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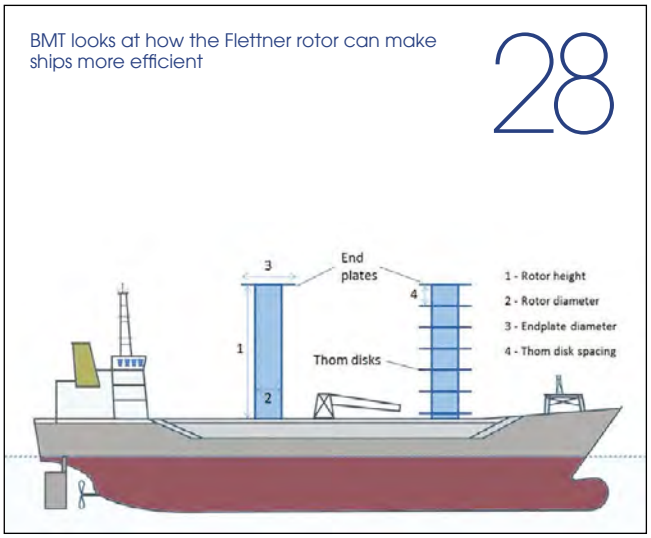

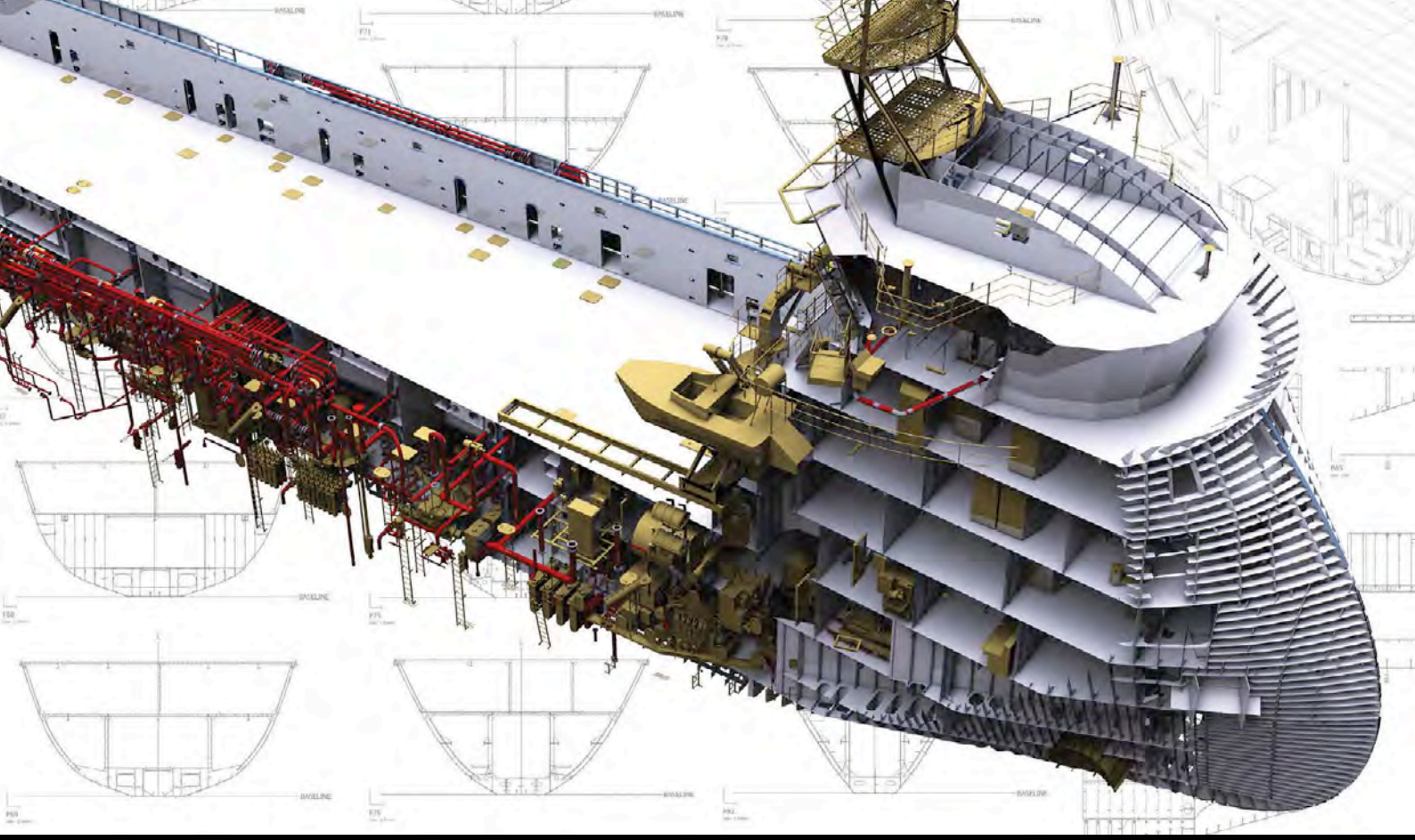

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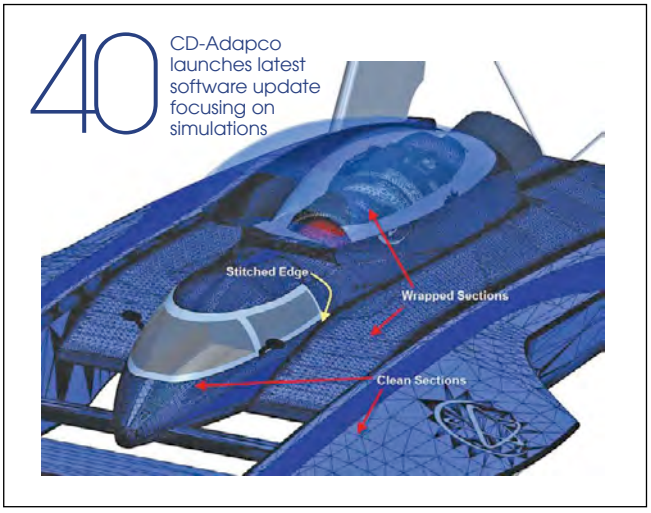

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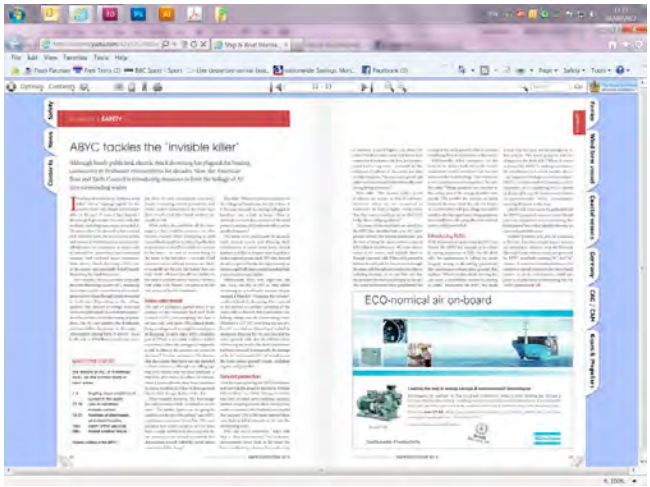

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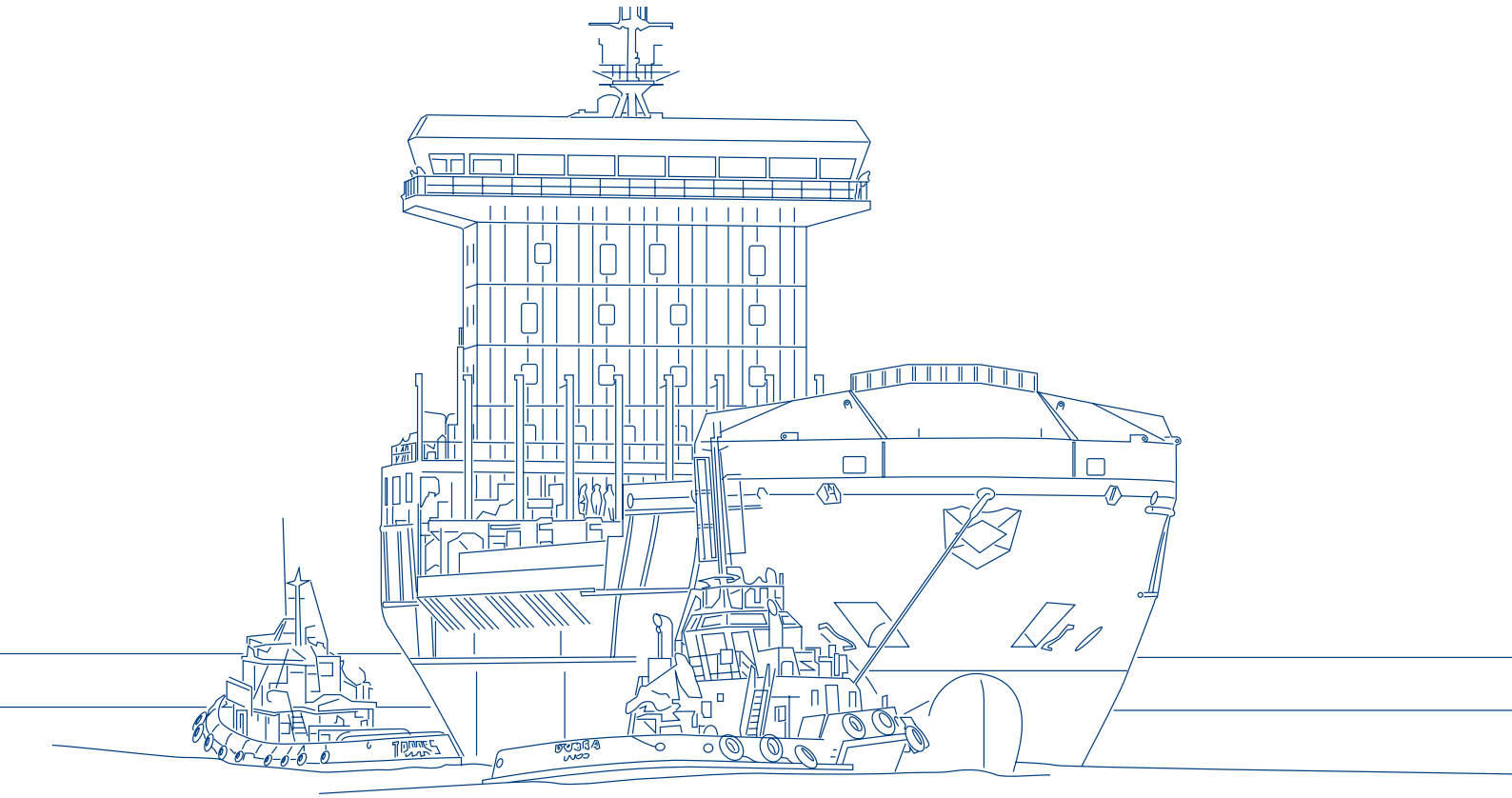

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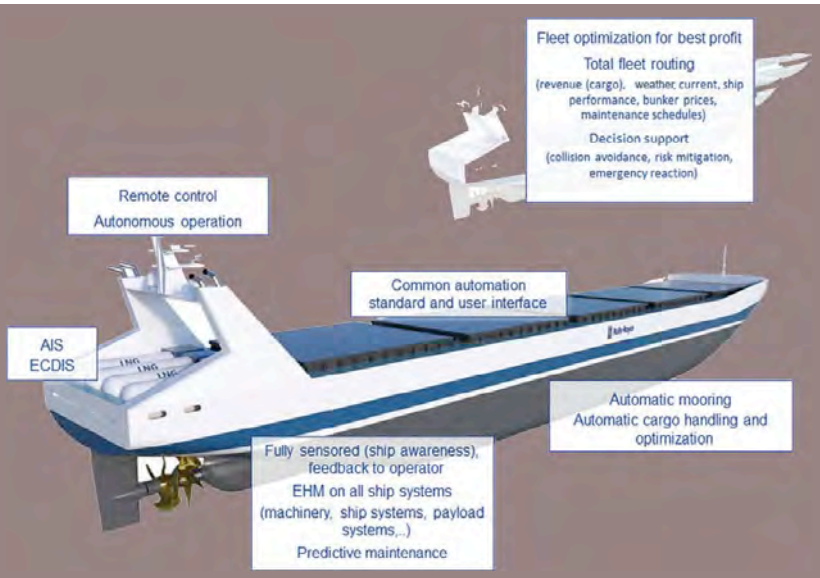

Robot ships

Rolls-Royce says that the future of shipping is the development of remote controlled ships to fill the ship intelligence gap

Crew training has come to the fore for ship designers as company CEO's seek to recruit and train enough personnel to operate their vessels.

It seems that the expected growth in the maritime industry will exacerbate this already chronic crewing problem. Help is, however, at hand. According to Rolls-Royce, automation is the answer and the automated vessel will be delivered through a series of evolutions.

The UK-based company says that "The best way to predict the future is to create the future," and to meet that demand Rolls-Royce has designed a number of systems and vessels that will begin the evolutionary journey of the maritime industry.

Oskar Levander, Rolls-Royce's vice president innovation, engineering and technology, marine, says that there are fundamental changes to the maritime industry that have already set the tone of change. LNG is established as the third fuel, says Levander, with the introduction of batteries and hybrids yet to come; then there will be ship intelligence which will see the sensors placed around ships so that shore-based crew will be able to monitor the vessel's performance. Finally vessels will be unmanned and the new era of shipping will be fully realised.

According to Levander, there is already a palpable shift from vessel to fleet optimisation, with five areas of optimisation that can be delivered through ship intelligence: energy saving, improved safety, reduced maintenance costs, the availability of the asset increased and the usability also improved.

Moves towards fleet optimisation have evolved through the use of data, which is now collected from key elements of the ship as it is operating, but as new ship designs are developed the mass of data from engines, trim, navigational aids and more will increase significantly. This data will be coupled with real time camera images that will allow distant operators to assess the vessel's situation and monitor cargo.

If confirmation is needed Martin Stopford, of Clarksons, has independently produced a similar view, albeit from a different starting point in these very pages (See pages 18-21).

In a paper first delivered to Indian industry figures last month Stopford praises the work of naval architects for delivering real savings through greater efficiencies over the last 150 years, but he says with every development and increase in vessel size the benefits become harder to realise.

Revolution is a necessary development for the industry to meet future demands, both technological and psychological, the latter because we must overcome our fear of change.

Stopford believes that there is also a gap that has arisen as the shipping industry has evolved with today's CEO's less likely to have served at sea and they are, therefore, less likely to understand the need for technological change and the potential benefits that it could bring to their company and society at large.

Levander, is more optimistic that the industry can be made to see the benefits of this brave new world. Embracing change is never easy, but if "We can demonstrate customer value then owners will turn," says Levander. He adds that it will take time.

Benefits are not just restricted to the operational efficiencies of the vessel operators, but include the ability to offer crew more comfortable and far safer working conditions where they can be near their families. In addition most accidents are as a result of human error, and therefore unmanned ships will be significantly safer as they do not suffer from fatigue, as their human counterparts do, and they will have a high degree of redundancy so that they remain safe should there be a failure of one of the systems.

"A pool of 10 captains will be able to control 100 ships," says Levander. And that will also bring down costs for the owner who will be able to build ships without the accoutrements necessary to maintain a comfortable working environment and to aid the navigation of the vessel.

Regulatory changes will also be necessary with regulations currently exclusively devised for ships that are manned. Regulations such as the Safety Of Life At Sea code (SOLAS) will need to be re-written.

Ships operating locally and making short journeys will most likely be the first automated ships, such as ferries; with the move to ocean-going vessels following.

Roboship may soon be sailing to a port near you! *NA*

Rules

IACS sets new boxship hull rules

International Association of Classification Societies (IACS) rules have been updated following the conclusion of investigations into the *Napoli* and *MOL Comfort* casualties.

Formal adoption of the latest rule, UR S11A which pertains to container ships only, is planned for 31 March with the rules entering into force on 1 July 2016.

Peter Thompson, global head of hull structures at Lloyd's Register and the chair of IACS' Hull Panel, told *The Naval Architect*: "The Expert Group on Container Ships concluded that there was a need to expand the scope of the current unified requirements with the aim of achieving an acceptable level of consistency in hull girder strength under specific loading conditions."

According to IACS the damage report and subsequent explanations from ClassNK identified that bottom shell plate buckling was "the area of initial failure", and that this was also the conclusion reached by the initial government led report into the *Comfort* loss.

The new rule effectively sets new net thickness rules for hull girders and shell plating, where in the past some class societies used gross thickness as their standard. This new element to the rules will set a new minimum standard that must be adopted by all class societies into their rules, explained Thompson.

Following the loss of *Napoli* in 2008 and the Maritime Accident Investigation Branch (MAIB) investigations into the casualty the MAIB recommended that hull girder strength and buckling checks are conducted on all post-Panamax container ships, in addition an evaluation of the original UR S11 rule governing design and wave bending moments for vessels with low block coefficients was proposed and that class use common methods to comply with these requirements. A project team was established, PT56, to look into these proposals.

However, an Expert Group reporting directly to the IACS council was formed under the chairmanship of DNV GL's Holger Jefferies, VP Research and Rules Holger Jeffries in November 2013 to look at the implications of the *MOL Comfort* loss following the break up and subsequent sinking of that vessel in June 2013 and the conclusions of this Expert Group were delayed until November last year, after the publication of a report into the *Comfort* loss by ClassNK.

A workshop to debate the implications of the ClassNK report then took place in October and new minimum standards for container ships were agreed between the IACS members and that rule, UR S11A, pertains solely to container ships.

Current IACS chairman and executive VP at Bureau Veritas Philippe Donche-Gay says: "I am very confident that the new rules will prevent another *Comfort* type of accident," he added "The accumulation of causes that combined to produce a statistically unique situation in which the *Comfort* took place."

A number of major container shipping lines have now set up equipment to monitor their own vessels in a variety of different situations over a significant period in order to look at possible whipping and springing issues that could arise on the large container ships.

IACS is also looking to see if there can be a common approach with its members to whipping and springing in ships.

