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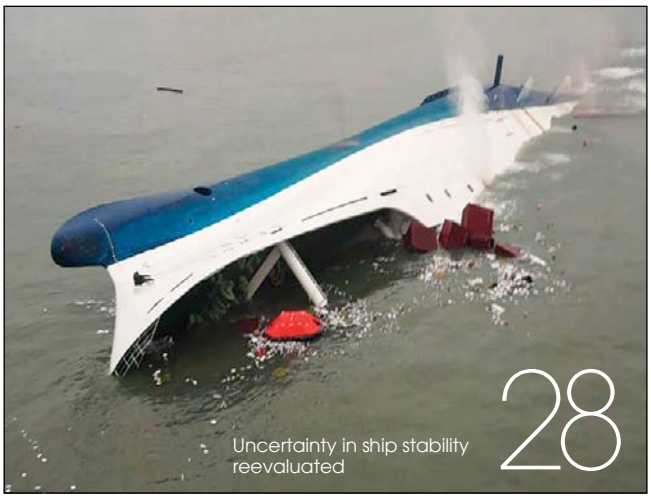

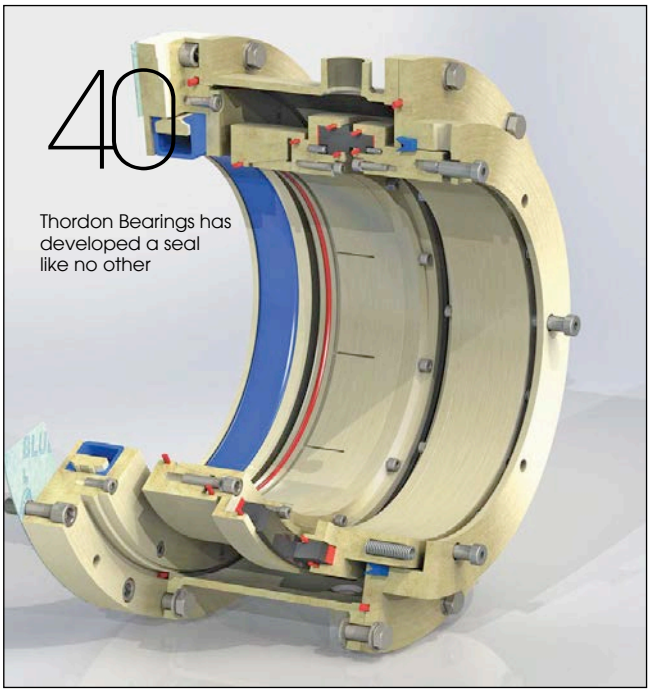

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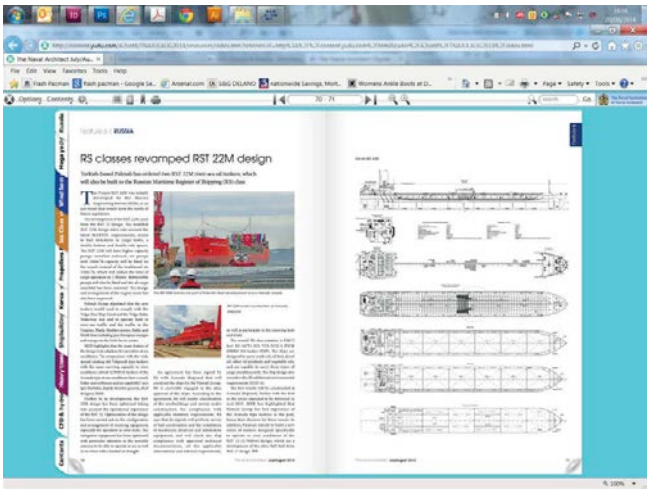

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EEDI – Rethink or Review?

