THE NAVAL ARCHITECT

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Green ships / CAD/CAM / CFD

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THE 8TH INTERNATIONAL EXHIBITION ON
SHIPBUILDING, SHIPPING AND OFFSHORE TECHNOLOGY

24-26/2/2016
National Convention Center (NCC)
Me Tri, Tu Liem, Hanoi, Vietnam

VIETSHIP 2016

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The Royal Institution of Naval Architects

Human Factors 2016

28-29 September 2016, London, UK

Call for Papers

The work of naval architects and marine engineers directly influence the operability and safety of the vessel and the seafarer. Decisions made at the design stage can influence human behaviour and health. And an improved understanding of ergonomics by engineers can 'design out' hazards and prevent incidents, both to the individual and the vessel.

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The Royal Institution of Naval Architects

Intellectual Property Rights and the Naval Architect

22nd June 2016, RINA HQ, London, UK

One Day Seminar

Intellectual Property Rights (IPR) are an increasingly important part of a company's value. As developed countries move to knowledge based economies, protection of IPR becomes both more difficult and more important for designer, particularly in a more competetive market. In a global marketplace, international protection of IPR is complex and generally not well understood in sectors of the maritime industry.

The one-day Seminar on IPR and the Naval Architect will provide designers, and others involved in the marine industry, with an understanding of IPR law and the extent to which it protects inventions and designs. The seminar will consist of a number of sessions in which presentations on various aspects of IPR will be given by experts and practictioners, followed by discussion.

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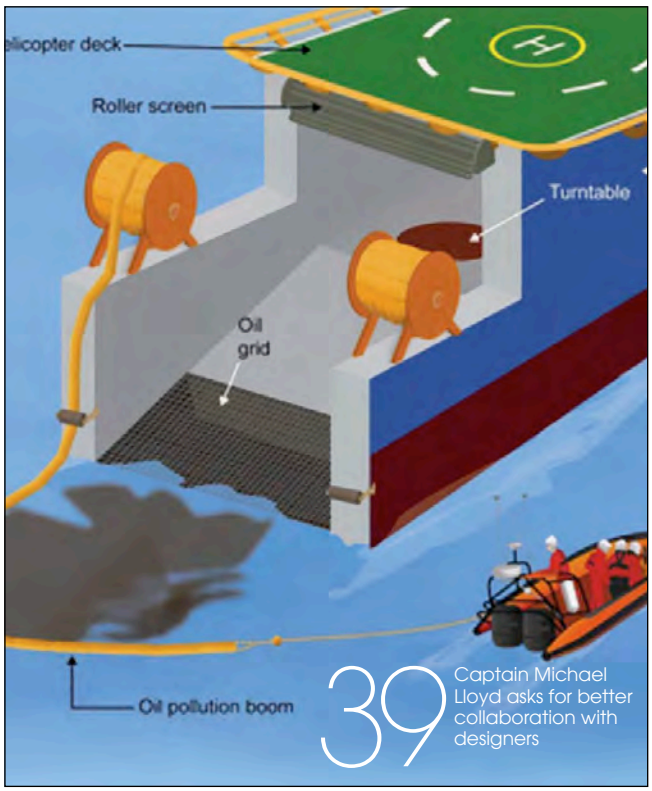

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International Conference:

Innovations in Small Craft Technology

13-14 April 2016, London, UK

Call for Papers

Few sectors of the maritime industry have seen greater innovation in design than the small craft sector. Both commercial and recreational small craft have benefited from the inspirational ideas of designers - ideas which although perhaps considered revolutionary at the time, have had a longstanding impact on the design of small craft today. This conference aims to review the new and innovative technologies available to the small craft designer and builder.

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The Royal Institution of Naval Architects

Design & Operation of

Ferries & Ro-Pax Vessels

25-26 May 2016, London, UK

Call for Papers

The last 10 years have seen a steady continued growth in the passenger ferry and Ro-Pax market, with particularly strong growth in passenger numbers. Despite the recent freight market downturn there is political pressure, particularly in Europe, to move more road traffic to intermodal maritime based logistics chain the so called “motorways of the sea” but these vessels are often still competing with fixed links (tunnels & bridges) and the budget airlines.

This conference seeks to investigate the curret trends in the design and operation of Passenger ferries and Ro-Pax vessels. Especially as designers have to cope with varying mixes of freight and passenger cars, depending upon the route and season.

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Suffering a sea change

A growing green lobby demands nothing less than decisive action against climate change from the transport sector

For some years now the mood of governments in general and the population around the globe has turned markedly against those that pollute the environment, and that includes the emission of greenhouse gases. Some industries such as the maritime and aviation sectors are finding that the pressure for change is now irresistible.

However, in the case of the maritime sector, the regulator, the IMO has yet to create and adopt the rules that are necessary to tackle the issues of environmental protection and global warming.

The issues around common but differentiated responsibilities (CBDR) have never been adequately dealt with, as emerging economies believe that an opt out of any market-based regulation, or at least a reduction on the impact of such rules, are necessary for these poorer countries. For their part the more mature economies have argued that any differentiation in carbon costs between flag states would be unworkable, as owners would simply re-flag their vessels to the cheaper registry.

This impasse over the CBDR and the market-based measures has persisted now since 1997 when the Kyoto Agreement was signed, and the IMO appears to be no nearer resolving the issue than it was some 18 years ago.

Discussions and an eventual agreement at the recent Paris meeting, the Conference of the Parties, the so-called COP21 discussions on climate change, omitted both the aviation and maritime industries from the final agreement that was signed and hailed by many as a breakthrough.

According to some environmental groups the omission of the transport sector from the eventual deal introduces uncertainty into the equation as it is now unclear whether the IMO, in the maritime industry's case and the International Civil Aviation Organization (ICAO) for the airline industry, are still the responsible bodies for globally regulating the reduction of carbon emissions from these critical industries. The result may well be the introduction of regional regulation to be enforced on the maritime and aviation sectors in order that the increase in average global temperatures do not exceed the 1.5°C target set by the COP21 agreement.

It is argued that the maritime industry is best regulated by an international body such as the IMO, rather than being subject to piecemeal regulation which may introduce differing standards of safety and which complicate matters for commercial shipping. However, the failure of the international body to gain agreement on a market-based measure of any kind in nearly two decades could have brought the very situation that shipping has most wanted to avoid into sharp focus.

Perhaps the lessons of the Ballast Water Management Convention (BWMC) have not been learned. The BWMC was agreed in February 2004 after some 14 years of negotiations. Since the adoption of the convention owners have sought changes to the rules, with some justification, particularly regarding the measurements of invasive species remaining active following the treatment of ballast water. The prolonged discussions have allowed the US to develop its own regulation regarding the treatment of ballast water which is different to the IMO and now it seems that the western coastal states may have a more stringent version of the rules than the US East Coast states, leaving owners with up to three different sets of ballast water rules to meet.

In order for the IMO to retain a leading role in the creation of rules for the maritime sector it will need to respond rapidly to the challenge of being omitted from the final COP21 agreement.

Given the democratic processes which govern the work of the IMO and other UN Agencies, the creation of regulation at the IMO is anything but rapid, as most observers of the organisation will confirm. However, a sea-change will have to come if the maritime industry is to avoid another damaging, lengthy debate as happened with the BWMC. Some progress has been made, with the introduction of the Energy Efficiency Design Index and the NOx and SOx regulations coming into force; but many consider this not to be enough.

Action against climate change must be decisive and seen to be effective. Nothing less will satisfy the growing lobby that perceives, rightly or wrongly, that the industry is shirking its responsibilities. For these changes to occur it may be that the IMO will have to change the way that it introduces regulations in order to significantly speed up the process, and for nations to ratify adopted rules in a more timely fashion. That would indeed be a welcome sea change. *NA*

Mergers

COSCO/CSC merger given green light

Successful discussions leading to the merger of China's two biggest shipping corporations, COSCO and China Shipping Containerlines (CSC), could open the door for the merger of the country's two largest shipbuilding groups.

A succession of State Owned Enterprises (SOE) have been restructured in the light of sluggishness in the global economic system, including steel and metal producers, the Metallurgical Corporation of China and Minmetals Corporation, along with rolling stock manufacturers CNR and CSR.

Merger of the SOEs has been a long standing government ambition according to local sources and the agreement to merge the two shipping companies has come as no surprise, though there still needs to be some clarity of the situation with the respective lines' alliance partners.

The merged group will be named the China COSCO Shipping Group and it is thought that it will form the world's fourth largest container shipping line after Maersk Line, MSC and CMA CGM with the French operator also rumoured to be in merger negotiations with the Singapore liner operator NOL. The new line will operate a combined fleet of 331 container ships and the two companies will also merge their dry bulk and port operations with the combined total value estimated at US$20 billion.

Reports in China suggest that now that the agreement over the COSCO/CSC merger is all but completed the government will turn its attentions to the shipbuilding sector, which is dominated by the China State Shipbuilding Corporation (CSSC) and the China Shipbuilding Industry Corporation (CSIC). These two SOEs were created from a single entity some 15 years ago during what the Chinese call 'the golden time', when shipyards were full and the global economy was riding the crest of a consumer wave.

Now that the golden time has ended Beijing believes it is time for these two massive corporations to re-merge as the shipbuilding industry undergoes massive changes, not least the rising cost of labour, which has tripled over the last 10 years and is continuing to increase.

Containerships

Ordering boom to end

Ordering of Very Large Container Carriers (VLCCs) is set to end this year as the owners have taken advantage of low yard prices and sought to order tonnage before the regulations requiring newly ordered ships to meet Tier III regulations come into effect, regulations which will limit the amount of NOx that the vessels can emit.

Tier III rules will apply to Emission Control Areas (ECA) from 1 January this year and MARIC, the Marine Design and Research Institute of China, believes there could be a significant slowing of vessel orders following the rush to beat the deadline for new orders, which will require that the new ships ordered to date meet Tier II regulations only.

According to DNV GL, Tier II rules were comparatively simple to meet by retuning the engine; however, Tier III rules will reduce NOx emissions by a further 76% over Tier II regulations, meaning that owners will need to fit Selective Catalytic Reduction (SCR) or Exhaust Gas Recirculation technology or switch to LNG as a fuel to achieve the required reductions in NOx emissions.

According to MARIC, from this year the focus for containerships and their design will be on flexibility and the VLCCs can only be deployed on the Asia/Europe trades, making the vessels inflexible for a modern market.

Maersk and CMA CGM made a great deal of money in 2013 with the lower slot costs available to them through their very large ships, but MSC also operated at a profit with its fleet of 13,000-14,000TEU ships. MARIC believes that this intermediate size may well become the workhorse of the trades between Asia and Europe as the larger vessels are only more competitive if they are full.

In addition, MARIC is preparing for what it believes will be a slew of orders in the feeder sizes as the feeder fleet is aging and there will be a need for vessels in the 1,000-1,800TEU range, particularly for the burgeoning intra-Asia trades.

Ferries

Hesitant yard ponders ferry order

Shandong shipyard Huanghai has been negotiating with an unknown European operator for a ferry order that could be for as many as eight ferries. The deal is for four vessels with two options and a further two options, a so-called 4+2+2 order.

However, *The Naval Architect* understands that the yard is hesitating to sign the deal as the price for the vessels is too low and it would not allow the yard to meet its revenue targets, which would see it cover its costs.

Further negotiations are anticipated to take place early next year with the deal if it is concluded expected to be announced within the first month or two of 2016.

Huanghai is one of a number of Chinese yards looking to move into new shipbuilding areas as the work for its main products such as fishing vessels and bulk carriers of up to 50,000dwt, a size set by the 7m draught limitation at the yard, has dried up. However, the yard is still working to fulfil orders for five multi-purpose vessels that are for German owners.

Huanghai says it is experienced in the building of ferries, having built vessels that replaced the older vessels

SENER

Photo: Courtesy Havyard Rijeka

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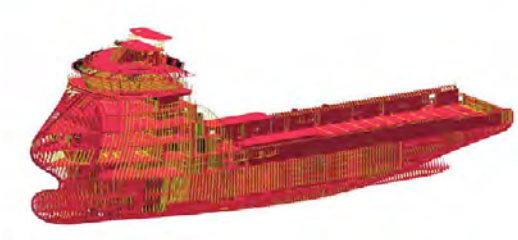

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on the China to South Korea services and also the Bohai ferry operating within China. The first new ferries on the Korean route following the *Sewol* tragedy were built at Huanghai, and the yard is keen to develop its experience in this field in order to move into the cruise market at a later date.

A number of Chinese yards are looking at the possibility of developing a cruise business with the private offshore construction yard CIMC Raffles, which is also keen on entering the market, citing its existing experience in the mega-yacht market as a base for launching a cruise business.

Meanwhile, SDARI is also positioning itself as the main cruiseship designer in the China market, working on a number of designs with yards following the deal struck late last year by Carnival, Fincantieri and Chinese President Xi Jingping. Shanghai Waigaoqiao Shipbuilding company is widely expected to build the first Chinese cruiseship within the coming years.

Stern tubes

Salt water stern tubes take off

Norwegian and German class society DNV GL is set to update its rules governing the use of salt water lubricated stern tubes which require owners to remove and inspect the bearings every five years.

From this month DNV GL has introduced a system that will use sensors that measure stern tube wear each time the propeller shaft stops turning, allowing the crew to monitor the condition of the bearing without removal and also giving the owner the opportunity to plan maintenance.

Arun Sethumadhavan, DNV GL Principal Engineer for machinery and systems, told *The Naval Architect*: "This is a unique system that shows the bearing interaction and gives an indication of shaft wear [without removing the shaft]."

Other class societies, such as Lloyd's Register, have already updated their rules and Bureau Veritas and the China Classification Society will update their rules this month, but the DNV GL system offers owners a more comprehensive service, the class society believes.

The US Environmental Protection Agency's decision in 2013 to introduce the Vessel General Permit, which regulates the lube oil emitted from the stern tubes of commercial vessels, will be reviewed every five years.

Regulation has boosted enquiries into the use of salt water lubricated stern tubes, which eliminate the possibility of any oil leakage and subsequent penalties from the US authorities.

However, sales of salt water lubricated stern tubes were still hampered by the requirement from class societies to remove the stern tubes every five years for inspection of wear and corrosion. With this limitation lifted, the sales are now "picking up some momentum," said Thordon Bearings director of marketing, Craig Carter.

Big Data

Too hot to handle

Vast amounts of data are now available to owners and operators in real time, so much data in fact that there is a need to develop software to monitor and analyse it, according to ClassNK CEO and Chairman Norubu Ueda.

According to Ueda, today's owners have access to an incredible amount of data that allows an operator to monitor almost every aspect of vessel performance in real time.

"With so much data now available to us the challenge is how to efficiently and securely manage this data," Ueda said. He added that ClassNK help the industry manage this mountain of data through its own software solutions.

ClassNK CMAXS is a planned maintenance and condition based monitoring system developed in collaboration with major shipyards, engine makers, and generator manufacturers. Using the flow, pressure and temperature sensors that are already installed on all engines and pumps in the engine room the software collects real-time condition data.

"Data is analysed using IBM's sophisticated algorithm, which then translates the data into valuable recommendations." However, CMAXS can combine data from different sensors, forming linear and non-linear estimates to provide a more comprehensive analysis.

These valuable recommendations are then made accessible to all concerned parties including shipowners, manufacturers, management companies and crew, both shore side and at sea, via cloud computing, Ueda explains. He went on to say: "This means that when an issue arises, crew can handle it immediately, no matter where they are in the world, and shipowners can know the condition of their ship's engine room anytime, anywhere."

The technology aims to detect potential damage early, minimising downtime and reducing repairs. Machinery maintenance and replacement intervals are carefully calculated, helping users realise a notable reduction in total life cycle costs.

"Looking forward, CMAXS also has the potential to simplify our surveys in the future by enabling us to monitor the condition of the machinery remotely and dispatch surveyors only when necessary."

CMAXS is currently undergoing trials on 11 vessels from eight different shipping companies with trials due to be completed in spring 2016, after which it is scheduled to be launched onto the market. *NA*

Shipping's COP out

With the gathering of the great and the good in Paris for the COP21 climate summit, the role played by shipping at the conference was always one that might be eclipsed by the large number of international players present, *writes Sandra Speares*.