Newbuilding

Shell enters LNG bunker market

Anglo-Dutch oil company Shell is to build an LNG bunker vessel, which will supply the gas to vessels at Rotterdam's GATE (Gas Access to Europe) terminal, and will be sited at the new break bulk terminal at the Dutch port.

The 120m long ship will be able to load bunkers at the terminal or at other places as the vessel will be capable of navigating at sea.

Shell says the vessel will be a "pioneering in design and will be built by STX Offshore & Shipbuilding [in South Korea]. It will have a capacity to carry

Shell's new LNG bunker vessel under construction at the STX yard in Korea will offer bunker services to LNG vessels at the Rotterdam break bulk terminal from 2016

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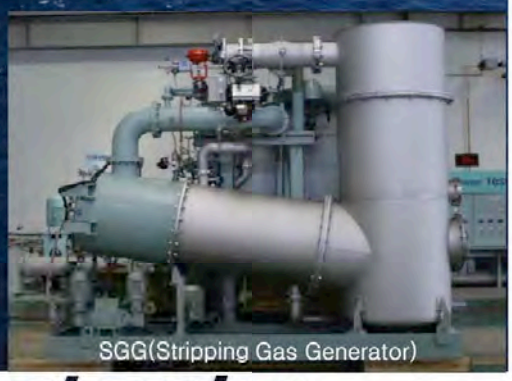

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Grahaeme Henderson, vice president of Shell Shipping & Maritime, explains: "We worked closely with customers on the specifications," and he added the new vessel "will use cutting-edge technology."

The new break bulk terminal is expected to be operational by the fourth quarter of 2016 and it will be adjacent to the GATE terminal. LNG is already delivered to the terminal area by large LNG carriers from gas supply regions around the world.

Shell believes that: "The development of this new vessel and its supporting infrastructure strengthens Shell's position in Europe's natural gas and LNG market. Global LNG trading began 50 years ago, when Shell brought the world's first commercial LNG cargo from Algeria to the UK. Shell Shipping & Maritime manages 44 LNG carriers – around 11% of the world's LNG fleet."

LNG

Temasek buys GTT stake

The Singapore investment company Temasek, which also owns container ship operator APL, has bought a 10.4% stake in the French membrane containment system design company Gaztransport & Technigaz (GTT).

The share acquisition represents Total's remaining shares in the LNG containment system company after the oil company had reduced its share of GTT in February last year from 30%.

Total and Temasek entered into a definitive agreement for the acquisition by Temasek of Total's entire remaining interest in GTT. During GTT's initial public offering in February 2014, Total had previously reduced its shareholding from 30% to 10.4%. Completion of the transaction was expected to be finalised by this month.

"We are pleased by Temasek's acquisition of an interest in our capital, as a long-term shareholder. Its geographical roots and its experience in the LNG and marine industries fit perfectly well with the company's strategy." said Philippe Berterottière, chairman and CEO of GTT.

Following the Temasek transaction GDF Suez remains the leading shareholder in GTT with a 40.4% stake while management and employees hold around 0.2% of the capital and the remaining 49% is held by the public in a free float of shares. However, private equity company Hellman & Friedman holds a 5% share of the free floating shares.

IMO

Sekimizu to step down

IMO Secretary General Koji Sekimizu has announced he will step down at the end of 2015 after just one term at the helm of the IMO.

The secretary general made the announcement following an illness to his wife saying that he would not be able to devote his full attention to the IMO job.

Nominations for the secretary general position have started to be posted with both Cyprus and Denmark nominating candidates. The Danish Government has nominated the Director General of the Danish Maritime Authority (DMA) Andreas Nordseth, who joined the DMA in 1991 and took up the position of Director General in 2009.

Meanwhile, Cyprus has put forward Andreas Chrysostomou the acting director of the Department of Merchant Shipping. Chrysostomou has been associated with the IMO since 1994 in a number of positions, including the chairmanship of the influential Marine Environment Protection Committee between 2003 and 2013 and the Design and Equipment subcommittee.

Regulations

ICS changes BWMC tack

The International Chamber of Shipping (ICS) has changed its position on the ratification of the Ballast Water Management Convention (BWTC) which has almost reached the critical mass needed to become law.

A statement from the ICS in mid-December read: "Notwithstanding the need to resolve outstanding issues and questions concerning the implementation of the IMO BWMC, ICS acknowledges the agreement in principle by the IMO Marine Environment Protection Committee meeting in October to address the various concerns raised by the shipping industry. ICS will therefore no longer actively discourage those governments that have not yet done so from ratifying the Convention."

Technology

NYK and partners take on SOx

The Monohakobi Technology Institute (MTI), an NYK Group company, has linked with Singapore-based Nanyang Technological University and Sembcorp Marine Technology and Japan's ClassNK to develop an exhaust gas cleaning system (EGCS) that will curb SOx emissions outside of the Environmental Control Areas after 2020 or 2025.

The research will be funded by a grant from the Singapore Maritime Institute and carried out with the support of the ClassNK Joint R&D for Industry Program. *NA*

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- Registrations Open: ***17 February 2015***
- Abstract Submission Deadline ***9 March 2015***
- Author Acceptance Notification ***6 April 2015***
- Refereed Paper Submission ***22 June 2015***
- Full Paper Submission Deadline ***13 July 2015***
- Early Bird and Presenter Deadline ***10 August 2015***
- Conference ***6-8 October 2015***

Organised by the Royal Institution of Naval Architects and the Institute of Marine Engineering, Science and Technology, the Pacific 2015 International Maritime Conference will coincide with the prestigious Royal Australian Navy Sea Power Conference, Navy Week celebrations in Sydney and the ***PACIFIC 2015*** International Maritime Exposition which is organised by Maritime Australia Limited.

The conference program will be conducted in two streams of parallel sessions and will cover the following topics:

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- Naval Ship Technology
- Submarine Technology
- Commercial Ships Operations
- Maritime Safety
- Maritime Environment Protection
- Offshore Resource Industry

Abstract submissions open from 10 November 2014 and prospective authors are invited to submit an abstract relating to the conference program topics in accordance with the instructions on abstract format and guidelines available on the conference website menu.

Abstracts are to be submitted online

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Regulations close in on shipowners

Anyone looking at Moore Stephen's latest survey on industry confidence can see that regulation is presenting a gloom and doom scenario for many. The industry preparedness for new bits of regulation has long been a bone of contention and the new low sulphur rules which came into force this month are no exception, *writes Sandra Speares*.

"The ballast water treatment legislation hangs like a dark cloud over all technical ship managers. This represents a huge investment accompanied by a high level of risk," said one respondent to the survey. Another observed: "Regulation is becoming more strict, and now accounts for a greater slice of operational expenses than it did a few years ago. This is bad. But, it is the only way to push older tonnage out of the market."

Another respondent emphasised: "There seems to be a lack of willingness to acknowledge the negligible level of pollution caused by shipping in relation to the volume of merchandise which is shipped globally." Other comments included: "New EU environmental regulations will have a knock-on effect beyond the primary maritime industries," and "Freight rates will not compensate completely for the additional cost involved in operating on low-sulphur fuel."

> "What actually happens from 1 January in terms of pricing, for example, and how the industry meets the challenges of the low sulphur regime in emission control areas remains to be seen"

While the rules are fairly explicit in terms of the penalties that will be faced as far as burning anything that is not 0.1% low sulphur in emission control areas are concerned, those penalties may not be as prohibitive, at least in certain jurisdictions, to stop companies trying to "wing it", thinking that the chances of being caught are outweighed by the costs of either buying low sulphur product, or fitting expensive scrubbing technology. It will evidently be difficult to inspect every ship entering, for example, US waters, so companies seen to be complying with the regulations on low sulphur, or if low sulphur is not available, are seen to be addressing the problem as best they can, may not have the rule book thrown at them.

In the frequent so called "magic pipe" incidents resulting in US prosecutions in recent years, it has to be noted that allegations brought against companies in the US were not as a result of dumping oily water at sea, but in lying to the US Coast Guard or falsifying oily water record books.

Whistle blowing has also provided evidence for prosecutors, and whistleblowers can get a share of any fine levied against a company.

While the US has generally been ahead of the game in piling on pressure to comply with environmental regulations – largely by the use of punitive fines – others have been somewhat more low key. At a conference at law firm Norton Rose Fulbright it was suggested that the level of fines imposed in similar incidents in the UK were much lower, with the suggestion being made that if the bar was not lifted in terms of fines levied, shipowners might just be tempted to hope for the best and "wing it".

What actually happens from 1 January in terms of pricing, for example, and how the industry meets the challenges of the low sulphur regime in emission control areas remains to be seen. In the view of Paul Davies of PriceWaterhouseCoopers: "compliance is not an option". In his experience in other industries, he said, regulators would not necessarily create a vast empire of people to look over every ship, but what was more likely to happen is that they would find a few key transgressors, "fine them to oblivion and the rest of us will quickly follow suit" Davies said. As far as the issue of choosing between high priced low sulphur fuel or scrubbing technology he said for charterers, it would be more competitive to use scrubbers. The last element, he said was the classic shipping question of why should I do anything if nobody else is?

Another issue that Philip Roche, a partner with Norton Rose Fulbright mentions is whether port state control authorities like the Maritime and Coastguard Agency will have the funds to invest in expensive testing equipment to ensure that shipowners are compliant with the new rules in force from 1 January 2015. In cases where shipowners are found not to have bothered to comply, they are likely to have the book thrown at them. However, those who can show port state control they tried to comply but their efforts have broken down through some deficiency or because they were supplied with the wrong fuel, are likely be greeted with a more pragmatic and cautious response on the part of the MCA, he said. *NA*

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XBow model courtesy of Ulstein Group ASA

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Ancillary equipment

WSS cleans up

Wilhelmsen Ships Service has announced an upgrade to its cargo hold cleaning solution, combining high-performance cleaning agents and mobile equipment to help owners, operators and their crews stay safe and compliant on a global basis.

The kit includes everything the crew needs, it is easy to assemble and ready to use. The improved design makes it easier to manoeuvre and operate, resulting in safer operations in accordance with Maritime Labour Convention (MLC) regulations. In addition, the equipment is combined with high-performance chemicals supported by clear documentation and literature, e-learning and demonstration videos.

Wilhelmsen upgrades its cargo hold cleaning solution

The process of cargo hold cleaning is more regulated than ever before. Any cleaning agents that may be discharged with waste water after cleaning must not be harmful to the environment. The Unitor cargo hold cleaning agents are not only effective, but also fully compliant with current regulations, notably MARPOL Annex V.

www.wilhelmsen.com

Classification

BV launches latest notation

Classification society Bureau Veritas (BV) has developed a voluntary notation intended to assist shipbuilders and operators to reduce underwater noise radiating from ships. The comprehensive set of standards and measuring services is grouped as NR614 Underwater Radiated Noise (URN). It aims to control and limit the environmental impact on marine life of all self-propelled ships and provide a standard and a system to assess compliance with specific vessel requirements for underwater radiated noise.

It covers both shallow and deep water conditions, sets out dedicated comprehensive measurement procedures, explains how to manage measurement uncertainties and sets specific underwater noise level requirements.

One of the main drivers of the notation is to aid European stakeholders in fulfilling the requirements of the Marine Strategy Framework Directive. This aims to improve the environmental state of European waters by proposing mitigation solutions to be put in place by 2016, with their efficiency proved by 2020. The BV notation has been issued in parallel with the European research project AQUO, which is focused on underwater noise, and includes the work of 13 partners - shipyards, hydrodynamics research institutes and bio-acoustic experts - from eight countries, and an end user committee has been built to review the project, including BV's notation.

www.bureauveritas.com

Cargo handling

MacGregor seals eco-bulker deal

MacGregor, part of Cargotec, has secured a comprehensive deck equipment contract from New Times Shipyard, in China, for Intership Navigation Co Ltd's three new 36,500dwt Laker-class bulk carriers. The vessels will each feature an optimised MacGregor cargo-handling system comprising MacGregor cranes and hatch covers as well as Hatlapa steering gear and electrically-driven variable frequency drive (VFD) Hatlapa deck equipment.

"The MacGregor team supported Intership with its cargo-handling solution development at a very early stage with planning sessions, technical layouts and budget pricing, so that the shipowner could present the new ship concept further to the charterer," explains Hans Berg, account manager for Intership at MacGregor. "These new ships will effectively be upgraded versions of Intership's existing Laker-class vessels."

The ships are expected to have a 20% reduction in fuel consumption in comparison with existing similarly-classed vessels. This is predominantly achieved through the use of an optimised hull form and propulsion system developed by DNV GL consultancy company, FutureShip.

Intership opts for MacGregor cargo handling package

MacGregor's equipment package will also play a role in delivering more sustainable operations. The solution consists of hydraulically-operated folding hatch covers, four MacGregor electro-hydraulic cranes (2 x GLB3628 and 2 x GLB3626), a Hatlapa VFD deck machinery ship set as well as Hatlapa Triton 800 rotary vane steering gear. MacGregor deliveries are planned to start at the end of 2015 and continue into 2016.

www.cargotec.com

Propulsion

Thordon cruises forward

Viking Star, a 47,800gt cruise ship, is one of three Viking Ocean Cruises' newbuilds to opt for Thordon COMPAC seawater lubricated propeller shaft bearings. Constructed at Fincantieri's Marghera shipyard, the 944 passenger *Viking Star* is the first of three new ships equipped with seawater lubricated propeller shafts instead of oil lubrication.

"We chose Thordon COMPAC for all our newbuildings because of the long experience of these seawater lubricated bearings which present no risk of oil pollution. With the elimination of aft seal maintenance and no oil required, we are expecting considerable cost savings over the life of the vessels," says Richard Goodwin, vice president-engineering at Viking Ocean Cruises.

Designed with the environment in mind, Viking's ocean ships feature energy-efficient hybrid engines, hydro-dynamically optimised hulls and bows for maximum fuel efficiency, onboard solar panels, and equipment that minimises exhaust pollution. And it meets the strictest environmental regulations with Thordon's pollution-free bearings with zero risk of oil discharges, as no oil is used. *Viking Star* has a Thordon COMPAC tapered key bearing design with a shaft size of 464mm (18.268").

www.thordon.com

Environmental

Clean Marine gets order for its EGCS

Clean Marine has announced that it has been selected by Hyundai Mipo Dockyard in South Korea to supply exhaust gas cleaning systems (EGCS) for two new MR tankers.

The order for Clean Marine EGCS will enable the new medium-range tankers, owned and operated by a British oil major, to comply with the upcoming stricter sulphur regulation without switching to more expensive fuels.

"These contracts confirm the growing market demand for Clean Marine's Allstream EGCS, which is a particularly competitive solution for the tanker segment" says Nils Høy-Petersen, CEO of Clean Marine. "We are very pleased to be working closely with Hyundai Mipo to deliver a cost-effective solution to help the owner comply with existing and pending emissions regulations."

The two MR2 type tankers (hull number 2495 and 2496) have a deadweight of 40,000tonnes and are part of a series of five sister vessels to be constructed at the yard.

www.cleanmarine.no

Paints & coatings

Hempel acquires to accumulate

To increase its presence further, Hempel has announced that it has acquired The Netherlands-based Schaepman's Lakfabrieken B.V, a Dutch supplier of specialised industrial, protective and decorative coatings. The acquisition is part of Hempel's five-year growth strategy, One Hempel – One Ambition, and supports its goal of becoming one of the world's top-10 largest coatings suppliers by the end of 2015.

The acquisition will enable Hempel to benefit from Schaepman's proven expertise in protective coatings, the company has said. At the same time, existing Schaepman customers will gain access to Hempel's broad range of products and expert global support. Hempel's global presence will also ensure Schaepman's specialist products are available to a wider customer base.

Further to this, building on its GLOBIC and DYNAMIC range of antifouling systems, Hempel has also launched two new antifouling products for dry-dockings and new buildings which, it says, deliver fuel savings of up to 3% and provide added flexibility to shipowners and yards, the company has claimed.

GLOBIC 8000 is a hydrolysing self-polishing antifouling product that fits between the existing GLOBIC 6000 and GLOBIC 9000 antifouling systems. It incorporates Hempel's nano acrylate technology which delivers a fine polishing control mechanism to bring the integral biocides to the surface at a stable rate ensuring a clean hull.

GLOBIC 8000 can be used on all vessels at all speeds, but its nano acrylate technology binder makes it particularly effective for slow-steaming operations because of its instant activation of polishing and biocide leaching, the company highlighted.

www.hempel.com

Bridge & communications

Kongsberg launches K-Sim Navigation

Kongsberg Maritime has unveiled its latest generation ship's bridge simulator, K-Sim Navigation, which will meet with the requirements for navigation training for merchant, offshore and naval vessels, the company has claimed. Designed for the future of advanced and integrated simulation training, K-Sim Navigation is based on the latest technology platform enabling more realistic training scenarios and enhanced user benefits for both instructors and students.

K-Sim Navigation features an advanced physical engine and hydrodynamic modelling, allowing vessels, objects and equipment to behave and interact as in real life. To enhance the realism further, a sophisticated new visual system is included, bringing vessels and objects in all possible weather conditions to life.

K-Sim Navigation has been developed with the user experience in mind. In addition to the realistic environment for students, instructors benefit from an award winning instructor system designed to facilitate ease of use. It features an intuitive and modern educational tool utilising a modified ECDIS chart as a starting point with a drag & drop function for creating exercises. The instructor system also includes automatic recording and an advanced assessment system for ensuring optimal training and feedback standards.

K-Sim Navigation's flexibility extends to hardware, with a fully scalable range of options available – from a PC based desktop system, through to a full mission bridge simulator. The system, built on the same core technology platform as the market leading K-Sim Offshore simulator, can easily be integrated with other Kongsberg Maritime simulators (including crane, offshore, engine, cargo, ballast and DP) to enable a comprehensive range of training scenarios.

www.Kongsberg.com

Ancillary equipment

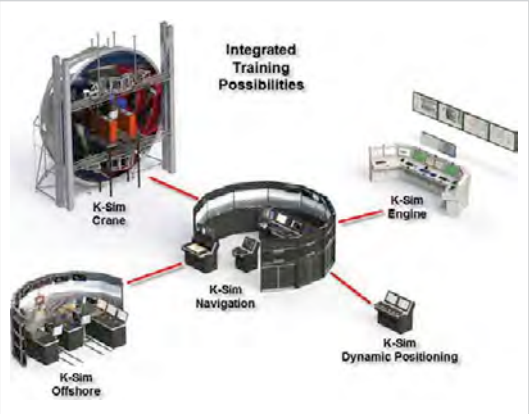
Singapore MPA on course with IBIA

The Maritime and Port Authority of Singapore (MPA) has accredited the International Bunker Industry Association(IBIA) new Mass Flow Meter training course. The course, which is next being held 17-18 November in Singapore, provides in depth information about mass flow meters; how to install and use them and looks at legislative, calibration and accuracy issues.