Ro-ro vessels, such as the *Ark Futura* (pictured), may not meet the Energy Efficiency Design Index if they were built to meet today's regulations, and this has led to calls for a change to the one-size-fits all rules which it is claimed cannot work in this diverse sector

Criticism of the Energy Efficiency Design Index (EEDI) as it is applied to all ro-ro and ro-pax vessels is growing from within the maritime industry. Ship designers and vessel owners and operators are gaining support from industry associations and others as the problems around designing any ro-ro ships to meet EEDI mount.

In this month's issue two naval architects have reviewed the application of EEDI to ro-ro vessels in particular. One is an opinion piece, which calls for IMO to re-think its policy on ro-ro ships and its carbon emissions regulation. The second relates the discussions that took place in a meeting organised by the ferry operators association, Interferry and CESA (Community of European Shipyards Associations). Detailed discussions on the efficacy of EEDI, particularly the second phase for ro-ro ships which is due to enter into force in 2020, led the meeting to conclude that it would be very difficult for the industry to meet the regulation.

One attendee at the Hamburg meeting said: "We cautioned IMO that since the ro-ro segments are so extremely diversified, we would ultimately have to try to fit a square peg into a round hole. The EEDI is a statistical methodology applied regardless of whether statistical significance is at all at hand."

Questions as to how this situation has arisen are being asked, even to the extent of why the IMO decided to regulate ro-ro ships, given the diversity of ship types and the comparatively small number of vessels that operate globally (around 90% of which operate in Europe alone), and whether it would have been better for such vessels to be regulated more efficiently locally, by the EU for example. This does of course beg the question as to who would regulate the remaining 10% and to what rules they would be regulated.

"We cautioned IMO that since the ro-ro segments are so extremely diversified we would ultimately have to try to fit a square peg into a round hole"

The situation for ferry owners and operators is further complicated by the fact that many of the traditional ferry builders in Europe have closed down and owners are now looking to China's yards to find suitable alternatives. However, building ferries has always been a complex art, and to ask inexperienced yards to build ferries that meet a regulation that is itself proving, at best, difficult to meet is possibly a step too far for owners and yards alike at present.

One of the consequences could be that orders for new tonnage will reduce as owners prefer to maintain older, more polluting tonnage, in the hope that EEDI as applied to ro-ro vessels will be reviewed at a later date and that even inexperienced yards will be able to build to this revision. Perversely, this would mean that rather than reducing emissions from this sector, EEDI will result in their increase.

Whilst the particular problems which the ro-ro sector is experiencing in the application of EEDI as it currently stands merits an urgent review, questions about the success or otherwise of EEDI in achieving its stated aim of promoting the kind of design improvements necessary to substantially reduce global emissions are being asked. It is a fact that the main reductions have either come from fuel alternatives, mainly LNG, or the reduction in speed of most vessels.

It is not clear, however, that LNG will significantly reduce carbon levels; it makes a substantial difference to NOx, SOx and particulates, but carbon reductions are limited to at most 20%, and with methane slip and other issues the carbon savings could be substantially less.

So the industry waits with significant expectation for the review of EEDI for all sectors currently underway at IMO. But perhaps a rethink rather than review is called for? *NA*

Market

Faltering market hits newbuilds

A worrying further decline in freight rates has precipitated a decline in second quarter income for container shipping lines and that decline is expected to show in Maersk Line's results due later this month.

Analysts expect that Maersk will record a second quarter loss which they reportedly attribute to "low prices and too many vessels on the water". Similar weak results were reported by the three major Japanese lines, NYK Line, K-Line and Mitsui OSK Lines, who have all downgraded their full year 2016 expectations.

Traditionally the container shipping market dips in the first quarter, following the Christmas rush and a decline in trading as a result of the Chinese New Year celebrations. Second quarter gains are then expected with the third quarter freight demand peaking for the year as retailers stock up for the Christmas rush.

