMO's Maritime Knowledge Centre (MKC), the Green Maritime Methanol project will bring together shipowners Boskalis, The Royal Netherlands Navy, Van Oord and Wagenborg Shipping, together with shipbuilders, Damen Shipyards, Feadship, Royal IHC; as well as engine manufacturers Pon Power and Wärtsilä. Other participants include equipment suppliers Marine Service Noord and C-Job Naval Architects.

The Netherlands' two largest ports, Rotterdam and Amsterdam, methanol suppliers BioMCN and Helm Proman and trade organisation Methanol Institute will also participate to address the bunkering and supply chain infrastructure.

The Green Maritime Methanol project is supported by the public-private partnership TKI Maritime and the Netherlands Ministry of Economic Affairs and Climate Policy

Research support will be supplied by some of the Netherlands' leading academic institutes, including the Netherlands Organisation for Applied Scientific Research (TNO), TU Delft, Netherlands Defence Academy (NLDA) and Marin as the project investigates operational profiles, ship configurations, engine configurations, performances, emissions and other issues.

"As part of the project, the partners will look at concrete possibilities to adopt methanol as marine fuel on either newbuilds or conversions of the existing fleet," explains Pieter Boersma, Business Director Maritime & Offshore of TNO.

Expedition ships

Ulstein signs agreements for further expedition ships

Norwegian shipbuilder and designer Ulstein has sealed an order from Lindblad Expeditions Holdings for a second polar expedition vessel.

It follows the December 2017 order for the *National Geographic Endurance*, which is scheduled for delivery early next year, and will bring the total of Lindblad's National Geographic fleet to four, following the delivery of the *National Geographic Quest* and *National Geographic Venture* in July 2017 and December 2018.

The new ship will be built to PC5 Category A, the highest ice class of any purpose-built passenger ship, and like its sister will feature Ulstein's trademark X-Bow design, for optimal efficiency and smooth transit in all sea behaviour, while offering increased space in the bow area. It will also feature the same 126-passenger capacity, across 69 cabins, the majority of which include private balconies. Other features include an "innovative" Zodiac loading system for offshore exploration.

Meanwhile, SunStone Ships, has signed a contract with a Chinese shipyard for a fourth vessel in its Infinity series, which was designed by Ulstein Design & Solutions. China Merchants Heavy Industry will build the *Ocean Explorer*, which will be chartered to operator Vantage Cruise Line after delivery in 2021.

The first vessel in the series, *Greg Mortimer*, is due for delivery in Q3 of 2019, to be followed by *Ocean Discoverer* (Q4 2019) and *Ocean Victory* (2020). There are also options for a further six vessels in the series.

The fleet of Infinity Class expedition ships will now be at least four strong

Emissions

SEA Europe sounds 2050 investment warning

The Shipyards' & Maritime Equipment Association (SEA Europe) says that "significant investments" in zero-emission waterborne transport is needed if targets of a carbon-neutral Europe are to be achieved by 2050.

SEA Europe, which promotes the needs of member associations representing both commercial shipping and the naval industries, believes that with 40% of global shipping under its control, European shipowners are key players in carbon reduction.

In January 2019, the Waterborne Technology Platform initiative, of which SEA Europe is a partner, published its Strategic Research Agenda, which aims to achieve zero-emission newbuild ships and inland barges from 2030, and zero-emission from all ships by the middle of the century. The goals are consistent with IMO's much-publicised carbon targets, and strategies such as the the European Commission's 'A Clean Planet for All' manifesto, announced late last year.

LNG carriers

Samsung HI wins LNG carrier contract from US owner

Samsung Heavy Industries (SHI) continued its resurgence from the financial trouble of recent years in February, with the news it is to build four LNG carriers for an as-yet-unnamed US-based owner in a deal worth Kwon870billion (US$774 million).

The new vessels will be built by the end of Q3 in 2022 and comes shortly after the announcement that SHI will build two further 180,000m^3 LNG carriers for Copenhagen-based owner Celsius Tankers, in a contract worth Kwon419 billion (US$376 million).

It follows a similar order Celsius placed in August 2018. The new duo will also include two new eco-friendly and smart ship technologies – SAVER Air and INTELLIMAN Ship – intended to further improve operational efficiency. Delivery is expected by August 2021.

SHI is targeting newbuilding orders of US$7.8 billion for 2019, an increase of 24% on last year's total of US$6.3 billion, which itself was boosted by a late flurry of orders in December. *NA*

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Slow progress towards 2020

As the months towards the new global sulphur cap stream by, shipowners are not receiving much that is helpful to be able to plan for a smooth transition, says Malcolm Latarche

Considering that to be ready to meet the 1 January 2020 deadline, owners will need to be running down the bunkers on board several weeks or months beforehand to ensure that they are left with no non-compliant fuels on board, and that any tanks used for carrying standard fuels have been cleaned, the situation regarding availability of compliant fuels is far from certain. Some of the oil majors are confident they can meet the demand for low-sulphur fuels but there is little knowledge about the miscibility of products from different suppliers.

Even those that have opted to install scrubbers – and which should therefore be immune from uncertainty – have been left a little unsettled by news of actual and possible bans on scrubber use in some port and territorial waters.

Following on from the ban on open-loop scrubbers by Singapore last year, Fujairah has adopted similar restrictions and China is also taking steps along the same path. On 1 March this year a ban on open-loop scrubbers came into effect in Norway's Heritage Fjords and although closed-loop and hybrid systems operating in closed-loop mode are still permitted, there is a requirement for emissions of water vapour to be strictly controlled or eliminated.

This action against water vapour is an entirely new issue for cruise ship owners – for it is only cruise ships that visit these fjords – to deal with and has been introduced on aesthetic rather than environmental reasons. According to the Norwegian Maritime Authority, the number of cruise ships visiting the Heritage Fjords is growing and under certain atmospheric conditions, the visibility in the fjords can become severely restricted by mist and fog caused by the water vapour emissions.

The bans on open-loop scrubbers are a reaction to the claims that the pollutants are merely being transferred from air to sea. Such claims are made by both environmentalist NGOs and by industry opponents who may have genuine dislikes of the systems, but who often fear the competition they will allow against ships without scrubbers that will need to burn much more expensive fuels from 2020.

The issue of washwater from scrubbers was an agenda item at PPR 6 in February and it was expected that the voluntary guidelines the IMO produced in 2015 would be amended and perhaps even made mandatory. In the run up to the IMO sub-committee meeting a number of organisations either offered papers to the meeting or presented them in other arenas.

One paper from the European Commission was not presented at PPR 6 but was submitted to the IMO for discussion at MEPC 74 in May. This was a hastily prepared 'evaluation and harmonisation' proposal that was fiercely criticised by the pro-scrubber shipowners' group Clean Shipping Alliance (CSA) 2020 for lacking in scientific content and drawn up in a manner which by-passed usual procedures. The EC paper followed a campaign by NGO's for a ban on scrubbers in European waters and the establishment of a Mediterranean Emissions Control Area (ECA).

CSA 2020 for its part launched its own defence of scrubbers with a study carried out over three years on samples of the washwater from Carnival Line cruise ships. According to the study, the samples were all well within the IMO guidelines and compared favourably to water standards of other national and international bodies.

The case for scrubbers was also made by the Japanese delegation to PPR 6 with a presentation highlighting that scrubber equipped ships bring additional benefits to human health beyond the elimination of SOx emissions. And in contrast to the recent scrubber restrictions, Japan reiterated that there was no intention to limit the use of any scrubber type in Japanese waters.

At PPR 6, the meeting concluded by endorsing scrubbers as a means of meeting the 2020 global cap but with no progress on the rules around the discharges from them. There was also a call for national delegations to present more scientific studies for consideration at PPR 7 next year and possible further action at the MEPC meeting in early 2019. There were however some new guidelines on preparation for the changeover and adoption of a standard reporting format or FONAR (fuel oil non-availability report) to be used in case no compliant fuels are available when a ship needs to bunker.

One thing that is becoming clear is that the competitive advantage that scrubber equipped ships may have is beginning to worry the diehard sceptics. At the end of February, both Maersk and bulker operator Pacific Basin revealed that they had now decided to install scrubbers on significant portions of their fleets. February also saw the impending departure of a long-time scrubber critic when it was announced the Paddy Rogers would be stepping down as CEO of Euronav sometime in 2019. *NA*

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Propellers

Wärtsilä EnergyProFin earns quiet endorsement

Wärtsilä's energy saving propeller cap, the EnergyProFin, has been listed in the 2019 Vancouver Fraser Authority's EcoAction Program, which provides discounts for vessels calling at the port that achieve best environmental practices.

The listing is in the vessel quieting category and means that vessels with the EnergyProFin technology will receive a 23% reduction in harbour dues. Vancouver Fraser Port Authority introduced the incentive to encourage companies to lessen their noise levels, given the known effects on the whale population in the Vancouver area. Wärtsilä will issue certificates to vessels fitted with the system to show they are entitled to the discount.

Suitable for all newbuilds and existing vessels, the EnergoProFin features fins that rotate together with the propeller. Given that a propeller's energy losses are related to the flow around and behind the propeller boss reducing these increases overall propulsion efficiency. Wärtsilä calculates that the solution provides an average of 2% fuel savings with a payback time of less than a year.

www.wartsila.com

www.portvancouver.com

Port of Vancouver's approach of reduced fees for quieter ships has been praised by action group OceanCare

Performance monitoring

INPEX picks Napa for LNG performance monitoring

Japanese oil and gas exploration company INPEX Corporation has announced it has elected to install ClassNK Napa Green performance monitoring and route optimisation solution onboard three LNG carriers.

Originally launched by Finnish software company Napa in 2012, ClassNK Napa Green is described as "a total solution for planning, monitoring and follow-up of ship operations". Features include voyage planning, the Napa Analytics Services for analysing hull and propeller condition and the Npa Optifloat trim optimisation system.

The *Oceanic Breeze* and *Pacific Breeze*, which were built to serve the Ichthys LNG project, and the *Symphonic Breeze*, which is used for the Prelude LNG project, are among the largest Moss-type LNG carriers in the world and highly advanced vessels, requiring particular maintenance. The installation of NAPA's system is seen as a means of verifying their performance matches the assurances given by shipbuilders.

Akihiko Itoh, Transportation Group manager at for INPEX's LNG trading unit explains: "The propulsion system of an LNG carrier is far more complex than that of any other vessel type, which is why a fundamental understanding of elements including the cargo containment and management systems, as well as the ultra-steam turbine, is critical to efficiency.

"From system configuration to setting KPIs, Napa's in-depth LNG knowledge, spanning design, engineering and operations enables us to effectively collaborate with them for transport fleet performance."

Japan is the world's largest LNG importer and the Ichthys LNG project, in which INPEX is a major stakeholder, is expected to produce up to 8.9 million tonnes of LNG annually over the next 40 years.

www.napa.fi

Seals & bearings

Viking Jupiter delivered with Thordon lubrication

Viking Cruises' latest delivery, the 47,800gt *Viking Jupiter*, became the latest in its fleet to be fitted with Thordon Bearings' COMPAC seawater-lubricated propeller shaft system in February.

Built by Fincantieri's Ancona, Italy, shipyard, Viking opted for water-lubricated propulsion as a cost effective means of reducing the environmental impact of its operations. Seawater lubrication means that the COMPAC propeller shaft bearing does not require an aft seal and is said to reduce maintenance costs. Uniquely, Thordon offers a 15-year guarantee for the COMPAC system.

Fincantieri has become a regular customer of Thordon, with the shipyard regularly recommending the water-lubricated option to clients during the design stage. Previous installations have included the *Disney Magic* and Princess Cruise Lines' *Grand Princess*. Two further 930-passenger capacity sister ships to *Viking Jupiter*, the *Viking Tellus* and *Viking Venus*, will also be equipped with the Thordon system when they are delivered in 2021.

www.thordonbearings.com

Cybersecurity

ABS develops bespoke cyber solution for US Ports

ABS Advanced Solution has announced a "first-of-its-kind" cybersecurity solution to assist US Coastguard (USCG)-regulated facilities meet guidelines.