In April last year the MPA was the world's first port authority to introduce a mandatory mass flow meter system for its bunker suppliers.

IBIA, chief executive, Peter Hall said: "This is the latest in our range of professional training courses for the bunkering industry. Ultimately, the use of a mass flow meter will result in a smoother bunker transaction landscape with less commercial disputes, shorter delivery times and a simpler custody transfer process."

www. ibia.net



Kongsberg launches it latest navigation simulator

This selection of RINA branded items is now available to members for a limited period at a special discount.

RINA
The Royal Institution of Naval Architects

50% all items now half price!

DESK CLOCK

Navigator World Time Clock with a dome lens, rotating bezel which indicates time around the world on a glass base. Makes a nice desktop centre piece. Dimensions are: 60 x 60 x 90mm

usual price: £30

*postage UK £3 - EUR £6 - ROW £9

Sale £15.50 + postage*

RINA CUFF LINKS

A pair of hard enamelled cuff links, with a colour RINA crest against a white background, complete within their own smart presentation box.

Sale £6.00 + postage*

usual price: £12

*postage UK £1.50
EUR £2.50 - ROW £3

RINA LEATHER WALLET

Smart black leather wallet, with space for bank notes & credit cards with a gold RINA crest embossed on the front.

usual price: £17

Sale £8.50 + postage*

*postage UK £2.50 - EUR £3.50 - ROW £4.50

To view these promotions and for the full range of items visit
www.rina.org.uk

LADIES SCARF

This scarf matches the colours of the RINA gentleman's tie, and comes in 100% polyester twill, featuring the RINA crest. Size: 137cm x 23cm. As you can see pictured the scarf is both smart and distinctive.

Sale £2.50 + postage*

usual price: £5

*postage UK £1.50 - EUR £2.50 - ROW £3.50

From Eco-ships to Smart-Shipping: revolution or evolution?[1]

The digital revolution will transform merchant shipping in the coming decades. Slowly, but surely, this revolution has already begun, driven by ecological imperative and economic expediency. Clarksons research president, Martin Stopford, analyses how the revolution might develop and the benefits companies can gain from it

Revolutions should have a simple goal. The goal of shipping's last revolution, containerisation, was to "put cargo in a box". But, this simple objective disguised a profoundly complex change which took 30 years to implement. "Automated shipping operations" is the goal of Smart-Shipping, a revolution which digital technology is making viable.

Today's shipping hardware is going nowhere, and smart-shipping offers a new direction. It will be even harder than containerisation to implement, but the rewards are compelling.

Technological revolutions should be simple says Clarksons research president Martin Stopford

The case for smart-shipping

Sir Ronald Swayne, Chairman of Overseas Container Ltd (OCL), the UK's first container company set up in 1966, observed that "technical development in liner shipping has not been so much a continuous process as an occasional leap forward, precipitated by a compelling call for change[2]. "Containerisation was not about the "box". Container boxes had been on the roads in North America for years. It was about new ships, new terminals and new company organisations needed to keep general cargo moving through ports congested by manual handling systems[3].

For liner companies after a century of moving general cargo in multi-deck liners, it was a traumatic change with many worrying shortcomings.

Today, the digital technology revolution is lurking in the wings and applying it to sea transport is an even more daunting prospect. The industry's design and engineering technology is mature and can no longer deliver major hardware improvements to deal with the challenges of higher fuel costs, climate change, emission regulations, and changing customer needs. But, digital technology is an untapped resource. Sea transport needs to think about making the same leap that transformed "mobile" hand phones into "smartphones", but on a much bigger canvas.

The technology is not revolutionary – the sophisticated digital technology is in our pockets and many businesses are already using it. The revolution lies in reorganising the shipping industry to make use of this technology, and in the process providing services for its customers and regulators that they don't even know they need (how about publishing real time emissions data on your website?).

Ship technology is running out of steam

You may well be wondering why sea transport needs a Smart-Shipping revolution and if it does, whether it would be a transformation on the scale of the container revolution? So let's dig a bit deeper.

When, in the 19th century, fossil fuels replaced sail; and steel replaced timber hulls, sea transport became an industrial process. Ships became small factories moving cargo. Over the next century marine engineers built better engines; and naval architects developed super-efficient steel hulls driven by propellers.

[1]The paper is based on a paper given at INMARCO-INAviation -2014, Mumbai, India 11th December 2014

[2]Swayne R.O.C "The Container Revolution" in Kummerman H. (1979) Ship's Cargo, Cargo Ships MacGregor Publications Ltd, page 113

[3]At the time cargo liners were spending half their time in port "like floating warehouses". It took "some 40,000 manhours to discharge and load at both ends of the voyage". An unsustainable situation. Kummermann H (1979) p 113

Gradually the fuel needed to move a tonne of cargo 1,000 miles was reduced, currently by 97%. The progress is tracked in Table 1, column 16 which shows the fuel efficiency of cargo liners since 1855. Fuel per thousand ton-miles fell from 88.9kg in 1855 to 2.6kg in 2014, and the speed has increased from 7.5knots to 23knots (close to 30mph). So the good news is that marine engineers and naval architects did a good job in building better ships.

Unfortunately there is some bad news too. After 150 years the physical technology has been squeezed so hard that there is not much left to squeeze. On the engineering front, diesel engines are close to their theoretical energy conversion ceiling and for 30 years there has been little efficiency improvement. For example the fuel consumption of 60,000 DWT bulk carriers delivered has been around 32 to 33tonnes per day since the late 1980s (Figure 1).

Recent eco-ships claim about 28tonnes per day, but this is mainly due to fine tuning in response to high fuel prices rather than any fundamental improvements in efficiency. Naval architects are still designing ever bigger ships, but the economies of scale diminish with each size increment as the size and fuel efficiency chart in Figure 2 (see page 20) suggests.

However, the pressures for improvement continue relentlessly. One is from the high cost of fossil fuels; another from the regulation of emissions from engines burning fossil fuels; thirdly the IMO commitment to cut the carbon footprint generated by moving 10+ billion tonnes of cargo a year by 50%; and finally people – the crew and customers want a better deal. But, the technology wave the industry started surfing 150 years ago is running out of steam, so each step along this this well-trodden path of improving the hardware gets smaller.

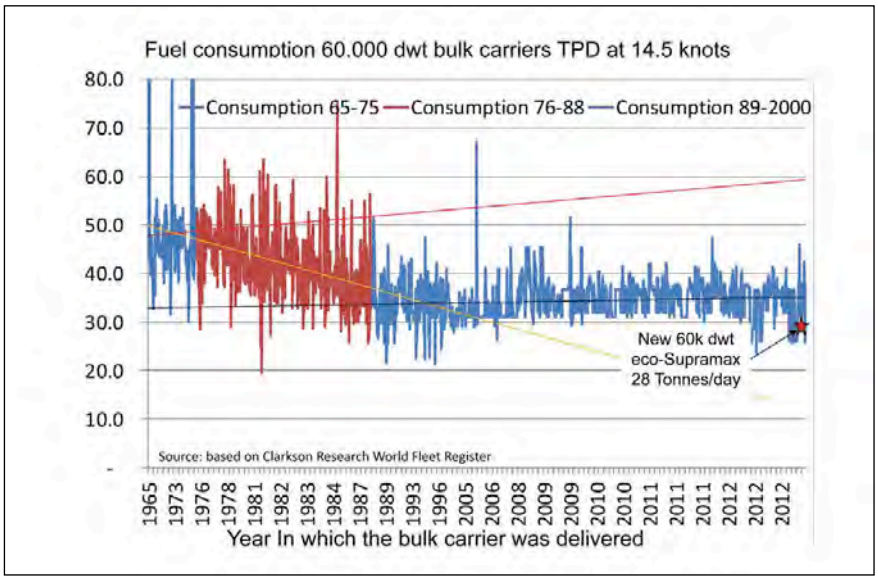


Figure 1: Fuel consumption static since 1980s

How digital technology delivers change

To take bigger steps down the road, we need to face an uncomfortable truth. The shipping business today is pre-occupied with ships and this clouds our judgement. Ships are only one part of the inter-continental transport business which starts at the origin of the cargo and ends at its destination – it's a total package, or at least it should be[4]. But, we are much better at measuring the performance of the ships than the performance of the total transport service.

So in future the industry must find a better way and the best technology deal on offer is the digital revolution. Other industries certainly think so. If we look at the work being done in the car industry and the airline industry, the systematic application of digital technology can improve many aspects of the transport performance. Add database technology and a new organisational structure to tighten up ship operations and in due course the whole door to door transport operation.

The automation of engine rooms and navigation has been around for years, but the new digital technology is dramatically better, cheaper and easier to tie into semi-intelligent systems. Google's achievements with their self-driving car, for example, seemed impossible a decade ago.

Table 1: Fuel consumption of typical cargo liners 1855-2013

4	5	6	7	8	9	10	11	12	13	14	15	16
Year built	Type	GRT	DWT	TEU	Cargo tons	Speed knots	Engine type	Horse-power	Fuel type	Tons per day	Cargo /tonne	Kg fuel/ /000 TM
1855	Liner	700	900		750	7.5	Steam 1	400 ihp	coal	12	63	88.9
1875	Liner	1,400	1,900		1,650	8.5	Steam 2	800 ihp	coal	12	138	35.7
1895	Liner	3,600	5,500		4,900	9.5	Steam 3	1800 ihp	coal	25	196	22.4
1915	Liner	5,300	8,500		7,500	11.0	Steam 3	2800 ihp	coal	35	214	17.7
1935	Liner	6,000	10,000		9,000	12.5	Steam 3	4000 ihp	oil	33	273	12.2
1955	Liner	7,500	11,000		10,000	14.0	Diesel	6,000	oil	25	400	7.4
1975	Liner	13,436	17,999		17,099	16.0	Diesel	9,900	oil	37	462	5.6
1990	Containership	52,181	60,639	4,814	57,607	24.0	Diesel	63,436	oil	195	296	5.9
2000	Containership	75,590	85,823	6,750	81,532	25.6	Diesel	57,054	oil	234	348	4.7
2013	Containership	51,872	61,152	5,466	58,094	21.5	Diesel	35,805	oil	106	546	3.5
2013	Containership	176,490	186,649	18,340	177,317	23.0	Diesel	85,705	oil	255	696	2.6

Source: Stopford, M (2009) Maritime Economics 3ED Table 1.3, updated

Automating ship navigation must be less complex than a busy street and better able to absorb the eye watering costs. In the same way the automation of ship engines, equipment, their operation and maintenance will produce many hidden benefits, including preventive maintenance. Much of the technology is already in place[5]. So the benefits could be wide-ranging and in other industries automation has proved more financially rewarding than senior management expected, because quality control systems function better[6].

In the case of shipping the performance data generated by automatic systems could provide improved vessel performance in terms of the efficiency of the ship and the voyage performance.

A study by Morgan Stanley illustrates the benefits anticipated for the Google car and maybe the type of hidden benefits that might be expected from an automated shipping system. They estimate 38% of the savings arising from reduced accidents; 39% in better productivity; 12% fuel saving and 11% congestion. These savings may not be exactly replicated in shipping, and may not show up in the management accounts, but they will show up in the long-term performance of the business.

From ship design to sea transport design

But, to make these smart digital systems will require much more than just commissioning some software and leaving it to the IT geeks to sort out. It calls for a rethink of the whole fleet management organisational structure. One of the biggest problems the commercial shipping industry will face in doing this is that after three decades of building fairly similar ships, flagging out and cutting costs to the bone, technical resources are in short supply.

In recent years there has been little need for this expertise and few shipping companies have a technical department, a technical director, or a principal with a technical qualification, in the way they did fifty years ago.

Human resources

The seagoing staff problem is just as daunting. There are over 50,000 ships in the deep sea trades, all requiring skilled engineers and deck officers. Providing properly qualified professionals in the coming decade is a challenge which worries many CEOs today. Keeping them in the company in the face of attractive opportunities ashore, or higher salaries offered by competitors is another worry. This ranks high in the priorities of shipping today. There may be plenty of unskilled people willing to come from the rural areas to man ships, but qualified staff is a different story.

The relevance of automated systems to these personnel issues is that in an automated system much of the expertise is held by the system, not the individual. Automatic monitoring can avoid engine room problems just as effectively as navigational problems.

Skilled fleet support teams, located in the main office or a ship network, monitor data reporting systems and working with capable, but less experienced, crew on board to ensure problems are rectified. This would require a culture in which personnel work as a team, without ship-shore barriers.

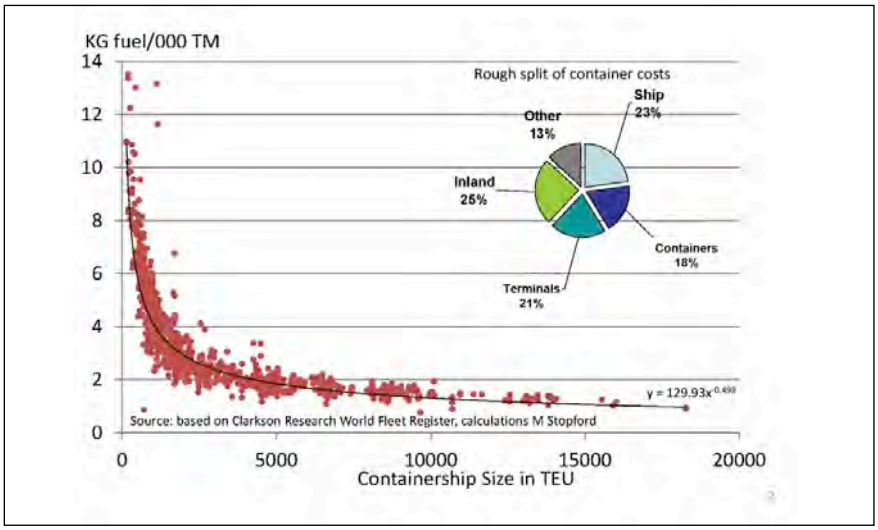
Although this may sound extreme, it might also open the way to a better career structure for bright young employees, with a flexible career path as they move between different roles on ships and in the office. The single channel career (i.e. "engineer for life") would broaden to a career path within the company.

At a company level this might have interesting results. Shipping companies have far more employees on board ship than in the office, especially in bulk shipping. Smart shipping might be a way to use these resources better by removing barriers. The possibilities are interesting and may be compelling.

It's a reorganisation revolution

Okay, all of this sounds so far from reality, it's hard to believe. But, people said the same thing about containerisation. And you could have said the same thing about smart phones. It's only 10 years since your mobile phone made calls and sent texts. Today it finds you the best restaurant for dinner in Beijing, tells you how to get there and translates the menu into English. Admittedly company automation systems are more difficult, but the tools are there to allow the shipping companies to reorganise the way the business is run.

Figure 2: Containership fleet fuel performance



[4]Since the 1980s "we trade ships not cargoes" has been a widely quoted bulk shipping industry mantra. Liner services are less speculative, but the ships only accounts for about 25% of the door to door cost.

[5]e.g. diagnostic tools identify and remedy marine engine faults using live data by plugging into the engine's on-board computer. Or crane manufacturers remotely monitoring the use of their cranes.

[6]Drucker, Peter (1985) "Why Automation Pays Off" in The Frontiers of Management p 271 "Automation, wherever installed in a manufacturing plant, has paid for itself in three years, often much faster. Automation builds quality standards and quality control into every step of the process.. quality savings alone are likely to repay the cost of automation".

On a good day the result might be a more efficient, more cost-effective business which is more rewarding for the people who work in the company "team", on ships and in the office.

Making it happen – the SAC strategy

If the DIGITAL revolution offers systems, automation and teamwork, how do you do it? The great thing about modern digital technology is that it is becoming increasingly flexible. You don't have to build the mother of all systems; so companies can take it one step at a time. The SAC strategy suggests splitting the task into three building blocks:-

a. Standardise interfaces: standardisation across the industry is crucial in allowing systems to work together and the use of "plug in" components and electronics.
b. Automate operations: This is the action. Automate navigation; on board operations; and administration in compatible systems communicating between ships and shore. Band width and data speeds are key issues and are getting better[7].
c. Centralise Analysis: centralise data onshore (or in the cloud), define and analyse significant Key Performance Indicators (KPIs) over time, human intervention to take corrective action when needed, provide comparative analysis across the fleet.

Is the change really compelling?

Sir Ronald Swayne was right that change only happens in shipping when there is a compelling reason. Today the industry is compelled by regulators, big charterers, the prospect of more cargo and the people who work on the ships (but will not in future, if things don't change). These pressures will not go away.

There are three reasons for going down the SAC route, or something like it. Firstly automation will make company quality control systems work better, which is money in the bank. Secondly, as "expert" knowledge is incorporated in the system, it becomes easier to move bright employees from one job to another, bringing flexibility and career development. Thirdly the automation systems will encourage a teamwork culture between ship and shore and across the fleet.

In fact the smart-shipping revolution is not really about digital technology, it's about people and how they will work together better in future to deliver 10 or maybe 20 billion tonnes of cargo. With shipping hardware running out of steam, can shipping companies afford not to give smart-shipping software a shot? It won't be easy, but shipping never is! *NA*

[7]For example Iridium NEXT — Iridium's second-generation global satellite constellation, due in 2015, will offer bandwidth closer to broadband speeds

Making the case for adding variety to Goal-Based Standards

Goal-Based Standards as applied by the IMO are a step forward in improving the design and operation of ships. Nonetheless, Professor Jeom Kee Paik suggests a way that the standards can be improved by taking into account forces that are variable and unexpected through health, safety, environment and ergonomic considerations

Goal-based standards (GBS) for ship design and construction have been applied to all types of oceangoing ships, emphasising that the IMO must increase its efforts to determine the overall standards for building new ships.