Ahead of the conference there were conflicting reports as to the role played by shipping in contributing to CO_2 emissions with many shipping observers not being particularly positive about the likely outcome of discussions in Paris. Shipping and aviation has now been left out of the draft agreed on 12 December.

One area of dispute ahead of the deal was the size of shipping's contribution to global CO_2 emissions, with a study by the European Parliament suggesting that shipping's share could amount to 17% in 2050 if no action was taken to deal with the situation.

If green lobby groups had described shipping emissions as an "elephant" in the negotiations' room on emissions at COP21, the elephant now appears to have been left out of the draft agreement altogether, although some argue that shipping's compliance is implied and also stress the industry is making great strides to address the issue.

The green lobby has not been happy to see shipping and aviation left out of the draft text at COP21. "Without inclusion of ship GHG emissions in the Paris agreement and significant additional action to reduce emissions, shipping will consume a growing proportion of the two degree carbon budget and ultimately make it all but impossible to meet climate stabilisation targets," some lobby groups suggested.

NGOs Seas at Risk, Carbon Market Watch and Transport & Environment believe aviation and shipping "could make up 39% of world CO_2 emissions in 2050 if left unregulated", and "if treated as countries, global aviation and shipping would both make the list of top 10 emitters."

"The agreement now leaves it unclear which actors have responsibility to reduce emissions from these sectors. If the International Civil Aviation Organization (ICAO) and IMO wish to retain a role, they must urgently scale up their ambition. Otherwise states and regional actors will have a right to adopt measures to ensure these sectors contribute to the 1.5°C target", said Andrew Murphy, aviation and shipping officer at Transport & Environment.

European shipowners, along with the EC, MEPs and various stakeholders were among those calling for shipping to be brought back into the COP21 text ahead of the agreement. "We firmly believe that deleting any reference to shipping and the progress needed at IMO level is a missed opportunity. The EU has already placed its faith in the IMO process by adopting legislation that will enable and support IMO in establishing a global data collection scheme", said Patrick Verhoeven, European Community Shipowners Association secretary general, before the agreement was reached.

Following the conclusion of the agreement, attention has now turned to next steps. "Following the adoption in 2011 of measures to increase the energy efficiency of the industry, the agreed next step is a global data collection system of CO_2 emissions", says Verhoeven. "The governments in IMO will resume discussions on such a system in April next year, with the aim of ascertaining the real contribution of international shipping to global CO_2 emissions. We strongly encourage all parties to ensure that these discussions lead to the establishment, as soon as possible, of a mandatory data collection system."

Once the data collection system is in place, the IMO will be able to decide on steps ahead. He underlined the importance of a global partnership at IMO "as no regional solution could ever guarantee global emission reductions or a global level playing field for shipping. The EU has adopted regulation that is meant to facilitate and precipitate a global solution for CO_2 emissions from ships. It is now time to translate these commitments into a global agreement".

In welcoming the draft agreement, the International Chamber of Shipping (ICS) commented: "The shipping industry remains committed to ambitious CO_2 emission reduction across the entire world merchant fleet, reducing CO_2 per tonne-km by at least 50% before 2050 compared to 2007."

Discussions are due to resume at IMO's Marine Environment Protection Committee meeting in April next year with a view to trying to agree a CO_2 reduction target for shipping. The ICS says it is also pushing for IMO to finalise a global CO_2 data collection system for ships, which ICS would like to see mandatory as soon as possible, prior to IMO deciding on the necessity of additional actions such as developing a Market Based Measure.

The shipowners' body maintains that dramatic CO_2 reductions from shipping will only be guaranteed if further regulation continues to be led by IMO. "CO_2 is a global problem and shipping is a global industry," said ICS secretary general Peter Hinchliffe. "IMO is the only forum which can take account of the UN principle of 'differentiation' while requiring all ships to apply the same CO_2 reduction measures, regardless of their flag state." Unilateral or regional regulation would be disastrous he added.

"Time finally ran out to agree a compromise on international transport acceptable to all nations, but nothing is really lost. No text is probably preferable to some of the well intentioned words being proposed at the very end of the Conference, which few people understood and which could have actually greatly complicated further progress at IMO," Hinchliffe insisted. *NA*

Energy storage

Saft system for 140m cable-layer

An ABB cable-laying vessel, known as the *SALT 306 CLV-design*, will be the first in the world to be fitted with a new generation liquid cooled high power Li-ion battery system from Saft that will help the vessel meet new emissions regulations.

The Li-ion Super Phosphate (SLFP) battery system has a 70kWh capacity that will mainly be used to assist the outloading of cable from the dock onto the 140m long vessel's turntables. This use is a response to new emissions regulations that stipulate a vessel's diesel engines must not be run while docked.

Saft claims that their battery system's cylindrical cell technology with liquid cooling offers significant advantages when compared with other air-cooled Li-ion technologies in high power applications, including "a wider operating temperature range; higher cycling capability; better battery level temperature control; improved abuse tolerance; better safety compared to other Li-ion chemistries."

The system will deliver "effective energy storage for backup in cable loading and propulsion assistance, helping to cut the vessel's fuel consumption by 27% and reducing maintenance compared with traditional AC systems," according to Saft. It will also be capable of peak shaving when propulsion power for the diesel-electric vessel needs to be rapidly increased.

Saft will develop and manufacture their battery system for the cable-laying vessel in France, and are scheduled to deliver the system in the last quarter of 2016. The cable-laying vessel is under construction at Kleven Shipyard, Norway, and is scheduled for delivery in 2017.

www.saftbatteries.com

Deck Equipment

Ongoing success in South Korea

MacGregor, part of Cargotec, has been contracted for a series of ro-ro access equipment packages and deck machinery orders for vessels that are under construction at docks including Hyundai Mipo Dockyard (HMD), and by the Hyundai Group and Sungdong Shipbuilding & Marine Engineering, South Korea.

The ro-ro access equipment packages will feature on the world's largest commercial ro-ro carriers, two post-Panamax 8,000 lane metre ro-ro carriers currently being built for the Luxembourg-based operator CLdN (Cobelfret). Each package has a gross weight of 2,200tonnes and comprises a stern ramp, internal ramps, bulkhead doors and four levels of hoistable electrically-operated car decks. The vessels are expected to enter service in 2017.

MacGregor has also secured orders for Pusnes deck machinery packages that have been specified for different ship types. These include 12 VLCCs; four Suezmax tankers; six LPG carriers; one LEG carrier; two long-range 75,000dwt product tankers; and one LNG/FSRU carrier. According to MacGregor: "Most of the deck machinery will be based on the renowned Pusnes high-pressure ring-main hydraulic system. One shipset will be based on a Pusnes frequency controlled (VFD) electric system."

MacGregor will be responsible for the design, contract management and supply of all key component and will make equipment deliveries into 2017.

www.cargotec.com

Pusnes deck machinery

Coatings

Two beats three for PPG

PPG has unveiled a new cargo tank coating that will offer efficiency gains of over 20% when compared with traditional three-layer coating systems, benefitting shipyards and owners and operators alike, according to the marine coatings company.

The two-coat phenolic epoxy system Phenguard Pro has been developed from Phenguard, an existing coating system that has been used by those in the chemical tanker market for 40 years and on over 1,500 vessels. It marks a response to demand in the IMO II/III product/chemical tanker segment and promises to maximise cargo flexibility while improving the efficiency of application, according to PPG. The coating is appropriate for newbuilding and refurbishment projects and boasts improved cleaning times because of the smooth finish it achieves.

PPG's global marketing manager, marine, Sijmen Visser, says: "Phenguard Pro achieves in two layers of 125 microns, what all other tank linings can only achieve in three. The coating system can be applied in temperatures down to 5˚C making it an 'all year round' solution that reduces the costs of heating for winter application."

www.ppg.com

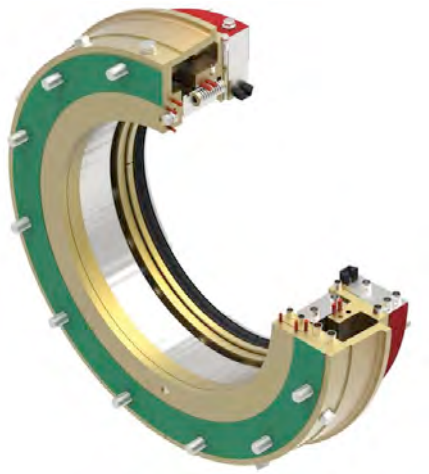
Seals & bearings

New fully diveable seal

Wärtsilä has introduced a new seal that can be fully serviced underwater without the use of a habitat, the first seal of its kind to do so.

The Sternguard In-Water Serviceable Seal (IWSS) is a fully split, oil-lubricated outboard face type seal that aims to minimise overhaul downtime and costs, and is available for stern tubes and thrusters.

Wärtsilä Sternguard In-Water Serviceable Seal. Caption: Wärtsilä's Sternguard In-Water Serviceable Seal (IWSS)



The seal can be used to retrofit any other type of seal and is available for merchant, offshore, IWW, cruise and ferry vessel types. According to Wärtsilä, it is not necessary to remove the propeller or shaft during retrofit and service in dry dock, or to drain oil from the stern tube for underwater overhaul. The seal runs on Environmentally Accepted Lubricants (EALs) or mineral oils and features an inflatable emergency seal and inner rope guard for enhanced protection.

Director of seals and bearings, Wärtsilä, Damian O'Toole, says: "With its easy retrofit and serviceability, this unique new seal offers flexibility of operations to customers across industries. At the same time, additional safety features ensure continuous reliability."

www.wartsila.com

Seals & bearings

ABB upgrades for ice

ABB, automation and technology group, has developed its existing Hybrid Bearing solution for ice-going vessels and has focused on maintainability in ice with a slewing seal that can be changed from inside the vessel.

The Hybrid Bearing solution, which has been used on open water vessels for over three years, has been re-developed for use onboard ice-going vessels. Mirva Nevalainen, product manager, Azipod X/V, propulsion products, ABB, says: "We wanted to gather operating experience from open water vessels first before expanding the technology to ice-going vessels."

Following the success of the technology, which Nevalainen says: "exceeded expectations for the open water vessels in operation," the principle of the solution was kept the same, but refocused for designs operating in ice. This involved considering different loading conditions in ice operations, including ice block impacts, ice milling and the possibility of propellers stopping in ice. Nevalainen adds: "We base the knowledge [of different loading conditions] on long term full scale load measurements we have been conducting."

ABB has also designed a new type of slewing seal that can be replaced from inside the Azipod room of the vessel. This development comes as ABB focusses on the maintainability of ice-going vessels, and means that the seal can be changed without drydocking, saving on unnecessary stops and costly repairs.

In previous designs it was necessary to disassemble the top of the Azipod unit to access the slewing seal, but ABB's new design allows for the seal to be split and for the bonding of the seal to be carried out in the Azipod room without disassembly.

www.abb.com

Pistons

Oil consumption cut

Federal-Mogul Powertrain, a division of Federal-Mogul Holdings Corporation, has developed a new piston ring for two-stroke diesel engines that will substantially reduce oil consumption and marine pollution.

The new eWAVE ring has been designed to distribute oil more evenly around cylinder bores through a patented "surface topography" that means less oil can provide greater protection, according to the company.

Richard Mittler, Federal-Mogul's senior expert manager, analysis and product development, technology, rings & liners, says: "eWAVE is the first ring that disperses oil around the bore in a homogenous layer, protecting against local oil film breakdown, improving the sealing of combustion gases, reducing wear and ensuring more uniform liner temperatures."

He continues: "This means the amount of oil injected into the cylinder can be greatly reduced and, because two-stroke engines expel their lubricant in the exhaust, less oil means lower carbon emissions as well as reduced operating costs."

Long-term trials, amounting to 8,000 hours of testing of the piston ring design, have shown improved resistance, according to the company, as well as a reduction in oil consumption by up to 20%.

www.federalmogul.com

CAD/CAM

Experiencing design

Dassault Systèmes has launched Solidworks 2016 to bring design into what it calls the "Age of Experience", deploying new features, enhanced capabilities and a user-friendly interface that will ease some of the complexities of the design process for designers using its 3D experience platform.

Alain Houard, vice president, marine & offshore, Dassault Systèmes, says that the new software brings a holistic design process that makes it possible "to design an optimised ship from all angles".

It aims to bring various departments of design, such as those working on ship structures, pipe lines or electrical lines, into closer collaboration through the software's design cloud, unifying compartmentalised design departments with the design of the ship as a whole and aiding the communication process between designers and other players in the design process, including manufacturing.

The new software carries a number of benefits in addition to making design changes easily observed, according to the company. These include not needing to duplicate what has already been created, providing modelling capabilities of all kinds, from electronics to glue, and the ability to quickly create the basic design of ships. The new software also means that 2D drawings no longer have to be made by hand, and are instead made automatically from detailed 3D renderings.

In addition, the system can automatically take into account the moving of a component, such as the engine, in relation to the ship as a whole, and, according to Houard, offers increased customisation that will improve functionality for designers.

www.3ds.com

Engines

Tier III engine launched at Marintec

MAN Diesel & Turbo launched its MAN 175D high speed engine at December's Marintec show in Shanghai, China.

Dr Matthias Schlipf, 175D Project Manager, MAN Diesel & Turbo, said: "The MAN 175D is compact, reliable and efficient – essential properties that facilitate safe manoeuvrability in even the most challenging of weather conditions. Featuring the best power to weight ratio in its class, I'm confident it will find a ready market in China, especially within the workboat, patrol boat and yacht segments."

The MAN 175D engine meets the IMO's Tier III regulations

Originally launched in Europe towards the end of 2014, MAN Diesel & Turbo states that the 175D's Chinese release was in great part due to local requests for a large, high-speed engine.

The MAN 175D has a compact, modular selective catalytic reduction (SCR) system, based on the MAN Ad Blue technology that has undergone many thousands of hours of testing. As such the engine already satisfies the IMO's strict Tier III NOx standards

The 175D's straightforward design also makes it quick and uncomplicated for customers to initially start up the engine and carry out maintenance work.

MAN says it has geared the MAN 175D as part of a high-speed propulsion package with a gearbox as well as MAN propellers and shafts that will optimise efficiency.

www.mandiesel.co.uk

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SHIP ECONOMY & TRADE

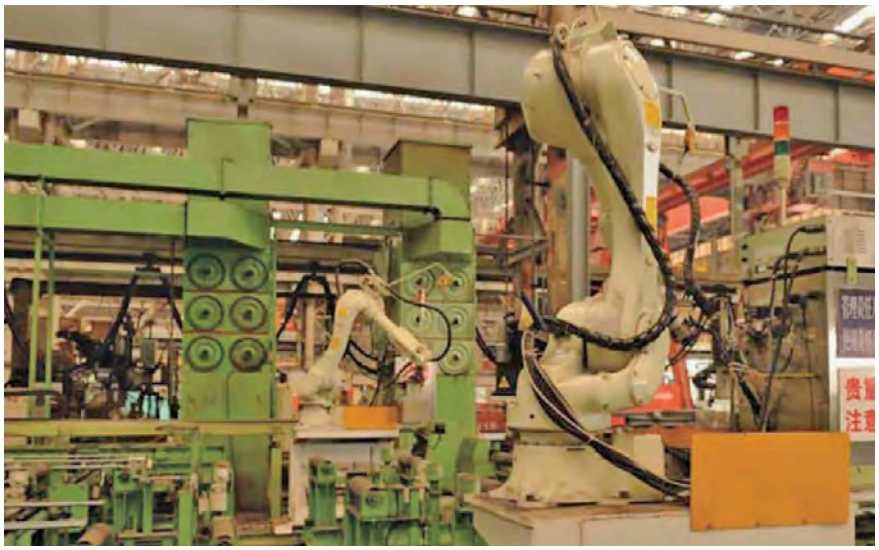
Jiangsu Province Shipbuilding Enterprises & smart manufacturing

Since the financial crisis, market competition in shipbuilding has become increasingly fierce, highlighting the importance of information and the information super-highway in the decision-making process, which transforms shipbuilding patterns and enhances competitiveness. Wu Xiuxia reports

At this time the Smart shipyards of NanTong, COSCO and KHI Ship Engineering (NACKS) are all part of the 2015 pilot project which is under the supervision of the Ministry of Industry and Information Technology. As the first smart shipbuilding pilot project this event is significant for conventional shipbuilding enterprises, integrating different high-tech and smart elements. This means that the idea of robot production is turning into a reality, which is inseparable from the in-depth integration of industrialisation and the information super-highway. It is predictable that smart manufacturing and digital manufacturing will bring about a new era for the shipbuilding industry.