"The big wild card is, how much can Maersk Line cut down on costs, which the carrier showed itself capable of in the first quarter where it was just able to stay afloat. But I doubt that we will see a plus now, because the rates have looked weak," one analyst reportedly said.

Weakness in the container market is also reflected in other major shipping sectors; too much capacity in the dry bulk and tanker markets is chasing too little cargo. Time charter rates for VLCC, Suezmax and Aframax tankers are close to two year lows, according to one analyst.

The fall in rates is a further blow for the shipbuilding industry which is seeing a significant fall in newbuilding orders as owners chase distressed sales and second hand tonnage even in the face of rock bottom newbuilding prices on offer. Yards in China told *The Naval Architect* that they were offering customers break-even prices on newbuildings, but owners were looking for premium rate equipment on their vessels and looking to drive down prices even further.

However, a further effect of the squeeze on rates could be the greater contraction of finance, in what is already a very tight market, for newbuildings as banks get the jitters.

Clarksons data reflects the declining market with total deliveries for 2016 expected to reach 1,016 ships, substantially down from the 2014 and 2015 figures of 1,313 and 1,400 vessels respectively and more than a third lower than the 2013 total of 1,548.

In addition, VesselsValue, the market data analysts, have recorded a 52% decline in second-hand sales and a 65% decline in newbuilding orders in the first six months of this year.

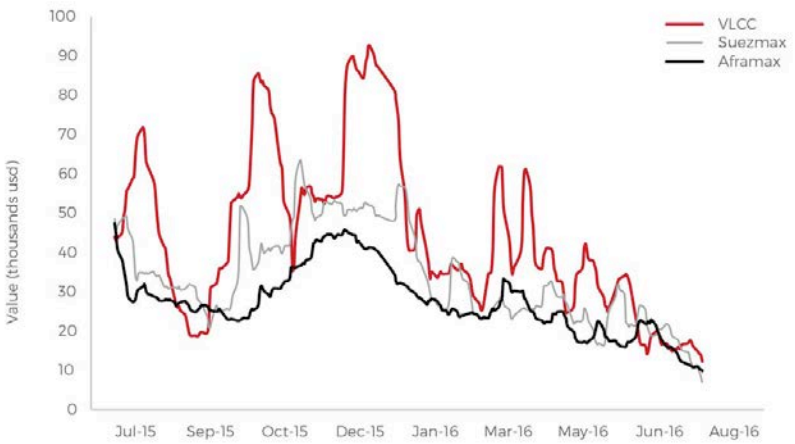
Shipyards

HHI bucks the trend

South Korean shipyard Hyundai Heavy Industries (HHI) has bucked the general trend amongst shipyards by posting a Won900 billion (US$819.26 million) profit for the first half of 2016, following the announcement of its second quarter earnings in late July.

Second quarter sales were Won9.8627 trillion (US$8.95 billion) and operating income stood at Won557.2 billion (US$505.71 million) thereby achieving operating profits for the first half of this year of Won882.4 billion (US$800.85 million).

According to HHI the profits in two consecutive quarters was achieved through "a series of drastic and comprehensive restructuring measures put in place in 2014 by the incumbent top management, and strong performances of Hyundai Oilbank, its refining subsidiary".



Daily crude tanker spot rate 1st July 2015 – 31st July 2016 for VLCC, Suezmax and Aframax Tankers

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The restructuring was accompanied by the stabilisation of manufacturing processes for the offshore plant business including a change of orders received from offshore clients. In addition the yard managed to increase its shipbuilding that it won at "profitable prices" and which "outweighed the Won260 billion (US$236.7 million) one-off cost for the voluntary retirement program".

Further measures to reduce material costs for HHI's non-shipbuilding businesses will continue, including the Engine & Machinery division, Electro Electric Systems and Construction Equipment added to the company's comparatively strong financial results.

HHI added: "It is encouraging to post profits for two consecutive quarters but we still have a long way to go. Bearing in mind the 80% drop in new orders for our shipbuilding business for the first six months of this year, we will continue to faithfully implement the management improvement plan to facilitate sustainable performance."