Under regulations first outlined by USCG in the draft Navigational and Vessel Inspection Circular (NVIC) 05-17, regulated maritime facilities will be expected to incorporate cybersecurity into their Facility Security Plans (FSPs). However, the facilities under this jurisdiction had to turn to ABS for guidance on how to comply.

The ABS solution consolidates the regulations, policies, procedures and best practices outlined in NVIC 05-17. Of particular focus was the USCG's recommended approach of the National Institute of Standards and Cyber Technology Cyber Security Framework (NIST CSF), which has been broken down into a simplified approach that breaks down 108 sub-categories into five functional areas that can be addressed in an action plan. ABS can also provide cyber awareness training to fleet security officers and other personnel.

The Californian ports of San Diego and Long Beach were both subjected to cyber attacks in the space of three months during 2018. The Long Beach incident, of the 'ransomware' variety, was later isolated to the port terminal of COSCO. The San Diego attack came days after a similar incident affecting the Port of Barcelona.

www.eagle.org

Satellite communications

Lindblad picks Fleet Xpress for latest expedition ship

Inmarsat has won the contract to supply mobile satellite communications services to Lindblad Expeditions' latest vessel, the National Geographic Venture.

The ice-strengthened expedition ship, the second in Lindblad's National Geographic fleet (see p.10), which will shortly begin cruising around the Alaskan coast, is the sixth Lindblad vessel overall to be equipped with Inmarsat's Fleet Xpress.

Ship-to-shore connectivity is regarded as a key selling point for adventure cruising, which is attractive particularly towards a younger generation of cruise-goer. With their reduced passenger capacities, these smaller vessels are ably catered for by smaller VSAT terminals, such as that used for FleetXpress, without compromising on connectivity.

The FleetXpress platform utilises both high-data Ka-band with continuous L-band to ensure connectivity even in remote locations, without requiring the space consuming hardware of a C-band based system that might be found on a larger cruise ship.

"For adventure cruisers today, connectivity is part of the package they are paying for; this is an audience which expects a highly educational vacation, but also to share experiences online instantaneously," says Christian Cordoba, Inmarsat's maritime channel manager for passenger ships.

www.inmarsat.com

Ballast water treatment

Optimarin gains USCG approval for reduced holding time

The US Coastguard (USCG) has approved that the holding time for ballast water treated by Optimarin Ballast Systems' (OBS) UV-based technology can be cut from 72 to 24 hours.

Water treated using UV systems must be held for a specified period to ensure that all organisms are inactive prior to testing. The USCG utilises a staining test involving chloromethylfluorescein diacetate (CFDA), which requires disruption of the organisms' cell membranes, but this does not always occur immediately.

However, it now recognises that increased UV doses, like the 35kW lamps used by OBS demonstrate greater efficiency and has been granted a revised minimum holding time. The easing of requirements is of particular benefit for vessels operating cabotage along the North American coast, allowing for shorter turnarounds during port calls.

Optimarin CEO Tore Andersen says: "This is another endorsement of OBS by the USCG, which itself will be utilising our technology in its new offshore patrol cutter programme."

www.optimarin.com

More than 500 units of UV-based OBS units have now been sold

Modelling alternative propulsion technologies for merchant vessels

John Buckingham and David Pearson, BMT, report on a collaborative project to quantify the benefits of energy saving technologies onboard a bulker, presented at RINA's recent Power & Propulsion Alternatives for Ships conference

The planned IMO sulphur emissions limit will likely lead to price increases of low-sulphur distillate fuels from 2020 and beyond and will create further pressure to improve fuel efficiency. The IMO measures planned for 2023 to meet the 2050 IMO CO_2 reduction target will formalise the need for improved fuel efficiency through Energy Saving Technologies (EST).

A wide variety of EST have been available for many years: the challenge lies in integrating and matching them to the ship's operating profile to provide demonstrable benefit, and thereby improve adoption rates. With many ships operating in slow-steaming mode, there is opportunity for wind-based devices to contribute a larger proportion of the required thrust. This in turn provides scope to explore how reduced engine loads affect fuel efficiency, the use of air lubrication drag reduction and the use of wild heat from engine jacket water and exhaust gases to generate power.

As part of a collaborative project with partners Black and Veatch, BMT has been developing the Vessel Technology Assessment System (VTAS) funded by the Energy Technologies Institute (ETI). This project has developed an approach that seeks to demonstrate the merit of such ESTs fitted to specific ships, quantify the potential fuel savings and associated CO_2 reductions, and inform the decision making process for shipowners investing in such technology.

Vessel selection

To assess the benefit of any combination of EST for a ship, it is necessary to align a power and propulsion model of the vessel with some known data so that an established baseline for comparison is created. The vessel selected for this study was a 61,000dwt bulker with the following principal particulars:

- Length overall 199.9m
- Length waterline 197.0m
- Beam 32.24m
- Draught 13.00m

This ship was selected based on the results of the Third IMO Greenhouse Gas Study (2014), showing that bulkers are the second largest CO_2 emitters after container vessels, where 61,000dwt falls into the highest CO_2 emitting size category for bulkers. A bulker was selected over a container vessel as they are more suited to a wider range of ESTs and CO_2 abatement measures.

Model data

The increasing use of onboard sensors to capture the key operating parameters of machinery allows this data to be used for more than the usual health monitoring and fouling assessments. The most useful data is listed in Table 1.

When such data is received at an adequate resolution (e.g. five minute intervals or better) and over a wide range of conditions, it provides a good basis for a satisfactory model definition of the vessel behaviour.

Modelling

The ship and its machinery is modelled using the best obtainable set of ship information which when combined with the environmental data provides:

- Ship's resistance
- Propeller speed
- Engine demand
- Fuel demand

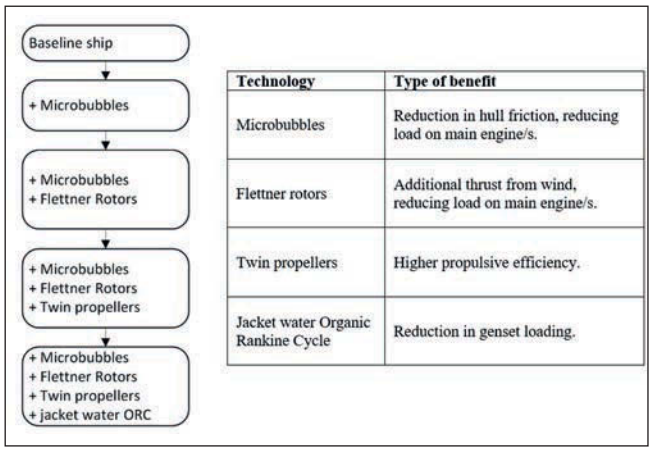
Each of these stages requires the best possible definition of the hullform, the propeller and the engine. If working in close co-operation with the ship owner many of these parameters can be provided, however, some may well remain unknown.

Ideally wake fraction and thrust deduction factors would be taken from a model test report or CFD study, but if these are not available, then working values can be derived from a statistical analysis of a range of empirical prediction methods.

The EST modelled in this study generally fall into one of three categories, euphemistically referred to as "wet, warm and windy":

Table 1 - Fleet Performance Monitoring data

Navigational	Machinery	Meteorological
Vessel location	Shaft revolutions per minute (rpm)	Wind speed & direction
Time & date	Shaft torque & therefore power	Significant wave height (SWH)
Speed & course over ground	Main engine fuel mass flow	Current speed & direction
Heading	Auxiliary engine fuel mass flow	Air temperature & humidity
Speed through water (STW)	Draught fwd & aft	Sea water temperature



Technology	Type of benefit
Microbubbles	Reduction in hull friction, reducing load on main engine/s.
Flettner rotors	Additional thrust from wind, reducing load on main engine/s.
Twin propellers	Higher propulsive efficiency.
Jacket water Organic Rankine Cycle	Reduction in genset loading.

Figure 1 - Study Option chart

Wet: Hydrodynamic efficiency technologies, primarily consisting of specialist hull coatings, propeller pre/post swirl devices, and air lubrication drag reduction (microbubbles).

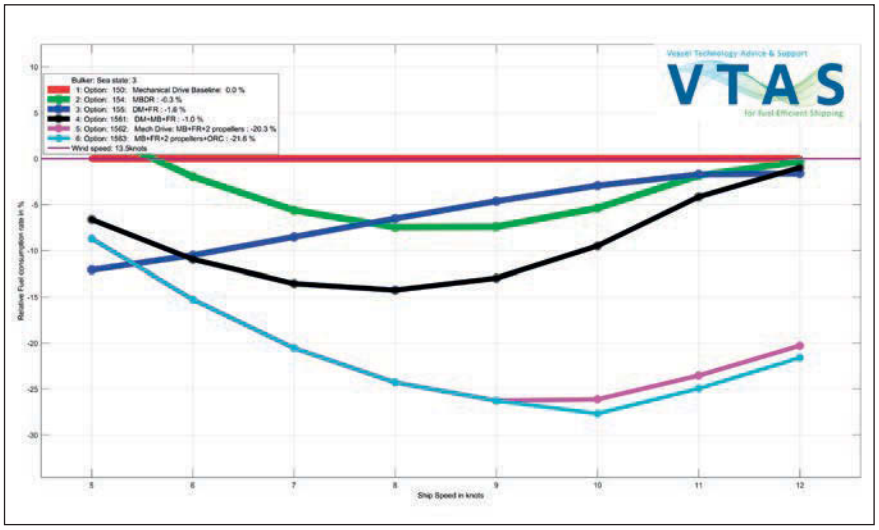
Warm: Refers to Waste Heat Recovery (WHR) technologies such as Organic Rankine Cycles (ORC) utilising heat from jacket water or exhaust gas and Turbo-Generators (TG) which extract energy from bypassing the turbo-charger turbine.

Windy: Wind-based auxiliary propulsion such as Wingsails, Flettner rotors, Kites or other types of sailing method.

The ESTs were applied to the ship model sequentially, the influence of each one stacking onto the previous one, and the complementary/negative interactions considered. This is illustrated in Figure 1.

This approach employs first principle models to represent the individual behaviours of each EST. Such models are validated by using them to replicate the declared performance of proprietary solutions.

Figure 2 - Fuel consumption relative to baseline



Option number	Description
1	Diesel mechanical drive, no EST fitted. Baseline
2	Baseline + microbubble drag reduction
3	Baseline + Flettner rotors
4	Baseline + microbubble drag reduction + Flettner rotors
5	Baseline + microbubble drag reduction + Flettner rotors + twin propellers
6	Baseline + microbubble drag reduction + Flettner rotors + twin propellers + Organic Ranking Cycle

Results

The fuel saving results for the various EST combinations referenced relate to the baseline ship are illustrated in Figure 2.

Conclusions

This study shows how the collective application of a set of EST can lead to fuel savings of up to 20% at the reduced service speed (12knots in sea state 3) of a 61,000tonne dwt bulker. At lower speeds the benefits increase due to the advantageous use of Flettner Rotors in improved apparent wind conditions.

These fuel savings are fed into a bespoke financial model which considers the capital and operating costs for the EST fit and the ship's operational profile. The benefit to the ship owner in fuel cost savings is balanced against the cost of EST fit varies with shipyard and supplier.

About the authors

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John Buckingham, CEng FIMechE, is Chief Mechanical Engineer at BMT. He is the Chief Technologist for the Vessel Technology Assessment System project, funded by the Energy Technologies Institute. *NA*

This article is written as an abridged version of a technical paper under the same title, originally published at the RINA conference 'Power & Propulsion Alternatives for Ships', 23rd January 2019, London, UK

把脉经济金融走势 权威解读行业政策
船舶经济贸易
SHIP ECONOMY & TRADE

Analysis of the Chinese shipbuilding industry in 2018

The Chinese Association of Shipbuilding (CANSI) has published its annual review, revealing the country's maritime industry may be leaner, but remains forward looking

All the major indicators of China's shipbuilding industry showed competitiveness in key areas continued to increase in 2018. Excess capacity was effectively reduced, the ship repairing industry flourished and R&D continued to make new breakthroughs.