Currently, the "China Manufacturing 2025" policy has been dedicated to the integration of the information super-highway and industrialisation. Experts in the field believe that the "China Manufacturing 2025" policy is to further deepen and upgrade the integration between these two trends. With the development of society and technology, the information super-highway has become an indispensable tool for management in the shipbuilding industry. Conventional shipbuilding has been increasingly replaced by the information super-highway, networking and the use of intelligent systems.

Domestic shipbuilding and the offshore industry must take advantage of the chance to enhance their competence in the information super-highway so that the industry can increase the pace of take-up in digital shipbuilding, which will ensure the competitive edge in terms of high-tech-high-value vessel and offshore competitive equipment, and will realise China's transformation from simply "made-in-China" to "smart manufactured-in-china".



Productivity is increasing with mechanisation which also improves quality

Smart approach to shipbuilding

With the help of information technology and its application in production, management and operation, Japan, South Korea and others have taken large numbers of orders, promoting their efficiency. Admittedly, China is a big country in terms of shipbuilding, although some of its products are considered to be cheap and low logo due to the lack of independent R&D, poor innovation, and the low degree of information and development competence.

At the end of last century, large scale state-owned enterprises (SOEs), such as Hudong-Zhonghua Shipbuilding (Group) Co., which is affiliated to CSSC and Jiangnan Shipbuilding, successfully built their own management information systems (MIS) and product information modules, thus realising the goal of parallel designing and promoting the development and application of Continuous Improvement and Monitoring Systems(CIMSs). They also introduced various shipbuilding manufacturing management systems at the same time. Many domestic private shipbuilding enterprises are also responding positively to this trend. Some large and medium-sized shipyards and designing entities established LAN, carrying out enterprise-level CIMS pilot work. Although these are preliminary attempts, they pave the way for future information super-highway development.

With the progression of the twelfth five year plan, China's shipbuilding industry has the foundation to become stronger and more competitive. Particularly after the financial crisis, the market became increasingly competitive, raising the significance of the information super-highway in the decision-making of shipbuilding enterprises. The information super-highway is significant for companies in terms of transforming shipbuilding patterns, enhancing competitiveness and qualification. Lots of shipbuilding

enterprises have made plans for future development in light of the information super-highway. They demonstrate unprecedented enthusiasm for the construction of the systems.

A private shipbuilding enterprise executive confirms the functions of the information super-highway construction, saying: "The fast expansion of enterprises has to be built with modern management tools". He points out that when new plants are under construction, involving hundreds of projects and billions of Yuan in capital, the workload can be finished within seconds. This is amazing compared with the 3-5 day work flow that is seen without the assistance from information super-highway management software. This is a great improvement for efficiency, but also represents an improvement in the accuracy of the data. Under manual conditions, it is impossible to input the raw material for as many as 20,000 to 30,000 types of steel and parts, not to mention the types and specifications exceeding 10,000 parts. But management software makes it possible to find out the inventory with a click, which can be as specific as the particular date's inventory, inventory capital turnover, fixed asset and depreciation value, etc.

The above become trivial changes after the application of the information super-highway on the management chain. With the trial operation of a digitalised national shipbuilding laboratory, and with the robot production line in operation in ship enterprises, plus a series of auto production lines featured with high efficiency and intellectualisation, more enterprises are combining the information super-highway with their development. With constant innovation and development, "smart manufacturing" has become a driving force for the "China Manufacturing 2025" policy. Liao Weiqun, vice president of Yangzijiang Shipbuilding Group, says, this year, Yangzijiang Shipbuilding is to further promote specified management projects, implementing "integration of information technology and industrialisation" policy into the ERP software management project, thus promoting product design, procurement and qualified delivery of ships.

Innovation-driven digitalised shipbuilding

With the establishment of modern shipbuilding, domestic shipbuilding enterprises have gained substantial impetus for their development. Different enterprises have turned their strategy from passive adaptation to active studying and application. Executives also give priority to the construction of the information super-highway, pooling much financial support and human resources into it in order to speed up the information process.

An executive from a mid-sized ship enterprise says that two years ago, in order to comply with industry standards, his enterprise had to make involuntary changes in order to survive. But now, with some favourable policies from the industry policy-makers, shipping industry enterprises have consciously invested capital in information construction, procuring a safer, more reliable and effective information process and consolidating their business. This will prove to be beneficial for the slack shipbuilding industry.

Jiangsu New Century Shipbuilding Group vice chairman, Zhu Bingkang, says: "Our group is to quicken the speed of digitalisation and construction. We should take advantage of advanced and applicable management systems, promote the modern shipbuilding management

Jiangsu New Century Shipbuilding Group is seeking to improve its competitiveness through increased digilisation

mode, therefore realising the integration of production resources, operational resources and construction resources, so that we can fulfil the mission of digital shipbuilding and the information super-highway." New Century Shipbuilding insists on innovation-driven development and maintains the sustainable development through "Internet-plus" policy implementation, modern information technology, organisation innovation and technological innovation.

Within recent years, Nantong COSCO KHI Ship Engineering (NACKS) is dedicated to CAD technology, successfully introducing TRIBON for designing and computer-integrated-manufacturing systems, and investing several times in information systems. Simultaneously, the company is developing its own R&D, with its application in such systems as Cost and Payment, PSPC, Fixed Assets, Cost Control, and Safe Information Management and Information Sharing. The development and application of these systems has greatly upgraded business management in terms of integration popularisation, automation, efficiency, management performance and lowering costs. The executive says that in the following stage, with the in-depth implementation of the twelfth five-year plan, the company is to focus on improving the computer integration competency, with much effort spent on TRIBON upgrading to AM12, the second development after its upgrading, ERP system improvement, FA projects, and robot development. It's also to reinforce its simulation experiments, verification and optimised technology studies and applications, increasing the pace of modern shipbuilding, digitalised shipbuilding, and enterprise upgrading.

Experts in the field suggest that, in the future, shipbuilding and offshore equipment manufacture should be a trinity of the information super-highway, automation and intellectualisation. Smart manufacturing is the outlet for competitiveness for the Chinese shipbuilding industry. It plays an essential role in improving production efficiency, product quality, lowering costs, industry upgrades and China's international competitive edge. However, it is worth mentioning that development of the information super-highway is a complicated process, which demands persistent effort instead of short term struggling. To realise digital shipbuilding we should increase the connectivity between design, production and management.

Experts also provide suggestions for this goal, namely comprehensive planning, implementation decomposition, and priority goals for which policy can emphasise the overall planning, information innovation systems and improve the connectivity between design systems and production management systems. An ideal carrying out of this strategy would avoid the trap of discrimination between tasks of minor and major importance, or disagreement between exterior and interior. A massive information process demands talents that master knowledge in shipbuilding, management, information technology or database technology, which is rare in China. How to train such talents, value them and retain them in the team is worthy of attention from leaders, and from the industry as a whole. *NA*

A systemic approach to energy management

As an Energy Technology graduate who was introduced to the details of maritime engines and turbines, of energy systems etc., my introduction into the field of naval architecture, focusing on one or two ships offering solutions to energy efficiency was a wake-up call, writes Francesco Baldi

At the start of my PhD studies at the department of Shipping and Marine Technology at Chalmers University of Technology in Gothenburg, Sweden, I had never seen a ship before. Nor did I know much about technical arrangements, or how the shipping business worked.

The very first thing that struck me was the limited extent of the work that had been done in this field at an academic level. Research studies about shipping are abundant, but only a few of them deal with energy efficiency. Out of those few, most relate to the field of hydrodynamics: optimisation of hull shapes and propeller designs, evaluation of different appendages such as Mewis Ducts or specially-designed rudders. Only a small amount of research evidence concerning the inner workings of the ship could be found.

At first sight, this is not surprising, given that marine fuel prices have been low for many years. Apart from the oil crisis between the 70s and the 80s, it is only in the late 90s that, driven by the rise in global demand and by stricter environmental regulations, marine bunker prices began to increase significantly. In addition, it is well known that propulsion constitutes the largest share of onboard power demand for most ship types, and especially for the common, large ships that research tends to focus on, such as tankers, bulk carriers, and containerships. In a world where energy efficiency had not been an issue until 10-20 years ago, why bother with what happens inside the ship?

Furthermore, diesel engines were, and still are, becoming more and more efficient in their conversion from fuel to mechanical power. There is no other thermal engine, no matter how big and highly technological it might be, that can rival large, two-stroke Diesel engines in their efficiency on the simple cycle. Out of the chemical energy entering the engine in the form of fuel, up to more than 50% is directly converted to mechanical power. Combined cycles based on gas and steam turbines, today considered the most efficient type of power plant for land-based applications, barely reach 55% efficiency in optimal conditions, while dropping quickly in performance as soon as the load on the system gets far from the design conditions.

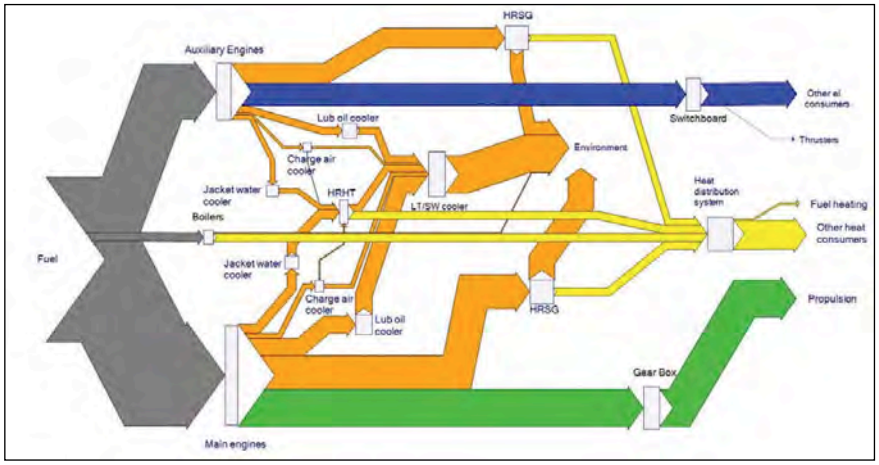
During five years of research, I used two ships as case studies, a chemical tanker and a passenger ship, where I looked in detail at questions related to energy efficiency in shipping, with a particular focus on addressing the problem with a systems perspective. As a consequence, I did not focus on any individual component, but rather looked at the entirety of the ship, and at how different elements of the system interacted with each other. Although it cannot be denied that ships built today are extremely efficient, especially when compared with other transport modes, we could still identify a substantial potential for improvement.

Waste heat from the engines

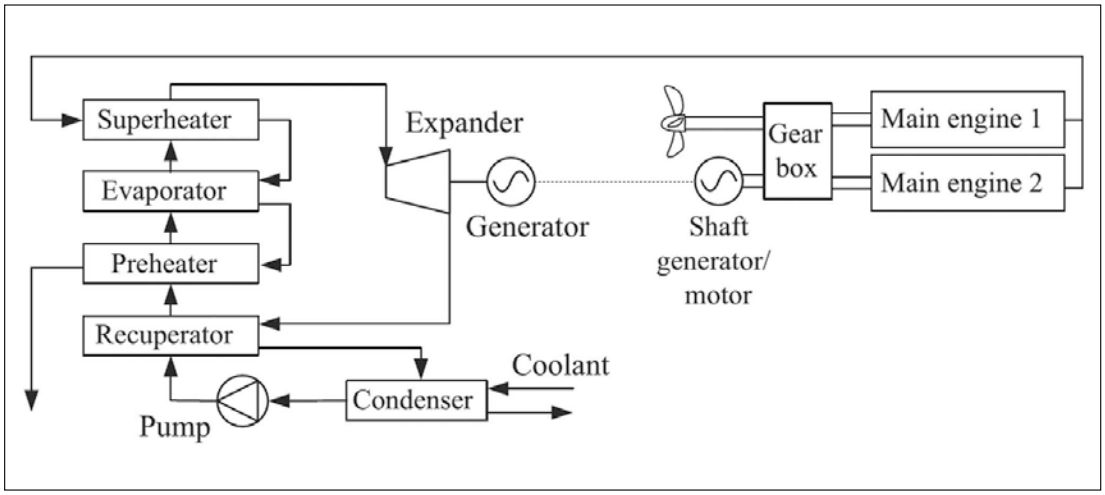
Now, 50% efficiency is quite a lot for an engine. But where does the remaining 50% go? The possibility for recovering exhaust heat from the main processes is normally referred to as waste heat recovery and is quite common on land-based applications, such as paper mills, refineries, and power plants. Most ships today employ exhaust gas boilers for recovering part of the heat that is rejected in the exhaust gas to fulfil onboard heat demand. That demand, however, is often very limited compared to the amount of energy that is wasted in the environment.

The amount of heat energy lost to the environment varies from ship to ship and it is not easy to draw conclusions that are valid on a general basis. However, in the two case studies the answer was clear: energy still available in the exhaust gas was significant.

In the case of the chemical tanker, in particular, calculations suggested that the heat demand is remarkably lower compared to the heat emitted to the environment. In



Representation of the energy flows on the studied passenger vessel over one year of operation. The high relevance of auxiliary heat and power demand can be observed, as well as the large amount of heat available for recovery



Schematic representation of the WHR that we evaluated for installation on a chemical tanker

particular, only 5% to 20% of the heat wasted in the exhaust gas alone is needed for onboard heat demand.

Waste heat recovery based on the Rankine cycle, where waste heat is used in the evaporation of water to steam, which is then expanded in a turbine to generate electric power, is today only applied to a handful of vessels. When the potential for using the extra heat in the exhaust gas using a Rankine cycle (in particular an Organic Rankine Cycle, which generally shows higher performance for this size and temperature levels) was tested on the chemical tanker, nearly 9% of the annual fuel consumption could be avoided thanks to the higher performance.

This figure could become even larger in the future, such as when distillate fuels are used instead of heavy fuel oil, as onboard heat demand becomes lower, because the fuel does not require heating any longer. In addition, the lower sulphur content allows the exploitation of the waste heat in the exhaust gas to an even larger extent, as sulphuric acid condensation does not represent an issue any more.

The same analysis on the passenger vessel, performed by our colleagues at Linneus University in Kalmar, led to smaller, but still remarkable savings of 4% fuel per year. Passenger vessels, especially when they are operated in cold areas such as in the Baltic Sea, have a much higher heating demand for accommodation which reduces the amount of heat available for further use onboard.

It should also be noted that these calculations only included the heat available in the exhaust gas. The heat rejected in the cooling systems is also a potential source of recoverable energy, despite its low temperature which is generally limited to around 90°C. Although this does not make it very attractive as a first choice for heat recovery, its large quantity could still improve the overall performance by a couple of percentage points.

Heat demand

For a handful of ship types, such as cruiseships or LNG carriers, heat demand represents an important part of the total power demand. For most other vessels, however, heat often represents a small share of the energy demand of a ship and is therefore seldom the subject of in-depth analysis and optimisation processes.

As it appears, however, scratching below the surface allows the identification of a number of potential improvements in relation to the management of heat demand.

When looking at the chemical tanker, we noticed that roughly 4% of the annual fuel consumption came from the auxiliary, oil-fired boilers. This quantity, although being low, was quite puzzling as the boilers are only used for tank-cleaning and in port. In practice, this relatively high boiler fuel consumption results from the fact that the ship operates in port for a large share of its total operative time (around 30%), which makes fuel consumption during port stays become relevant on the yearly balance sheet.

Turning once again to experience from land-based energy systems, it can be seen that the imbalance between heat availability and demand over time is by no means exclusive to shipping. Solar-based heating suffers similar problems: the sun shines only during daytime while heat is needed over the whole day. Such situations can be addressed by the use of thermal energy storage, i.e. saving some of the heat when it exceeds demand (when the ship is sailing) and using it when the available heat is not sufficient to meet demand.