Meanwhile, Samil PwC, a local member of the global accounting firm PwC, announced on July 26 that HHI's Won3.5 trillion (US$3.2 billion) management improvement plan will be sufficient for the diverse company to make an operating profit and secure liquidity even in the worst case scenario.

In a board of directors meeting held at the end of July HHI decided to continue with its restructuring plan and took the decision to sell it finance houses, Hyundai Finance Corporation and Hyundai Venture Investment Corporation. The sale will also include the offloading of all of HHI's financial subsidiaries, Hyundai Futures, Hi Asset Management and Hi Investment & Securities. With the disposal of these assets HHI says it intends to focus on its core businesses.

Newbuilding

Joint tanker design for Swedes

Swedish shipowner Ektank will jointly design the two product tankers, with naval architects FKAB also of Sweden, that it has ordered from China's Chengxi Shipyard Co, Ltd, a China State Shipyard Corporation operated yard.

The 18,600dwt vessels will have a length of 154m with a width of 23.75m and a design draught of 9.35m. Known as the FKAB T28 project the product carriers will have a total capacity of 22,700m^3.

The ships will reportedly be the first product tankers built at the Chengxi yard which is more accustomed to building bulk carriers.

"It has been very interesting to develop and further elaborate the design together with FKAB creating the next generation of product/chemical tankers. These vessels will be designed to meet all known future demands both from governments, the industry and from our customers," Jörgen Johnsson, CEO Ektank AB, said.

Green technology

Bubbles are a silver lining

As shipowners seek to reduce emissions and fuel costs, the introduction of new green technology is vital in the face of increasing environmental legislation.

A decision on whether or not the global sulphur cap of 0.5% is introduced in 2020, or postponed until 2025 will be decided at the Marine Environment Protection Committee meeting in October and any future carbon curbing measures will have a significant effect on emissions, but Silverstream Technologies believes its anti-friction innovation will also have a key role to play in improving ships' performance.

The Silverstream system works by producing a thin layer of bubbles to create an 'air carpet' along the vessel's hull. This reduces friction with the water and provides net efficiency savings in excess of 5%, and in turn reduces fuel consumption and associated emissions, the company says. The system can be retrofitted in 14 days and has a payback period of between two to five years depending on various factors such as vessel size, speed, operational profile and the price of oil the company estimates, and can be fitted both to newbuildings and existing tonnage.

The system was trialled by Shell and has been installed on Norwegian Cruise Lines' new vessel *Norwegian Joy*, under construction at Meyer Werft in Germany.

Commenting on the system, Silverstream's chief executive, Noah Silberschmidt, says: "Many operators have already seen a rise in fuel costs due to the significant amount of time that they operate within the 0.1% ECA zones. These costs will only increase further when the global 0.5% limit for sulphur in fuel comes into force in 2020, which is the anticipated date of implementation for the regulation. In conjunction with the growing commitment to sustainability, we are seeing considerable interest from operators, particularly in the cruise sector, who want to offer assurances to their customers that they are proactively looking to minimise the environmental impact of their operations. They are doing this by getting

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ahead of regulations and implementing proven clean technologies that increase efficiencies and reduce fuel consumption and associated emissions.

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Correction 1

In the July/August issue of *The Naval Architect* in the story entitled: Fillet Tee joint solution for containership cracks, we would like to point out that this story was written by journalists from the magazine using a paper published by a number of organisations. In addition, under the section entitled 'Test results', the second paragraph should read as follows:

Table 3 shows test conditions and results of ultra-large scale crack propagation tests, Figures 7 and 8 show the fracture appearance in Scenario 2. The long brittle crack propagated along the large heat input weld joint separated the crack-running plate completely.