All good, then. However, weakening momentum in the recovery of the world economy and the ongoing readjustment of the newbuildings market mean that deep-seated problems such as difficulty in securing financing and orders remain, and the situation facing the shipbuilding industry is still grim.

By the end of December, Chinese shipbuilders had completed 34.58 million dwt, down 14% year-on-year. New orders totalled 36.67 million dwt, a 8.7% increase. Overall, outstanding orders stands at 89.31 million deadweight tons, an increase of 2.4%.

Completed exported ships reached 31.64 million dwt (down 13.6%). New export ship orders reached 32.05 million dwt (up 13.9%) , while the overall export orderbook was 78.68 million dwt (down 14.7%). Exported vessels accounted for 91.5%, 87.4% and 89.1% of the completed tonnage, new orders received, and outstanding orders, respectively.

Year-on-year drop

From January to November 2018, CANSI reports there were 1,212 shipbuilding enterprises realising a combined profit of RMB403.2 billion (US$60.3 billion), a year-on-year decrease of 31.7%. Among them, the shipbuilding industry generated RMB285.36 billion (US$42.7 billion), down 30.8%); the ship supporting industry achieved RMB49.98 billion (US$7.5 billion), down 40.9%; the ship repair industry was RMB17.56 billion (US$2.6 billion) down 15.1%; the offshore engineering special equipment manufacturing industry was RMB36.61 billion (US$5.5. billion), a drop of 12.2%.

Polar condensate tanker *Boris Sokolov*, built by Guangzhou Shipyard International

The larger shipbuilding enterprises achieved combined profits of RMB9.14 billion (US$1.4 billion), a year-of 35.5% on 2017. Among them, the shipbuilding industry was RMB5.15 billion (US$800 million) down 17.7%; the ship supporting industry RMB2.29 billion (US$400 million) down 49.5%; the ship repair industry was RMB520 million (US$77.6 million), down 24.6%; while the offshore engineering special equipment manufacturing industry was made RMB470 million (US$70.4 million) a fall of 39%.

Characteristics

In 2018, Chinese shipbuilding companies continued to maintain a leading position in the international market. In terms of deadweight tons, the annual global shipbuilding completion volume, new orders received and orderbook accounted for 43.2%, 43.9% and 42.8%, respectively.

The concentration of the shipbuilding industry towards the larger yards continued to increase, with completion by top 10 enterprises in the country accounting for 69.8% of the national total, an increase of 11.5% over 2017. Similarly, the trend for placing new orders with the dominant enterprises is obvious and the top 10 enterprises now make up 76.8% of the national total, up 3.4%. These 'backbone' ship enterprises have obvious competitive advantages, and each of them is among the global leaders for completion, tonnage, new order tonnage and orderbook.

Innovation capabilities continue to improve

In 2018, China's major ship enterprises kept up with market demand, continued to optimise their products and received multiple bookings for green environmentally friendly ore carriers and feeder container ships. New high-tech, high value-added ship types such as ultra-large liquefied gas carriers, 18,600m^3 LNG carriers, 48,000dwt semi-submersible heavy lift vessels, and polar expedition cruise ships have also made progress.

The backbone enterprises increased technological innovation and research efforts, product R&D and construction capabilities, and delivered batches of 20,000 TEU-class container ships, as well as building *Pacific Vision*, the world's

first 400,000dwt 'intelligent' very large ore carrier (VLOC), and the world's first installed sail device (the 308,000dwt VLCC *New Vitality*, see February 2019's *The Naval Architect*). There has been a batch of other high-end vessels, such as an 8,000-car ro-ro (Wilhelmsen's *Titus*), its first ice-class condensate tanker (*Boris Sokolov*), a 1,400TEU dual-fuel LNG container ship (*Containerships Nord*), and a 350,000ton-displacement FPSO (*Petrobras 67*). Meanwhile, construction of domestic large-scale luxury cruise ships entered the formal implementation stage, and *Xue Long 2* ('Snow Dragon 2'), China's first domestically built polar research vessel and its manned submersible *Shenhai Yongshi* ('Deep Sea Warrior') were launched and are undergoing sea trials.

Reducing excess capacity

In 2018, the international new ship market remained highly competitive, with insufficient demand and overcapacity. Through a combination of market forces and government strategy, a number of Chinese enterprises with poor management capabilities, low product quality and poor operating efficiency have gradually been eliminated by the market. In recent years, major central enterprise groups and local key private enterprises have further reduced the shipbuilding capacity by approximately 20 million dwt by promoting the relocation of old facilities, optimising the production capacity, internal resource integration, and adjusting the product and industrial structure.

Meanwhile, the Chinese ship repair and modification sector continued to operate effectively, and the standard of repair and modification technology continued to rise. The major repair and conversion yards continued their efforts in the high-end modification, completing the world's first ultra-large container ship lengthening modification project, the world's largest orange juice carrier modification project and the first domestic membrane-type LNG cargo container repair project. They also retained the leading positions in cruise repair, FPSO modification and offshore engineering equipment repair.

As China officially joined the Ballast Water Management Convention and imminent the date of entry into 2020 sulphur cap, the ballast water treatment system and the scrubber installation markets were also active. In 2018, China's major ship repairing companies undertook 896 scrubber installations , an increase of nearly 90% year-on-year; the project to undertake ballast treatment systems increased by more than 15% year-on-year.

Adhering to an innovation-driven strategy

China's ship supporting enterprises adhered to an innovation-driven strategy and strived to improve product manufacturing capabilities and R&D. Breakthroughs in core technology research and development included green and intelligent low-speed diesel engines, the first low-speed diesel engine equipped with exhaust gas recirculation systems, and the first domestic 25MW dual-fuel gas turbine generator successfully passed the test. Progress was also made in the construction of high-quality product brands, such as the EX340 series ultra long stroke low speed diesel engine, the ACD320 dual fuel engine and the CHD622 marine high speed engine. Other achievements included the launch of China's first self-controllable global maritime broadband satellite communication network.

Lean shipbuilding

In 2018, in the face of fierce market competition and rising comprehensive costs, China's key ship enterprises took the initiative to continuously strengthen production management and strive to reduce costs and increase efficiency and enhance corporate competitiveness. China State Shipbuilding Industry Corporation (CSSC) has researched and formulated its 'cost engineering' implementation plan, while China Shipbuilding Industry Corp (CSIC) is focusing on 'lean shipbuilding' top-level design on key projects. COSCO Shipping Heavy Industry Co is focusing on advanced shipbuilding technology and lean management, with the aim of improving construction efficiency and management level through a shipbuilding precision management system and promotes intelligent shipbuilding.

Forecast

In 2019, the environment facing the global new ship market remains complex, with opportunities and challenges. It is estimated that the global tonnage will increase by 70 million dwt in 2019, and the shipbuilding completion will be around 90 million dwt. The orderbook is expected to remain at around 180 million dwt. In 2019, China's shipbuilding completion volume is projected to reach 35 million dwt, with 30 million dwt of new orders anticipated. At the end of the year, the order book will stand at arund 85 million dwt. *NA*

In November 2018, Shanghai Waigaoqiao Shipbuilding Co delivered the world's first 400,000dwt 'intelligent' VLOC *Pacific Vision* for China Merchants Energy Shipping

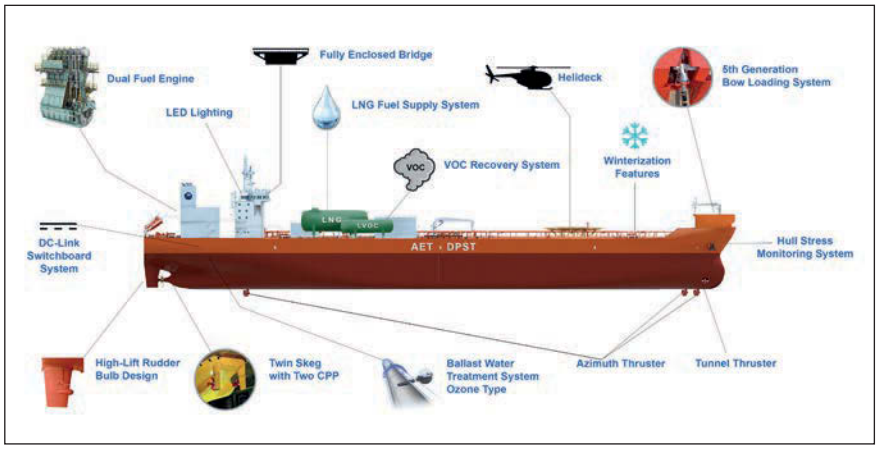
The next generation shuttle tanker

With a host of innovative technical features and significantly greater efficiency to comparable vessels, AET's LNG dual-fuel dynamic positioning shuttle tankers are being designed to superior specifications

As specialised ships transporting crude oil from offshore terminals, the Dynamic Positioning (DP) mode of shuttle tankers is critical in enabling them to load cargo in rough seas, where waves can reach anything up to 5.5m. Since the deployment of the first shuttle tanker over three decades ago, DP vessel design has evolved significantly in terms of ship performance, operability, safety, energy efficiency and environmental sustainability.

AET, a leading tanker owner and operator, has now taken the design of shuttle tankers to a new level by applying novel and state-of-the-art technologies in two newbuild 123,100dwt LNG dual-fuel Dynamic Positioning Shuttle Tankers (DPSTs) that will make them among the most advanced of their type in the world, with maximum efficiency and minimum emissions.

Due for delivery from 2019 and 2020 respectively, these ships will serve on long-term charter to Norwegian international energy company Equinor (formerly Statoil) in the Norwegian, North and Barents Seas. They will be owned by AET Sea Shuttle (AETSS), a joint venture between AET and Norwegian shipowner ADS Shipping. The ships are currently under construction at Samsung Heavy Industries (SHI) in South Korea, with the construction managed by a specialist project management team from MISC Group's marine services arm, Eaglestar. OSM Maritime Group is providing the technical management when the vessels are in operation.



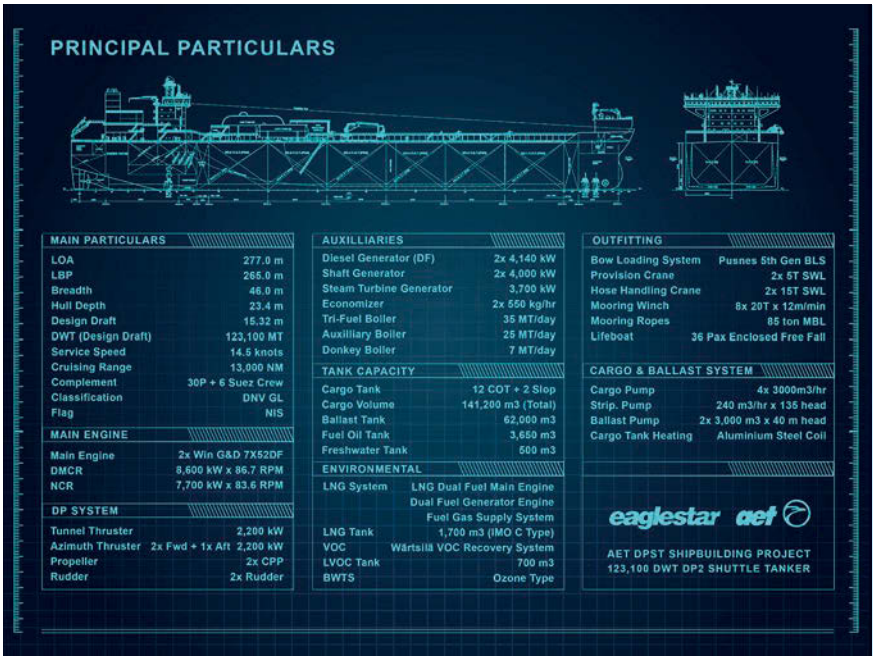
Efficiency measures include DC and LED lighting

An avant-garde class tanker

The hull of the vessel is designed with superior specification of 30 years fatigue life based on North Atlantic and North Sea trade.