The original GBS concept comprises the following five tiers, as shown in Figure 1: goals (Tier I); functional requirements (Tier II); verification of compliance (Tier III); regulations and rules for ships such as classification rules, IMO requirements and relevant national requirements (Tier IV); and applicable industry standards and practice (Tier V). Tiers I-III basically constitute the IMO's GBS, and Tiers IV and V are associated with regulations and practices specified by classification societies and/or industries.

The IMO's GBS are timely and excellent, as they stimulate innovations in ship design technologies that help ships to remain safe throughout their design lifetimes, in accordance with relevant inspection and maintenance schemes. The concept of the IMO's GBS is also well suited with the scope and objective for design, building and operation of offshore installations. However, the standards require some modification to complete the concept.

Ships and offshore installations usually operate under normal conditions while in service, but can face extreme and even accidental conditions, as shown in Figure 2. Ship and offshore structures are subject to various action effects resulting from these extreme and accidental conditions.

The sources of such actions and action effects include welding induced high temperature causing initial imperfections (e.g., initial distortions, residual stress or softening in the heat-affected zones of welded aluminium structures); abnormal waves/winds/currents; dynamic pressure loads arising from sloshing, slamming or green water; low temperature in Arctic operations; cryogenic conditions resulting from liquefied natural gas cargo; ultra-high pressure in ultra-deep waters; elevated temperature due to fire; blast loads due to explosion; impact loads associated with collision, grounding or dropped objects; and age-related degradation such as corrosion, fatigue cracking and local denting damage.

Such events sometimes result in catastrophic consequences that lead to casualties, property damage, and pollution.

Professor Jeom Kee Paik says the IMO's Goal-based standards are incomplete

Figure 1: Original IMO GBS concept with five tiers

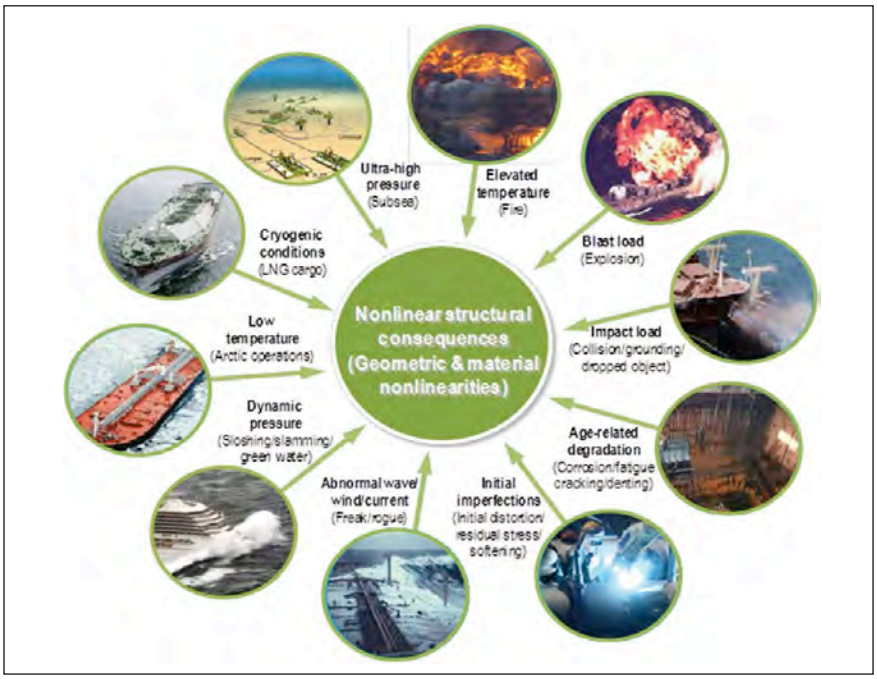


Figure 2: Extreme and accidental conditions for ships and offshore installations

To prevent such disasters, proactive safety measures should of course be developed in association with more detailed examinations of the related phenomena and their consequences.

The paradigm change is currently pertinent in design and engineering, as shown in Figure 3. Successful design and engineering should meet not only functional requirements but also health, safety, environment and ergonomic (HSE&E) requirements. Functional requirements represent operability under normal conditions, and HSE&E requirements address safe performance and integrity in extreme and accidental conditions.

To complete the IMO's GBS concept, therefore, a new tier associated with HSE&E requirements must be included in an explicit manner. Figure 4 shows the concept with the sixth tier added which shall also constitute the IMO's GBS.

Safety studies are required to meet HSE&E requirements by ensuring the safe performance and integrity in case of extreme and accidental events. More refined and sophisticated technologies should be applied because the mechanism of consequences due to extreme and accidental conditions is highly nonlinear by nature associated with non-Gaussian, multi-physics, multi-scale and multi-crtieria, together with a lot of uncertainties involved. Today, it is well recognised that a risk-based methodology is the best practice for safety studies by taking advantage of probabilistic and limit-state-based techniques.

As far as the structural designs are concerned, it is difficult to determine the true margin of structural safety using only linear elastic methods when the remaining limit states are unknown [1, 2]. It follows that determining the true limit state is crucially important for obtaining consistent safety measures that allow structures of different sizes, types and characteristics to be compared fairly. The ability to correctly assess the true margin of safety would also inevitably lead to improvements in related regulations and design requirements. This is important because a designer may need to assess not only intact structures, but also structures with premised or accidental damage, as a way of anticipating their damage tolerance and survivability in association with HSE&E requirements [3, 4].

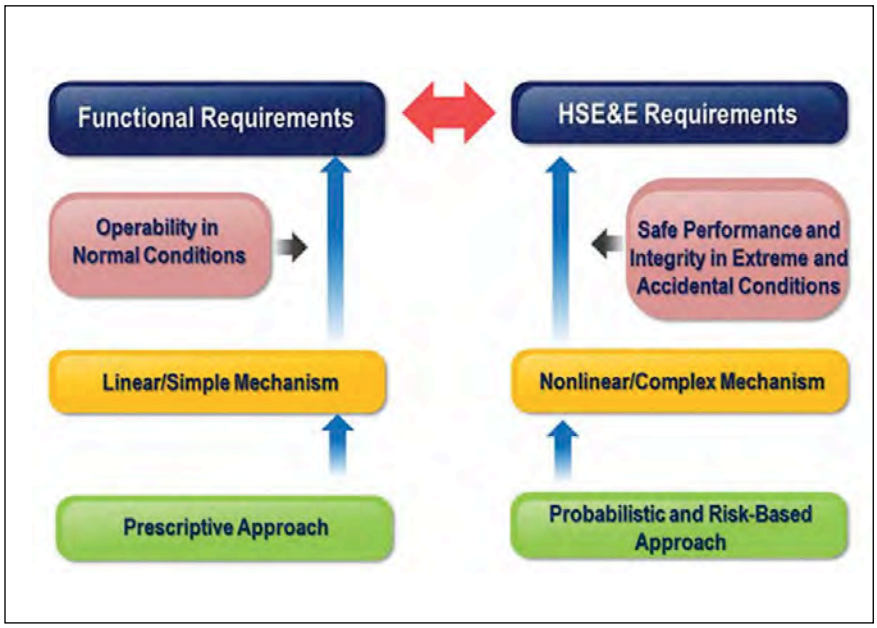
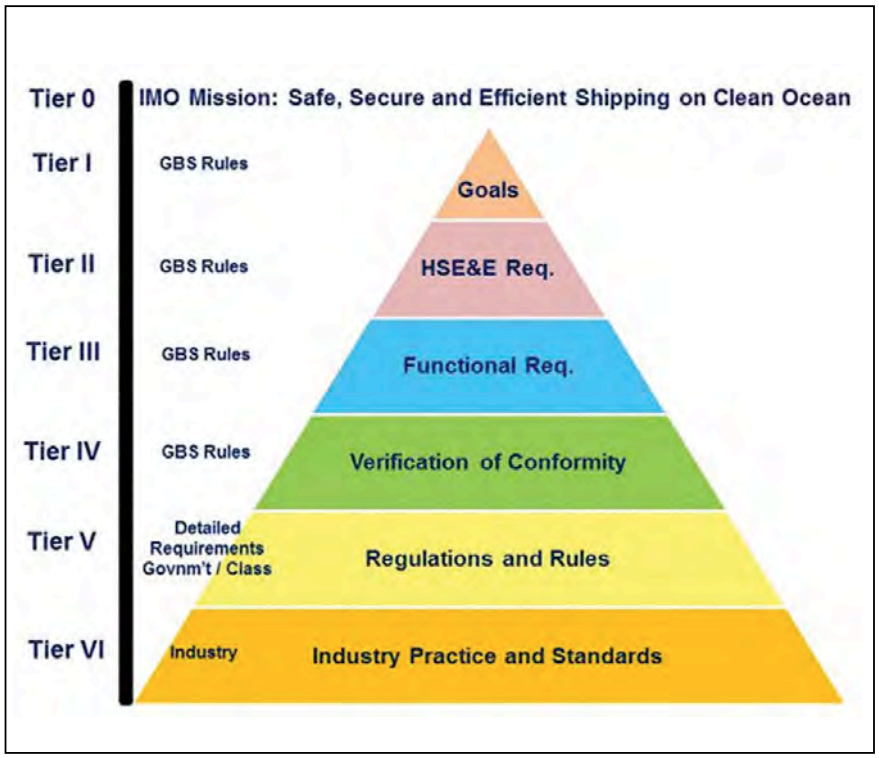


Figure 3: Paradigm change in design and engineering

It is obvious that integrated and multidisciplinary approaches should be applied, because computation by itself is not enough to solve such highly nonlinear problems, and testing is essential with large- and full-scale test models. Also, operations must be monitored to provide feedback to a service database relevant to the design stage. *NA*

Figure 4: Modified IMO GBS concept with six tiers



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DM Consulting's Basic Dry Dock Training is a 4-day course that covers the fundamentals and calculations of dry docking. The course begins with the basics and safety concerns, and progresses through all phases of dry docking: preparation, docking, lay period, and undocking. The course ends with a discussion of Accidents and Incidents.

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China's lacklustre marine diesel industry must power up

Currently, China's exports of marine diesel engines makes up a relatively small share of its maritime equipment exports and at relatively low prices too. The industry's overall standard lags when compared to those of its peers in advanced countries. Zhang Shou Chun reports

In recent years, despite the relatively fast development of China's marine diesel engine industry, exports of the equipment still only accounts for a relatively small share of the total maritime equipment export of the country, which is also sold at a lower than average price.

With the industry still relatively small and fragmented, lacking design and R&D expertise and high-end capabilty, overall, there is a wide gap between the industry standard in China and that of the advanced countries.

Chinese Customs statistics showed that between January and August 2014, the total value of marine diesel engine imports and exports was US$930 million, up 12.3% period-on-period. Export growth, however, started on a high note and gradually deteriorated. By unit, 38,400 were exported, a leap of 96.1%. However, in terms of export price, a 38.7% drop was recorded. The total export value grew markedly, but the price drop was also significant.

In the eight months, exports of the equipment generally traded made up 92.8% of the total, an increase of 39.1% in the period, while export prices decreased 28.6%. Exports in the form of Chinese Special Customs Control Areas Logistics Trading showed a 4.9% share of the total, with prices up by 1,138.6%. And, exports via petty trade in the border areas accounted for 1.7% of the total, up 160%, and their price also saw a 36.3% increase compared with a year ago.

During the period, the country exported marine diesels valued at US$69.39 million to 83 countries and regions on six continents, of which 75.7% were to Asia, up 15.7%, but export prices fell 42.3%. The European market had a 14.1% share, an increase of 32.1% with prices increasing 27.2%. The top 10 export destinations for China-made marine diesel engines were: the Philippines, India, Indonesia, Vietnam, Burma, the Russian Federation, Bangladesh, France, Singapore and Japan.

The first China-made marine diesel engine crankshaft – the 5.5m long, 4.4 tonnes MAN14V32 40 – is the work of CSR Ziyang Locomotive Co., Ltd

Among them, the first five totalled 54.9% of the total engine exports. In that period, the Philippines, making purchases of US$7.97 million worth, or a 14.1% share, for the first time came first on the top 10 list. While the export volumes to the Philippines grew by 50%, but prices were down 12.5%; India took in a 12.7% share of the total exports with prices increasing 2.5%; Indonesia 10.1%, up 29.8%, with prices down by a marked 89%.

In that period, Shandong, Jiangsu and Zhejiang were the three provinces that exported the most marine diesel engines, 61.9% of the total. Among them, Shandong claimed the largest share at 35.7%, up 50.7% year-on-year, Jiangsu followed right behind claiming a 14.6% share, a 106.9% increase, and Zhejiang was responsible for 11.6% of the total.

Between August 2013 and August 2014, the country saw its marine diesel engine export clearly gathering momentum. Although the shipbuilding market is still in a slump currently, there have been signs that it is heading for a recovery. In the fourth quarter this year and next year, marine diesel engine exports are expected to remain steady.

In the first eight months of 2014, China imported US$861 million worth of marine diesel engines, 11.7% more when compared to the same period last year, and import prices also increased by 7.4%. Of the total, general trade imports accounted for 16.7%, 5.4% more than in the previous period, at US$144 million, with prices up by 25%. And, original engine manufacturer's imports amounted to US$69 million, making 8.2% of the total, an increase of 13.1%.

In that period, the country imported marine diesel engines from 18 countries and regions around the world, with Asia responsible for 62.2%, up 8.9%; Europe 25.8%, up 15.3% , and North America 11.9%, up 20.1%.

Korea, Japan and Germany were the three biggest sources of marine diesel engines for China during the period, with Korea supplying 37.8%, 20.3% more at a price 26.5% higher on average; Japan 24.4% at US$21 million with price down 21% and Germany 17.6%, up 97.9%, at US$15.2 million with price rocketing by 118.7%.

And, the major destinations of the imported equipment were Jiangsu and Zhejiang province, and Shanghai, accounting for 18.5%, 14.8% and 13.8% of the total, up 3.4%, 148.2% and down 31.1%, respectively.

The country's marine diesel engine imports was clearly picking up between August last year and this year. Since February this year, the country has been importing marine diesel engines valued at about US$100 million or above every month, with the highest at US$157 million and the lowest at US$109 million. Considering situations in the first eight months of the year, the outlook for imports in the fourth quarter of the year and next year is positive, with volumes continuing to climb.

In 2013, global imports were valued at US$3.67 billion worth of the equipment, down 12.1% year-on-year. China was the leading importer spending US$1.14 billion, 31.9% down on a year ago; Singapore spent US$366 million, up 7.8%, whereas the US paid US$233 million, 70.1% more.

Currently, the key producers and exporters of marine diesel engines are Germany, the US, France, Japan and Korea. In 2013, global exports of the equipment totalled at US$51.52 billion, 1.5% more year-on-year. Of the total, Germany accounted for US$7.66 billion, up 2.7%; the US US$6.48 billion, up 4.1%, and Japan US$5.08 billion, down 15.6%. China was placed 13th with exports valued at US$1.46 billion, a 14.5% increase.

Global marine diesel engine trade statistics as at the end of July 2014 showed, the US was the top exporter with marine diesels valued at UD$4.48 billion, 35.5% more against the same period last year. Germany is in second place, but related statistics were unavailable. France came third with exports valued at US$3.114 billion, up 6.8%. Japan was fourth with US$2.8 billion worth of export, a 7.2% decline. China ranked 12th exporting US$921 million worth of marine diesel engines, 9.5% more.

China, Singapore and Korea are currently the main importers of marine equipment in the world. Between January and July 2014, China imported marine diesel engines with a total value US$751 million, 7.5% more than in the same period last year; Singapore at US$184 million, was down 6.8%, and Korea US$112 million, increased by 38.1%.

Looking at China's marine diesel engine import statistics over the year, it is clear that its shipbuilding industry has a relatively big demand for marine equipment and the demand – in both quantity and quality – has been on the rise.

A marine diesel engine is the heart of a ship. This means if the marine diesel industry of the country is healthy and can steadily develop it forms a fundamental back up to the shipbuilding industry. Without a strong core maritime equipment manufacturing sector, the country would have no home-made products to depend on and its shipbuilding industry could not truly be called powerful and see its ultimate development aspiration realised. Thus, the marine diesel industry should continue to step up on the following tasks:

Firstly, it should speed up professional development, boost scalability and specialisation, aim for a breakthrough in grasping core technologies, sharpen R&D capabilities and exert its brand building, as well as promoting a change of focus from OEM's to shipbuilding system integration, grooming suppliers of integrated shipbuilding equipment solutions. These efforts will see more local shipbuilders adopt home-made marine equipment.

Secondly, China should not accede to the talk of international division of labour when it comes to the shipbuilding chain. The country must continue to perfect and strengthen the shipbuilding chain that is already in place, invest more in the shipbuilding equipment sector and particularly in marine diesel manufacturing and it must step up related R&D efforts.

Thirdly, marine equipment manufacturers should aim for innovation in product lines such as [medium-speed diesel engines and associated critical parts, high-speed diesel engines and associated critical parts, low-speed diesel engines for miniature bore cylinder vessels and associated critical parts, and also high-power integrated propulsion systems and associated critical equipment], with the goal of developing branded and intellectual right-protected products.

In addition, the industry as a whole must encourage overseas companies to set up professional R&D institutes in the country that focus on shipbuilding, marine diesels and related equipment. Furthermore, those companies capable of acquiring overseas manufacturers, or forming joint venture companies should be encouraged to do so in an effort to tap into a mature network of overseas suppliers. *NA*

The Magnus effect, a well spun yarn

Spinning rotors produce energy that can be used to propel ships using less fuel and reducing unwanted emissions. David R Pearson, naval engineer with BMT Defence Services, explains the part that the Flettner Rotor has to play in the design of more efficient ships

Wind propulsion has been a popular research topic for green shipping enthusiasts throughout the 20th and 21st centuries, particularly at times of high bunker prices. The potential benefits are obvious; with the promise of reduced fuel consumption comes the possibility of improved profit margins, a reduced freight rate and a reduction in greenhouse gas emissions.