Could thermal energy storage be applied to shipping? When we simulated this possibility for the chemical tanker we noticed that in theory all of the boiler fuel consumption could be avoided, but this would require heat storage not available in a realistic application. When imposing a realistic limit volume available for the storage medium, we estimated that roughly 60% savings on annual boiler fuel consumption is achievable in realistic conditions.

This might appear to be small savings compared to the annual fuel consumption of boilers and engines, but it would constitute a retrofitting option with low investment costs and a short payback time. The application of the same type of system to the passenger vessel achieved similar results. In this case duration in port is lower while heat demand is higher. Although the uncertainties on the instantaneous heat demand suggest that results should be taken with a pinch of salt, the savings in this case were estimated at 2-3% of the yearly fuel consumption. Also in this case, although the potential might appear low, it could be achieved with a relatively low investment cost.

Benefits of a systems perspective

The examples above show where current ship energy systems can be improved yielding savings of 2-10% of annual fuel

consumption. However, ships of the future are required to reduce their total fuel consumption by far more than 10%. According to the latest IMO Greenhouse Gas report, emissions of carbon dioxide from shipping will increase dramatically in the coming 40 years, mainly as a result of the increase in maritime transport demand. Of the 16 scenarios analysed in the report, only one predicted a reduction of shipping-related CO_2 emissions by 2050, while the other scenarios depicted a much more gloomy future where these emissions will increase by up to more than 200% compared to 2012 values.

On the other hand, researchers from the Tyndall Centre in UK calculated that, in order to achieve the 2°C climate goal, shipping will need to reduce its GHG emissions by more than 80% by 2050.

Such an ambitious goal will require not just one solution, but many different technologies. Fuels generated from biomasses, sails, ultra-slow-steaming, unmanned vessels, are just some of the different technical solutions that will allow the industry to achieve nearly carbon-free shipping.

As a result of the use of such a variety of diverse technologies onboard, the energy system of a ship will resemble more and more that of a small community. A wide number of energy sources and demands, part of which are intermittent, will be connected to one common network. Such a system will require very accurate planning to avoid the optimisation of some of its parts leading to the sub-optimal performance of others. In more general terms ship design would benefit from a renewed and stronger focus on systems engineering, at least as far as the design of the energy system is concerned.

To make the point clearer, it is necessary to look at the ro-pax vessel sailing in the Baltic Sea. Parallel to Diesel engines, powered by methanol, fuel cells will be used to contribute to auxiliary power generation. Propulsion power will be provided, in addition to the propellers, by four Flettner rotors. The exhaust heat from the prime movers will be used for several purposes onboard: heat demand for common spaces and cabins, absorption chillers for cooling and chilling purposes and for contributing to auxiliary power demand using a Rankine cycle.

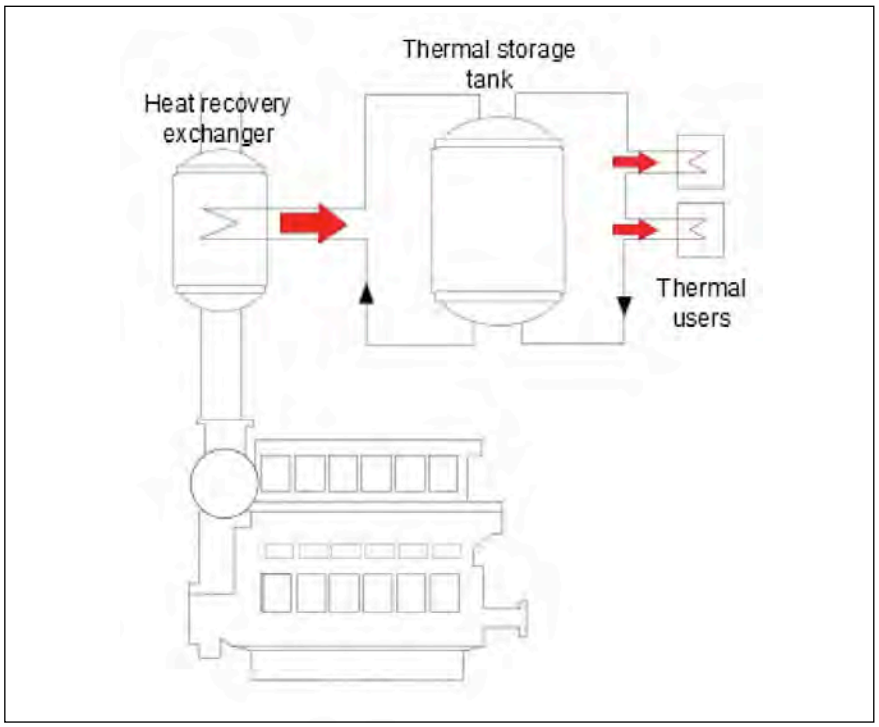
Part of the energy will be stored in a medium-temperature latent heat storage system, to be used for keeping both fuel cells and engines warm during the port stay and for the remaining heat demand when in port, to avoid using standard boilers. On the vessel, a voyage optimisation system will constantly micro-manage heading and speed to reduce propulsion power requirements to a minimum, while the onboard energy management system will have to constantly allocate mechanical, electrical and thermal demand to the different available prime movers and recovery systems.

This will require the definition of optimal control strategies, including not only considerations about energy efficiency, but also safety, reliability, redundancy, and all other aspects of the system engineering design process. The design of such a system will constitute a challenge that the shipbuilding industry will have to deal with in the future.

In this regard, advanced energy systems modelling will represent a requirement for appropriate and efficient ship designs. The advances in computational performance experienced in the last 30 years allows even personal computers to perform complex system simulations in a reasonable amount of time, to the point that global system optimisation is not just a dream.

Attempts to achieve this ambitious goal are being made by a number of players in the field, providing additional evidence that awareness is rising about the needs of using models which are able to accurately predict not only how individual components work, but also how these components interact together. These models will need to be flexible in the trade-off between accuracy and computational demand, so as to be applicable at all stages of the system engineering process: from the conceptual design and evaluation, to the detailed optimisation of individual subsystems, to the online model-based control of the whole system while in operation.

The results already achieved by some of the actors in this field demonstrate that, as has happened many times in the history of shipping, tough challenges exist only to be faced by the bright minds that are easy to find in this sector, both in industry and in academia. The energy systems of most ships built today are not dissimilar from those built 20 to 30 years ago. Will we be able to say the same in 20 years? *NA*



Schematic representation of the installation of thermal energy storage onboard a merchant vessel. The heat coming from the main engines is first transferred to a tank containing heat storage material. An additional heat exchanger allows heat to flow from the heat storage tank to the utilities

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Statistical analysis software & speed loss evaluation

In recent years, the main efforts within the maritime industry have been on energy efficiency and regulations regarding safety and environment. Related to that appear several new concepts such as "Green Shipping" and "Smart Ships", reports Carlos Gonzales, marine engineer

The improvement in maritime technology, such as sensors, network connections and data loggers, gives the chance to continuously and automatically monitor a ship's performance. This means it is now possible to evaluate and plan predictive maintenance routines that will keep the ship's efficiency up.

One of the most significant benefits of continuous monitoring is the reduction of uncertainty in data analysis due to the large amount of data recorded and analysed.

The major operational cost for the ship owner is related to the fuel consumption. It is well known to ship owners that the most important factor influencing consumption is increased ship resistance, in other words, the appearance of speed loss.

According to one study published by Casper Service, hull resistance may increase from 12% in the first year after the dry docking period to 40% by the end of the fifth year. It is important to pay attention to this in order to plan predictive action before the efficiency levels become very low, costing the operator a lot of money due to extra fuel used and increasing atmospheric emissions in consequence.

The objective of this document is to explain a tool that will help ship owners to operate their ships more efficiently. This optimisation will focus on the evaluation of the hydrodynamic performance, studying the speed loss progression over time by means of statistical analysis software. A reliable prediction of ship speed loss is essential from economic and environmental perspectives.

The software will help owners to take optimal decisions that could maintain or raise their ships' performance. Proactive action, such as planning docking periods for the right time (predicting when the ship performance will reach the limits of optimal efficiency, saving operational costs) and evaluating the dry docking periods (i.e. if the anti-fouling system applied on the hull is effective or not), is a powerful tool to operate the ships in the most efficient way.

Statistical analysis (SA) software

In this document, I have used software offered by the Norwegian company Kyma as a reference; this company has 25 years of experience in the market and its software is considered a good example for understanding the usefulness of SA software.

Statistical analysis definition

Satistical analysis refers to the setup methods used to process large amounts of data and report overall trends. Statistical analysis is particularly useful when dealing with noisy data because it provides ways to objectively report on how unusual an event is, based on historical data recorded.

Statistics are applied every day to become more scientific about decisions that need to be made.

Data analysed: performance observations

The statistics will manage large amounts of data in order to make a reliable long trend analysis. These data are called performance observations.

The SA software creates the performance observations automatically. The software collects data automatically from different sensors, such us power meter, GPS, Speed Log instrument, flow meters, etc.

The data from the sensors are not always steady, so, in order to get sensible and comprehensible instant values for the operators, the software has a logging period setup. During this logging period, the software gathers the data and calculates the average of the data. Commonly accepted, the logging period is 15 seconds. This method uses the cumulative moving average (CMAn):

$$CMA_n = \frac{X_0 + \ldots + X_n}{n}$$

The brute-force method to calculate this would be to store all of the data, calculate the sum, and divide by the number of datum points every time a new datum point arrived. However, it is possible to update a cumulative average as a new value:

$$CMA_{n+1} = \frac{X_0 + n \cdot CMA_n}{n+1}$$

The above formula is used on the SA software.

For the statistical analysis (long trend evaluation) it is established as a reliable data output frequency, with one performance observation per day. Therefore, all the averaged instant data calculated every logging is recorded daily.

The purpose of the continuous monitoring is to reduce the uncertainty of the data analysed.

The average for the speed deviation compared with the baseline (design data) will give the performance observation that it is used in the statistical analysis. Each performance observation is stored in a database for further evaluation by SA software.

Reference bases implemented on the SA software

The performance observations are plotted on graphs. However, these observations are useless without reference bases to compare with. The SA software uses two reference levels.

One reference level is the design data for each ship, obtained from the model

tank test. This level will be kept constant for all the ship.

Another reference level is the benchmark level, which is created with data collected after delivery and/or after any major repair on the ships. Therefore, this reference level will be dynamic and it will change after any major event.

Constant reference base on SA software

The data from the model tank test will show the relationship between the power delivered to the propeller and the ship speed through the water for ballast and design draft conditions. The daily average of speed through the water (performance observation) is compared to the baseline, giving a deviation in percentage, which is used on the SA software.

As a result, the speed deviation is corrected on the software for the ship's cargo condition ("power vs. speed" relation is not the same at ballast and laden condition). Following this premise, the speed deviation value per day is calculated taking into account the vessel mean draft, ship speed through the water and the power delivered to propeller.

This baseline designates the "zero level" on the statistical analysis. This level is constant for the ship's life.

Dynamic reference base on SA software

The dynamic reference base corresponds with the benchmark level. A benchmark is a standard set by a number or several numbers to estimate the basis of something to compare with.

The benchmarking automatically updates after any major event. The benchmark is created by taking the average of a number of daily observations (i.e. 120 performance observations) starting after a major event. The observations are only valid for benchmarking if data is on the wind limits and the ship is not on manoeuvring or in an abnormal sailing mode (main engine load above 35 % MCR).

It is very important to reset benchmarking after any major event because the ship will have a "new ship status" to compare with. This will be a new benchmark level. Therefore, the benchmark designates the "new ship condition" to be used as a new reference level to compare the ship performance.

Filtering applied on the SA software

The software automatically creates performance observations day after day for this reason; it is required to set some filtering on the SA software to avoid useless data that could invalidate the long trend analysis.

The vessels sail around the world finding diverse weather conditions, sea currents, sailing modes (normal navigations, manoeuvring, etc.) and cargo conditions (ballast/laden conditions).

The software works continuously, which makes it very important to apply filtering to discard data in case of bad weather conditions (using the Beaufort scale as a reference: if the wind force is above BF6 then the performance observation must not be used on the statistical analysis) and/or if the ships are under abnormal sailing modes (if ships are manoeuvring or the MCR is less than 35%).

In addition, the speed deviation is corrected based on the ship's cargo condition. This is made by correcting the design baseline with the mean draft value (mean draft will indicate the ship's cargo condition).

Analysis done by the SA software

After the filtering, the software has a new set of data on which it performs the statistical analysis. It creates a new trend function in the form of f(x) = ax + b based on only the included data points. This line is plotted along with all the included data points as a solid line.

The trend function is calculated from the data points using the linear regression model of least square fit. This is a common method in statistics to find a linear relationship between a set of data points. The least square method creates the following equations for calculating "a" and "b" in the formula:

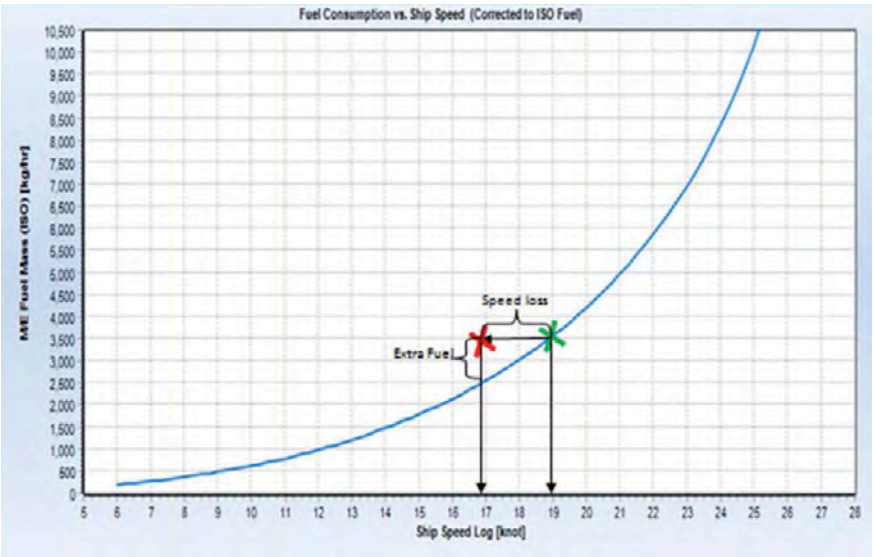
$$a = \frac{n \cdot \sum x \cdot y - \sum x \cdot \sum y}{n \sum x^2 - (\sum x)^2}$$

$$b = \frac{\sum y \cdot \sum x^2 - \sum x \cdot \sum x \cdot y}{n \sum x^2 - (\sum x)^2}$$

Using this trend line, the users can find out how the ship is currently performing (compared to benchmark and baseline). By means of a simple colour coding, it is possible to determine the ship performance status referent to the speed loss. The colour-coding (see figure 3) included in the software is as below:

- Blue: the ship is in the benchmark period
- Red: The performance status for the ship is "not ok"
- Yellow: The performance status for the ship "should be under observation"
- Green: The performance status for the ship is "ok"

Figure 1: Trend line for ship performance comparison



The trend line calculated with the performance observations will show the speed loss, and can, in consequence, estimate the fuel impact due to this loss. Such a calculation is made looking into the baseline "FO consumption vs. Ship speed", and this baseline is made looking at the same relation of "Power vs Speed" and "SFOC vs. Power".

The effect of this speed loss on fuel consumption can be seen in Figure 1.

In the scenario that the ship desires to reach 19 knots, the design baseline and the actual speed loss due to the hull resistance has increased. The ship's 16.9 knots speed (11.1% speed loss as the trend line shows on the next section on this document) can be extrapolated into extra fuel usage that results in raising the operational costs and increasing the atmospheric emissions in consequence. The extra fuel used due to the speed loss is 1,000 kg/hr if it is converted to tonne/day:

$$\Delta m = \frac{1000 * 24}{10E3} \cdot = 24 \quad \text{[tonne/day]}$$

Figure 2: Long trend representation for Speed loss

The estimated fuel impact is related to fuel oil based on ISO corrected calorific value (HCV or LCV).

Hull status & speed loss

To make this evaluation, the main inputs to be considered are:

- Shaft power
- Ship speed through water

The speed loss is caused by increasing the ship's advance resistance. Knowing that, it is straightforward to analyse the hull status by means of a speed loss study.

It is important to remark that the speed input used is the speed through the water because it takes sea currents into consideration.