This has ensured that the ship is capable of operating in the most challenging weather conditions. In terms of hull performance, the hull form has been optimised with 2.7% performance improvement from the base model by modifying the hull volume distribution as well as the shape of the skeg, forward and aft hull shape. Meanwhile, the appendage of the ship is also optimised with a 5.7% performance improvement from the base model by adjusting several items, i.e. thruster tunnel, rudder angle and introduction of a rudder bulb.

The twin-screw DPST will be propelled by two low pressure dual-fuel 7X52DF two-stroke engines supplied by Winterthur Gas & Diesel (WinGD) which fulfil the International Maritime



The specs for AET's DPST shuttle tanker

Organization's (IMO) Tier III emission requirements when operating in gas mode and does not require any exhaust gas after treatment system. The main engines will be the first prototype manufactured with an integrated fuel gas pressure regulating system.

The DPST is also equipped with a LNG fuel gas supply system and a volatile organic compound (VOC) recovery system. LNG will be used as the primary fuel with marine gas oil as the secondary fuel. VOC's are the light components of crude oil, which evaporate during loading operations or during the carriage of highly volatile crude oil cargoes. The vaporised liquid VOCs will also be utilised as fuel with the mixture of LNG through the fuel mixing module, supplied to the main engine and auxiliary engines. The VOC surplus gas will be used as a supplementary fuel for a triple fuelled boiler. Without this unique system, large quantities of VOCs are emitted into the atmosphere during loading of shuttle tankers in oil fields; but this vessel will capture and reuse 100% of the VOCs emitted from the crude oil cargoes.

Based on maker's analysis, the combination of VOC and LNG will potentially save over 3,000tons of fuel every year as well as reducing the CO_2 emissions significantly. HAZID and HAZOP on the LNG fuelled system and LNG bunkering were carried out during the design phase to ensure that the highest safety design was achieved.

Holding on tight

For operating in the high sea states, the DPST is designed to DP Class Two under DNV GL's DYNPOS (AUTR) notation and redundant propulsion notation RP (2,50). The DPST is able to maintain station keeping and heading based on environmental forces varying ±12° off the bow with a maximum of 80% of the thrust. In a typical DP mode, the shuttle tanker will operate in two-split DP redundancy mode at low weather conditions and three-split mode in heavy weather conditions to enhance redundancy.

Conversely, the thrusters of the DPST are designed with four redundant groups. The position reference system of the DPST consists of five different sources despite only three sources being required. One of the position reference systems is a Hydro-acoustic Position Reference (HPR) that comprises of a HiPAP transponder which can be lowered down from the ship's bottom hull. Hardware in loop (HIL) and DP FMEA tests were carried out to verify the soundness of the design and station keeping capability during single failure of the system.

The DPSTs are currently under construction by Samsung Heavy Industries, with delivery expected in late 2020

The fifth-generation bow loading system (BLS) has been fitted to the DPST for loading cargo from the offshore production or storage facility during heavy weather in DP mode, which is also known as a 'blue line operation'. The BLS comprises of two main components, i.e. the hose and hawser handling system. The BLS has a new structural design, integrated hose alignment roller, rotating coupler valve and is able to operate with a larger hose connection and working operation angles.

Beyond energy efficiency

The Energy Efficiency Design Index (EEDI) requirements for shuttle tankers are further tested and challenged due to the additional power required for manoeuvring and DP. The EEDI of these DPSTs is an 11% improvement by comparison with the average EEDI of recently built shuttle tankers, and the value comes extremely close to a typical tanker of similar size.

Compared with the traditional shuttle tankers, which utilise four-stroke auxiliary engines as the power generating plant, this ship will have two shaft generators driven by the main engines. The combination of the onboard DC grid system and the shaft generator will result in the vessels burning less fuel and generating lower emissions. Such a configuration (operation of shaft generator in DP mode) is seen as highly sophisticated, as the DP system requires a very responsive power supply and action for the thrusters and propellers.

With the application of a DC grid switchboard system, this DPST is expected to achieve fuel savings of up to 1,000tons per annum as well as footprint and weight savings of up to 30% compared to a traditional AC system. The system allows the generators and some shipboard motors (cargo pump, cooling sea water pump, ballast pump etc.) to run at variable and optimum speeds. This is in contrast with the typical AC systems, where generators run at a fixed and maximum speed regardless of the power demand, resulting in poor fuel efficiency at low loads. The DPST is also equipped with winterisation features, such as heat tracing, space heater and canvas cover in order to enable operation at cold climate with -19°C temperatures.

With the application of all the these carefully selected and designed features and technologies, the next generation of DPSTs developed by AET will represent a great leap forward in making energy shipping much more sustainable in the future. *NA*

Harmonising maritime workplace design through collaboration, new technologies and open innovation

OpenBridge, a unique interdisciplinary project aiming to solve the problems of inconsistent interface design across bridge systems that has plagued the maritime industry and its operators for decades

An ongoing industry-academia collaboration based in Norway, the OpenBridge project aims to provide better user interfaces for ship bridge equipment through open innovation in order to simplify and enhance multivendor integration.

OpenBridge is running from 2017-2022, with its consortium comprising of over 25 project partners representing diverse industry stakeholders, including shipping companies, ship builders, equipment suppliers, designers, classification societies, regulatory authorities, researchers, maritime trade unions and maritime academies.

Project Leader, Dr. Kjetil Nordby of The Oslo School of Architecture and Design has been focusing on design of advances user interfaces for maritime workplaces over the last eight years. Nordby explains: "OpenBridge is a result of our long-term research strategy of combining knowledge spanning design, engineering and human factors for enabling efficient and human centered digitalisation of maritime workplaces. It establishes a research framework that enables us to link state of the art user interface research with industry development processes."

Dr. Nordby is managing the Ocean Industries Concept Lab (OICL) that focus on research supporting the maritime industries. The OICL team consist of a multidisciplinary group of researchers, designers and engineers working on next generation workplaces using innovative technologies, including Virtual and Augmented Reality (VR and AR).

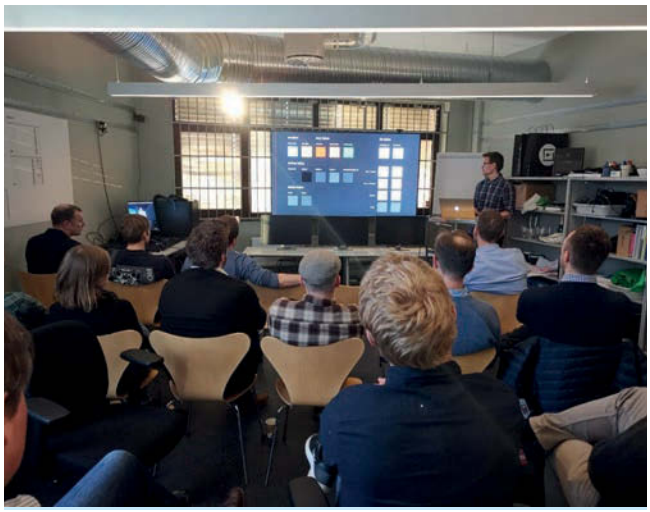


Figure 1. Stakeholder workshop on OpenBridge Design System (Photo: Kjetil Nordby)

Ongoing challenges and the failure of the integrated bridge

Ship bridges are complex working environments and consist of many different types of equipment, sourced from many differing suppliers. It is not uncommon to have over 30 different brands on a contemporary bridge. These multivendor bridge systems include equipment that comprises of many different design philosophies. This variation in user interface designs ultimately impacts the seafarers attempting to manage complex operations within the bridge and ship. Field studies on a wide range of vessels performed by researchers at The Oslo School of Architecture and Design revealed a complete lack of design consistency across bridge equipment interfaces.

Steven Mallam, Associate Professor at the Department of Maritime Operations, University of South-Eastern Norway and OpenBridge partner, is a maritime human factors researcher interested in the effects of design on safety. He states that inconsistent and poor designs of bridge systems have negative impacts on crew work tasks and can contribute to human error and accidents at sea.

Mallam explains: "Research shows that operators who work within complex systems, such as control rooms, flight decks, operating theaters or ship's bridges, have difficulty managing the complexity of their work environment. High levels of information, constantly evolving variables and the need to communicate between people and technology create unavoidable complexity.

"The design of the work environment and equipment has shown to influence human behaviour and how people work, including the success or failure in executing tasks. Optimising design has tangible benefits for human performance."

Struggling with inconsistent design is nothing new for the maritime industry and several ongoing initiatives from maritime stakeholders seeks to provide consistent design across navigational equipment, including the IMO's E-Navigation and S-Mode development work. These initiatives are limited to consistency across specific equipment. OpenBridge differs from these efforts in that it focus on design of all current and future user interfaces on a ships bridge.

There are good reasons for why the lack of harmonised workplaces is maintained in the maritime industry.

Nordby states: "When OpenBridge began in 2017 the first objective was to identify the main barriers for achieving consistent design across bridge equipment. What we found was that different maritime stakeholders struggled with different problems. The companies delivering smaller systems to the ships bridge, struggled with cost of acquiring design competence and implementing solutions, while delivering customised solutions to each bridge system increases costs. Ship bridge producers have a high integration costs and struggle with delivering consistent user interfaces when customers demand equipment from many different equipment vendors."

Furthermore, a systematic review of current maritime regulations and design guidance relating to bridge equipment revealed a lack of support that effectively supports consistent design for digital user interfaces across all systems.

Mallam describes the today's situation: "Most current user interface design guidelines address generic principles of design, such as workstation and equipment layout, readability, visual contrast or consistent use of symbols. However, there is limited support that may enable design consistency and guidance for entire user interfaces across multivendor bridge systems. This is certainly true for practical frameworks equipment producers can readily implement."

Looking to the web industry for design consistency

In order to address these ongoing challenges, the OpenBridge project looked outwards to other domains to understand how issues of design consistency were tackled. Most notably, the web-industry has evolved design systems for varied content creators. For example, web or app developers, whether professional or amateur, follow specific design frameworks in order to maintain consistency in design across differing platforms.

By following widely adopted design frameworks, they make sure a large portion of their users already are familiar with the user interface principles when they start using the application. These design frameworks are offered for free by large actors, such as Google and Microsoft.

OpenBridge builds on these concepts and bases much of its design guidelines on design principles already widely adopted in web industries whenever possible. In doing so, a large portion of OpenBridge users will be familiar with central aspects of the user interfaces. In addition, maritime-specific elements are added, such as palette handling, thruster symbols or maritime iconography.

The OpenBridge design guidelines adhere to current maritime regulations (e.g. SOLAS V/15 and their associated guidance documents), as well as class rules, and in many cases uses stricter tolerances than contemporary maritime regulations. The concept is that any stakeholder who implements OpenBridge design guidelines by default also adhere to relevant workplace design regulations. As OpenBridge guidelines are based on descriptive input, with design examples and development tools, as a systematic approach, it is relatively simpler process for smaller companies to implement and deliver approved designs.

Figure 2. Researcher Synne Frydenberg and Lasse Thomasgård performing field studies (Photo: Rachel Troye)

Andres Hjellbakk, VARD
Electro and OpenBridge partner

"OpenBridge is adding value to the industry as a whole, and as a company, improves the products and services we are able to offer our customers. The OpenBridge design system provides the opportunity for customers to freely choose between many compliant bridge system vendors. This can result in both cheaper and more harmonised designs, increasing the economic feasibility and usability of integrated bridge systems."

Making an impact on maritime industries

Nordby says that initially industry stakeholders viewed the OpenBridge concept skeptically, even warning him of the inevitable resistance and challenges he would face: "Several maritime insiders told us that the industry would resist, that the OpenBridge philosophy was an idealistic and unrealistic solution for a traditional industry that was unwilling to change or accept open innovation as a way to gain a competitive advantage".