Flettner Rotors (FRs) are a form of wind based propulsion that utilises the 'Magnus effect', a phenomenon exhibited by a spinning body in a fluid flow incident upon it. It is this effect that is responsible for the curving flight path of a ball in many sports.

A FR typically comprises a cylinder with an endplate affixed to the top, mounted vertically to the deck of a ship. Through the action of a motor, the cylinder rotates in an air stream and a lift force is generated that can contribute to the propulsive needs of the ship (Figure1).

FRs were first installed on a ship named *Buckau* in the 1920s, by a German scientist named Anton Flettner who realised their potential for ship propulsion. This installation was the proof of concept that allowed *Buckau* to sail across the Atlantic in 1926.

Although *Buckau* was successful in achieving its overall goal of saving fuel, the high capital cost alongside reduced bunker prices meant that ultimately the economics did not work and the rotors were taken out of commission. However, with the modern focus on energy efficient design and fuel saving technologies, matched with high bunker prices, the focus has once again come round to FRs and their potential to save shipowners money, as well as improve the green credentials of a ship.

There have been a number of previous studies that have modelled FRs and their benefits to shipping; however for the most part these do not consider ship fit factors and focus instead on potential savings over set wind routes. This study has sought to address this by creating a model that considers the limitations and locations of rotors on a ship, and makes only general assumptions about a ship's voyage routing for a generic assessment of suitability for a given ship type.

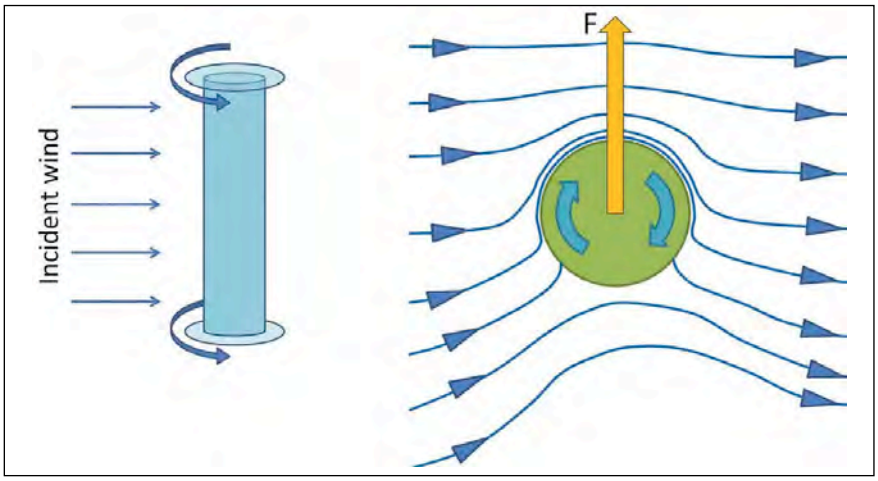

Figure 1: The Magnus effect

Model approach

When planning an assessment for the potential retrofit of FRs on a ship, it must first be ensured that the candidate ship is architecturally well suited to accommodate them.

A candidate ship must be of a type that has an open area of deck, without extensive superstructure that would inhibit air flow, or deck gear/cranes whose operation may be obstructed by the FR. The FR imparts considerable forces to the structure of the ship so the mounting sites must be carefully chosen.

Certain ship types are unsuitable from the outset; Ro-Pax and container feeder type vessels lack the clear deck space required. For container vessels the installation would require the sacrifice of some container carrying capacity, besides the requirement for clear space around the rotor.

However, vessel types such as dry bulk carriers and tankers represent an ideal FR platform with their open deck, relatively slow steaming speeds, and favourable operating profiles which make them a more attractive proposition.

The ship selected to demonstrate the FR model is a chemical tanker of approximately 14,700tonnes deadweight.

Rotor design

A 'standard' FR is a basic cylinder shape, with an endplate mounted at the top in order to improve the lift/drag ratio. The primary design parameters of a FR are shown in Figure 2.

The only dynamically controllable variable of FRs is the rotational speed, which consequently affects the velocity ratio, defined as the ratio of the cylinder surface speed relative to the air speed. Over a limited range of speeds, the coefficients of lift and drag increase with the velocity ratio.

The BMT FR model was created within MatLab (software for numerical computation, visualisation, and programming), and performs all of the FR related calculations for a simulation

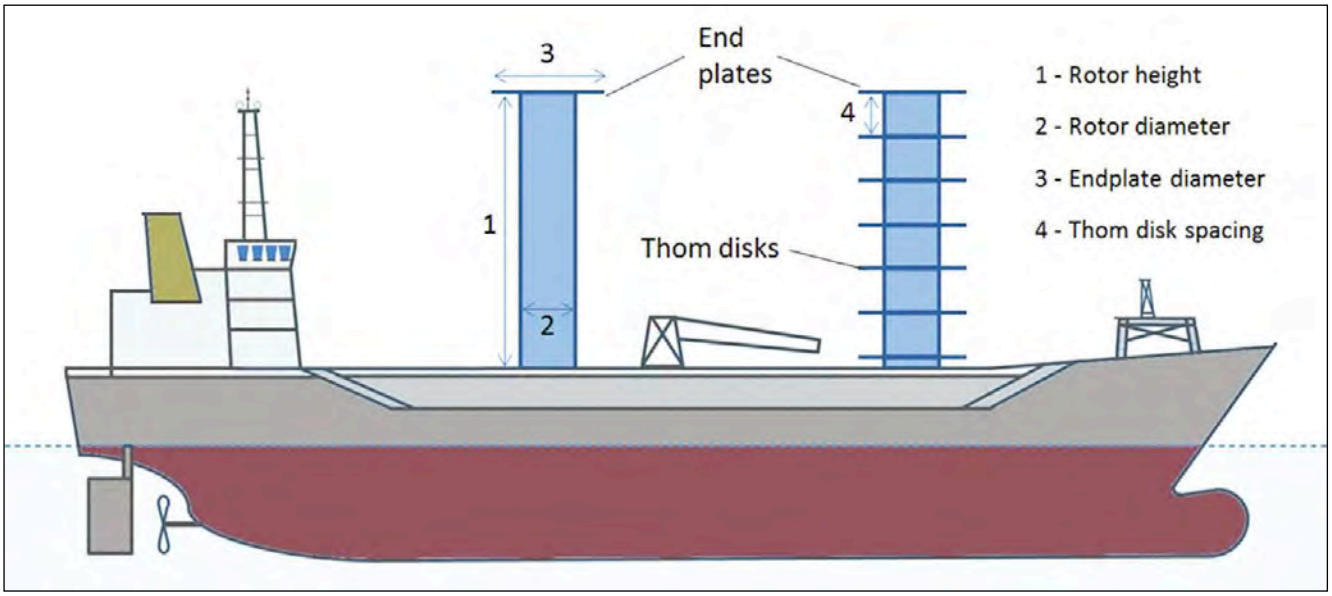

Figure 2: FR features

and then feeds the results back into the ship model based on BMT's proprietary marine power and propulsion tool.

Once the FR model has been run, the ship model assesses in detail how the ship's power and propulsion systems respond to the reduction in resistance and the FR drive power demand.

Wind and forces

It is the apparent wind incidence upon the ship which is used for calculating the velocity ratio. The apparent wind varies in strength

and direction for every combination of ship speed, true wind speed and true wind direction, thus the FR model takes all potential combinations into account.

It is assumed that the rotor is always rotated at the highest beneficial rotational speed; where that is not possible the rotors are turned off to minimise drag and power consumption. For a full 360degs azimuth the forces are averaged using a conservative approach to identify the effective FR thrust.

The power to drive the rotors is added to the ship's electrical load, while the main engine power is reduced due to the lower apparent resistance. In the ship model, the main engine and diesel generators fuel demand is evaluated.

Negative effects

There are other factors that affect the overall FR performance:

- Increased heeling moment from sway forces
- Extra rudder drag from weather helm.

The sideways (sway) forces on the ship can become significant when the apparent wind angle is nearly dead ahead or astern. This large sideways force when combined with the vertical lever arm of a FR creates a heeling moment on the ship and will thus increase the angle of static heel. However, this was found to have a negligible effect (<1%) to performance, as the static heel does not exceed any roll angle normally experienced by the ship.

Another potential effect of large sway forces is the ability to create unbalanced yaw moments. This yaw moment must be countered by applying increased rudder angle (weather helm), which will increase drag and reduce the benefit from the FRs.

Power and savings

Figure 3 shows how the FR reduces the effective resistance seen by the propeller.

The benefit is most pronounced at lower ship speeds. This change in resistance translates into consistent fuel savings for all ship speeds as seen below in Figure 4.

With a generic operating profile, the ship used in this example stands to save up to 10% of its annual total fuel consumption with the installation of two FRs. There is good confidence in expecting better results after the application of wind routing and rotor throttling to obtain maximum aerodynamic efficiency.

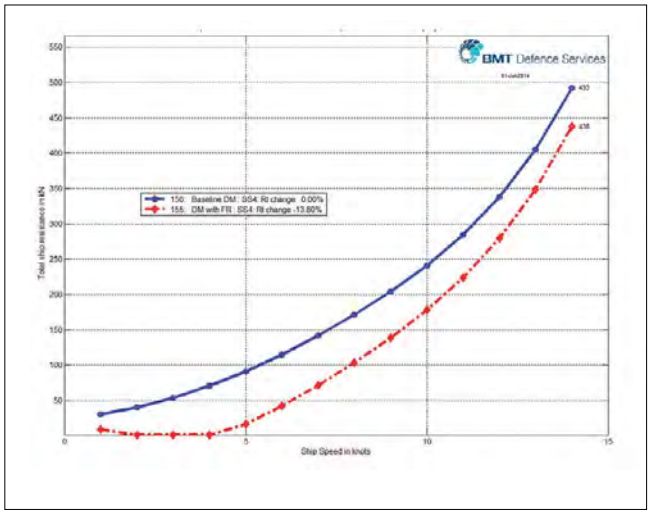

Figure 3: Resistance change with FR

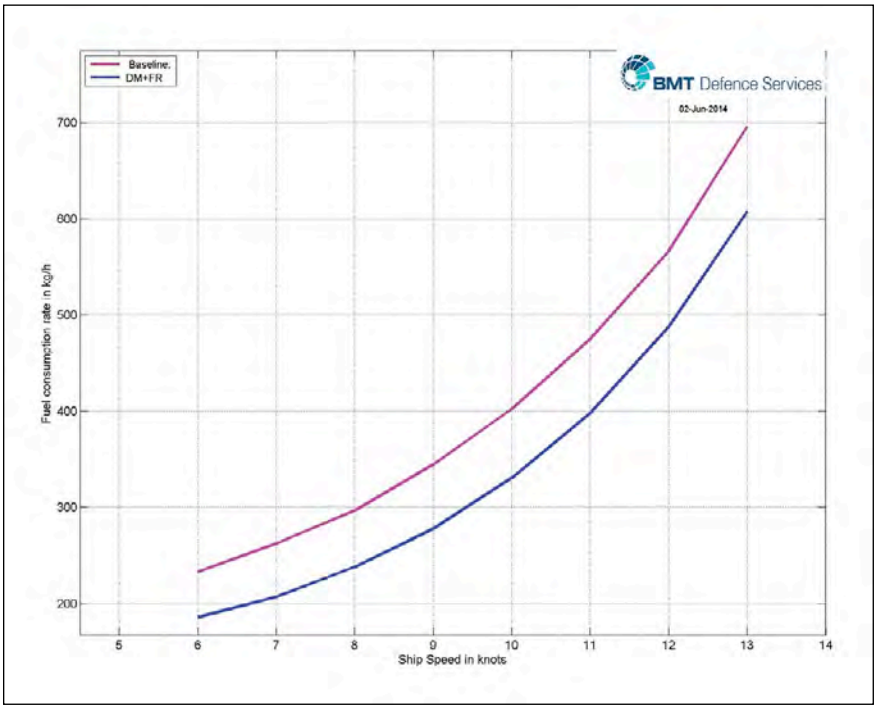

Figure 4: Fuel consumption rate vs ship speed

Conclusions

The fuel-saving capability, carbon emission reduction potential and overall seaworthiness of FRs has been proven in several full scale installations to date, with positive results being reported as recently as 2013 with *E-Ship 1*. FRs represent an opportunity to improve the net efficiency of some ships, both when incorporated into new buildings and when retrofitted.

A FR model has been developed which allows a conservative assessment of the potential fuel saving benefits, demonstrates appreciable fuel savings, and considers some of the practicalities of their use. *NA*

Acknowledgements

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Anthony Veder develops green fleet

Dutch Anthony Veder has received two new vessels to its fleet that will enhance its environmental efficiency operating profile whilst also cutting costs

The two latest vessels, *Coral Star* and *Coral Sticho*, were launched at the end of last year and were constructed at Avic Dingheng Shipbuilding, China. The two vessels will carry liquefied ethylene gas (LEG) from SABIC's Wilton facility on Teeside to manufacturing plants in North-West Europe and Scandinavia.

2012 saw Anthony Veder receive its first dual-fuel LNG carrier *Coral Energy*. However, these latest two vessels will be powered by LNG. *Coral Methane* is a combined LNG/LEG/LPG carrier, when operating in LNG mode, the vessel can sail on the boil off gas of the cargo whereas *Coral Star* and *Coral Sticho* are LEG/LPG carriers. These vessels run on LNG by virtue of the installation of a fuel gas package, consisting of two LNG bunker tanks, and associated equipment.

The engine concept has also been modified. *Coral Methane* has two engine rooms, one for liquid fuel engines, and one for gas fuelled engines. *Coral Star* and *Coral Sticho* are equipped with dual fuel engines, capable of running on liquid fuel or gaseous fuel, the gas supply to the engine is via double walled piping for safe gas supply. The double walled piping, as well as the engine design itself allows engine operations to be conducted in a similar way to conventional engines.

"The primary reason is our belief in LNG for the future. Emissions of NOx, SOx, particulate matter and CO_2 are reduced or negligible. Our crews are fully trained to operate vessels with gas", explains Machiel Mastenbroek, naval architect, Anthony Veder.

He adds that by using LNG additional equipment has been limited when looking at alternative green solutions such as scrubbers.

"Furthermore, closed loop scrubbers require a high load of base chemicals sodium hydroxide, and consequent handling by the crew of these chemicals", Mastenbroek says. Although LNG bunker tanks require space, it is comparable to scrubber equipment, Sodium Hydroxide storage, and tanks for technical water, waste water and handling tanks, required for the operation of a scrubber. The benefit for LNG fuel tanks on our vessels is their lower centre of gravity compared to scrubbers.

Further to this, the vessels have a more modern design that will make them more sustainable in the future when compared to older vessels, including those that have been designed based on hydrodynamics and have cleaner engines, the company says.

The vessel design has been optimised for low fuel consumption and features what the company calls an eco-hull. Special attention was paid during the design and model testing to the hull efficiency, including the design of the bulbous bow.

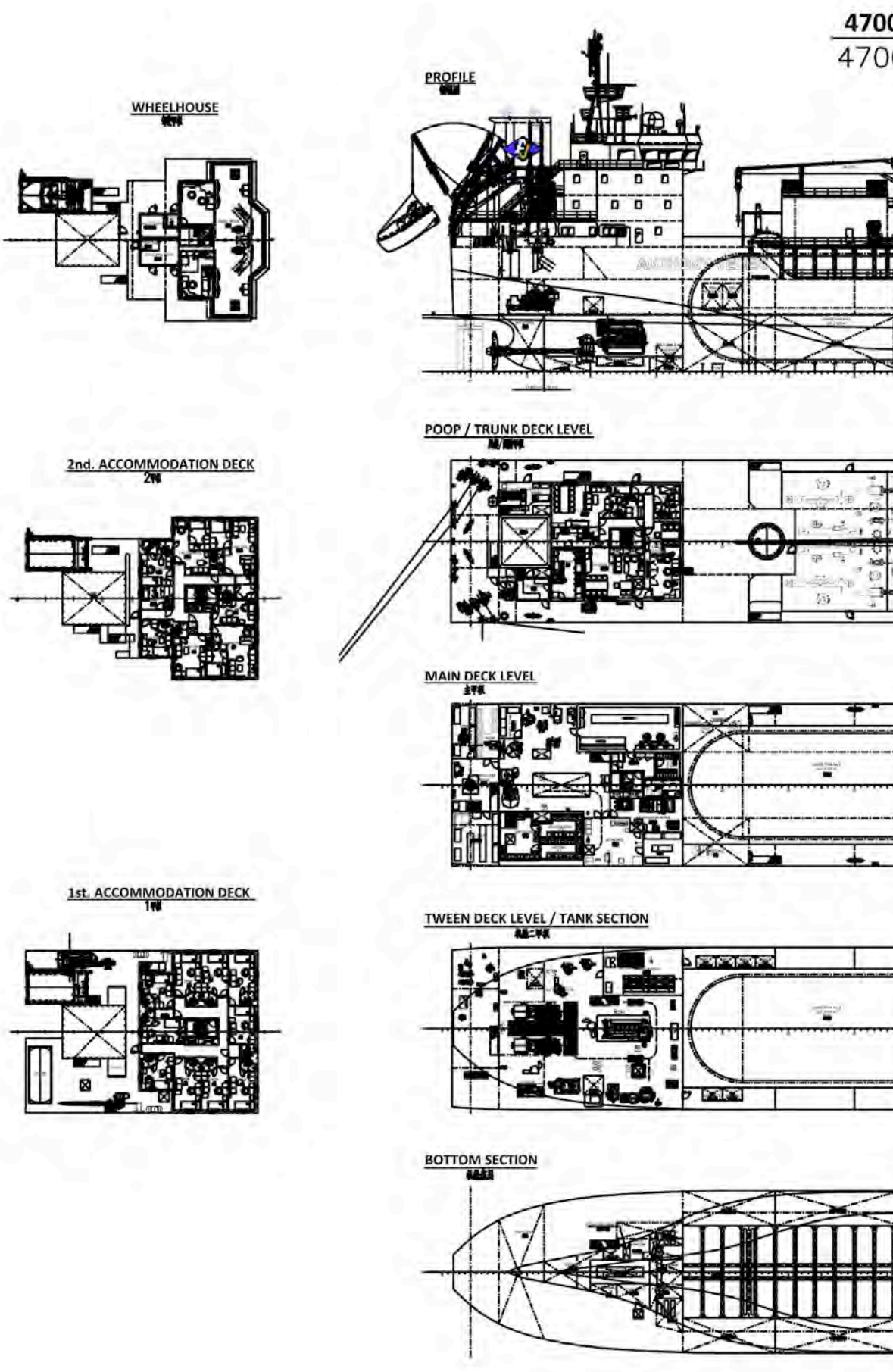
The vessels have been laid out with a shaft generator offering power under normal sailing conditions, in order to reduce the running hours of auxiliary engines (that have higher SFOC/kW).