However, the long brittle crack arrested in the fillet Tee joint consists of a large heat input weld joint and test plate. Figure 9 shows the fracture surface of Scenario 2, which was made to appear by the forced fracture after the test. In the 16mm Fillet Tee joint the brittle crack propagated and arrested in the fillet weld metal. In the 12mm Fillet Tee joint the brittle crack hardly propagated in the fillet weld metal. In Scenario 2, the long brittle crack which extended from the crack running plate into the Fillet Tee joint was arrested in the fillet weld metal without penetrating the test plate simulating the hatch side coaming.

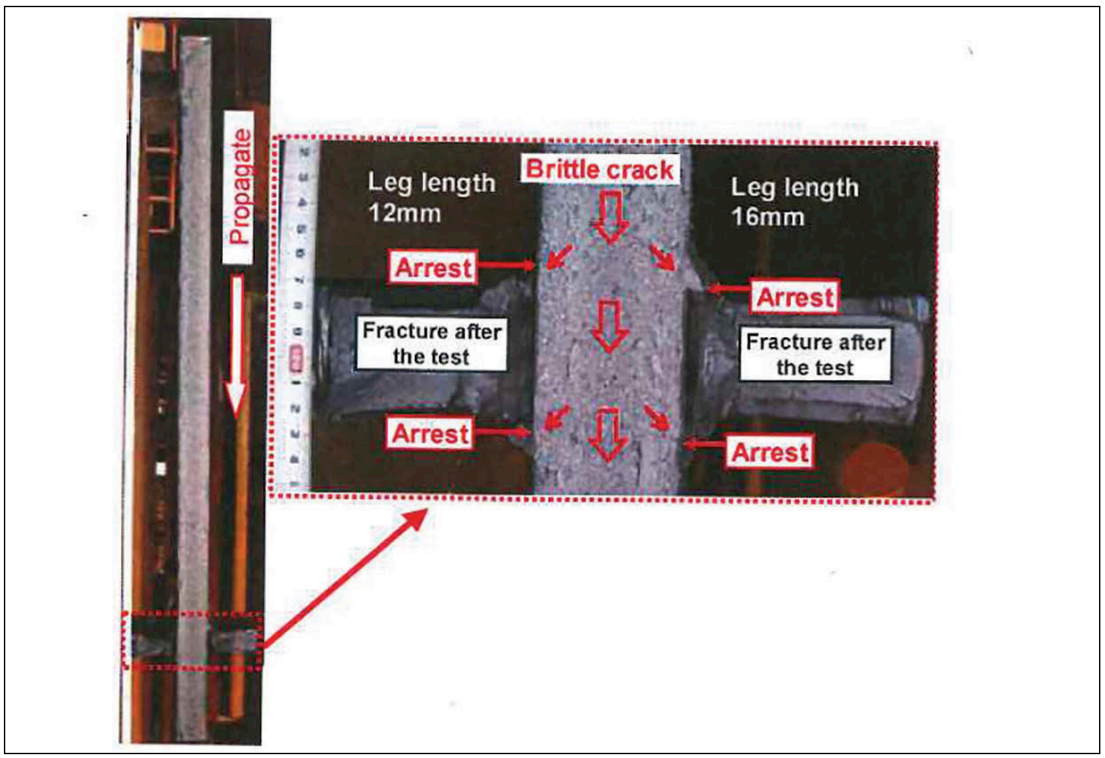
These tests confirmed that Tee joint structures of thick steel plates with long brittle cracks can be arrested by adopting a fillet joint structure in which an un-welded face is provided in the weld.

Correction 2

In addition, on our letters page in the July/August issue we published a table that required two corrections in the third and fourth columns, 'Capacity/GT' row, and all the figures in the lower two rows should have a decimal point, as in the corrected table below.