However, momentum is building behind the project, taking it from an interesting, but theoretical, idea towards the development of better practical solutions. This industry interest and support is demonstrated by the fact that the initial OpenBridge project consortium has swelled from 16 to over 25 partners over the past six months. Many of these partners are now starting to test OpenBridge solutions in their systems.

The development of the OpenBridge design system is an agile and iterative design evolutions based on input and review from all project partners. By bringing together expertise in maritime design systems, equipment developers, designers, ship-owners, seafarers, human factors specialists and regulatory bodies,

Figure 3. OpenBridge compliant application designs presented in the integrated bridge SeaQ Horizon by VARD (Photo: Jon Fauske)

designs are proposed, evaluated and tested continuously.

Collaboration is key to OpenBridge, and drawing together cutting-edge design tools and visualisation systems, including VR and AR, with participatory involvement through workshops where hands-on work and face-to-face discussions drive designs forward.

OpenBridge is now in the process of completing the first version of its maritime design guidelines focused on digital user interface design. Using a step-wise model for rollout, OpenBridge will then focus on harmonising digital design guidelines with the implementation of physical interfaces, followed by further additions. This will be followed by harmonising digital design guidelines with the implementation of physical interfaces.

Nordby states: "Our ambition is to alter how we build workplaces in ships and solve a pervasive challenge in maritime design. We realise this is an ambitious goal. Yet, the momentum we are building within this project has increased faster than first anticipated. I'm optimistic that the OpenBridge project may have significant impact in the coming years. "

The OpenBridge project received funding in early 2019 to extend its project until 2022. For more information on OpenBridge, please visit: www.openbridge.no. *NA*

For more information on the Ocean Industries Concept Lab and maritime research taking place at The Oslo School of Architecture and Design, please visit: https://medium.com/ocean-industries-concept-lab

Raising the bar for bridge and navigation solutions

Sperry Marine's latest networked bridge system, cybersecurity and high-resolution radar products takes the fruits of the company's experience in the defence sector and makes it available to commercial operators

Technological advances have been of enormous benefit to the safety and reliability of navigation, but the spatial requirements of such hardware don't necessarily allow for the optimum design of the ship's bridge.

IMO's SOLAS Chapter V – which covers the carriage requirements for shipborne navigational systems and equipment - has a sliding scale of requirements depending on a ship's size, but the specification for even a modest vessel of 500gt includes a 9GHz radar, electronic plotting aid, speed and distance measuring device, a transmitting heading device, an automation identification system (AIS), electronic chart display and information system (ECDIS) and global navigation satellite system (GNSS).

Naturally, such equipment requires more space than simply the consoles with which the bridge team directly interacts, and until relatively recently the various servers, cabinets and cabling required to maintain an integrated bridge system meant a host of additional clutter that needed to be factored in when considering design of the bridge environment, not to mention the cost of servicing and replacement components.

However, with advances in computing, the bridge is becoming more spacious and flexible than it was in the past, particularly for higher end vessels. In tandem with this is the growing requirement for fully digitised bridge solutions that make navigational information available from anywhere on the vessel and also relay that data back to shore.

VisionMaster Net takes Sperry Marine's earlier VisionMaster FT integrated bridge solution and digitises it

VisionMaster Net

One of the established players in this field is Northrup Grumman-owned navigation solutions provider Sperry Marine, which last year launched its new networked bridge concept: VisionMaster Net. Building upon the same interface as its earlier VisionMaster FT solution, VisionMaster Net is designed as a modular network that utilises an ethernet ring for all bridge system sensors, including the radar transceiver.

According to James Collett, Sperry's managing director, the shift from analogue to digital brings enormous benefits, particularly for radar. He explains: "It means you can move your radar picture anywhere on the vessel, which from an installation standpoint makes it much simpler. You can then very easily move that hardware away from the traditional front of the bridge to the wings, but you can also then get it off the ship very easily, because the data is delivered in a format that makes it very easy to move."

This will also empower the shoreside team to provide greater assistance should a problem occur, as the master can more effectively relay what is happening. Collett says: "When you get an incident at sea at best you might have the master talking through what he's experiencing over the satellite phone. But now we're giving them a whole bridge of information; whether it's speed, heading, radar or chart picture.

"That needn't necessarily be an emergency situation; it might just be looking at the planned course. When that comes back to shore someone might overlay weather data and determine the conditions might cause disturbance that could damage the cargo and advise slow steaming or changing course."

Increasingly, Collett points out, Sperry's clients have a whole team of shoreside 'captains' supporting remote operations and while oceangoing vessel autonomy remains several years off, remote assistance is well underway, with tools such as VisionMaster Net becoming key building blocks.

"We'll be delivering VisionMaster Net to a series of very large container vessels – thought to be the world's largest – currently under construction in China for a leading liner operator," says Simon Pinkney, Sperry Marine's head of product development (implying a series of container ships currently being built at CSSC-run shipyards for MSC). The company also has commitments for passenger ferries and chemical tankers.

"VisionMaster Net will be the heart of the bridge system, providing a platform for enhanced navigational tools for onboard and remote decision-making, with high-precision location sensors and CCTV, delivered in a smaller footprint with additional cyber hardening," adds Pinkney.

While this doesn't necessarily mean operators will be using the system's full functionality from the point of delivery, Collett emphasises that it's about putting in place tools that allow owners and operators

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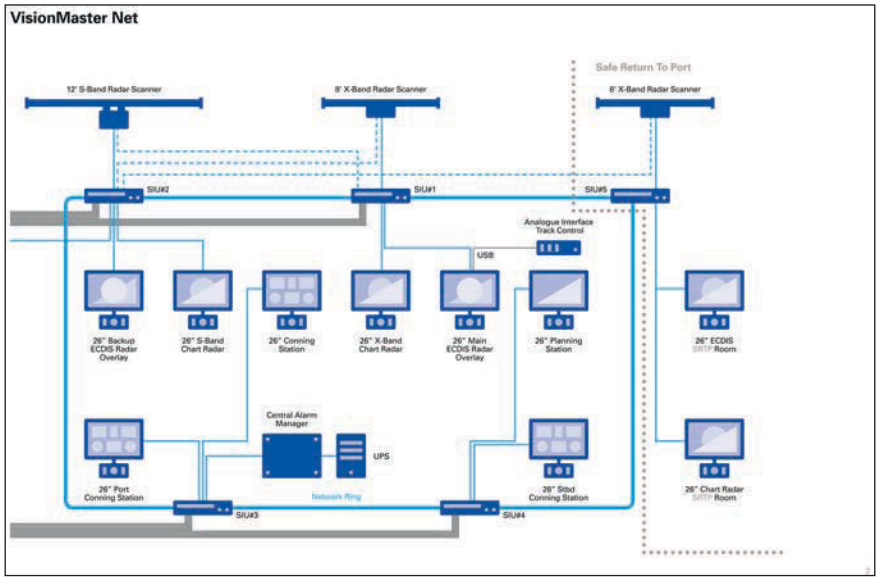


Network architecture for the VisionMaster Net. The radar returns of the S and X-Band transceivers are digitised via system interface units and relayed via an ethernet network

to do things differently when they feel safe and confident about doing so.

"Until now the bridge was separated from the rest of the ship's operation, with good reason as there remains a level of paranoia about attaching that bridge to the rest of the outside world. Arguably, it's because of that 'air gap' there have been very few cyberattacks on vessels."

Cyber protection

Cybersecurity, particularly as it relates to the bridge, is a major area of focus for Sperry Marine. In collaboration with its parent company Northrop Grummann, it recently launched the Secure Maritime Gateway, a cybersecurity tool which uses multiple firewalls and 'demilitarised zone' between the front and back of bridge to ensure there is no direct connection between the navigation systems and the main ship network. The Gateway has been certified to the International Electrotechnical Commission's (IEC) 61162-460:2018 standard for cyber protection for the digital interface for maritime navigational equipment.

"Cybersecurity is in our DNA," explains Pinkney. "We don't even commonise networks in our building and we're constantly vigilant. It's not just hardware and software, but a whole way of working."

One of the drivers behind this vigilance is that while commercial sector accounts for around three quarters of Sperry's business, the other quarter comes from UK defence programmes, including the Queen Elizabeth-class aircraft carriers, Type 45 destroyers and Astute-class submarines.

Inevitably, their security demands are higher, but Collett says that, if anything, the protracted nature of government procurement means defence hardware seldom uses the latest software. "When a product is changing every year, or faster, you don't see the real benefits. The military solution has greater resilience and redundancy in case something goes down, but in terms of the operating system it's often not at the same level of what's in the commercial world, which is a bit ironic for the taxpayer."

Solid state radar

One product heavily indebted to Sperry's naval heritage is Seaguard, a high-resolution radar system which originated as a naval surveillance tool and was officially launched in January. Sperry worked closely with regular client Royal Caribbean during trials and the cruise is its primary target market.

"It's basically a solid-state radar and highly accurate so it can identify individual targets when they're moving," says Collett. "Cruise operators are interested in it because of its ability to find people in the water. But we see other applications, perhaps for ice detection on the Northern Sea Route where vessels have to go through ice-packed waters."

Whereas all vessels above a certain size have minimum carriage requirements for radar, these IMO standards are well short of what's possible. "Radar relies on a return and the bigger the object the greater return you get. The [magnetron] VisionMaster Net radar will meet IMO's spec but higher performance comes with an additional cost. The benefit is you are able to resolve smaller targets, whether that's a buoy, another vessel moving across your course, or a person bobbing around," explains Collett.

"The other problem with radar is you will get returns from the waves themselves that you have to cancel out. So you have algorithms running to determine when there's an object there and when it's just a wave, in which case the radar screen shows black."

SeaGuard is initially envisaged as an auxiliary system that provides additional situational awareness in specific operating conditions, and the regulations covering tasks such as search and rescue would prohibit its use as a main navigational radar. Another prohibiting factor is cost; it's around seven to eight times higher than a conventional magnetron-based X-band navigational radar with comparable features.

However, given the transceiver can meet and exceed IMO performance requirements, and has the benefit that there is no magnetron to maintain and replace, Sperry Marine is not ruling out applying for type approval at a later stage.

Could solid state radar eventually become the standard for all commercial vessels? Collett thinks all radar technology is on an upward trajectory. "I'd be pretty safe in saying that IMO's radar standards have been the same for the last 30 years, but manufacturers are leaping well over that standard now. With VisionMaster Net, where we're doing an analogue to digital conversion up in the radar then sending that signal to a PC, so there's greater capability for image enhancement and to explore iterations to improve the picture quality.

"The components you need to make solid state radar are very expensive, but we expect the price to come down over time, which probably means in another 10 or 20 years all radar will be solid state. Maybe at that point IMO will say every radar should be solid state and it becomes the performance standard for safe navigation, because these radars are already on the vessel." *NA*

Bio-UV goes with the (lower) flow

Size matters for the French ballast treatment manufacturer, but it's still targeting a quadrupling of turnover by 2022

With the protracted saga of the Ballast Water Management Convention implementation, the different discharge standards set by IMO and the US Coastguard, and latterly the scramble for type approval and customers alike among manufacturers, the fact that ballast management is simply a particular application of water treatment sometimes appears almost irrelevant.

Yet that's precisely the philosophy of French company Bio-UV Group. The Montpellier-based outfit had already been manufacturing its UV-based solutions for applications such as swimming pools and drinking water before it launched its Bio-Sea ballast water treatment system (BWTS) in 2012, and for now at least this historic business continues to account for the majority of its turnover.

To date, Bio-Sea, which has both USCG and IMO (G8 standard pending) type approval, has been installed on around 150 vessels. But with the BWTS market for UV systems, both for newbuildings and retrofits, expected to be worth in the region €7.5 billion over the coming years, Bio-UV is targeting an annual consolidated turnover of €40 million (US$45 million) by 2022, almost quadrupling its 2017 turnover of €10.2 million. Overall, it is conservatively targeting €150 million of the ballast windfall, or 3-5% (around 2,500 vessels), and by the end of January had already received more orders for Bio-Sea than the whole of last year.