The engine selection was optimised with loading cases, to such extent that by clever combinations a Wärtsilä 6L34DF could be selected, instead of a 9L34DF, further reducing off-load design and emissions. The vessels are equipped with waste-heat recovery systems to increase fuel efficiency. The use of box-coolers reduces the required pumping capacity for cooling systems, and consequent electrical load.

Coral Star and *Coral Sticho* were delivered in July and September 2014, respectively. The vessels sailed from China to Europe for gas trials where after they now fully operate on LNG. *NA*

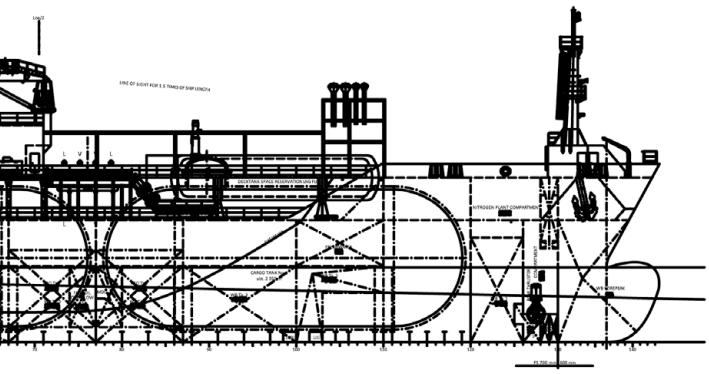
Coral Star the first in the series of LNG powered vessels for Anthony Veder

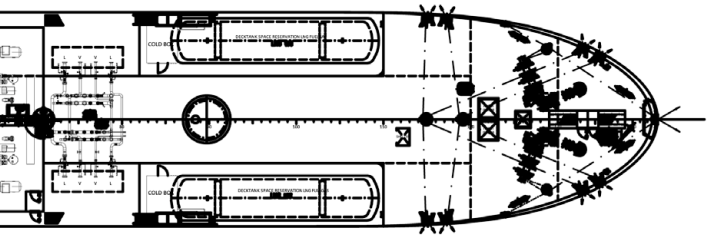
General Arrangement of *Coral Star*

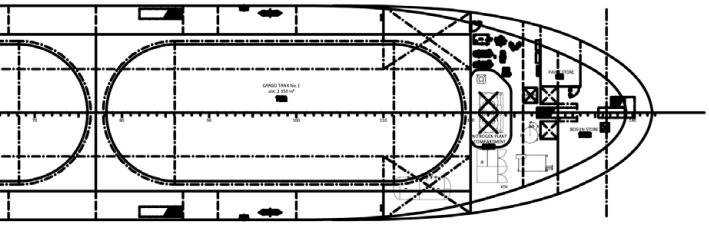


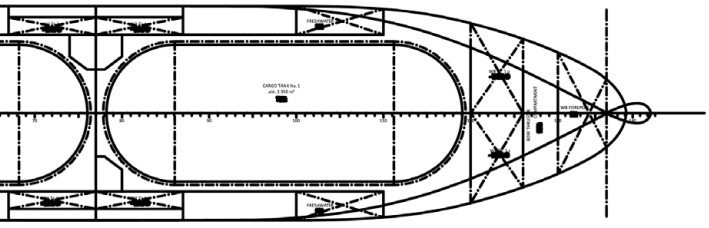
0 cbm LEG/LPG

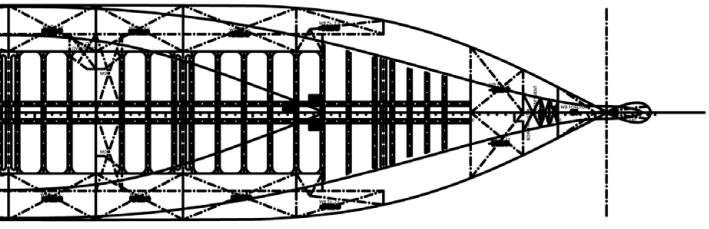
0m³LEG/LPG运输船

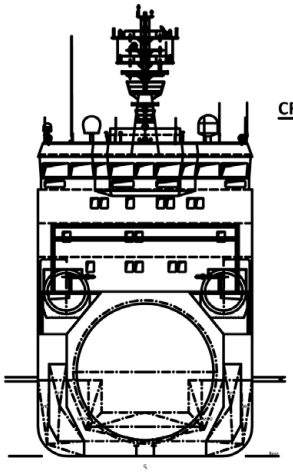












CROSS SECTION

Principal particulars

Length over all	max.	99.95	m
Length between perpendiculars		93.60	m
Breadth moulded		17.20	m
Depth to maindeck		9.80	m
Cargo tank capacity (100 %)	abt.	4 700	cbm
Draught (design)	abt.	6.50	m
Corresp. deadweight all told		3087	t
Draught (scantl.)	abt.	6.85	m
Corresp. deadweight all told		3604	t
Service speed at design draught		13.50	kn

Major overhaul needed for Filipino yards

Politicians in the Philippines are looking to kick-start the shipbuilding industry in what some claim is the world's fourth largest shipbuilding nation. Government support for local yards, however, may not be enough as a government commissioned report highlights major concerns which suggests the authorities are facing a tall order

Official statistics can often mask a more salient truth. Nowhere is this more true than in the Philippines which is often called the world's fourth largest shipbuilder.

It is not, however, just Manila that is finding its statistics were under scrutiny. The OECD, the Organisation for Economic Co-operation and Development, published a report into Shipbuilding in the Philippines in November 2013 which placed the country fifth in the shipbuilding stakes.

The OECD report also suggested that a new shipyard could be developed in the north at Port Irene, Cagayan Valley which has a 54,000ha business hub of the Cagayan Economic Zone Authority (CEZA) and "is being primed to be the country's next world-class shipyard," says the OECD report.

Shipbuilding on a global basis is, however, in crisis. Following the 2008 economic crash many owners stopped ordering and the collapse of cargo volumes, along with the inevitable increase in cargo capacity as ships ordered before the economic downswing were delivered, has meant that vessel earnings have also taken a turn for the worse.

The Filipino maritime industry needs a root and branch reorganisation says maritime consultant Captain Thomas Wissmann

In this context developing a shipbuilding industry of your own would be difficult enough, but doing it with an underdeveloped steel industry, a non-existent maritime machinery industry and a maritime administration, MARINA, that is considered not fit for purpose, then it is no longer an uphill struggle more a mountain to climb.

Maritime consultant Captain Thomas Wissmann was commissioned by the Philippine Department of Transport & Industry and the European Commission to look into the development of the Filipino shipbuilding industry. His report, which was published in the second half of last year, was damning.

Wissmann told *The Naval Architect*: "It was a bit of a shock for them to hear the plain truth about yards that are defunct, very poor environmental & HSE standards, as well as a huge managerial deficit in most yards. I assume that they now will assess their approach in a different way."

According to Wissmann one of the main problems for foreign owned yards

HHIC-Phil has delivered more than 51 ships to clients around the world and was considering whether to build another shipyard in Misamis Oriental, Mindanao. Source OECD.

is the high cost of electricity and supply chain issues though customs handling and congestion is also a problem that every ship builder faces. "But, by far the biggest challenge for the government is the need to revamp the MARINA, the maritime administration. They are completely incompetent and understaffed for the challenges they face! This of course led to communication issues with other government agencies and a complete false picture of the country's situation."

Far from being the world's fourth largest shipbuilding nation, the Philippines' shipbuilding prowess is predicated on erroneous information, says Wissmann. "To state that the Philippines is number four in the world as a shipbuilding nation is pure nonsense and was based on fake orderbook reports…ie. based on a VLCC order that never materialised," explained the consultant.

In Wissman's view there are only seven yards in the country that could be used for any significant shipbuilding and ship repair services. All others are limited by their location, water depth, facilities, and environmental standards.

The seven yards are: Hanjin Shipyard, Subic; Keppel Subic Shipyard; Subic Drydock; Keppel Batangas Shipyard; Herma Shipyard, Bantaan; Tsuneishi Shipyard, Cebu and Mactan Shipyard Corp., Cebu.

Aside from the Herma yard, which only builds vessels for its parent company, the foreign owned yards build ships mainly for foreign owners and have benefitted from either the Domestic Shipping Development Act and the Philippine Overseas Shipping Development Act of 10 years ago that exempted shipbuilders from tax, allowed for income tax holidays and exemptions on import duties in an effort to stimulate the growth of shipbuilding in the country.

Both these acts have now expired with no replacement yet to be penned and the government continues to offer the subsidies inherent in the defunct acts until such a time as new legislation is agreed, says Wissmann. "The Board Of Investment is still granting the same incentives… But anyway, the incentives in general are not very attractive as they don't promote building ships, but help developing shipyards," explains Wissmann. "Countries like China or even France and the USA have much better incentives that actually finance both the ship buyers and the yards," he added.

A subsidiary of Keppel Singapore uses the same technologies and standards as those of Keppel Singapore

According to the Society Of Naval Architects and Marine Engineers (SONAME) of the Philippines if the Manila Government offers the same tax breaks and support to domestic yards as it has to foreign yards entering the country to take advantage of the government's inducements and the comparatively low cost of labour, then the domestic yards will be able to compete better with their foreign competitors.

SONAME chairman Samuel Lim argues: "The government needs to do more to provide the business environment that will encourage shipbuilding," he added that if "the government offered the same tax free incentives to domestic yards that they gave to foreign shipbuilders then the domestic yards would develop."

"The Philippines' yards can be successful," he said.

However, Lim also pointed out that the Philippines could not be a significant player in the global shipbuilding stakes without the development of a steel industry. "Steel and machinery all comes from abroad," and this acts as a hindrance to the Filipino industry.

Currently The Philippines is the world's fourth largest shipbuilding nation (according to official statistics, see above), in gross tonnage terms, with 1.3 million gt built in 2013, more than double the work of the fifth placed nation, Vietnam, but a considerable distance behind the big three nations, Japan, 14.5 million gt, South Korea, 24.5 million gt, and China 25.9 million gt.

There is a small steel industry and there are ambitious plans to rebuild the industry to regain some momentum. Wissmann says there are plans to open a Green Ship Recycling facility in the Phividec Economic Zone that would give the steel industry a new boost.

"In general it can be said that the largest hindrance for any investments in the sector are the dumping prices for steel from China and the constant smuggling of steel into the country. The Chinese may have to raise the prices eventually to more realistic values but the policing of smugglers will stay a major affair unless the politicians really want to deal with it and put measures into action that will stop the smugglers," Wissmann argues.

In conclusion Wissmann details the main problems in brief: "With the Philippine Islands' industry and general economy growing consistently it is obvious that more goods need shipping every year. Therefore the local shipbuilding and repair market should also be increasing. Nevertheless, not much can be seen in terms of shipbuilding activity in the country - in respect to the local transport market. This appears to have the following reasons:

- High numbers of imported second hand vessels
- Long delivery time of newbuilding projects
- Insufficient marketing of local shipbuilding capability
- Insufficient financial incentives for building locally

- High cost for imported materials used in shipbuilding
- Non-implementing of existing laws and regulations
- Substandard in terms of environmental and HSE measures
- High bureaucracy levels.

The truth is there is a great deal of work needed to bring all the yards operating in the Philippines up to standard and the first step in building that industry is for government to acknowledge the problems running through the industry and to put measures in place to arrest its slide.

	Hanjin Shipyard	Keppel Shipyard	Tsuneishi Shipyard
Annual Capacity	18 Vessels	8 Vessels	16 Vessels
Types of Vessels & Tonnage	Bulk Carrier 205K DWT Container 12,800 TEU Tanker 320KDWT	Rig Pontoon/Tug Boats	Bulk Carrier of up to 180K DWT(Cape Size), Car Carrier
Location	Subic	Batangas	Cebu
Project Cost	US$ 1.77 Billion	US$ 33.33 Million	US$ 267 Million
Employment	25,000	5,801	13,000

Philippine shipyards are now building more ships of bigger tonnage capacities like bulk carriers, containers and tankers. Source OECD.

Some of the Philippines' shipbuilding facilities

Hanjin Heavy Industries Corporation Philippines (HHIC Phil) was established in Subic Bay in February 2006. In the same month, the first shipbuilding contract was signed for four container ships.

The company's yard has two of the largest drydocks in the world. The larger dock was constructed to build supertankers and large bulk carriers but no such vessel has been constructed there and a first order for a VLCC has been cancelled. The shipyard says 45 vessels are on order for delivery within three years, nine deliveries per year on average compared to 20 in 2014.

Numbers of employees vary. A Philippine government website says HHIC-Phil employed 17,673 staff in September 2013. Figures from the yard itself vary from 20,000 to 24,000 employees. In assessing the yard's current status it should not be forgotten that the company closed its Korean yard and has pulled out of a major investment project in a Mindanao shipyard due to a bribery scandal.

Expansion plans for a third dry dock have been put on hold. The company had issues with the Subic workforce in the past, and there have been 30 deaths reported since 2006. Further problems with environmentalists have been reported with the risk that HHIC could withdraw from the Philippines remains relatively high.

Keppel Subic Shipyard (KSS) (formerly Subic Shipyard and Engineering, Inc.) Serves ocean going vessels of up to 340,000dwt. It provides repair, conversion and building services, tank cleaning, internal tank coating as well as voyage repairs for internal tanks using ultra high pressure.

The graving dock has a capacity of 350m to 550m in two sections. KSS's extended drydock is equipped with an intermediate gate that facilitates the effective turnaround of projects.

KSS is one of the biggest yards in the Philippines with a drydock capacity of up to 350,000dwt. A 1,500t gantry crane, the largest in the Philippines, is used to move prefabricated modules for installation on vessels.

The production workforce, including the managers have been trained in Singapore and Japan. The management provide training to the workforce to continually improve their skills and knowledge.

The Subic yard president stated that the supply chain is its greatest obstacle in the Philippines. Goods take too long to arrive at the yard, handling costs are very high and, import procedure is complicated. Another significant problem is that many skilled workers are leaving for better paid jobs overseas.

In an effort to keep its skilled labour KSS has established a career programme with rotations to their overseas yards. In general it can be said that with their diverse product range (that is adjusted to market developments ahead of time), their quality management systems, international reputation and competitive price structure the company is well positioned to continue its successful operation in the Philippines.

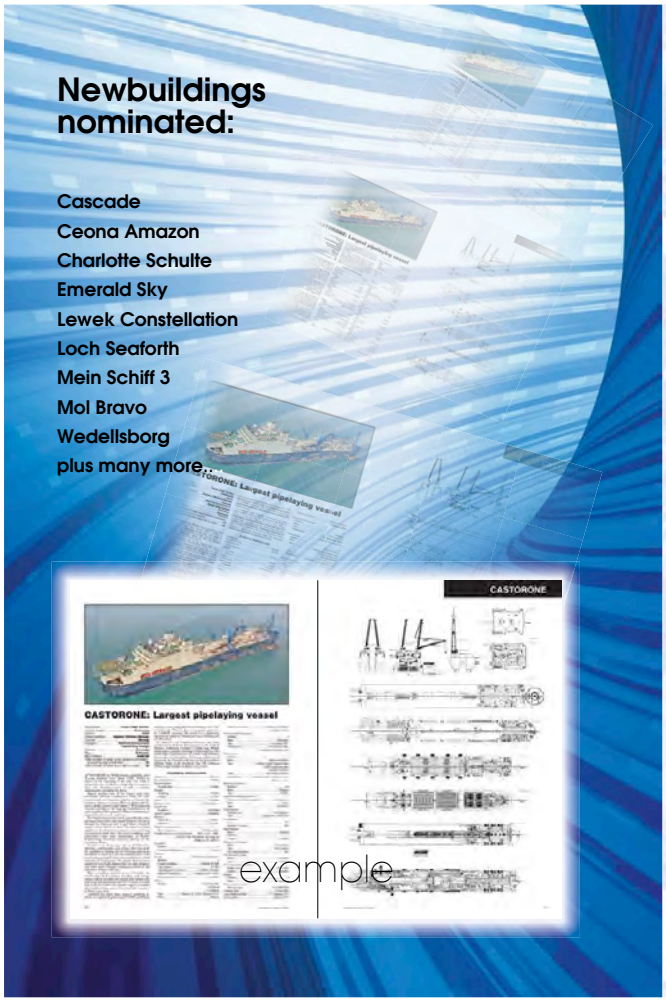
Herma Shipyard, Inc. (HSI) is a Filipino-owned shipyard with a 170,000m^2 facility in Mariveles (Bataan). Herma builds for the fleet of its company owners only. It is evident that business is slow as the current tanker project has taken three years to complete. No other vessels were under construction in June 2014. The facilities consist of the following:

- Graving Dock (Width: 27m, Length: 159.05m, Depth: 12.2m.
- PB 2 (Length: 142m. Depth: 7m)
- PB 3 (Length: 149m. Depth: 7.8m)
- Slipway (Length: 120m. Width: 20m)

Tsuneishi Heavy Industries (Cebu), Inc (THICI) builds merchant ships of up to 180,000dwt. THICI's main facilities are located in a 1.47 million m^2 land area consisting of two slipways, a building dock, a warehouse, an assembly factory, and various workshops and a training centre. The company says it launches a new vessel every two months. This shows a slowdown from the previously stated maximum capacity of 16 vessels per year.

It was reported that the company works with approximately 770 of their own employees and up to 10,000 more sub-contracted workers depending on demand. This, unverified, information would explain the managerial difficulties for ship repair projects. The general downturn in ship deliveries and the fact that Tsuneishi must fill several Chinese yards gives further concerns about the status of the yard. In Japan orders fell 50% in 2014. A good overall point is that Tsuneishi also builds vessels for their own fleet and can sustain a longer draught in completed orders.