The hull resistance is influenced by several factors. The most representative factors for ship operations are:

- Still water resistance
- Wind and wave resistance
- Resistance due to vertical ship motions
- Resistance due to steering
- Resistance due to fouling

One of the filters applied to the SA software is for weather conditions. Hence, if the weather is bad, the data is automatically deleted. In this way, the influence of

Figure 3: Speed Log deviation from baseline. The SA software shows the results for the last period (after last drydock)

"wind and wave resistance" is discarded from the statistical analysis.

Each performance observation represents the average data per day, deleting the momentary effect caused by steering.

The resistance due to still water and vertical ship motions have an important influence when a vessel is sailing in rough water. Normally, if there are strong winds, there will also be rough seas. Therefore, by discarding the performance observation for windy conditions it is ensured that the effects of still water and vertical motions on the ship resistance have been neutralised.

By eliminating other factors, the speed loss evaluation provides an excellent indicator about the resistance added due to fouling. If the hull is painted with low quality paint, fitted with low quality anti-fouling systems, or the ship is berthed for long periods at ports, the performance of the hull will deteriorate faster.

Deteriorating hull performance results in speed loss, and means that more power is required to reach the service speed and fuel consumption is higher, producing greater atmospheric emissions.

Above in Figure 2 is the long trend representation available on SA software offered by Kyma for one LNG carrier that recently underwent a drydocking period.

In Figure 3, the black line at "zero level" is the design level from the model tank test.

The blue dotted line is the benchmark level, generated with the average values of the performance observations (120 points) after the last drydock period, during the "benchmark period".

The red dots are the performance observations generated daily within acceptable weather conditions and normal sailing status.

On the above example, the trend line (speed loss) level on the end of that period is 4.3% below the benchmark level or 11.1% below the baseline [-4.3% (compared with the benchmark) + -6.8% (benchmark level compared with baseline) = 11.1 %].

In conclusion, the speed loss is 11.1% compared with the design status (baseline) or 4.3% compared with the benchmark generated after the docking period.

The SA software gives the speed loss (in knots) for three MCR levels (50%, 75% and 90 %) with the actual ship performance.

The effect of this speed loss converted into fuel impact is estimated for the SA software. For the actual example the results are in Table 1.

In addition, the software predicts when the ship will reach next colour area, giving one visual alarm that shows "Observe" when the trend line reaches the yellow area and "Not OK" when the trend line reaches the red area.

Analysing the trend line, the ship owners can see when the speed loss will be below the optimal level. If the speed loss shows a deviation of more than 10% compared with the benchmark level then the ship performance is not optimal, and action should be taken to raise the performance (such as drydocking). Left unchecked, the operational costs will increase.

MCR (%)	Speed loss (knots)	Fuel oil impact (tonnes/day, ISO reference)	CO_2 emissions (estimated, tonne/day)*
50	-0.75	+ 8.5	26.47
75	-0.87	+ 14.2	44.22
90	-0.91	+ 19.9	61.97

Table 1: The effect of speed loss converted into fuel impact.

*Calculated with the conversion factor used by IMO for HFO, C=3.114 tonne FO/ton CO_2

Evaluation of the actions executed on the ship by the SA software

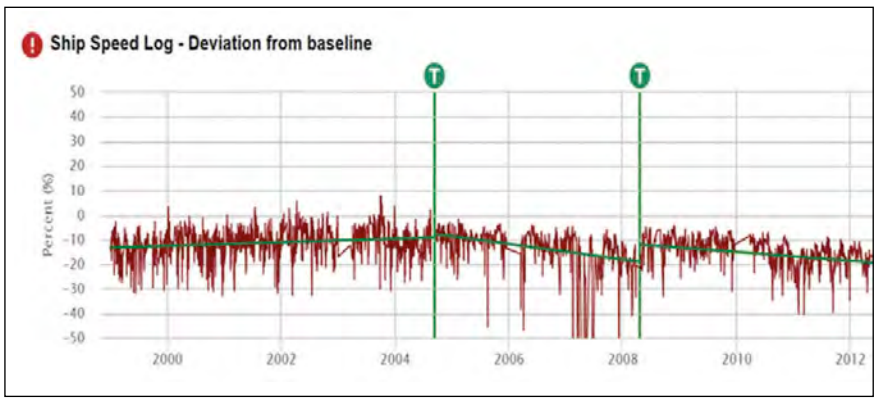
Ships require different repairs and modifications during their operational life. These modifications aim to keep the ship's performance high; for instance, applying new coatings, fitting the ship with a new bulbous bow design or using a new propeller design. These actions must be taken into account for the statistical analysis. The software helps to evaluate if the modifications have had a good effect on the ship's performance or if they have failed to meet expectations.

Related to the previous paragraph, the SA must be interrupted if some major event takes place, such as a drydocking period. When the repair is over, a new benchmarking period will resume and a new trend line will start. The new benchmark level for the actual ship condition will be the reference for further comparison of the performance observations after the trend event.

See Figure 4 for an image of the Kyma SA software, which shows a long-term progression over 12 years of the speed loss with major events set on the graphic. Two trend events (green vertical lines) corresponding with two drydockings can be seen.

After the first drydocking, the statistical analysis does not show a big improvement on hull performance. However, after the second drydock period, the trend line jumped up to 8% better performance than before that drydocking period. It shows that the actions carried out on the ship during

Figure 4: Long-term progression of ship speed loss over 12 years



that drydocking period have been efficient, raising the hydrodynamic performance about 8%, which in turn cuts fuel and emissions as a consequence.

Future development

Some companies are already making software that includes the automatic evaluation of statistical analysis such as Kyma or BMT Smart. The next step is to enable the automatic and real time transfer of data from onboard the ship to the ship owner's office onshore. That transmission of data will allow owners to evaluate performance and look at their vessels' progression in order to be more effective when making predictive maintenance. In addition, this possibility will also create a "Big Data" database for owners. They will have a big database with all the parameters included on the software from their ships for further evaluation and comparison between sister ships. To do that, they will require a bigger server or cloud to manage the information.

The company used in this document has the automatic transfer option, and according to that company, they are improving constantly to offer the best service possible on the evaluation of the data on real time.

Conclusion

By using software with statistical analysis for analysis of speed loss, it is easier to predict the hydrodynamic performance as well as to evaluate the jobs carried out on the ships, evaluating, for example, how effective the applied coating system is or how effective the latest drydocking period was.

It will help owners to keep track of the actual speed performance and keep efficiency as high as possible, while reducing operational costs and atmospheric emissions.

The real examples used in this document show how easy it is to quantify the speed loss (hydrodynamic performance) and its effects on the operational costs. In the end, SA software is a useful tool for supporting the owners in their decision-making.

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RINA-QinetiQ

Maritime Innovation Award

Innovation is key to success in all sectors of the maritime industry and such innovation will stem from the development of research carried out by engineers and scientists in universities and industry, pushing forward the boundaries of design, construction and operation of marine vessels and structures

QinetiQ Maritime Innovation Award seeks to encourage such innovation by recognising outstanding scientific or technological research in the areas of hydrodynamics, propulsion, structures and material which has the potential to make a significant improvement in the design, construction and operation of marine vessels and structures

The Award is made annually to either an individual or an organisation, in any country. Nominations for the Award may be made by any member of the global maritime community, and are judged by a panel of members of the Institution and QinetiQ. The award will be announced at the Institution's Annual Dinner (tbc)

Nominations are now invited for the 2015 Maritime Innovation Award. Individuals may not nominate themselves, although employees may nominate their company or organisation...

QinetiQ

Nominations may be up to 750 words and should describe the research and its potentail contribution to improving the design, construction and operation of maritime vessels and structures

Nominations may be forwarded online at www.rina.org.uk/maritimeinnovationaward

or by email to: maritimeinnovationaward@rina.org.uk

Nominations should arrive at RINA Headquarters by *31 January 2016*

Queries about the award should be forwarded to the Chief Executive at hq@rina.org.uk

RINA - Lloyd's Register
Maritime Safety Award

The safety of the seafarer and protection of the maritime environment begins with good design, followed by sound construction and efficient operation. Naval architects and engineers involved in the design, construction and operation of maritime vessels and structures can make a significant contribution to safety and the Royal Institution of Naval Architects, with the support of Lloyds Register, wishes to recognise the achievement of engineers in improving safety at sea and the protection of the maritime environment. Such recognition serves to raise awareness and promote further improvements.

The Maritime Safety Award is presented annually to an individual, company or organisation that in the opinion of the Institution and Lloyd's Register, is judged to have made an outstanding contribution to the improvement of maritime safety or the protection of the maritime environment. Such contribution may have been made by a specific activity or over a period of time. Individuals may not nominate themselves. Nominations are now invited for the 2015 Maritime Safety Award.

Nominations of up to **750 words** should describe the nominee's contribution to:

- safety of life or protection of the marine environment, through novel or improved design, construction or operational procedures of ships or maritime structures
- the advancement of maritime safety through management, regulation, legislation or development of standards, codes of practice or guidance
- research, learned papers or publications in the field of maritime safety
- education, teaching or training in maritime safety issues

Lloyd's Register

The closing date for nominations is 31 January 2016. The Award will be announced at the Institution's 2016 Annual Dinner.

Nominations may be made by any member of the global maritime community and should be forwarded online at www.rina.org.uk/MaritimeSafetyAward or by email to MaritimeSafetyAward@rina.org.uk

Queries about the Award should be forwarded to the Chief Executive at **hq@rina.org.uk**

Integrating design and manufacturing for improved efficiency

Rachel Yee from Intergraph PP&M together with Hannu Kakela from NESTIX Finland explain how an integrated operating environment brings recognisable improvements to fabrication yards

Fabrication yards across the globe struggle with the growing demand to improve efficiency and lower operational costs. According to on-site observations, any fabrication process in a multi-disciplinary environment needs a holistic approach to improve efficiency and maximise throughput.

In a joint collaboration project in Malaysia, Intergraph PP&M and NESTIX examined how an integrated production planning and execution system can help yards to more effectively manage their pipe spools workshop. This solution brings together multidisciplinary design, construction, material management, quality management, and process machines to automate shop fabrication and promote more efficient handling of pipe spools fabrication processes.

This article describes a case of a pipe spools workshop owned by the second largest fabricator in Malaysia, which provides a full range of construction and engineering services required for the oil and gas industry. The case study showcases the main benefits of an integrated approach, and how it can be applied in order to provide a complete solution addressing all of the challenges identified.

Overcoming industry challenges

Shop fabrication, an early stage in industrial construction projects, has a significant influence on the successful delivery of a construction project. Effective planning and scheduling of industrial fabrication activities become essential to reduce time and cost of construction projects during this stage. However, the fabrication process in marine, shipbuilding and the offshore industry is always complex and associated with a high degree of uncertainty. Such complexity makes it difficult for most manufacturers to produce reliable project estimations.

Fabrication yards are constantly facing various challenges in their business, including:

- Massive quantity of single parts and assemblies per project
- Continuous cost pressure from the market
- Shorter project delivery schedule
- Frequent design changes
- Shortcoming of traditional planning methods.

In order to improve efficiencies in production processes, especially pipe spools fabrication, many yards have tried to increase their workshop capacity by gravitating to more automated fabrication machines and processes, such as CNC machines and robotic fit-up and welding machines. However, yards that have invested in this equipment have found that their traditional planning and

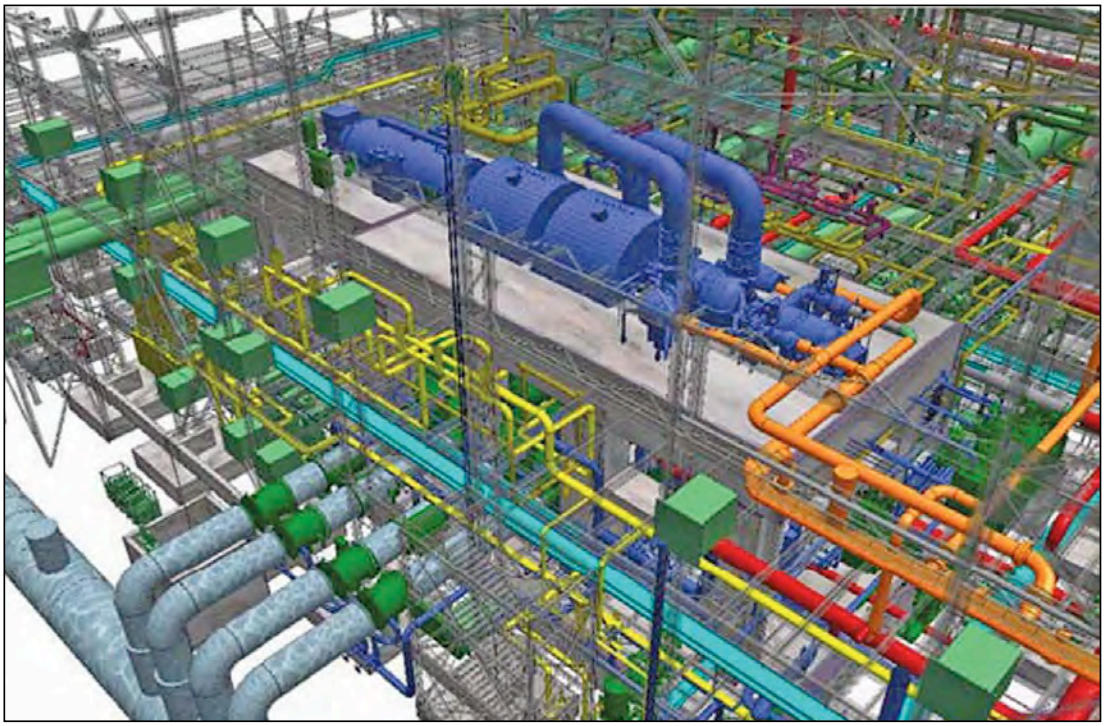


Figure 1: CAD model in S3D

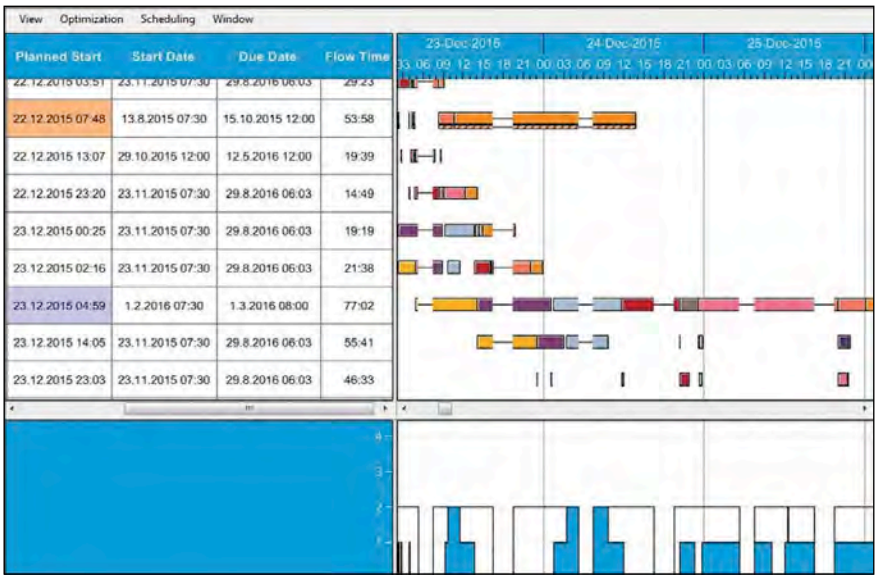


Figure 2: Work load diagram

routing procedures were insufficient to drive the highly linked process flows through the automated workstations.

We found the same problem in this yard. Typically, in their planning process, pipe spools orders are released for production based on their required dates without considering the shop level loading. On the contrary, there are also cases where orders are released to the shop way before the required dates in an attempt to achieve the level loading of the shop to match capacity with demand. The production workforce fabricates spools using whatever reachable materials are available on the shop floor.

In shipbuilding and the offshore industry, we learned that work station planning cannot be optimised according to the serial production approach, but must be performed by attribute-driven work content. Planning and routing decisions must take into consideration the variables of individual process times, work station capacities, emerging engineering design, schedule changes, and shop level loading. Traditional planning methods could not handle these variables effectively and are not sufficiently responsive to the dynamic nature of the shipbuilding and offshore environment. Therefore, implementation of an effective production planning and parts control and pipe spools fabrication in the ship hull and offshore structure, based on the principles of digital manufacturing, is needed.