Seeking partnerships

Like many players in this competitive market Bio-UV is seeking an edge. Currently, only around half of the company's sales take place outside of France and while that includes some blue-chip clients such as CMA CGM, Bio-UV founder and chairman Benoit Gillman admits that to achieve their ambitions they are looking to forge partnerships overseas. "We are looking very carefully for strategic joint ventures in strategic parts of the world. We've had discussions with Damen, who are interesting for many reasons, as well as Asia, the Mediterranean, and possibly the Middle East," he says.

CFD modelling was used in the creation of the 1.8m Bio-Sea reactor, which contains a single 22kW UV lamp

Gillman notes that any joint ventures are more likely to be for industrial assembly, while the parts themselves would continue to be shipped from France. One of the drivers behind this is that shipowners are more likely to source equipment from national or regional manufacturers. "The good thing about type approval is that you cannot easily change or copy components, because everything is listed and recognised."

The type approval process extends to the stringent requirements for shipboard water testing for each system, which has a deterrent effect on less discerning manufacturers who might be contemplating creating a knock-off ballast treatment system.

UV popularity

UV technology is the fastest growing form of water treatment and appears to be gaining traction over electrochlorination (EC) systems for ballast water treatment in particular. There are no chemicals involved, and therefore no chemical bi-products and it is not affected by factors such as salinity or temperature. While the basic principle, that of passing the water through a chamber (or reactor) containing lamps emitting ultraviolet C (UVC) rays, is relatively straightforward, much depends on the volume of water being treated, its quality, and flow rate at which it needs to pass through the chamber. To ensure compliance with IMO D-2 and USCG discharge standards, UV disinfection takes place during both the ballasting and deballasting phases.

Bio-UV manufactures a range of different lamps for a variety of purposes. As with all the company's products, the R&D for Bio-Sea was conducted by a team of specialists who use CFD to model the turbulence and flow rate inside the UV reactor during the design process, before investigating the required irradiance of the UV lamps according to the water quality and its bacteriological effects.

But because of the type approval system does not allow for modifications the Bio-Sea UV reactor is a 'one size fits all' design covering a wide spectrum of water quality capable of treating up to 150m^3/h with a single 22kW lamp (housed in a 1.8m reactor), multiple units of which can be installed according to need on a modular basis. This contrasts with some rival UV systems, which use multiple lamps in a single chamber, but cuts down on overall maintenance.

Control of the entire system is handled by an automated system which uses sensors to monitor the UV intensity (W/m^2), temperature and flow, with a touchscreen interface. At the end of each operation a cleaning cycle is triggered that flushes and refills the system.

Main customer base

While CMA CGM last year ordered Bio-Sea systems for nine 22,000TEU container ships under construction at CSTC Shipyard in China, each of which will be with two Bio-Sea B 10-1500 FX units (giving a combined 3,000m^3/h capacity), the company says it prefers to focus on vessels in the 300-500m^3

range. That includes PSVs and OSVs, megayachts, ro-ro's, ro-paxes, multicargo, cruise, container ships and smaller bulkers. "When we receive orders for 1,000-2,000m^3 of course we compete and try to win but it's not our main customer base," says Gillman.

For larger vessels EC ballast treatment is likely to remain the most cost-effective choice for the foreseeable future. A critical factor in this is the UV transmittancy (UVT) of the water. Even apparently clear water can contain contaminants that compromise the ability of the UV radiation to inactivate microorganisms. Typically drinking or swimming pool water will have a UVT of around 95%, whereas clean marine water has a UVT of 80%. With lower UVT (the turbid water of Shanghai port has a UVT of 55%) comes an exponential increase in power required to treat the water with sufficient intensity. Ultimately LED-based UV systems may be achievable but currently these are only possible at a low wattage.

Bio-Sea is modular and can be upscaled according to the required flow rate

It also means that for UV systems in particular it's just as important to have a good filtration system, with an automatic backwash filter, for the ballasting part of the operation. Given the growing bottleneck for ballast retrofits there is widespread concern that some filter makers may have underestimated demand. Again, the exacting requirements of type approval mean that any changes to the filter systems mean reapplying, a process which costs in the region of US$1 million.

Such shortages, however, are a short-term problem issue relevant to the current retrofit boom. The ballast market, like its technology, can now be argued to have attained maturity and is likely to enter a period of consolidation, as weaker manufacturers fall by the wayside. Gillman anticipates that by 2024, when this period draws to a close, there is likely to be no more than a combined 16-20 manufacturers for UV and EC systems alike, their business comprised of spare parts for existing machinery and the 1,000 or so newbuildings a year requiring a system. But with the added insurance of Bio-UV's non-ballast historical business, he is philosophical. "If we can achieve 5% of the market, providing 50 Bio-Sea systems a year, I will settle for that," he reflects. *NA*

Powering-up a dynamic sector

Record demand for cruise vessels is a boon to engine technology systems, writes David Tinsley

An unprecedented volume of cruise ship construction, with orderbooks at the few yards which dominate the market stretching at least five years ahead, is a boon both to the European commercial shipbuilding industry and to business for advanced power and propulsion systems.

The cruise lines have long been champions of innovation in marine design, engineering and propulsion. Their technical disposition allies with the sector's philosophy of continual enhancement of fleets and services as fundamental not only to business development and brand competitiveness but also to the overall expansion of the market.

The technical challenges presented by the growing complexity and standard of cruise vessels, whether at the upper capacity end of the mass market or in the fast-rising segment of expedition-type and ultra-luxury ships, are amplified by the weight of environmental legislation in force and in prospect. While responding to the regulatory pressures, owners are also demonstrating awareness of the branding advantage that can be conferred by initiatives that reduce the ship's overall carbon footprint.

The sector is a major practitioner of modern diesel-electric technology, and this experience is now being taken forward into the specification of LNG dual-fuel electric installations for a growing number of high-capacity newbuilds. The prime movers for the 'power station'-type plant selected are principally medium-speed designs from the MAN, Wärtsilä and MaK stables in the wide-bore, 430mm-480mm range.

The powering mode, typically with multiple, distributed main generators, offers redundancy as well as the requisite potency to sustain a considerable hotel load as well as propulsion needs, plus the flexibility to efficiently match energy production with actual requirements at any time across the operating profile.

Diesel-electric Symphony

On delivery in March 2018 from Chantiers de l'Atlantique, the 228,000gt *Symphony of the Seas* pushed the boundaries by becoming the world's largest passenger ship, in terms of gross tonnage. Accommodating 5,518 passengers on a double-occupancy basis, the Royal Caribbean-owned behemoth is a showcase for the diesel-electric mode, incorporating four Wärtsilä 12V46F engines and two 16V46F models producing a combined 96,000kW, with up to 60MW translated into propulsive force via three 20MW Azipod azimuthing electric thrusters.

Power station at sea: looking across one of the Wärtsilä 46-series vee-form diesels in Royal Caribbean's *Harmony of the Seas*

> "Further progression in (ship) size means that enormous amounts of power are placed on propellers"

The vessel also features an under-hull air lubrication system, of the type introduced in 2014 on the Meyer Werft-built *Quantum of the Seas*. *Symphony of the Seas* is only marginally larger than *Harmony of the Seas*, commissioned two years earlier out of the Saint-Nazaire yard, and which has the same 'power station' layout and ratings.

The EVO generation

Geneva-based MSC Cruises, one of the industry's fastest growing brands, has kept faith with GE Marine Solutions to provide the electrical propulsion systems for two 169,400gt Seaside EVO-class newbuilds entrusted to Fincantieri. The vessels will be the largest-ever cruise ships constructed in Italy, as derivatives of the previous title holders, the 153,300gt *MSC Seaside* and *MSC Seaview*, delivered in November 2017 and spring 2018, respectively. GE Marine's systems have been installed in 14 existing vessels of the MSC fleet.

Leading the Italian project consortium responsible for the powering of *MSC Seaside* and *MSC Seaview*, GE supplied each ship's propulsion controls, four 12.8MVA main generators, transformers, variable frequency drive core components, and two synchronous propulsion motors. A similar package forms the scope of the contracts for the EVO generation, but with increased ratings for power generation and propulsion motors.

In the *MSC Seaside* type, the four main generators are driven by Wärtsilä 46F diesels, two of the aggregates using 12-cylinder models of 14,400kW and two being 14-cylinder engines of 16,800kW, making for a power concentration of 62.4MW at 517rpm. The propulsive power take-off is 40MW, whereby two 20MW electric motors turn fixed-pitch propellers.

Due to the midships position of the motors, the shaftlines are longer and have more support than on most ships. Arranging the machinery in each vessel's middle section improves weight distribution and layout efficiency and facilitates Safe Return to Port (SRtP) requirements.

Virgin: new territory for Wärtsilä medium-speed diesels, selective catalytic reduction (SCR) systems, open-loop scrubbers, and ABB electrical machines and propulsors

LNG capability

Delivered by Meyer Werft towards the end of 2018, *AIDAnova* opened a new chapter in cruise ship propulsion as the sector's first vessel fitted with all main engines capable of operating on LNG. The outfit is comprised of four 16-cylinder models of the MaK M46DF type. *AIDAnova* leads the Helios-class, and similar power arrangements have been nominated for newbuilds of the same type from the Papenburg yard and Meyer Turku for various Carnival brands besides AIDA Cruises.

Wärtsilä has achieved a breakthrough in the cruise market for the dual-fuel version of its 31-series medium-speed engine platform, promoted as the most fuel-efficient design in its class. The 30,000gt polar cruise vessel ordered by French operator Ponant from the VARD group in Norway, due for delivery in 2021, will have a six-engine installation, comprising four 14-cylinder and two 10-cylinder Wärtsilä 31DF engines, for primary operation on LNG.

A total of about 20 LNG dual-fuel electric-powered cruise ships have been firmly ordered to date, with options set to take the tally further. The Meyer Group alone landed contracts for 12 LNG-powered cruise ships over the course of last year.

Through research conducted at its Rostock factory in Germany, MaK brand owner Caterpillar was proactive in demonstrating that its M46DF dual-fuel engine could run efficiently on LNG at less than 20% load, and avoid the risk of visible smoke and soot at start-up and during manoeuvring.

Carbon conscious

As a sulphur-free fuel which emits less CO_2 than heavy fuel oil (HFO), LNG is a popular and practical option for bridging the gap between fossil fuels and renewables. Nonetheless, the industry acknowledges that it is only a transitional solution to meeting the far more onerous regulatory requirements which it will face in the coming decades. Synthetic fuels usable with relatively small modifications to existing reciprocating engine designs is currently one field of investigation. Meyer Werft is among those involved in research to develop fuel cell technology and other technical innovations for passenger vessels.

Royal Caribbean is investing in a new level of environmental compatibility in its ICON generation of 200,000gt vessels booked with Meyer Turku. In addition to dual-fuel main machinery, each 5,000 passenger-capacity newbuild will be equipped with a Ballard proton exchange membrane (PEM), pure hydrogen fuel cell plant. The 100kW device will be integrated by ABB into the electrical system and will help take up the hotel load in port.

Virgin berths

A high environmental standard has figured prominently in the criteria stipulated by newcomer Virgin Voyages for its future fleet, although it has not sought to help realise this objective by using dual-fuel engine technology. Rather, it has nominated Wärtsilä 46F HFO-burning prime movers, in conjunction with hybrid exhaust scrubbers and selective catalytic reduction (SCR) systems, as the heart of the ABB electric power and propulsion system for each of four 110,000gt newbuilds in Italy. The engineering design will also be distinguished by the adoption of Climeon's heat power solution, to generate electricity using waste heat from the diesel engines, reducing fuel consumption and CO_2 emissions.

Each of the four ships to be built at Fincantieri's Genoa-Sestri yard will be propelled by two Azipod XO units, having a combined effect of 32MW.

While the industry continues to show its mettle in the design and production of ships at the uppermost end of the scale, further progression in size means that enormous amounts of power are placed on propellers, which poses extra demands on achieving high onboard comfort levels in conjunction with hydrodynamic efficiency.