Type	Membrane	CDTS	CDTS block coeff corrected
Capacity	170,000	210,000	188,764
Gross tonnage	124,237	138,458	138,458
Capacity/GT	1.368	1.517	1.363
Comparison	1.000	1.109	1.000

Figure 9



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Internet energy efficiency drive powers low carbon future

If low fuel prices may have given owners and operators something of a reprieve on costs, the importance of energy efficiency continues to grow and a new website has been designed to help them as they continue to operate in a demanding economic environment, *writes Sandra Speares*.

At the centre of the new website, launched by the IMO, is information on the different segments needing energy efficiency attention, whether machinery, propulsion or hull design.

In looking at each segment in turn, the aim is to gauge the maturity of approaches to the topic in the market as a whole. This maturity encompasses the extent the technology has been embraced by industry, whether it is a tried and tested solution, or at a more rudimentary level as far as implementation is concerned.

The new website provides important information and updates on the Global Maritime Energy Efficiency Partnerships (GloMEEP) project – a GEF-UNDP-IMO initiative that supports the uptake and implementation of energy efficiency measures for shipping, thereby reducing the industry's greenhouse gas emissions.

The portal builds on the work undertaken by IMO's Marine Environment Protection Committee to promote technical cooperation and technology transfer relating to improving the energy efficiency of ships.

The economic downturn in the shipping segment has had an inevitable effect on emissions volumes from ships according to the Third IMO Greenhouse Gas Study in 2014. The study states the industry emitted 796million tonnes of CO_2 in 2012, which accounts for about 2.2% of the total emission volume for that year.

In contrast, in 2007, before the global economic downturn, international shipping is estimated to have emitted 885million tonnes of CO_2, which represented 2.8% of the global emissions of CO_2 for that year.

While part of this decrease is doubtless due to activity levels associated with the downturn, measures taken by the industry to reduce fuel consumption and increase energy efficiency have also had a role to play.

Classification society DNV GL provided the technical content for the website as well as developing a tool to appraise the technical and operational energy efficiency measures for ships. The tool aims to support interested parties in investigating and assessing energy efficiency measures and could potentially serve to assist decision-making.

It calculates the effect the measures have on the Energy Efficiency Design Index and Energy Efficiency Operational Indicator and the economic cost including the Marginal Abatement Cost Curve, the cost of reducing one more tonne of CO_2. The output of the tool is a list of the available measures for the chosen ship type and size, and their effect.

In using the website, interested parties can look at individual aspects of energy saving and assess how developed technology is in the segment in question as well as the costs involved in using it.

For example, a section on shore side power which gives details of facilities that may be needed for larger vessels with more complex requirements, specifications for different power needs and system requirements for different sizes and types of ship as well as investment costs for different categories and size of vessels. As the information points out, in the case of cold ironing the costs associated with its use that are mentioned only relate to the vessel itself and not to any port infrastructure.

Other topics include: auxiliary systems and engine performance optimisation, shaft generators, waste heat recovery systems, hull cleaning, cargo handling systems, propeller retrofitting, energy efficient lighting systems and the use of Flettner rotors, to give some examples.

"We in DNV GL are proud to be part of IMO's GloMEEP initiative and do hope the portal will be used as a knowledge base for users interested in becoming more energy efficient. Driven by its purpose of safeguarding life, property and the environment, DNV GL is happy to provide information for capacity-building, technical assistance and transfer of information relating to improving the energy efficiency of ships.

"The portal's purpose is to educate users on the range of energy efficiency technologies currently available for the international shipping industry and guide the user to additional information", comments Liv Aune Hagen, consultant at DNV GL's Shipping Advisory section and project manager responsible for GloMEEP.

The International Association of Ports and Harbors (IAPH) has recently joined the GloMEEP project as its third strategic partner, along with the Maritime and Port Authority of Singapore and the Institute of Marine Engineering, Science & Technology.

IAPH will be collaborating with the GloMEEP project on the development of tools and materials to help in quantifying air pollutants and GHG emissions in ports, and will assist in the identification of measures to cost-effectively reduce port related emissions.