Source: Thomas Wissmann



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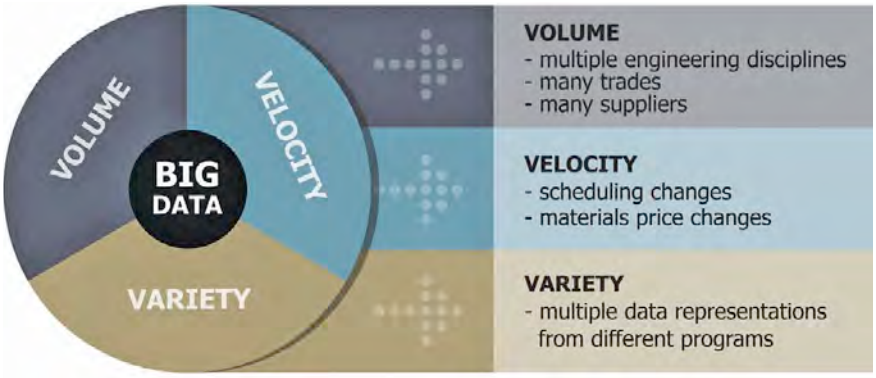
Big Data in Shipbuilding

Patrick David, R&D engineer and Patrick Roberts, director of operations, SSI USA discuss the impact of big data in shipbuilding

There is a massive amount of data generated during shipbuilding. Due to the complexity of vessel construction, it is hard to ignore the possibility that there might be relationships buried in this data that could lead to enhancements in business decision making regarding efficient resource management, purchasing and other critical factors influencing profitability.

Teasing out those relationships is a job for "Big Data" analysis. To explore this topic, an ad-hoc working group has been formed consisting of software makers SSI and Praeses LLC., along with multiple US shipyards across the NSRP (National Shipbuilding Research Program) such as General Dynamics and Huntington Ingalls Inc. The group has identified several potential opportunities along with various challenges to implementing Big Data analysis.



SSI looks at the bigger picture of handling 'Big Data' in shipbuilding

What is Big Data?

For clarity, the definition proposed by Gartner Inc. is often used: "Big data is high-volume, high-velocity and high-variety information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making."

This definition identifies three key traits pertaining to the data under consideration for analytics: Volume, Velocity, and Variety. Each of these traits applies to shipbuilding.

Volume

Across the shipbuilding enterprise there is a large amount of data being generated. Schedules for operations are built around the many constraints that a shipyard has to contend with. Collaboration with vendors and lead-time materials has to be coordinated. Ship design and production information needs to be created and resources must be planned against the schedule and design as well. These are just a few of the global examples of data creation. Looking further into the shipbuilding process reveals multiple layers of data effecting the entire organisation.

Shipyards recognise that there is a wealth of information being generated at every level of the enterprise, but to date have only been able to focus on the elements that directly impact efficiency and production schedules. There is far more data than might have been anticipated initially and the industry as a whole lacks a cohesive method of cataloguing and utilising this data beyond simple planning and scheduling. The ability to consider this volume of data in the context of all the data being generated across the enterprise holds the possibility of greatly enhancing insights to make better business decisions.

Velocity

Though a normal ship production cycle can seem quite long compared to other industries, within the shipbuilding enterprise the actual time constraints and requirements are very demanding. Multiple entities must coordinate very large capital across several disciplines in order to maintain a smooth construction schedule.

Resources must be carefully planned and scheduled from the beginning of a ship construction project, materials must be ordered and delivery schedules coordinated with just-in-time practices in some cases, and design information needs to be created and generated for directing production. Small changes in any of those resources can disturb the entire production schedule downstream leading to very costly schedule over-runs or missed deliveries. The ability to quickly respond to changes in the production environment with the best course of action is essential to minimising the risks and costs for the shipyards.

Variety

One of the largest obstacles to any Big Data Analytics implementation is the various forms that the data may take. In higher-tech industries there is often a mismatch in data types across existing systems. In shipbuilding this is more acutely felt due to the relative lack of data collection methods. The organic way in which shipyards operate at the lowest levels means that methods of data collection and verification can be as complex as full computer software tracking and cataloguing or as low-tech as a clipboard hanging in a warehouse. The challenge is finding a method of accounting for the various types and formats of data that can be tightly integrated into a Big Data analytics workflow.

Of the three main points in the definition of Big Data, Variety may be the most challenging for shipbuilders. Combining relevant data from across the enterprise, often stored in disparate formats and systems, is a vital component in being able to leverage data analytics.

Challenges

Shipyards, by nature, lack the computing infrastructure and toolsets for conducting Big Data analytics. Due to the volume of data that is created in a shipbuilding environment, this could become an issue of storage and management. In addition to the storage requirements, there are also requirements for software systems for managing the data (i.e.: databases and tools). There are often other

systems already in place that use a similar set of tools such as CAD/CAM design software and enterprise resource planning (ERP) systems that may already have some of the same requirements for data storage and collation, making the challenge of infrastructure a reasonably surmountable one.

Closely coupled to the issue of computing infrastructure requirements is the relative lack of Big Data analytics tools. Toolsets that cross disciplines as part of a concerted effort to leverage Big Data analytics are rare in the shipbuilding environment.

Another challenge for Big Data analytics implementation in the shipbuilding industry shares a common root with traditional analytics: a lack of data alignment. The problem lies in the fact that even though this data may be harvested for particular purposes, it lacks any sort of alignment with the other types of data being collected.

Related to the issue of data alignment is the problem of optimisation of data collection methodologies. Though there may be data collected in many places throughout the shipyard, they are not necessarily being approached in the most efficient manner possible. Without strong business processes and methodologies to guide the collection process and validation, the data collection may take more resources than actually required or could allow bad data through.

Conclusion

Many industries have reported great successes integrating Big Data analytics into their business processes. Considering the amount of raw data currently being generated, and the amount of data that could be captured, in a shipbuilding environment it is only natural to question if there may be a place for Big Data analytics in the shipyard enterprise.

There are many challenges facing shipyards that are considering implementing a Big Data analytics workflow into their environments. Infrastructure, tools, personnel, lack of data alignment, and lack of comprehension and communication all conspire to make the task appear more daunting than it actually may be. In particular, a general lack of awareness of the methodologies in Big Data analytics have kept it from being considered as a possible means of enhancing business decision making.

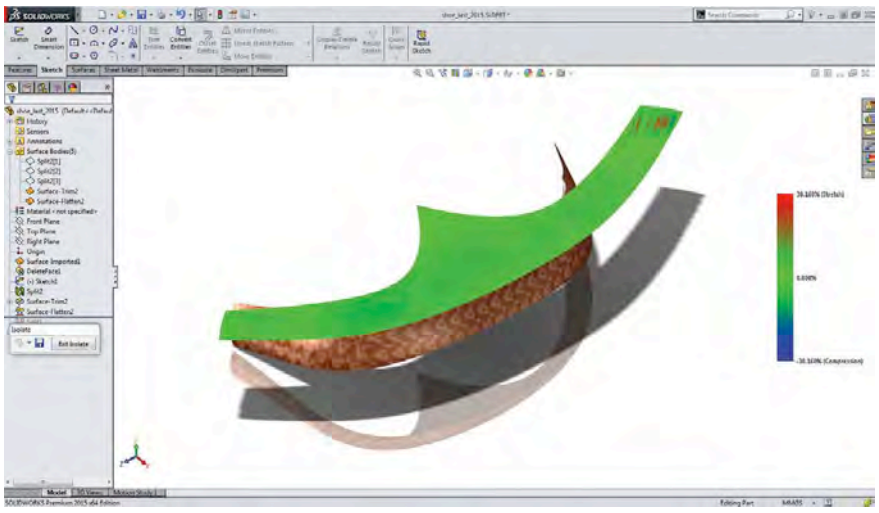
The allure of unique and valuable business insights that could be available through considering Big Data analytics is enticing. It is hard to ignore the possibility that there might be relationships buried in the large amount of data generated across the shipbuilding enterprise that could lead to enhancements in business decision making. *NA*

Dassault's future thinking

Dassault Systemes has introduced its SOLIDWORKS 2015 to the market which gives users cloud-based capabilities and better productivity, work processes and operating costs

Shortening the design cycle was the aim of Dassault Systemes' latest upgrade by allowing designers to span multiple disciplines with ease, says the company. New features such as collaborative sharing have been added through the system's cloud-based capabilities to ease the design process.

"Customers in this market face a wide range of new challenges including design and building using new composite materials, integrating new electronic systems, compliance with environmental systems – including bilge water treatment, speciality marine equipment sanctions/missions (eg: oil skimming), compliance with evolving marine standards and doing all this while being more efficient and cost effective with design and manufacturing," Eric Leafquist, product portfolio manager, SOLIDWORKS explains about the key demands in the market.



SOLIDWORKS 2015 allows you to automatically flatten 3D models to improve manufacturability of products with compound curvature

To meet these demands and to add to the collaborative sharing quality, several other features have been added, such as the 'Flatten Surface' functionality in SOLIDWORKS Premium 2015 that enables complex surfaces to be flattened to help guide yards to determine such things as the amount of Aluminium hull plating is required and planning for the amount of hull core material required. SOLIDWORKS MBD 2015 enables annotations and manufacturing information to be placed on the 3D model, reducing the number of drawings needed and their distribution. Also, SOLIDWORKS Routing (in Premium 2015) now supports running rectangular ducting, HVAC and other sections with a design to streamline overall vessel design. *NA*

CD-Adapco simulates reality

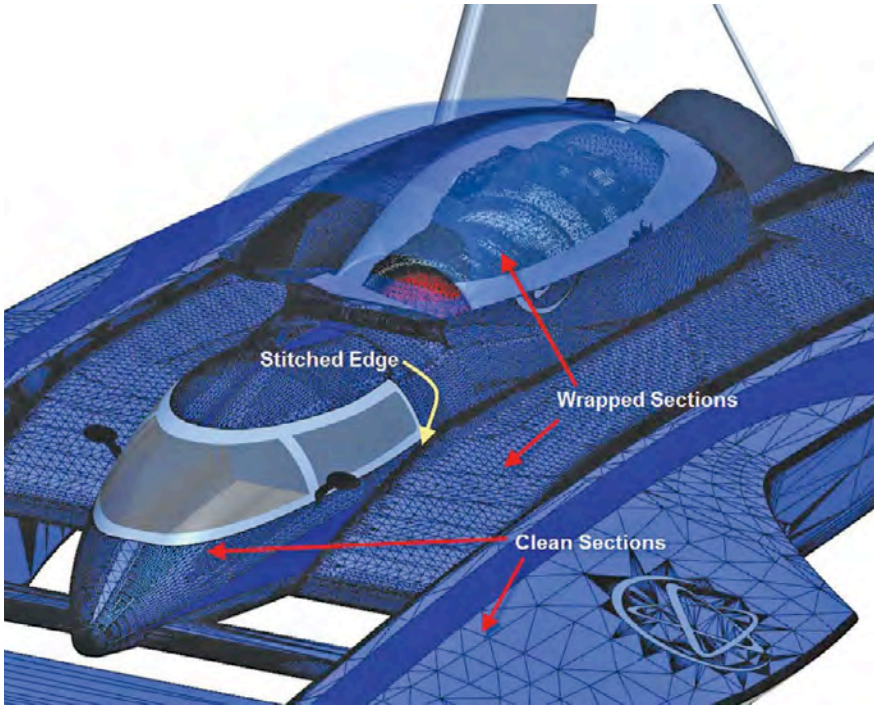
CD-Adapco has launched the latest version of its software v9.06 which has focused on creating more accurate simulations that are closer to the final product during development

To create better simulation CD-Adapco has taken in factors that are likely to significantly influence the performance of a design in operation. A new acoustic wave equation solver has been added that accurately predicts the propagation of an acoustic signal from the flow field, making its capture more accurate. By using the MUSCL convection scheme it provides a higher accuracy in applications like shock waves, wakes, vortices and propagating sound waves by minimising the numerical dissipation.

One of the main points of creating a good simulation is the realism of it. To improve this partial wrapping and extended overset mesh capabilities delivers what CD-Adapco says is a new level of realism in modelling and more detailed systems and sophisticated motions. The partial wrapping allows STAR-CCM+ users to selectively apply the surface wrapper, a core strength product, to regions of the geometry while retaining the complete fidelity of other parts.

"The good news is that a new method introduced to STAR CCM+ v9.06 will allow you to selectively wrap dirty surfaces, while preserving those that are clean. The new partial wrapping feature will allow the user to select portions to the geometry and declare them as clean. When a surface has been declared clean for partial wrapping STAR CCM+ will then wrap the geometry as normal. Once a clean, closed surface is obtained the flagged surfaces are then removed from the wrap and the originals are stitched in their place," explains James Clement, STAR-CCM+, product manager, CD-Adapco.

Adding to this is gap handling as the overset mesh removes the limitation of efficiently modelling contact between moving bodies and parts. The overset mesh allows objects to move around a computational domain freely without over complicating the mesh.



This unlimited boat simulation leverages partial wrapping to take advantage of clean geometry and only wraps the portions that need it

"The dynamic fluid body interaction (DFBI) model allows you to solve for motion, in six degrees of freedom or less, based on the forces and moments acting on a body, such as a boat on a free surface. To date, however, there has been one major constraint when using overset mesh, namely that all gaps had to be resolved with at least 2-4 cells, however small the gap, for overset mesh to work correctly," David Mann says. "The upcoming release of STAR-CCM+ V9.06 removes that constraint with the introduction of gap handling for overset mesh via the new "zero gap" interface type. Now, you have the option for STAR-CCM to automatically close gaps where the mesh is too coarse for overset mesh to work," he adds.

Users can now choose to resolve the flow in small gaps by using a fine mesh, or if too small, they can be closed using a smaller mesh. Overset mesh and discrete element modelling (DEM) can now be combined and used to solve a new range of applications.

Other features that have been added are enhancements to the user workflow which now includes faster setup and a new level of design exploration performance. An interaction tool for the creation of morphed control points that drives mesh deformation and enables adjoint-based shape optimisation cases to be easily setup.

Jean-Claude Ercolanelli, VP product management, CD-Adapco adds: "We are working at complementing the multiple engineering disciplines that are already in STAR-CCM+ with Computational Solid Mechanics capabilities." *NA*

Putting the theory to the test

Computational fluid dynamics has been the buzz word for recent new ship designs with development in this area for optimisation. However, as designs still need to be model tested, research bodies are also raising the bar through the development of better facilities

To keep up with the demands of designing environmentally friendly ships, research institutions have been making investments into their facilities to expand upon their testing capabilities; whether this has been through the improvement of actual test tank facilities or the development of the technology that these institutions employ to carry out the studies, such as MARIN's latest fast Bull computer cluster.

The University of Southampton is building a new towing tank at the newly opened Southampton Boldrewood Campus, which the University shares with Lloyd's Register's Global Technology Centre. The Wolfson Unit says that the aim is to provide a world class facility supporting research, teaching and commercial clients, not just for conventional ship model testing but across the aerospace, energy, and transportation sectors.

The building prior to fitting external cladding

Tank	Location	Length	Width	Depth	Date built
QinetiQ No. 2 Ship Tank	Haslar	258	12.0	5.5	1931
University of Southampton	**Southampton**	**138**	**6.0**	**3.5**	**2015**
Kelvin Hydrodynamics Lab	Strathclyde	76	4.6	2.3	1964
Southampton Solent University	Southampton	60	3.6	1.8	1962
Newcastle University	Newcastle	37	3.7	1.3	1951

Test tanks in the UK

The new tank measures 138m long, 6m wide and 3.5m deep with a high speed carriage and capability of producing a full range of unidirectional seastate simulations.

Barry Deakin, Wolfson Unit highlights that this is a landmark event, not just for the University but for the whole of the UK and its maritime industries. "In recent years we've become accustomed to closure of many of the UK's major testing facilities, with the sad loss of world class towing tanks in Teddington, Feltham, St Albans, Gosport and Cowes," he adds.

The table shows what little remains of our once extensive range of test tanks around the UK, and where the new tank fills a significant gap in the size range. Until now, the most recent construction of a large towing tank was the No.3 tank at Cowes, 200m long and with a speed of 14m/s, built for testing hovercraft in 1969. That tank was closed in 2008 and its loss has been a serious blow for the industry.

As an educational resource, the Wolfson Unit is also expected to provide an essential experimental component of the University's MEng Ship Science undergraduate and MSc Maritime Engineering Sciences postgraduate teaching programmes, which encompass naval architecture, yacht and small craft, offshore engineering and marine engineering. It will also facilitate, and increase the range of, experimental projects that may be undertaken by individuals and groups as part of their studies.

"The carriage has been designed with teaching needs fully in mind and will be used in conjunction with a bespoke teaching space in the same building such that groups of 20 students can carry out laboratory work and fully experience all aspects of the experimental study of hydrodynamics. Such experiential learning is considered a vital part of the education process and provides an essential grounding to learning of theory and the application of computational design tools," says Deakin. To widen its application, full use will be made of the latest wireless technology with live streamed video and data feeds which will allow experiments to be followed live anywhere in the world.

The tank will be equipped to complement the wide range of ship and offshore research underway within the Faculty of Engineering and the Environment. It will provide the ability to carry out detailed studies of non-linear phenomena necessary for understanding fluid - structure interaction, a current example of which is a study of the response of hydro-elastic models to rogue wave events.

For more fundamental fluid dynamics work the EPSRC National Wind Tunnel Facility grant has provided significant funding for bespoke carriage mountable Laser Doppler Anemometry and Particle Image Velocimetry systems. A large volume optical motion capture system for underwater and above water motions will allow interesting work in areas such as launch and recovery of marine vehicles, autonomous craft design and

vortex induced motions of floating offshore structures.

Over the long term, the installation of modern control systems will significantly enhance research productivity with the ability to carry out autonomous operations of repetitive tests and provide a data rich test environment ideal for computational analysis validation studies.

For over 45 years the Wolfson Unit, which is an integral part of the University, has conducted towing tank tests by hiring the facilities most appropriate or convenient for each specific project. Principally the facilities at Southampton Solent University, Haslar and Cowes have been used, but occasionally other tanks around the world have been hired and equipped by the Wolfson Unit for their clients' tests. The Wolfson Unit will be the main commercial user of the new facility, their engineers have assisted in the design, and it is the aim that most of their hydrodynamic testing will be conducted there.