Given the degree of attention which therefore has to be given to the aft end, Chantiers de l'Atlantique has recently embarked for the first time on designing and manufacturing its own propellers. The yard has an extensive database and experience as the platform for its initiative and is being assisted by MARIN in the field of propeller optimisation. The first application will be a twin-screw newbuild from Saint-Nazaire. ***NA***

Herculean engine endeavour brings results

A European research alliance, unprecedented in scale and ambition, has fostered advances in large marine engine technology from studies over a decade and a half

Although still regarded with scepticism in some quarters of the industry, public funding of technological R&D carried out on a collaborative basis has become far more commercially circumspect and results-driven over the years.

European Union and national programmes, augmenting individual corporate budgets for R&D, which may typically be in the order of 2-3% of vendors' annual turnover, have been structured to stimulate cross-discipline R&D cooperation, reflecting the greater technical complexity and functional integration in ships' powering and operating systems.

Scale and effectiveness in EU-sponsored endeavours have been taken to a new level by the Hercules programme, the largest-ever joint R&D undertaking focused on marine engines. Many of the technologies developed and refined through four phases of research spanning a 14-year period have led directly to new products and methodologies that have influenced the design of some recently introduced engine models. A strength of Hercules has been the continuity expressed both in the series of consecutive projects and in the maintenance of core partner alliances throughout.

Shared vision

Sharing a joint vision, the major low- and medium-speed engine licensors and manufacturers, MAN Diesel & Turbo (now MAN Energy Solutions), Wärtsilä Corporation, and Winterthur Gas & Diesel (WinGD) collaborated with universities, research institutions and other industrial partners to increase engine reliability, efficiency and emission control. The combined budget across the entire programme amounted to more than €100 million (currently equivalent to US$112.8 million).

The final meeting under the long-running Hercules engine R&D programme was convened in Hamburg last October

Hercules-A, -B and -C absorbed a total budgetary allocation of €76 million (US$85.7 million) over 11 years, more than half of which was covered by EU funding. Hercules-2, which ran from 2015 to 2018, had a budget of €25.1 million (US$28.3 million), thereby taking overall expenditure on the programme to just over €101 million (US$114 million).

The EU increased its share of the cost of the latest phase, Hercules-2, putting up €16.8 million (US$19 million), or 67%, of the total budget. This had the remit of building on the three preceding projects, integrating the best and most viable technologies. Key objectives were identified as the development of a fuel-flexible, large marine engine, employing adaptive control methodologies to retain lifetime performance, the formulation of new materials to support high-temperature applications, and the development of techniques and technologies so as to achieve near-zero emissions.

Accelerating transition

The overarching aim has been to accelerate the shipping industry's transition to better operating economy and significantly reduced environmental footprint, while strengthening the participants' technological and international market standing.

Pragmatism in Hercules-2 was better ensured by having the involvement of the user community, represented through an external associates group (EXAG) comprising fleet operators Hapag-Lloyd, A.P.Moller-Maersk and Costamare.

Already the global market leader in large marine engines, Volkswagen Group

The Hercules Programme

Phase	Duration	Budget (Euros)	Partners
Hercules Integrated Project (A)	2004-2008 (43 months)	33 million	42
Hercules-B	2008-2012 (36 months)	26 million	32
Hercules-C	2012-2015 (36 months)	17 million	22
Hercules-2	2015-2018 (42 months)	25 million	33

member MAN Energy Solutions (as MAN Diesel & Turbo in its former guise) was far-and-away the largest recipient of EU money ploughed into Hercules-2, having qualified for €6 million (US$6.8 million) from the Horizon 2020 coffers. While such allocations from the public purse do not meet the approval of all in the industry, the proponents of selective subventions argue that such funding produces results that help fuel increased European competitiveness, wellbeing and wealth creation. The overall German participation, represented by 11 of the 33 partners, underscored the country's powerhouse standing in engineering.

MAN and Wärtsilä led the three initial phases of the programme, and were joined at the helm of Hercules-2 by two-stroke specialist WinGD, at that time the 70%/30% Swiss-based joint venture of China State Shipbuilding Corp (CSSC) and Wärtsilä, respectively, and which subsequently became a wholly owned subsidiary of CSSC.

Turbocharging and EGR

In its 2018 annual report, in reference to the work carried out under the programme, Wärtsilä noted that: "Many of these technologies have found their way into Wärtsilä products such as the Wärtsilä 31". The reference is significant, as the design is widely perceived as having raised the bar in medium-speed engine efficiency and is generating sales in disparate sectors of shipping.

In fact, there have been manifold, tangible results as the programme has evolved. The work has contributed to areas such as two-stage turbocharging and exhaust gas recirculation (EGR), and to the rise of LNG as a marine fuel.

At the final plenary meeting held in Hamburg during October 2018 to mark the completion of Hercules-2, achievements were identified in many spheres. One area highlighted was the work on intelligent engine control, featuring the development of predictive model-based engine control, for improved dynamic behaviour and reduced emissions at part-load. Major advances were also recorded in the field of emissions abatement. This included an exhaust aftertreatment solution that entailed the development and prototype testing of SDPF technology (a diesel particulate filter with SCR coating) on a marine diesel engine to minimise NOx and particulate matter (PM) emissions.

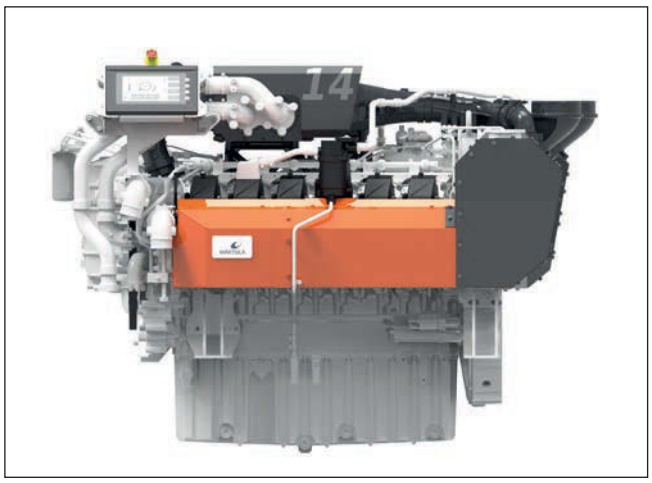
High-risk development efforts have been brought to successful market introduction. Long-term value engendered by the Hercules programme may also be expressed in the platform it has provided for the build-up of relevant, inter-disciplinary networks among European industry and academia. *NA*

Wärtsilä's new baby has Liebherr genes

The Wärtsilä four-stroke engine programme is gaining a high-speed dimension with a collaboratively developed design focused on space-saving, lower cost and future emissions compliance

Achieving compactness without sacrificing ease of maintenance, affording higher power concentration without extra weight, raising fuel efficiency without penalising emissions performance, and ensuring robustness without detriment to load response, are challenges for engine designers, amplified in the case of machinery for marine auxiliary applications and small-ship propulsion.

Addressing evolving market requirements while advancing the company's realisation of its Smart Marine vision, Wärtsilä unveiled a high-speed engine addition to the company's portfolio in November 2018. The Wärtsilä 14 type constitutes a broadening of the product range beyond the medium-speed category and into the lower regions of the power scale, below that of its current, smallest production engine, the Wärtsilä 20 series.



Auxiliary applications in large merchant vessels constitute one of the target markets for the Wärtsilä 14 high-speed engine

The choice of development partner, in the shape of Liebherr, underscores the outward-looking disposition of the Wärtsilä organisation. Liebherr is a diversified, international construction, lifting and mining equipment group based in Switzerland, most closely identified in

the marine field with terminal, shipboard and offshore cranes. Its high-speed engine production interests are geared mainly to the construction sector. These have been augmented by recent new model introductions, including the first outcome (a six-cylinder in-line diesel) of collaboration with Russian truck and engine manufacturer Kamaz.

The 135mm-bore, Wärtsilä-branded newcomer leverages Liebherr high-speed engine know-how in combination with key Wärtsilä engine technologies. The two companies have agreed to cooperate on a long-term basis in the research and development of high-speed engines for the marine and offshore markets.

Auxiliary gensets

In addition to the propulsion of small vessels such as tugs, offshore vessels, workboats and local ferries, one of the main target applications for the Wärtsilä 14 is that of auxiliary generating sets in merchant ships, including container vessels and tankers. As a genset drive, the engine is set to be released from the end of 2019 onwards in 12- and 16-cylinder configurations, covering a power output band of 675-1,155kWe. The propulsion version, initially as a Tier II engine, is scheduled to follow in mid-2020.

The vendor's case for the engine's suitability as an auxiliary rests on a combination of purported attributes, including competitive capital expense and installation costs, compactness and high power density. One key innovation is the digital fuel injection system, which is optimised for marine distillate fuel oils. The engine's operation on light fuel oil (LFO) with a maximum sulphur content of 0.5% is apposite to the shift to cleaner fuel in auxiliaries. Models supplied later in 2020 will be available with integral emissions aftertreatment, using Wärtsilä's proprietary NOx reducer (NOR) system based on selective catalytic reduction (SCR) technology, thereby ensuring IMO Tier III compatibility.

Load-taking capability is said to better than that of medium-speed machinery, rendering fast response and fast-start performance in all conditions. It also incorporates Wärtsilä UNIC automation system modules for monitoring and safety purposes.

Liebherr manufactured

The new engine shares the same bore, stroke and displacement as that of Liebherr's D9600 vee-form series. The Wärtsilä 14 will not be manufactured by Wärtsilä, but by Liebherr, which has diesel production sites in Switzerland and France. Liebherr will also be responsible for ongoing product development of the Wärtsilä 14, while after-sales backing will be afforded through Wärtsilä's global lifecycle support and services network.

The 14-series design has been promoted as the first Wärtsilä-branded high-speed engine. However, the organisation is no stranger to high-speed diesel technology. In 1989, it secured a stake in the French manufacturer SACM, and went on to produce high-speed engines under the aegis of Wärtsilä SACM. In 1995, the Finnish group entered into a joint venture with Cummins to design, develop and produce two product families of high-speed diesel and gas engines for the marine and power generation markets.

The creation of Cummins Wärtsilä Engine Company (CWEC) had been intended to generate incremental business for both sides, supporting Wärtsilä's objective at that time to become a major player in the high-speed sector and Cummins' aspirations to extend its coverage further up the power band. The Wärtsilä 200-series high-speed engine, which had been launched shortly before by Wärtsilä SACM, provided the basis for the larger of the envisaged two CWEC engine families. The other series was a 170mm-bore engine, intended for production at Cummins' Daventry production complex in the UK, part of which was set aside for CWEC activities.

CWEC, though, had a short lifetime, being dissolved in December 1999. Cummins retained responsibility for production in Daventry of the QSW models, otherwise designated as the Wärtsilä 170 diesel and 180 gas engine, and Wärtsilä took over from CWEC as the producer of the Wärtsilä 200/220 types at the Mulhouse factory in France. In 2004, the product rights to the 200/220 series were sold to Dresser's Waukesha business unit.

The revived Wärtsilä interest and new initiative in the high-speed segment follows the development of the 175D high-speed series by MAN Diesel & Turbo, now MAN Energy Solutions.

In its guise as MAN B&W Diesel, the company had become involved in high-performance, high-speed engines through the absorption of the Paxman marque and the VP185 as part of the 2000 purchase of Alstom Engines UK. As MAN Diesel & Turbo, it created a High-Speed Business Unit in 2010, and went on to develop the D7 high-speed diesel for 1,500-5,000kW applications. MAN Group activities in the high-speed field had otherwise been concentrated on MAN Nutzfahrzeuge, now MAN Truck & Bus.