Holistic fabrication

During the project, it became clear that in order to achieve the goals for on-time delivery, optimised resource and material allocation together with maximised throughput, the fabrication process in a multidisciplinary integrated environment needs to be covered holistically. This integrated system approach has been applied in:

Spool design data interface

Engineering design data is a key component for production planning. It involves macro-level planning that provides working instruction, information for pipe parts nesting, cutting, fabrication and assembly.

In this project, Intergraph Smart 3D (S3D) was used as a 3D CAD software for design, modelling and spooling activities. It produces isometric and spool drawings, the bill-of-material (BOM), and profile configuration file (PCF) files for the production department to execute their job. Pipe parts and assembly information are imported from S3D into production system by reading a PCF (Piping Component file) file.

The system interacts with project scheduling to schedule pipe spools fabrication according to the needs of pipe spool assembly or delivery date.

The yard uses SmartPlant Construction (SPC) to manage their construction activities based on work package (WP) concept. The spool fabrication work packages is read into production system, including pipe spools ID, work packages start and end date, work steps and attachments.

Production planning

Production planning aims to bridge design and production using 3D CAD data, production scheduling, and production-related information, i.e. material information, work queue and shop level loading.

Through the interface with the material management system (SmartPlant Materials - SPMat), the material catalogue is shared with the 3D CAD system, and, at the same time, the material information and inventory status is shared with the production system. An order will not be released by the system into production if the material required is unavailable. This prevents the issue where spools are fabricated half-way and staged in the middle of the production line.

Followed by order release, nesting on selected pipes and real geometry remnants are made automatically using different nesting strategies for the purpose of material optimisation.

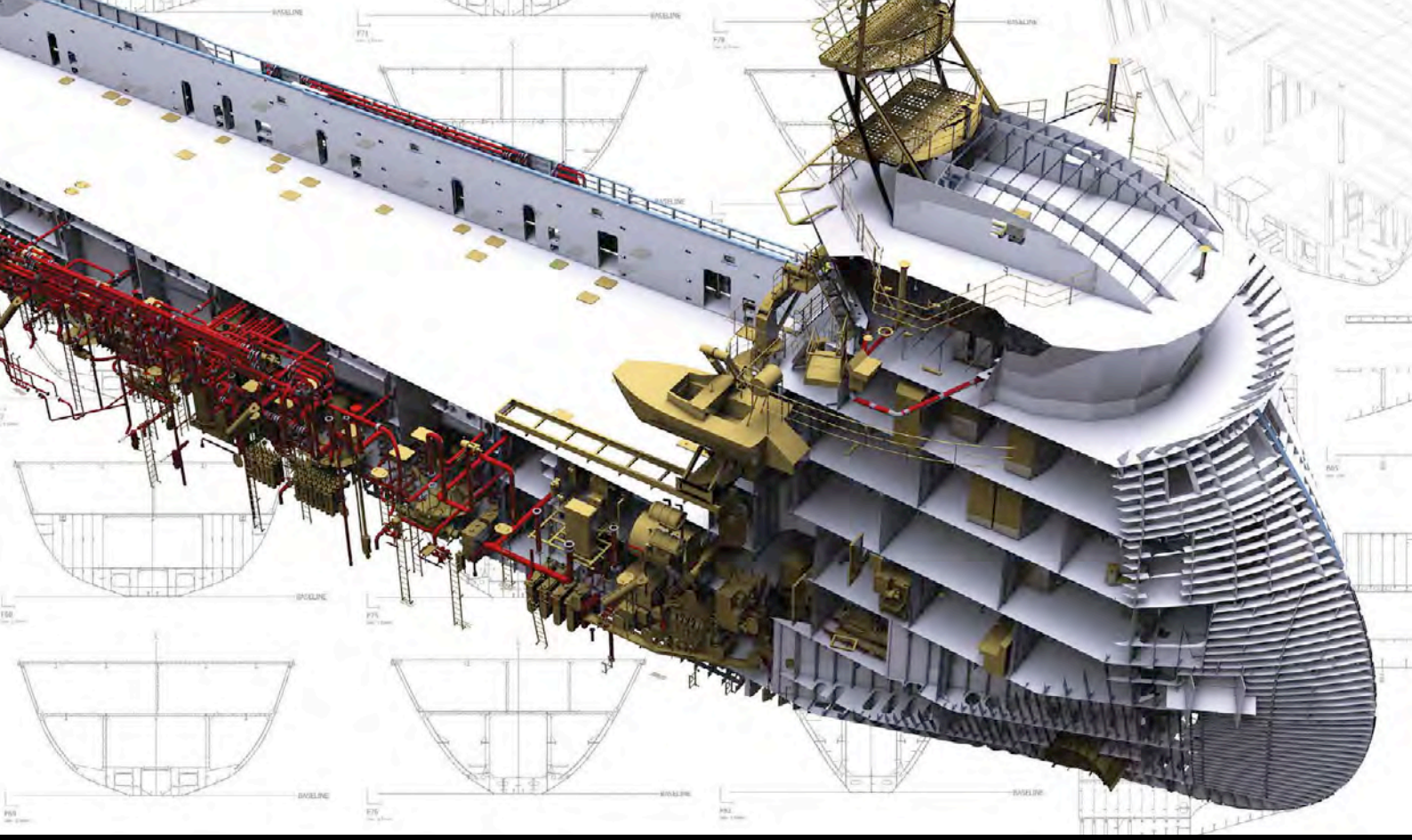
During the work phase definition, the production times of different works for parts and assemblies in the workshops is calculated based on actual pipe cut-length, nesting and welding seams. Therefore, the required production capacity for all production orders' work phases can be specified accurately. Production flow times are shortened when the load of workshops is balanced and optimised in advance, making the most of a finite capacity.

Production execution

Work queues are established during the production planning following the DBR (Drum-Buffer-Rope) principle. The machine queue is now the basis for material flow in the workshop. Production execution starts when material is released on to the shop floor, and it is important that the material is released just-in-time (JIT) to guarantee "LEAN" material flow in production. Material picking lists with detailed information of material location in stock, quality and dimensions, guides operators to pick the right material and bring it to their workstation at the right time.

Production integration and feedback

During the work phase's execution, traceability of production status, material



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- Automatically add bevel information
- Define pipe spools
- Model wireways and route cable
- Automatically maintain part naming based on assembly sequence and properties

PRODUCTION DESIGN

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- Generate NC code for any burning machine
- Generate pipe and HVAC spool drawings
- Generate 3D assembly drawings
- Generate profile plots/sketches
- Generate 2D workshop drawings
- Generate system arrangement drawings
- Generate cable pull schedules
- Automatically update drawings as changes happen
- Drive NC profile cutting
- Drive NC pipe fabrication
- Visualize the assembly sequence
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used, and location play a significant role as thousands of fabricated parts must find their way to the right assemblies and workshops at the right time. When material, part, or assembly related work has been completed, the status of the corresponding order will be updated accordingly, and at the same time, worker and machine operation times, quality, and material utilisation are followed up in real time.

Production feedback enables the construction team to further plan or make necessary adjustments to any activity that depends on the completeness of production, e.g. installation/erection. This information is further referred to as a benchmark for continuous improvement of the rules set in 3D CAD software.

Managing change

Changes of design and schedule are reflected in the production system through the interface with 3D CAD software (S3D) and construction management system (SPC). In the production system itself, via different menu options, it is possible to view the production events (disturbances, pauses, rejections and completed works), or to observe the inventory of the storage locations. This allows the contractor to halt production and take stock of the required changes quickly so that the most efficient measures can be taken to accommodate the changes.

Real-life project results

We faced difficult challenges during the initial implementation of the system, especially changing the way people work. The workforce showed resistance when they were requested to follow the process defined in the system; often, workers in the shop work on what they see in front of their machines. They are also instructed to work continuously to fill up the machine capacity as idle time is simply not allowed. Production people commonly interpret idle time as being non-productive.

Several brainstorming and training sessions were conducted throughout the system implementation and go-live period. After the system was stabilised, we could see that the implementation of Smart Production in integration with Smart Yard was bringing recognisable advantages in the following areas:

Reduced labour and duration for production planning

Through interface with the 3D CAD system and with automation in spool splitting and routing, pipe nesting, capacity calculation and load balancing, the duration for work preparation is shortened.

Reduced remnant and scrap

With detailed inventory management and auto-nesting capability, the integrated solution managed to reduce the remnant turnover time and scrap generation.

Reduced material-in-process on the shop floor

The excessive inventory that stays on the buffer rack in the workshop has greatly reduced. This is mainly because the work order is only released into production when all the required material is available in the warehouse. Furthermore, the operator picks material and sends it to the shop floor according to work queue, and parts are produced following the demand schedule (Just-In-Time).

Improved traceability and visibility of the real-time production status

The system follows each work step in every work phase through the production process in real time. Traceability is improved by having information on who did what to which raw material or part and when the action occurred. Real-time production reporting enhanced the management of change, and consequently helped to reduce the reworks and span times to fabricate the spools.

Increased accuracy of production data

Production receives design data via the interface with the 3D CAD system and turns dynamic engineering data into stable procurement data. As a result, information transfer is no longer via paper methods and the risk of transcription error is reduced – human error like miscounting materials or mistyping dimensions is eliminated.

It is clear that the integration of a production management system with 3D CAD software and PLM systems, such as Smart Yard, has the ability to optimise the spools fabrication process, which can be a bottleneck in most fabrication yards. By seamlessly integrating design, procurement, and site materials, the system improves communications and streamlines information exchange at all levels of the workforce, and more efficiently supports the planning and management of production. Duplication of effort and re-creation of information are greatly reduced because of greater visibility, providing more insight and allowing faster decision making that keeps schedules and deliveries on track. The resulting business advantages include shorter delivery times, more accurate task management, reduced risk and better control of the production process. *NA*

Figure 3: Integrated, consistent dashboard reporting at different level of process

Saving ocean soundscapes

The need to address noise pollution in shipping is a pressing environmental concern that has strong implications at the design level. Research from the University of Southampton is targeting this issue, and shows how computers can be used for achieving quieter oceans

Water is very effective at propagating sound waves and as a result there is significant concern that as ships increase in terms of size and effective power their impact on the underwater soundscape is causing real environmental harm (Tasker et al., 2010). While of course there are multiple sources of noise in the oceans, natural and anthropogenic alike, shipping as a whole contributes to a large proportion of the total ambient sound level. Although certain aspects of this problem are understood, it is, in general, an open field with a number of unanswered questions.

As a consequence of realising the negative effects of shipping noise, concerns have been raised over whether regulation should be put in place to limit these emissions. Indeed, there are already aspects of marine operations, mainly related to the oil & gas industry, which have specific environmental noise controls in place. A loose parallel may be seen between the maritime and the aerospace industries, with the latter having been driven primarily by fuel efficiency in its early days, much as shipping is now. As time has progressed, efforts to minimise noise from aircraft have grown greatly, so it is not unimaginable that a similar scenario will unfold for ships in the near future.

Why are ships noisy?

The wake flow developed along the ship, in which the propeller must operate at all times, produces a large boundary layer region which contains unsteady turbulent flow. This is further affected by ship motion caused by waves or manoeuvres. As a result, propeller blades experience constant load fluctuations, primarily at the blade rate but also over a broadband range, which manifests itself in a complex noise signature.

Furthermore, the propulsion of large merchant ships requires a significant amount of power to pass through the relatively confined region of a propeller disc. The resulting high power density associated with operating the propeller close to its optimum efficiency induces a local pressure drop and causes an enhanced risk of cavitation. Load variations due to non-uniform and turbulent inflow act to make cavitation less stable and potentially more prone to generating noise.

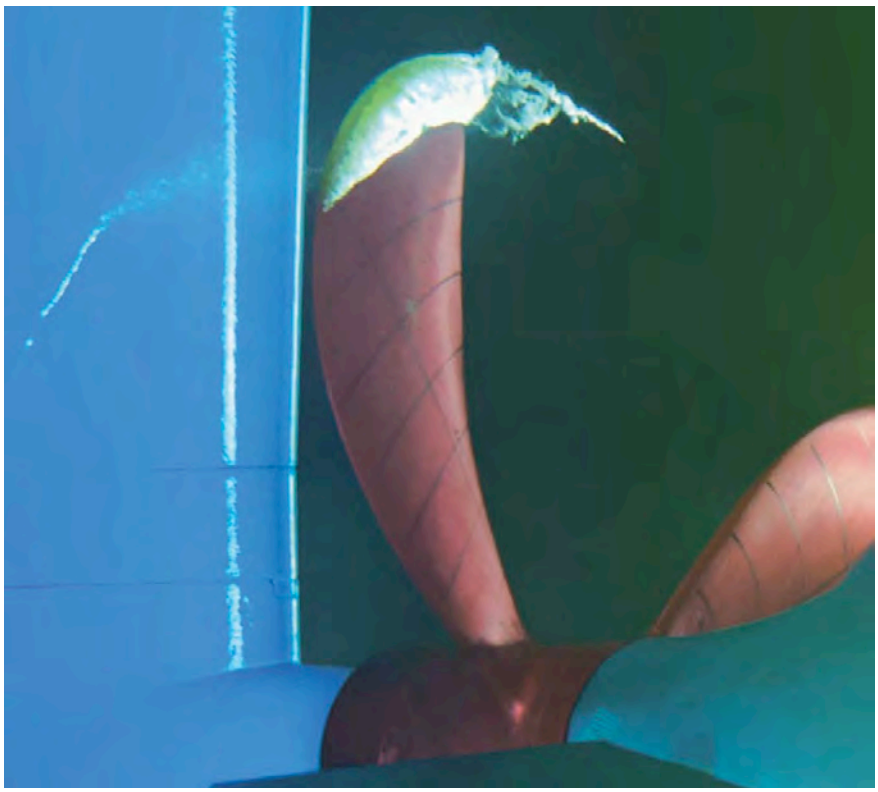
Out of the multiple noise sources present in the ship-propeller system, the low-frequency noise due to cavitation and non-uniform wake are of primary concern from an environmental impact point of view. This is because the sound they generate is likely to propagate at large distances due to high power and low attenuation, affecting the largest area, and because the sound is typically in the frequency band many organisms are capable of hearing.

Due to the presence of such a variety of complex, non-linear phenomena, marine propeller flows are very interesting, but also difficult to deal with, both numerically and experimentally. An example of a model-scale propeller operating in a non-uniform wake is shown in Figure 1. One may note prominent cavitation close to the tip which then becomes trapped in the tip vortex further downstream.

How to measure noise?

One of the primary means of assessing the radiated noise of a ship is full-scale testing

Figure 1: Example of experimental cavitation observations on a fully appended ship model placed in a cavitation tunnel. Source: Daewoo Shipbuilding \& Marine Engineering Co., Ltd.



at sea. This involves placing an array of hydrophones at a remote location with low ambient noise and favourable noise propagation conditions, such as apt water depth and seabed type, and recording the noise from a passing ship. This, while shown to be feasible, for instance during EU-funded projects such as AQUO and SONIC (Brooker & Humphrey, 2014, 2015, Audoly et al., 2014), is currently far too expensive and would present a real challenge if, for instance, regulation requiring the noise from each newly built ship to be assessed were introduced.

An alternative to this approach is the use of model-scale testing in facilities like cavitation tunnels or de-pressurised towing tanks. This method is significantly cheaper and more available than full scale testing, but still only affordable in a limited number of cases. Due to physical limitations of the experimental facilities, most model measurements are to some degree compromised by phenomena such as reverberation, background noise due to machinery like impellers or carriages, and near-field fluctuations that can be included in the data. The difficulty here is also finding an appropriate method of scaling the near-field measurements to full scale and deducing the correct far-field noise level from them.

Due to the limitations of the experimental methods, making trade-offs, performing optimisation, or sensitivity studies of the radiated noise against propulsive performance is an expensive and challenging endeavour. These limitations also pose a major obstacle to truly understanding the commercial shipping noise effects and being able to conclude whether an action is required by the maritime community in order to reduce the environmental impact. Fortunately this gap in our understanding of the problem may be overcome using numerical analysis tools.