Completion of the tank concrete base and walls

The building construction is complete and outfitting with the rails, carriage and wave makers is progressing. There remains a substantial amount of development and commissioning work to do, but the tank will become operational this year, when the Wolfson Unit looks forward to being able to offer an even more flexible and efficient model testing service. *NA*

Fincantieri's brave new world

Keeping up with demands of modern shipbuilding whilst floating part of the company on the stock market will see Fincantieri maintain its place in an ever changing shipbuilding future

Currently, Fincantieri's cruise ship orderbook stands at 15 vessels and the company claims that its product portfolio is the most diversified on the market, both in terms of owners and ship sizes and market segments.

Over the last couple of years Fincantieri has been adjusting to the fluctuations in the market and part of its strategy is to hold its market position and enable future growth through its initial public offering (IPO). On 3 July last year when the company placed 450 million shares, all derived from a capital increase, at a price of €0.78 (US$0.98) per share which resulted in primary proceeds of €351 million (US$443 million), representing 27% of Fincantieri SpA's share capital. The primary proceeds raised through the IPO will be used to strengthen the group's balance sheet and support its future growth strategy.

"Fincantieri is expanding rapidly on a global level and the IPO enabled us to further enhance our visibility in the international markets, which are of strategic importance for the development of our business. The exchange is for us also synonymous with transparency and will allow us to acquire additional capital to implement our development plan", says a spokesperson for Fincantieri.

One of the significant projects to be delivered from the shipbuilder in 2014 was *F.A Gautier* and LNG ferry for Canadian operator Société des traversiers du Québec

In addition, Fincantieri says that owners are still looking to maximise their return on investments, where the company looks to find the optimal balance between revenue maximisation and reduction of capital and operational costs The company says that a critical factor of this is the capacity to develop customised proposals according to the specific needs and requirements of each owner.

Fincantieri keeps the orders flowing through 2014 and into the coming year through its move in to the stock market

Fincantieri is also still focused on what it calls its make or buy strategies, by outsourcing lower value-added activities while insourcing those relating to the design, production and installation of highly specialised systems and critical components.

Fincantieri's spokesperson explains that: "So far we have particularly focused on insourcing (partially or completely) the production and installation of items such as cabins, public areas, air conditioning and galleys."

The company also highlights that one of the most significant projects currently under construction is the ferry *F.A Gautier,* which is scheduled for delivery for the end of the year, and is the yard's first experience with LNG fuelled ships.

He says that the project has been quite challenging for all those involved, including the owner. The vessel was designed from scratch with everything having to be completely reworked during the design development. *F.A Gautier* has a length overall of 133.20m with a moulded breadth of 22.40m and a capacity of 800 passengers. The vessel

"Fincantieri is expanding rapidly on a global level and the IPO enabled us to further enhance our visibility in the international markets"

is fitted with four Wärtsilä 12V34DF engines that have a power output of 5,220kW at 720rpm and has two 250m^3 LNG tanks.

Fincantieri has also been working on two additional cruise ships for Viking cruises. These ships will be sister vessels of those ordered last year with the deliveries scheduled for mid-2016 and early 2017.

A spokesperson says that the Viking projects have been challenging because the owners have a clear business model; which Fincantieri has worked closely with. The two vessels, *Viking Star* and *Viking Sky* will weigh approximately 47,800gt and will have 465 staterooms, accommodating 930 guests. Also, like their sister ships, the vessel was designed by experienced naval architects and engineers, including London-based SMC Design and Los Angeles-based Rottet Studios. *NA*

GHENOVA evolves with AVEVA Marine

Spanish engineering company GHENOVA Ingeniería has opened up new opportunities in Brazil through the capabilities of AVEVA Marine

To mitigate the shipping industry's contraction, Spanish engineering company GHENOVA Ingeniería says that it has seized opportunities in the high-growth markets of Latin America. A key project enabling them to establish a strong position in this market is the design of a fleet of LPG tankers for Transpetro, using AVEVA Marine.

Ignacio Grau, GHENOVA's head of marketing and communication, says that Europe, especially the naval sector, has been GHENOVA's core market since the company's foundation. Several projects signed in Brazil, both for naval engineering and energy, are now expanding the company's client base. "For us, expansion into Latin America was the natural choice," explained Julián Fontela, GHENOVA's manager of business development.

The depressed shipping market following the slump in 2008 especially impacted GHENOVA's customer base in Europe and in the naval sector; the company recognised the need to pursue new opportunities in high-growth markets.

An engineer works on a design in AVEVA Marine at global head offices in Seville, Spain. Photographs courtesy of GHENOVA

"Our main office in Latin America is in Brazil, and from there we are orchestrating our expansion into the rest of Latin America," Julián explained. "Projects executed from the Brazilian office are of strategic importance for us, because each one demonstrates both the high quality of our work and our long-term commitment to our customers in the region as a whole. This strategy really represents a key ingredient for the growth of the company."

In September 2011, a year after GHENOVA first entered Brazil, the company signed a €7 million (US$8.7 million) contract with the STX Promar shipyard (now Vard, part of the Fincantieri group) to carry out the engineering of eight LPG tankers for Transpetro, a subsidiary of Petrobras.

Julián Fontela, GHENOVA's Manager of Business Development, and Ignacio Grau, GHENOVA's Head of Marketing and Communication.

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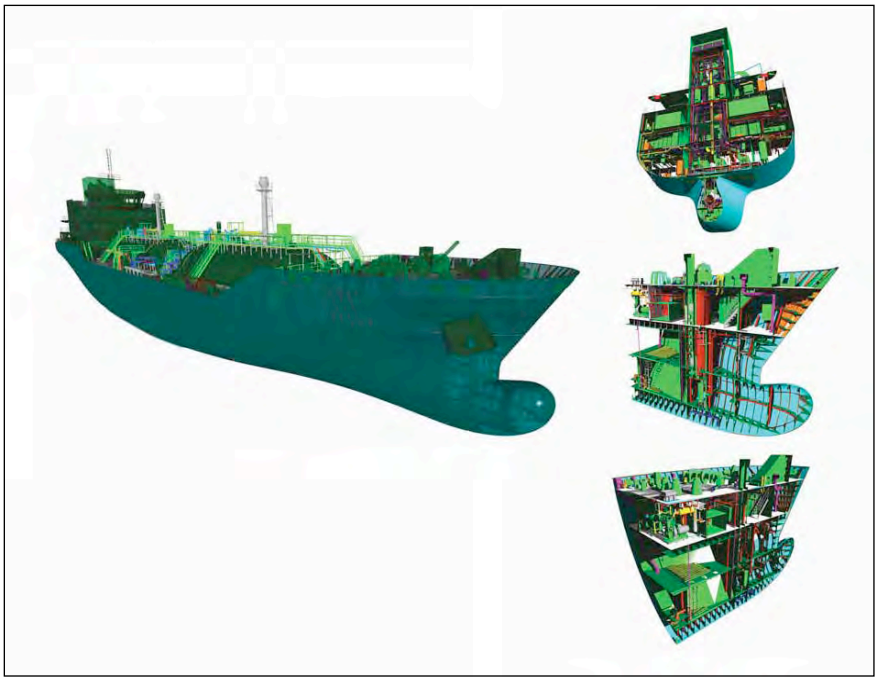
The LPG project

The project consists of the detailed engineering and purchasing support for the prototypes of three LPG carrier designs. A design for four vessels with a pressurised capacity of 7,000m³ has already been delivered. The first three are already in fabrication. The first vessel in the series has been christened *Oscar Niemeyer* and was delivered in December 2014. A further vessel design, for two LPG carriers with a smaller pressurised capacity of 4,000m³ have also been constructed. GHENOVA is now working on a design for two semi-pressurised vessels that will each have a capacity of 12,000m³. GHENOVA is responsible for all the detailed engineering of the structures, piping, equipment and outfitting, the electrical, instrumentation and electronics systems, and HVAC and accommodation. The Brazilian team are using AVEVA Hull, AVEVA Outfitting, and AVEVA Cable Design, collaborating with their colleagues at the Spanish headquarters with the help of AVEVA Global.



Left: 7,000m³ series LPG tanker design in AVEVA Marine. Right: Sections of the tanker model. Images courtesy of GHENOVA

Selecting the tool for the job

With experience of Tribon, GHENOVA had successfully adapted to AVEVA Marine several years ago. Their AVEVA deployment forms part of a suite of applications that enables GHENOVA to meet a wide range of client- and project-specific requirements. As a result, GHENOVA selects the design software on a case-by-case basis.

Julián explains: "Each of the different types of software that we use is one system within a diverse toolkit. Every client has different requirements and meeting those requirements is key. We don't only design ships; among other things we also design thermal power plants, so our choice of software for any particular project is usually dictated by the nature of the project and the client's requirements."

As a result, AVEVA Marine was chosen specifically for this project because it best matched Transpetro's needs and was consequently mandated by Vard in Brazil. "This is an entirely new project for us, so it was essential to select a 3D engineering and design tool that could deliver true strategic value," explained Francisco Cuervas, general director of GHENOVA. *NA*

7,000m³ series LPG tanker design in AVEVA Marine. Images courtesy of GHENOVA

The Royal Institution of Naval Architects

Design & Construction of

Super and Mega Yachts

13-14 May 2015, Genoa, Italy

First Notice & Call for Papers

After years of downturn the Super and Mega Yacht industry is starting revive, and the demand for new builds is increasing quarter on quarter in 2013/14. While orders for larger yachts have remained constant, growth has been seen mainly in the 24-30 metre category where new designs that introduce innovative features have been the most popular. However, the coming into force of far reaching regulations such as the Maritime Labour Convention 2006 (MLC 2006), and the mandatory regulations on Energy Efficiency for Ships that include EEDI and SEEMP, adds an unknown quantity to the recovery.

The industry as a whole is starting to come to terms with the MLC 2006, which came into effect in 2013. Particular areas of concern have been in relation to smaller vessels. The minimum crew set out by the MLC and cabin space requirements has in some cases meant that a vessels lower deck is entirely devoted to the crew, couple this with unclear freeboard rules, that reduce openings and passages, and the space available to the owner becomes much smaller. Builders and owners have had to adapt to these new rules and in some cases lobby for yacht focussed 'equivalencies' from their flag states that will help maintain build orders.

RINA invites papers on all aspects of large yacht design, construction, and operation, from designers, builders, researchers, equipment manufacturers, operators, and regulators. Topics may include the following:

- All Aspects of Design – Hull, General Arrangement, etc.
- Operation
- Regulation & Classification
- Environmental concerns- Energy efficiency, SEEMP, etc.
- Powering & Propulsion
- Sea Keeping
- Materials
- Interiors- Features, Finishes, etc.

Selected papers may be published in the Transactions of the Royal Institution of Naval Architects

www.rina.org.uk/superyacht2015

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Guidelines for Arctic development

As shipping along the Northern Sea Route (NSR) has developed over the last few years, The Russian Maritime Register of Shipping has highlighted the need for a consistent set of rules and services to cover major aspects of Arctic ship design and operation

For this reason The Russian Maritime Register of Shipping (RS) says that its research programme continually includes ice-related topics that it explores along with key Russian R&D centres.

"Some of our latest projects include the research of ice loads acting on propeller blades in ice conditions. If the blade breaks on a ship in the icebreaker-lead convoy it always leads to time and cost issues, not to mention the danger of ship damage by ice," says Maxim Boyko, head of RS Research Department.

Boyko explains that this is why the class society is developing its rules with close attention to modern calculation technologies and model testing of propeller blades. RS has elaborated rule requirements to determine the minimum dimensions of propeller blades and minimum required propulsion power based on typical load scenarios applicable to Arctic navigation.

Another important topic that it has investigated is related to the scope of hull and machinery survey, which is one of the main class society objectives. In reality, the number of critical hull damages that can occur in ice is quite stochastic; and it depends on actual ice conditions that vary significantly both in short-term and long-term perspectives.

"On top of that, we are always under the influence of human factors in the Arctic; the operational regimes there require special skills, and generally, some small damage that does not lead to ship safety diminution is normal navigational practice", he explains.

However, RS says that the significant damage and side shell thickness diminution due to abrasion with ice should be observed and assessed against its class requirements. In this respect the result of the research would be to seek the opportunity to optimise the required number of dry docking surveys and to identify the additional safety measures that should be implemented to ensure the safety of the structure. As an example of this, a special side shell protective coating should be provided.

RS is currently working on the model testing of propeller blades

Maxim Boyko, head of the RS Research Department explains that the Yamal project offers a "unique" view on applying ice class rules

Rule development for newbuildings is also a very important topic in the class society's research programme. "In this sense, we learn a lot from our experience gained during the Yamal Project. It is a unique feedback and unique data we gain by applying ice class rules to high ice class LNG carriers of non-conventional hull form and dimensions that help us to expand our knowledge into non-conventional Arctic ships," explains Boyko.

The research includes the application of high-tensile steels in extremely cold conditions, winterisation of deck equipment, and the implementation of different structural design solutions. *NA*

PPG puts on its winter coat

US-based PPG Protective & Marine Coatings has announced that it is developing a coating that will be able to meet with class Winterisation standards

The coating that is under development looks to reduce the ice build-up on vessels, therefore, making it easier for the deck and equipment to be kept ice free. The ice class notation provides coating manufacturers with expected conditions that might be encountered by the vessel during its service life, which then allows them to provide a coating solution that will best fit the operational profile. Whereas the winterisation notation is a set of measures to ensure that the vessel will be able to operate in the harsh conditions.

"Basically, the ice class notation is linked to newbuilding specification, while winterisation targets operational aspects during service life", says Christophe Cheikh, global product support manager, marine coatings, PPG Protective & Marine Coatings (PPG).

Cheikh explains that this technology that would be employed in the coating is already being developed in the US. The technology in the coating would work by giving the ice low adhesion on surfaces, so effectively the ice would then drop off from surfaces. Development of the coating is still being carried out with surveys being done and further product testing with customers.

> "the ice class notation is linked to newbuilding specification, while winterisation targets operational aspects during service life"

Based on the ice class notation of the vessel, PPG is currently proposing to its customers its SIGMASHIELD1200 solution for the underwater area or a more fit for purpose coating solution (in anticipation for the conditions that the vessel can structurally withstand). PPG's SIGMASHIELD 1200 is a premium epoxy coating specially designed to resist impact and friction from the ice under water. *NA*

The Royal Institution of Naval Architects

Damaged Ship III

25-26 March 2015, London, UK

First Notice & Call for Papers

Recent incidents at sea have shown that investigations and understanding of the behaviour of damaged ships are as important as ever. Significant process has been made over the last 10 years but there still remain numerous scientific and practical challenges.

After any major accident it is imperative to rapidly quantify the damage, assess damage stability and the residual strength of a vessel. Damage stability appraisal must also consider the likelihood of progressive flooding, the effect of the mass and motion of flood water within the vessel, capsizing probability and effect of waves on stability. There is a need to consider both the global strength capability of the ship structure and the local residual strength of damaged and buckled plating and the effect of flooding on internal structure.

Following on from the successes of two previous RINA Damaged Ship conferences; this event will focus on the assessment and analysis of stability, strength, sea worthiness of a ship damaged by collision, grounding, structural failure, fire or explosion. It will also consider procedures to minimise risks for passengers, crew, ship, and environment and to develop safe countermeasures including sequences for transferring crew, offloading cargo, and ballast water, for salvage operations.

RINA invites papers form designers, builders, operators, classification societies and legislative government bodies on topics including:

- Initial damage assessment and verification
- Behaviour of a damaged ship in a seaway
- Stability in waves, extreme motions, capsize dynamics
- Modelling water ingress and ship flooding
- Assessment of global and local integrity of the damaged ship
- Pollution mitigation
- ERS planning and decision support systems
- Existing and proposals for future damage stability regulation
- Education and training on damage stability

Selected papers may be published in the Transactions of the Royal Institution of Naval Architects

www.rina.org.uk/Damaged_Ship_III

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October 20-23, 2015
Kormarine, international conference, Busan, South Korea.
www.kormarine.com

The Royal Institution of Naval Architects

Ice Class Vessels

28 -29 April 2015, London, UK

First Notice & Call for Papers

The Polar Regions continue to experience heavier traffic in marine shipping and exploration. The more convenient access to the arctic as a result of changing ice levels, and the increased competition for natural resources by different states, has focused the need for more unified and detailed regulation on the operation, safety and design of all vessels that operate in the polar environment.

Many kinds of Vessel operate near the poles, all of which are exposed to a number of unique demands. Ice exerts structural loads on the hull and propeller when keeping station, sea spray and atmospheric conditions can create an accumulation of icing on important deck equipment, and the safety and wellbeing of the crew when exposed to below freezing temperatures, not only in normal operation but also in emergency conditions, all have an impact on how a vessel is designed to operate. On top of this codes and standards need to reflect the growing exposure of vessels to these conditions, this is reflected in the growing momentum in updating the IMO Polar Code.

RINA invites classifications societies, shipyards, operators, surveyors and designers and anyone with an interest in the full of possibilities ship operation in ice, to submit papers on:

- Hull Design, Construction and Equipment
- Modelling of Ice Loads on Hull & Propeller
- Vessel Operation- Navigation and Station Keeping in ice flows
- Safety Systems- Emergency Response and Search & Rescue
- Crew Consideration / Human Factors
- Regulation- Standards & codes of good practice
- Ship Systems and Machinery for polar operation (heating, propulsion, engines etc)
- Environmental Systems consideration (Ballast Water Treatment, Ship emissions etc)
- Materials, Welds and Coatings

Selected papers may be published in the Transactions of the Royal Institution of Naval Architects

www.rina.org.uk/Ice_Class_Vessels

☐ I would like to offer a paper and attach a synopsis of no more than 250 words

☐ I wish to receive details on exhibition space and sponsorship opportunities

☐ I would like to receive a full programme brochure and registration form

Name: Position:

Company:

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Please return to: Conference Department, RINA, 8-9 Northumberland Street, London, WC2N 5DA
by fax on +44 (0)20 7259 5912 or by email: conference@rina.org.uk

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