In the event, the D7 was dropped from the catalogue and the new 175D has been taken forward for marine genset and small-vessel propulsion duties, initially in 12V format for the 1,440-1,920kW power band, to be joined in the future by 16V and 20V versions. ***NA***

TECHNICAL PARTICULARS

	Wärtsilä 14	
Cylinder configuration	12V	14V
Nominal power, kWm(propulsion)	755-1,005	1,005-1,340
Nominal power, kWe(genset)	675-865	900-1,155
Nominal speed, rpm	1,500-1,900	1,500-1,900
Bore, mm	135	135
Stroke, mm	157	157
SFOC @85% MCR, g/kWh	205	205
Length/width/height, mm	2,080/1,435/1,495	2,514/1,540/1,517
Weight, kg	2,700	3,800

RMC upbeat on outlook on strong demand for ferries

STX Finand's former facilities in Rauma are finding a fresh lease of life under the auspices of Rauma Marine Constructions, reports Kari Reinikainen

It is rather rare that a shipyard once closed should be brought back to life, let alone stage a successful comeback. However this is exactly what has happened with Rauma Marine Constructions (RMC), the Finnish shipbuilder on the west coast of the country.

The facilities that RMC uses today were previously part of STX Finland, which in turn was part of the South Korean STX Offshore & Shipbuilding group. A crisis at the parent company forced the closure of the Rauma yard in 2013. A year later, a group of investors, backed by the Finnish government, launched RMC.

Ro-pax ferry for Kvarken Link, which trades as Wasaline

The premises RMC occupies form part of an industrial park, where a number of other maritime cluster companies also have operations. RMC builds its business on two key cornerstones: high level of competence in project management and cooperation with a network of other companies in the Finnish maritime cluster.

"We are recruiting all the time, this is a company experiencing a period of growth," says Jyrki Heinimaa, CEO of RMC. "Our target is to double our own staff to 200," he tells *The Naval Architect*, adding that in the days of STX Finland, the yard alone employed about 1,000 people. However, as RMC relies more on its network on strategic partners than its predecessor, its own staff number is much lower. At present, RMC employs roughly 1,000 people by itself and in its strategic partner network.

RMC has decided to concentrate in two main sectors in its newbuilding business: ferries and naval vessels. It also carries out repair work and builds blocks for assembly at other shipyards.

Last year, it delivered its first newbuilding, a ro-pax ferry named *Hammershus*, for Molslinjen in Denmark. It has a firm order for a LNG/biogas powered 1,500 lane metre and 800 passenger capacity ro-pax ferry from Kvarken Link, which will operate between Vaasa in Finland and Umea in Sweden, plus an initial contract for a large and fast ro-pax vessel for the Tallink group's Tallinn-Helsinki service with a price tag of about €250 million.

"The use of LNG as fuel is a default expectation in ferry newbuildings these days. In the Kvarken Link vessel, a battery pack of 2MW will provide power for the hotel load and it will also improve manoeuvrability of the vessel by allowing a rapid increase of power output," Heinimaa says.

Changing propulsion technology

The Tallink vessel will follow the principles established by the LNG powered ro-pax *Megastar*, built by Meyer Turku in 2017, but Heinimaa points out that lots of new thinking will be incorporated in the planned new ship. "Technical requirements plus the needs of the market have changed in the meantime," he explains.

The planned Tallink ship would make several crossings a day, which means that its propulsion system will be much in focus. "LNG will again be the principal fuel on the ship, but the design will incorporate a number of additional options, of which batteries are a possibility," Heinimaa continues.

Technology is developing rapidly on the propulsion side and options that only a few years ago would have been prohibitively expensive are becoming tolerable from the cost point of view. "While first generation installations can still be quite expensive, the price will rapidly fall in subsequent generations. This means that propulsion systems based on one or two fuels are starting to give way to multiple fuel options in the future," he states.

RMC is also in talks with the Finnish government to build four 3,000tonne displacement corvettes for the Finnish navy, is largest naval programme of all time.

Heinimaa stresses that RMC maintains both commercial and a naval business capabilities in its organisation, given that full time focus on naval work might complicate a return to the commercial sector later on. "Naval projects are public procurement, which means that the dynamics are very different from the commercial sector," Heinimaa points out.

When STX owned what is now RMC, the yard specialised in large ro-pax and cruise ferry tonnage, with Tallink as a major customer.

Given that many major ferry companies continue to operate cruise ferries and ro-paxes built in the 1980s and 1990s, there is a significant need for fleet renewal.

Chinese shipyards are now vying for this business, but it remains to be seen whether or not they will be able to permanently establish themselves in this market. ***NA***

Shipping and technology in same group helps Langh to develop scrubbers

The Finnish group is reaping the benefits of developing its own exhaust gas cleaning systems

Langh Tech, part of the privately owned Langh Group of companies, has established itself as a manufacturer of scrubbers. The fact that the group is also a ship owner and has a cleaning business helped it to expand to this currently dynamic part of marine business.

At first, such a variety of businesses may seem unlikely to offer much in terms of synergies, but Laura Langh-Lagerlof, commercial director at Langh Tech, points out the group structure helped a lot in establishing the scrubber business.

The cleaning chamber, or scrubbing tower, for Langh Tech's scrubber system

"In about 2011, charterers started to ask us what are planning to do when the year 2015 starts to draw closer, Langh-Lagerlöf explains to *The Naval Architect*, referring to when the 0.1% limit in Sulphur Emission Control Areas (SECAs) first took effect in the Baltic and the North Sea.

The company started to look at the various products on the market at the time, but came to the conclusion that not only were the prices comparatively high, but the technology available also left something to be desired. *Containerships VII*, a 966TEU container vessel in the company's fleet, had recently been fitted with a scrubber and this gave Langh first-hand experience from of the products then on offer.

From the start it was clear that scrubber installations in the company's ships would have to be of a closed loop type, because the ships trade to the northern parts of the Gulf of Bothnia, a region that is both environmentally sensitive and with extreme weather conditions in the winter. At this point, the cleaning services unit of the company became a valuable asset, as it had not just provided these services, but also manufactured water purification systems since the early 1970s.

"It's from here that our product development regarding scrubbers started: we decided to build a closed loop system in a container and we had the water treatment system. However, we now needed the scrubber unit and soon found out that suppliers were reluctant to sell that alone," Langh-Lagerlof continues.

The only practical way ahead was to build a scrubber unit from a scratch. "At first, we only had a closed loop system and it took a lot of testing to make it work properly," she notes.

Own ships used as testbed

However, by the summer of 2014 a hybrid scrubber of the company's own creation was installed onboard four of its ships. "To add the open loop function was simple at this point as we had done the most demanding work already when designing the closed loop system," Langh-Lagerlof says.

The fact that the company has ships of its own that it used as test beds proved high beneficial in the early stages, she notes. Not only could technology be tested on board them, but installations onboard the company's own ships could be demonstrated to potential customers.

In January 2019, Langh Tech announced it was to supplyopen loop scrubbers to four 180,000dwt bulkers and three 3,000dwt very large ore carriers for South Korean owner Polaris Shipping. Other recent customers include D/S Norden, the Danish dry bulk and product tanker operator, which bought units to 12 of its owned ships. Marmaras Navigation and Delta Tankers, both based in Greece, have bought a total of 10 units.

As the IMO's emission control rules that require ships to either use low sulphur fuels or have a scrubber installed on board are to take effect from 1 January 2020. Langh-Lagerlof expects the market for retrofits to remain busy in the near term.

"After the retrofit boom, the focus of the business will move to newbuildings," she continues. Owners contemplating to have scrubbers installed onboard obviously look at the payback time of the investment, which is about one year in the case of an open loop system and about two years in the case of a hybrid system.

"The actual payback time will depend on the power installed on board – the more power there is, the shorter the payback time," Langh-Lagerlof notes. "Having a scrubber fitted onboard ships is an advantage, at least for those owners who time charter their ships out to third parties. Ships with a scrubber onboard tend to attract charterers first," she says.

The Langh Group is privately owned and it can be regarded as a medium sized company in Finnish terms. Its moderate size and an informal culture in decision making have been great assets in developing the business and to innovate, Langh-Lagerlof concludes. ***NA***

Consider the bigger picture, urges Deltamarin

Early employment of holistic energy modeling can produce good results, explains the Finnish naval architects and engineers

Ship design would benefit from a holistic view, in which the designer builds a clear understanding of the operations of the planned vessel and energy efficiency is among the areas that gains could be made through this approach, says Mia Elg, development manager at Finnish naval architects Deltamarin.

"The first thing to do is to look at existing ships to find out what could be improved, starting from the operational point of view. This can mean optimising the timetable, so that there would not be peaks of high speed followed by slow steaming. It can also mean optimising the maneuvers to enter and leave ports," Elg tells *The Naval Architect*.

The LNG-powered *Viking Grace* is also equipped with a Norsepower Flettner rotor

If holistic energy efficiency modeling is carried out in the beginning of a project, significant possibilities will arise to improve the energy efficiency of the vessel and to lower fuel consumption. Elg said that Deltamarin has found concrete evidence of a 30% improvement in the case of a tanker compared to existing fleet of the owner, with improvements of 10% to 20% quite common.

Deltamarin is currently involved in a newbuilding project that the Finnish cruise ferry operator Viking Line has under construction at Xiamen Shipbuilding Industry's shipyard in China and the new 63,000gt vessel will have a lower fuel consumption than the 2013-built 57,600gt *Viking Grace*, despite the fact that the new ship will be larger and have higher capacity.

"Even with one additional lane (due to greater breath of the ship), the vessel consumes absolutely less fuel compared to the newest ship on the same route," she points out.

Concept design focus

In the case of a newbuilding project, it is essential to focus on the concept design phase, where the largest impact to the ship cost and operational efficiency, are made. Also any knowledge of the ship's future operational profile should also be focused into the concept design work. For this, any operational energy efficiency studies made for the existing fleet can be utilised.

In order to be able to do this, Deltamarin is investing substantial amounts of its own funds into R&D: this allows it to build a base of knowledge and expertise that again allows it to advise its clients in holistic optimisation of the ship's lifetime energy and environmental efficiency.

"Concrete design tools and processes have been developed as a result and implemented in the daily project work, such as the DeltaKey energy flow simulation tool and DeltaSeas analysis for designing the ship hull considering the environmental loads. DeltaWay is a new concept design process, applicable currently for RoPax ship types," Elg says.

It has become an established practice to build a digital twin of a vessel. Elg points out that this should be started at an early part of the design process and it is not necessary to have a huge number of parameters at the start. These can be added on later and data from existing vessels can be used to help in the process.

Modern technology makes it possible to gather huge quantities of data. This is an obvious advantage of the technology, but it is still necessary to ask the question to what extent the signals are relevant in the design process of the vessel. After all, the aim is to make the new ship more efficient than existing ones.

Capex vs. opex

New technologies are making inroads to power vessels and to save energy consumption on board. The question that an owner must address is to what extent should capital expenditure increase in order to obtain lower operating expenses.

The picture is rapidly evolving as technologies are rapidly becoming cheaper and thereby very real options for use onboard ships. With the holistic energy modelling, Deltamarin has studied the profitability of alternative machinery options when using LNG as fuel, dimensioning energy storage capacity for the ships and various efficiency technologies, such as the waste heat recovery equipment.

"Holistic energy efficiency evaluation is also included in the new cargo ship designs, where the ship hull and machinery can be optimised according to the actual operation area and environmental conditions," Elg notes.

The Finnish maritime cluster employs more than 50,000 people it is of vital importance that there is a vibrant shipbuilding sector in the country, said

Deltamarin has recently been involved in the design of Viking Line's current newbuild project in China. Credit: Viking Line

Kristian Knaapi, Deltamarin's head of sales and marketing. "You can think of the design process as three parts – concept, basic and detailed designs. If you do not have the one and two, how can you have the number three," he observes.

Closer cooperation between ship designers and builders is also something that Knaapi would like to see more of. "Knowledge creates knowledge. It would be good to swap people (between design firms and yards) so that they can learn from each other's environments. There is no point in designing a ship so very fine that it cannot be built," he concludes. *NA*

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RINA conference,
Jakarta, Indonesia
www.rina.org.uk/ICSOT_Indonesia_2019.html

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

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

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