Computational solutions

High-fidelity turbulent flow modelling has become increasingly accessible with the steady rise of computational resources available. These allow for unsteady flow features, vital from a noise prediction point of view, to be predicted much better using methods like Large Eddy Simulation (LES) or Detached Eddy Simulation (DES) than with the URANS 'workhorse', omnipresent in marine Computational Fluid Dynamics (CFD). In the marine context, however, the inherently high Reynolds numbers make it challenging to use such methods on a regular basis, particularly when predicting full scale values.

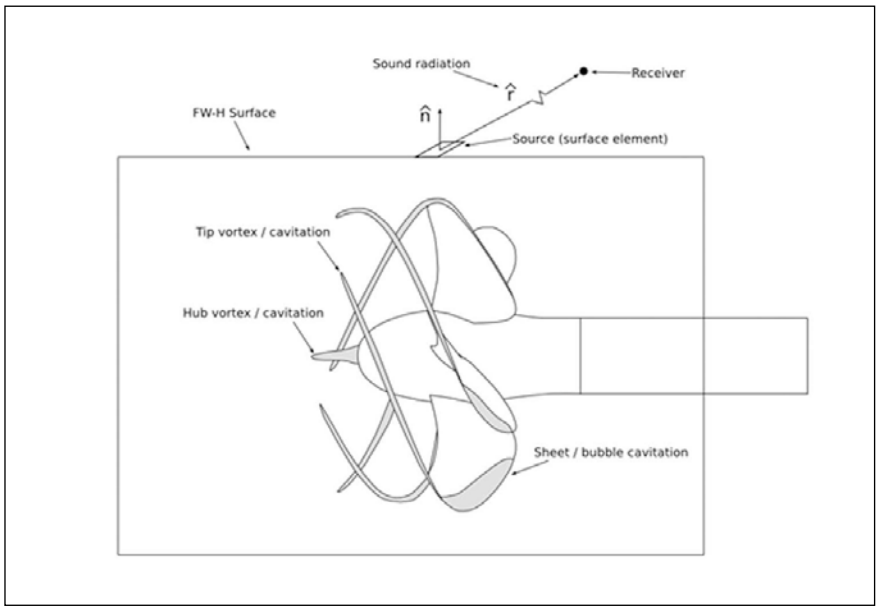


Figure 2: Illustration of the porous Ffowcs Williams - Hawkings acoustic analogy: flow around a body is solved as in regular CFD, data is sampled on a control surface surrounding the problem, and radiation equation is then solved from the interpolation surface into the far-field

A significant difficulty in computing marine flows is also associated with the relatively high speed of sound in water compared to air. This implies that the speed of the wavefronts that need to be captured for a hydroacoustic simulation is greater, which limits the maximum time steps possible. Furthermore, the higher density and speed of sound in water imply it has a much higher acoustic impedance. This means that for a pressure source of the same amplitude the induced particle velocity will be much smaller for water. From a numerical standpoint, the associated computational effort required to achieve full convergence using high order schemes, and mesh density necessary to keep the dissipation and dispersion errors low may be expected to be higher for a computation in water than in air. It also follows that the amount of acoustic energy in the flow, compared with that contained in the other range of wave numbers, will be relatively low.

As a result, approaches alternative to solving the full compressible Navier-Stokes equations into the point of interest, typically in the far-field, are often sought for. One of these are the acoustic analogies, arguably the most popular being the one by Ffowcs Williams & Hawkings (FW-H) (1969). This method involves solving flow around a moving object in the near-field and then solving surface and volume integrals, obtained by virtue of the Gauss theorem applied to rearranged Navier-Stokes equations, in order to deduce the radiated pressure signals at an arbitrary location away from the body. In a traditional sense, the surface integrals would be solved on the body surface. An alternative variant, termed the porous method, assumes that the control surface is not coincident with the body surface, but instead encloses a volume of fluid surrounding the object, as depicted in Figure 2.

The latter approach removes the need for the volume integral to contain fluids of different properties and instead only requires flow field data to be known on the FW-H surface. This makes said method applicable in cases where there are two

or more fluids present in direct proximity of the body and where main noise generation mechanisms may be present further away in the fluid. One such case is a cavitating marine propeller, which may yield significant pressure oscillations in the near-field, as well as induce significant amounts of turbulence, as seen in Figure 3 with the example of a hydrofoil.

There has been a growing interest in numerical prediction of marine propeller noise in recent years with a large proportion of studies utilising acoustic analogies in one form or another. Ianniello et al. (2013), for example, applied several of the FW-H methods to study non-cavitating noise radiated from model-scale propellers and full-scale ships using CFD. Their study showed how promising the approach is to predicting radiated pressure induced in the marine environment. An important point is that this type of calculation could be used at final vessel design stages to verify whether it meets given noise criteria.

The ongoing work undertaken at the University of Southampton is aimed at extending the acoustic analogy approach and use it in conjunction with high-fidelity CFD methods in order to study the multi-scale nature of marine propeller noise. It is viewed as the next step in accurately tackling this problem, as methods for predicting large-scale cavitation phenomena do exist but often fail to account for the more intricate flow features. To date, research has been focused on establishing the baseline simulation frameworks, predicting the non-cavitating noise of propellers (Lloyd et al., 2015, Lidtke et al., 2015) and characterising noise due to hydrofoil sheet cavitation.

At present, the in-house acoustic analysis code is being extended in order to more accurately account for high- and broadband-frequency noise components. Building from the research to date, a postgraduate research project is planned with the aim of studying noise radiated by ships fitted with energy saving devices (ESD's), such as accelerating ducts. Another related project, undertaken in collaboration with Lloyd's Register (LR), has set out to further develop numerical methods for the assessment of erosive cavitation.

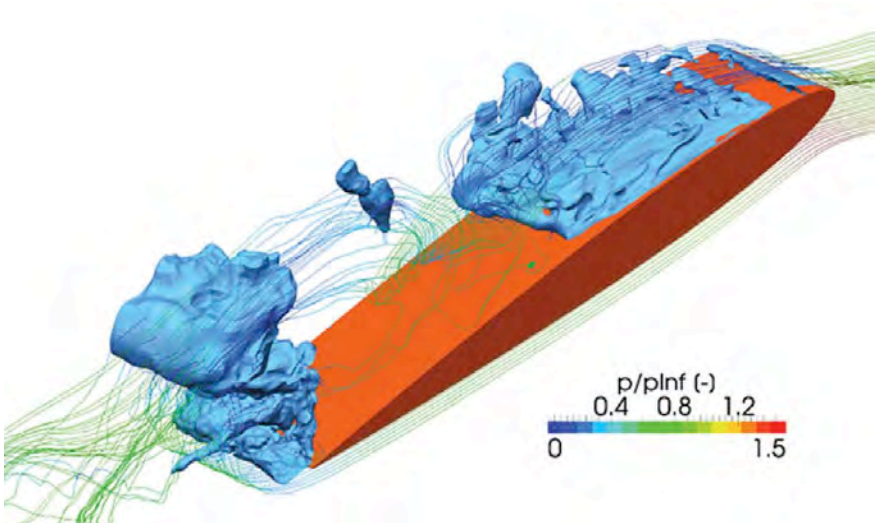


Figure 3: Sheet cavitation on a hydrofoil visualised as an iso-contour of the volume fraction field (=0.5), also showing complex flow pattern around the cavities using instantaneously computed streamlines

Prospects

It is hoped that in future the investigated numerical methods will become widespread in the maritime community, providing reliable tools for assessing novel ship designs based on their noise pollution potential. Irrespective of whether regulation is introduced in order to govern this side of marine vessel construction, dissemination of such evaluation techniques will lead to minimising the impact of shipping on the oceans. In the short term, numerical noise prediction techniques present a unique opportunity to support full- and model-scale experimental studies. Given the large number of free parameters involved, correlating the two has always been challenging and it is believed that providing a third, independent method of assessment may accelerate progress in devising unified and widely accepted testing and scaling procedures. *NA*

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A case for common sense

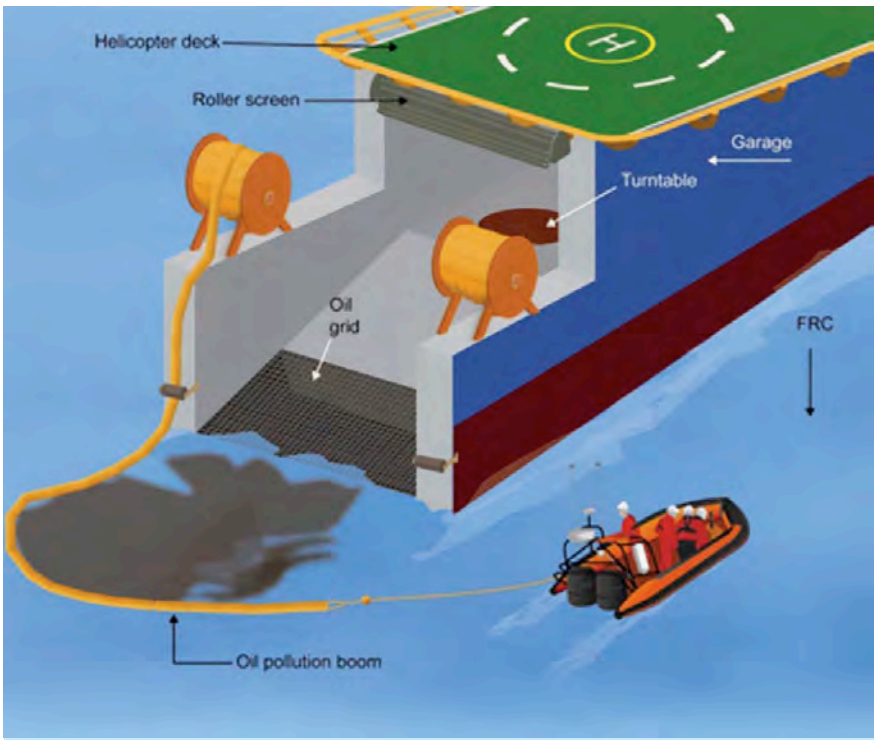
Captain Michael Lloyd discusses the pressing need for better collaboration with professional seamen in the design of vessels operating in ice, and offers a novel solution for more than one design shortfall

Ice and the extreme cold are formidable forces for those who routinely operate in polar and sub-polar conditions. The "work warm-up schedule" developed by the Saskatchewan Department of Labour, and adopted by The American Conference of Governmental Industrial Hygienists (ACGIH) in 2013, exemplifies this reality. It states that in even what could be considered normal Arctic weather conditions there must be four breaks in a four hour work period, and that in temperatures below -32°C in 20knot winds – not unusual in the Arctic – only emergency work should be undertaken. Such conditions can be alleviated by the design of a vessel's work areas, providing heat and shelter. However, despite their clear necessity, their arrangement is often not considered in collaboration with those who work on vessels sailed in ice; a fact that presents something of a growing problem.

As the gradual melt of the Arctic ice continues and the advance of technology enables more ships to enter the Arctic Ocean it is obvious that progress will dictate that the exploitation of the Arctic for mineral wealth will grow. In 2009, the US Geological Survey estimated that the Arctic may be home to 30% of the planet's undiscovered natural gas reserves and 13% of its undiscovered oil. Further recent surveys such as that by Woods Mackenzie have shown this could be on the low side with some going as high as 30%.

Owing to the lack of port facilities in the region and the cost of work ships designed for the region, it makes sense that any work ship destined for the region must have a fully utilised multi-capability that is optimised for those working in the extreme cold.

Designs should combine ice class suitability for the area of operation, taking into account the necessary ice breaking capability, with wider functionalities and features. These should include supply capabilities, anchor handling and towing, search and rescue, pollution control, helicopter landing and carrying, and prolonged operational sustainability. Vessels should also be manned by crews with ice experience.



The proposed stern ramp launch system, with accompanying boat garage and helipad, can also be used for pollution control

While ice classification, supply capabilities and anchor handling and towing functions are obvious and little different from that required for standard winter operations in the North Sea (except for the limitations that the ice will impose), the remaining operations, from search and rescue to sustainability, are a cause for concern and desperately require further attention in design.

Stern launch and recovery

Search and rescue requires the launch and recovery of Fast Rescue Craft (FRC). If the ship is operating in sheet ice conditions there is little point in lowering boats, but for conditions where there is broken ice or open water the launch of boats and their maintenance must be considered.

Presently, these boats are stowed and launched from single point launch davits on the sides of the vessel. The problem here is that in ice conditions the ice will be alongside the ship, hampering the launch and recovery of FRCs. The one area that will be free from ice, even if only temporarily, is the stern, which is kept free by the progress of the ship through the water and the action of the propeller. With this in mind, it makes sense that a stern launch ramp arrangement should be used; the boats would still be able to be used from their side davits positions, but they would also be able to be transferred to the stern area when required.

The naval architecture branch of the US Coast Guard's Engineering Logistics Centre carried out an assessment of vessels with stern launch capability – presented at the World Maritime Technology Conference in 2003 – to develop criteria for the design and evaluation of stern launch and recovery systems for small boats from ships of up to 400 feet in length.

The overall tests involved eight ships of different nationalities but the results determined that the average launch times were 14.25 seconds and the recovery times 14.3 seconds, while figures of 5 seconds were achieved. These times are far better than any I managed during my four years in command of such ships with side davits. The whole launch and recovery process is what can be determined as the transition phase, which is the launch and then the approach and recovery. It is this last part that is the most difficult and time consuming. A boat being recovered on the side davit has to slow down on the approach and match speed with the mother ship to catch the davit wire and hook on before recovery. On a ramp recovery this is not required. Obviously this is very dependent on weather, the FRC used and the ability of the crews both on the boat and on the ship. It is essential that any FRC using ramps have water jet propulsion and certainly dry start diesel engines will enable the boat to be started on the ramp.

The main problem of a stern ramp position is the limitation in a seaway caused by the pitch of the vessel while heading into the sea. The average vertical lift limits referred to are 2 metres at an average speed of 5 knots. To those inexperienced in ice water conditions this might seem a major problem but ice has a considerable damping effect on the sea conditions. The vertical lift does not interfere with the launch but only the recovery and if the ship is still equipped with the side davits the boats can be recovered there.

I am not suggesting that the davits should be abandoned. They should be present for normal operation and to offer a choice to the command for launch, recovery or both. The stern ramp availability is driven by sill depth and pitch motions, whilst a davit needs to consider a range of constraints associated with the environment, including pendulum effects, hoisting speed and the safety of deck crew.

None of the tested ships featured extendable hydraulic ramps that would be capable of increasing the sill depth of the ramp, but such an idea is certainly not beyond the bounds of ship design. If these ramps were to be used the operational

ability of the stern ramp recovery would be considerably extended.

Improving the work environment

The stern ramp design also allows FRCs to be swiftly housed in a garage area built over the stern. Once the boats are on the ramp a winch could be used to drag the boats into the garage where, with a turntable arrangement, they can be quickly rotated. This speed is essential when a prolonged search and rescue operation is required and crews are replaced and an immediate launch is required.

The garage capability would also enable the frequent maintenance required for such boats operating in ice. In the davit position it is almost impossible to work on the boats in freezing conditions because of the time people can spend working outside and the limitations placed on ice covered equipment, as well as the inherent difficulty of working while wearing heavy weather clothing, especially gloves.

Further to this, positioning the workshop at the stern above the ramp means that the helicopter landing pad can be placed on the roof. I am frequently surprised by the continuing use of the bow for this pad as anyone who is familiar with arctic conditions knows that ice accretion is a very real threat.

For example, while operating in force 9 gale conditions with my engines reduced just to keep seaway, my ship accumulated around 300tonnes of ice on the bow area in one night. Any metal, especially if vertical, is a magnet for ice. This means that a helipad on the bow, which requires structural supports, will become ice covered and inoperable during any bad weather.

In contrast, a helipad that is located on the roof of the proposed stern workshop is not only out of the way of sea-spray, but benefits from the heated maintenance garage below, which would free the helipad from ice.

An integrated design solution

Pollution is probably the greatest problem of all in ice, firstly because of its impact on an increasingly fragile environment, and secondly because of the commercially crippling consequences such a spill would have for the unfortunate owner/operator. The US National Research Council states that we are far from ready to deal with any major incident. I would add that in the majority of cases, we are far from ready to deal with even a minor incident.

The use of chemicals to disperse the oil is still subject to considerable debate, especially in the Arctic. In July 2013 the Society for Experimental Biology stated: "A new study suggests that although chemical dispersants may reduce problems for surface animals, the increased contamination under the water reduces the ability for fish and other organisms to cope with subsequent environmental challenges." It is also problematic as to whether the dispersant does more harm than the oil.

This then leads to the recovery of the oil. The current system of dealing with oil pollution on the seas is to utilise booms together with vessels equipped with skimmers. Sometimes the vessels are equipped with both and on other occasions two vessels have to be used.

In 1999 off the French coast, a spill of up to 7,000 tonnes occurred. Operating in bad weather over several days, five oil recovery vessels using booms and skimmers recovered just over 1,000 tonnes. There are several different types of oil skimmers, including vacuum, oleophilic, mechanical, weir and rope skimmers, but all designs depend on the laws of gravity. All of the mentioned skimmers, apart from the rope skimmer, act at the free water surface and are therefore susceptible to wave action. As the weather and wave action increases, the capability of these skimmers reduces dramatically.

However, the main reason for the overall poor performance of all of these types of oil recovery systems is that they are recovering from the side of the vessel. While this is not an efficient method in good weather, in poor weather it has an almost negligible capability. This is because of the action of the waves, current and wind. For recovery the vessels are stopped or just keeping steerage way. The ships then lie at an angle to the wind and seas. The winds and currents then cause the booms which are surrounding the oil alongside the side of the ship to elongate out of position, meaning that the oil is no longer being drawn into the suctions of the skimmers. In addition, once the wave height is over one metre the ability of the suctions to pick up the oil reduces, and the rolling of the ship adds to the problem. It is regrettable to say that the whole concept of side recovery is not efficient.

With a stern recovery ship, booms can be deployed from the stern to encircle oil and by returning the end of the boom to the ship on the other side of the stern a catchment area is formed. The ship can then keep its head to sea and wind by using a slow centre thrust unit. By using a ramp tube pumping system with large suctions mounted behind grills that extend several feet below the water, the booms can be slowly reeled in, drawing the oil towards the ship. There is no wind sea or current effect on the boom as the ship is heading towards these effects with the boom directly astern.

The ship can also be backed into the oil. Several such suctions behind a grill running from side to side across the stern will take in far more oil than any side skimmer, transferring it to oily water separators that can then be pumped into separate tanks. With large quantities of oil a barge can be moored alongside the ship without any problems as the ship will have steerage way at all times. On top of this, it is also far easier cleaning the grill fronts than cleaning the side skimmers.

This is not rocket science, it is simply using good seamanship practice and common sense to solve a problem that presently the marine industry has been trying to solve by engineering alone.

When designing ships for the ice, account must be taken of those who have experience, not just in ice, but in the many varied tasks that such a work ship must undertake. Naval architects that work together with professional seamen can achieve the type of ship that will justify their high cost, and will ensure that the ships can meet the changes of the future. It is a given that the shipping movements in the Arctic are going to steadily increase. Apart from the normal hazards that the sea produces, the lack of adequate charts for the Arctic coupled with the ever-present dangers of ice will ensure the essential role of multi-functional ships, now and in the future. *NA*

Building a future

Capt Thomas Wissmann has followed up his 2014 research for the Philippines Government (NA January 2015, pages 34-36) on the South Asia country's shipbuilding industry with an update on the industry in the Philippines and Vietnam

The economic and financial crisis has put an end to the boom in global shipping and shipbuilding markets and still affects competitors in South and North Asia. Large over-capacity in many segments of the fleet has led to low freight rates and decreasing ship prices.

As a result the maritime technology industry is seeing declining profitability on many new building projects. A massive decline in completions began in 2011 and continues to this day.

Also notable is a decline in workforce at the shipyards. Japan, for example, has seen a decline in its shipyard workforce from 54,000 to 44,000 between 2009 and 2014, a decline of almost 20%. After a good year 2013 new orders globally declined again in 2014 from 103.2 million GT to 82.6 million GT, leaving little hope for improvement in 2015. This data was sourced from the Japanese Shipbuilders Association and their report published in March 2015, as well as from IHS Fairplay statistics.

South Korean yards are faring little better. In the new KOSHIPA (Korean Offshore & Shipbuilding Association) report for 2015 statistics show that new orders were down to 293 vessels in 2014 from 407 in 2013, completions were down to 277 from 301 and the orderbook total was only up to 891 from 877.

It can be further stated that the situation in the Philippines and Vietnam has, in some ways, not changed since 2014. The development in these 'emerging' shipbuilding nations still shows a strong decline since the global financial crisis broke.

Plans from Hanjin in Subic Bay to venture into the VLCC market never materialised despite the fact that the dry docks in the Philippines would easily accommodate these size vessels. Instead, a few orders from European ship owners for the new Panamax size container vessels are being built. They have to build four at the same time in one dock to be able to float them out simultaneously, which does not give a competitive edge when negotiating new orders and is slowing down the building process and delivery. In addition, the high prices for electricity and general infrastructural problems in the Philippines hinder further consolidation of the business.

However, for the first time in the history of the Philippines maritime and shipping industry, shipyards have, through their heads or representatives, organised their first-ever national association to provide a "common voice" in representing the needs of shipyards as its major objective. The organisation has been officially named the Shipyards Association of the Philippines (SHAP). SHAP was launched on 17 June last year, the opening day of the three-day 2015 Marine Ship building and offshore event, at the SMX Convention Center, in Pasay City, Metro Manila, Philippines, where the first set of SHAP officers were elected.

The shipyards currently represented in the SHAP include the R & LT Shipyard, RRT Marine Service Corp., Colorado Shipyard Corp., Western Shipyard, Elfa Shipyard Corp., Fortune Shipbuilding and Lighterage, Elfa Shipyard Corp., Keppel Shipyard, Frabelle Shipyard, RBL Shipyard, Austal Shipyard, Philippine Iron Works, Josefa Slipways, Herma Shipyard, SAS Shipyard Inc., Chesteel Marine, and Tsuneishi Shipyard.

Nevertheless, to describe the mostly unchanged situation in the Philippines today I would like to use the words of our Philippine colleague Barista Uno from his blog from March 2010: "The plain truth is that the Philippines' shipbuilding sector is squarely in the hands of foreigners – Korea's Hanjin in Subic, Japan's Tsuneishi in Cebu and Keppel of Singapore in Subic and Batangas. They're all here because of the cheap local labour. The only Filipino-owned company that's into the newbuilding game in any significant manner is Herma Shipyard in Bataan province. Herma, though, isn't a player in the commercial sense as it has been constructing double-hulled tankers for a sister company, a domestic tanker operator, not for third-party customers. The Koreans, the Japanese and the Singaporeans can pack up and leave tomorrow, and the Filipinos will not be any closer to having their own shipbuilding industry that would earn them the title 'shipbuilding nation.' Those fond of brandishing the phrase to describe the country are seeing a mirage."

That view is as true today as the day it was written more than five years ago.

The situation in Vietnam, the world's number five in shipbuilding activities, also remains grim. Thanks to a number of favourable conditions such as competitive labour costs, strong development of oil and gas activities, a skilful labour force, and favourable geographical conditions, Vietnam maritime's supporting industry has developed to a certain level. But huge debts of the state owned companies mean they need complete restructuring, including foreign investment.

From the Vietnam Shipbuilding news of 11 February 2015: "The Shipbuilding Industry Corporation (SBIC) has risen from a proverbial shipwreck after an active restructuring and is now ready to sail," stated Chairman of the firm's member council Nguyen Ngoc Su.

So far, the reform process of the SBIC – formerly known as Vinashin – is on the right track, having restructured US$135 million of foreign debt and VND16.61 trillion (US$790.95 million) of domestic debt, he said. Su revealed that during this year, the SBIC plans to restructure its remaining debt of about VND10 trillion (US$470 million).

Currently, the firm has 16,500 employees, a sharp decrease from 33,184 in 2010, said Su, adding that in 2014 alone, the SBIC

laid off more than 4,000 staff. Vu Anh Minh, head of the Transport Ministry's Department for Enterprise Management, said collaborating with foreign partners is a strong solution for the SBIC, as fruitful outcomes have resulted from cooperation between the firm's subsidiaries and a number of partners, including Samsung, Damen and Veka.

In 2015, the SBIC is set to generate total revenue of over VND7.2 trillion (US$343.8 million), including over VND4.72 trillion from shipbuilding and VND375 billion from repair services. Last year, the SBIC delivered 76 ships, including 33 to foreign clients.

In view of these statistics and statements it can be said that the outlook for the shipbuilding industry for the South East Asian yards has not changed from last year's conclusions. Only where quality and product mix can be adapted to market trends can a recovery from the global crisis be seen at the end of the horizon.

Traditional markets like orders for dry bulk carriers, according to Clarkson's weekly report from 8 May 2015, crashed to a 20-year low during the last four months and Japanese yards are suffering from this development especially. This is all disappointing news, but as we all know, in good markets and bad, there is still a lot of cargo to be moved and statistics show a constant growth of global trade. The same can be said for Offshore Oil & Gas. Worldwide output is still on the rise with 2.8% more predicted for 2015.

Hopefully we will see increased efforts in the region to help the industry to adapt to the changing environment more quickly and will be able to declare an end to a crisis that was self-generated through over supply and dumping prices.

Executives from the leading shipbuilding companies in Japan, Europe, China, South Korea and the United States meet annually at the "JECKU" shipbuilding summit. This is the most important industry meeting with top level representatives of practically all major shipyards in the world. The last meeting was held in Paris on 6 November 2014 and an abstract of its most important points can be found in chairman Dave Iwamoto's end note:

"Supply is still outstripping demand in the conventional shipbuilding markets creating imbalances in the day-to-day business. Measures have been taken to address this overcapacity with the yards focusing on quality of shipbuilding versus quantity and specialisation into new high-tech business fields such as the offshore market. However, these measures alone will not be enough to restore a healthy supply and demand balance in the sector. Further ideas and opinions were put forward and discussed by the regional shipbuilding delegations.

"Focusing on the environmental footprint of shipping offers real opportunities for the shipbuilding sector to support the removal of underperforming ships from the market and offer energy efficient, technologically advanced vessel solutions to the regulatory demands which are placed upon the sector. Regulation, hence innovation, is seen as a key driver to promote the fleet renewal into energy efficient vessel types and for the development of technologies to be retrofitted to ships to allow them to meet the energy efficient design profiles required today. Regulation needs to have implementation certainty in order not to impede technology development.

"The JECKU Top Executive Meeting was reminded to be mindful of any practices that may lead to excess capacity and market distortions. Furthermore, it discussed initiatives currently in place for dealing with overcapacity [that] could be pursued for the healthy development of world shipbuilding."

Considering the above and a few more statistics from last year (See Box) it can be said that the situation in shipbuilding is grim for many of the Asian countries and changes as envisaged by JECKU are not implemented fast enough to avoid further yard closures. This is especially the case with yards that continue to focus on producing bulkers, which will have little

Key Shipbuilding Indicators

Even assuming a) no major shocks to the global economy, b) eventual recovery from current economic weakness, plus c) ensuing future growth in seaborne trade and tonnage demand, worldwide shipyard capacity requirements in the next 15 years look set to be well below the levels seen in their peak year of production, 2010. It is estimated that rather than the 51.6 million ton of capacity that was active in 2010 some 39.8 million tonnes could be required in 15 years, or a reduction of 22.9% from 2010. Even if we assume that more regulations will come into force during that period and the retirement age of vessels will be reduced to 25 instead of 30 years, a deficit of ca.-10.5% would still remain.

In January-May 2014, the aggregate shipbuilding output in China amounted to 13.02 million deadweight tons (dwt), down 24.3% year-on-year. SteelOrbis, May 2014, https://www.steelorbis.com

In 2013, the shipbuilding volume of Korean shipyards recorded 12.50 million tonnes, down 8.1% from 2012. In the midst of a year-on-year decrease of 21.8% in the global shipbuilding volume, Korean shipyards also experienced a reduction due to declines in work in progress, delay in ship delivery schedules, etc. Simtos Korea (Seoul International Manufacturing Technology Show), March 2014.

Japanese shipbuilders saw their order wins down by nearly 50% in May, amid concerns that the recovery from the high Yen may be tapering off. Figures from the Japan Ship Exporters Association show its members clinched 14 export orders totalling 454,140gt, compared to 29 export orders of 953,900gt in May 2013.

Source: IHS Fairplay, 23rd June 2014, from a report made for the Organisation for Economic Cooperation and Development (OECD)

chance of survival as the market is more than saturated.

The five-year outlook

Considering the situation I want first to look at the Risk & Chance Factors in Global Shipbuilding Demand & Capacity:

- Major disruptions to normal cargo trade arising from military conflicts, political disputes or natural disasters;
- Major shocks to the global economy especially if these result in severe and widespread recession. As noted earlier the 2008 recession led to large-scale cancellation of vessel orders. As a consequence global ship completions declined by 40.8% from 2008 to 2012 in relation to 2003 to 2007 completions;
- A slowdown in China's demand for raw materials;
- Change in demand for commodities. For example the use of coal for electricity generation could decline, leading to large reductions of coal shipments and a coinciding decline in dry bulk carrier employment. (Coal imports were down in China by 18% in 2014);
- Serious maritime casualties can entail rapid and fundamental changes to existing regulations;
- Major technology innovations that radically alter the performance and running costs (e.g. the introduction of new "eco-type" designs that reduce fuel consumption and therewith bring substantial savings on fuel cost). This could generate additional demand for new tonnage to replace the less fuel efficient vessels. Nevertheless, the recent drop in oil prices may slow down this development.

To further analyse the future outlook the newest reports from China and Korea may help.

Chinese shipyards are seeing a general consolidation process that deals with a market rebound and not yet a recovery due to the fact that prices were too low in the two years before 2013. It is projected that the industry is to bottom out in 2015 and will slowly start to recover in 2016. In 2015 the industry still has to live with low margin orders from 2012. The recession of China's shipbuilding sector has seen the closing of many unproductive and speculative yards as the sector undergoes consolidation that is likely to carry on for the next few years.

Sources say that today China has only around 700 active yards with about 85 having received new orders this year. One prediction included a statement that after the consolidation period we will see only 10 Chinese shipyards accounting for 75% of the country's shipbuilding market share. (From sources that cannot be independently verified).

South Korea has a longer history as a leading shipbuilding nation than China, and its government and shipyard associations seem to have best adapted to the situation that arose with the global financial crisis. They are using their higher experience level to venture further into the LNG tanker market that shows demand and are also developing their capabilities to work in the more demanding offshore vessel industry. The government plan aims to achieve three goals by 2020:

- Increase marine industrial plant orders up to US$80 billion from US$25.7 billion in 2011;
- Raise the percentage of critical engineering and components manufacturing that can be carried out in the country from 40% in 2011 to 60%;
- Strengthen the competitiveness of the parts and equipment industry for offshore plants to the extent that the rate of localization jumps from 20% in 2011 to 50%.

In the KOSHIPA report for 2015 the chairman Dae Young Park writes: "Korean companies have moved forward with a revamping exercise through restructuring in core business areas to play a crucial part in helping spur growth of shipbuilding & offshore industries. Externally, Korean companies have mapped out a plan to actively cope with the changing market environment by fully leveraging the leading-edge technologies and know how accumulated over many years of work."

In the same report the preview of the association for 2015 is given as follows: Korean shipyards are expected to see a growth of new order intake by more than 15%, fuelled by strong performance in LNG Carriers, FLNG, and ultra large containership sectors, although new orders from global shipping and offshore markets are expected to edge downward slightly from the level of 2014. *NA*

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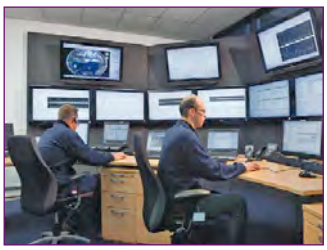

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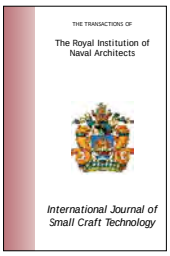

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