GloMEEP and the GLO Ballast Partnerships Programme are being used to accelerate legal, policy and institutional reforms in developing countries in order to implement the Ballast Water Management Convention and MARPOL Annex VI. *NA*

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Stabilisers

Drag reduced with stabiliser cover

Equipment provider, SKF, has developed a prototype stabiliser cover that promises to reduce drag and fuel consumption.

The Dynamic Stabilizer Cover can be used across many vessel types, including ferries, yachts and cruiseliners to reduce the amount of water resistance innately created by a stabiliser's fin box, which creates resistance even when stabilisers are retracted.

The solution offers a simple structure for high reliability and an effective covering for stabilisers when retracted or extended, comprising two inflatable cushions on each side of the ship made from a Kevlar mesh coated with neoprene rubber. Its operation is integrated within the standard stabiliser controls and occurs automatically.

"Once the stabiliser is housed, the cushions are filled with compressed air to seal the fin boxes," explains SKF. "When the fin is extending, the cushions are deflated and subsequently reinflated."

The product responds to growing environmental concern within the maritime industry and provides a permanent solution for shipowners looking to improve their fuel consumption and reduce emissions.

"The effect varies depending on vessel size," says an SKF spokesperson. "For a huge cruiseship, which accommodates enough passengers to populate a small town, [a stabiliser without such a solution] translates into significant extra costs when oil prices rise."

The cover has the additional advantage of operational reliability, as the operability of the stabiliser is unaffected in the event of a fault with the air cushion, according to the company.

www.skf.com

Software tools

Bottom slamming update

ClassNK releases the latest version of its design support software PrimeShip-HULL (HCSR) Ver.3.5.0., adding additional functions, including an evaluation for bottom slamming to the direct calculation software.

Performance and usability have been improved, according to ClassNK, and the design evaluation function for the prescriptive calculation software has been given a wider scope and additional functions such as the evaluation function for bottom slamming.

The new function uses a finite element (FE) model for hold analysis that is required by the International Association of Classification Societies (IACS) Common Structural Rules for Bulk Carriers and

SKF has developed a prototype Dynamic Stabilizer Cover


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Oil Tankers (CSR BC & OT) and includes automatic creation functions for evaluation panels, slamming loads and reports. In addition, it features an upgraded manhole modelling function, batch edit for multiple opening information, and a registering function for screening evaluation points.

The software aims to make it easy for designers to carry out rule calculations in line with the CSR BC & OT and to optimise their designs.

"Users will be able to benefit from even further reduced evaluation time and greater support in the design of safer ships compliant with CSR BC & OT," says ClassNK.

www.classnk.or.jp

Pumps

Seawater pump sized up

Colfax Fluid Handling's ALLMARINE MI-D seawater pump series has six new sizes to cover the needs of ships ranging from about 60,000dwt to more than 200,000dwt and can come with a new turnkey control for the flow of cooling seawater.

The pump's patented double-suction, symmetrical design, with one shaft seal, no internal bearings, and corrosion resistant materials, offers numerous benefits, according to the company.

"The MI-D is probably the lightest and smallest water pump for large flow rates yet, it also has an outstanding service life and extraordinary efficiency in Marine applications," says Christian Martin, director of product management.

Efficiency is greater than 80%, the pumps are maintenance free between service intervals, and the fact their NPSH values are below 4m makes these pumps well-suited for ballast systems, according to the company. In addition, four-pole motors reduce space needs and procurement costs compared to six-pole motors.

CM-1000 controls the flow of cooling seawater pumps according to the temperature of the fresh water and current cooling requirements, saving considerable amounts of electricity. A new turnkey version provides the full electronics in a modular solution that includes frequency converters.

In addition, CM-1000 can shut down the pumps completely when the ship is at a standstill or slow steaming in a cold environment and switch them back on automatically as required, reducing energy consumption.

www.allweiler.de

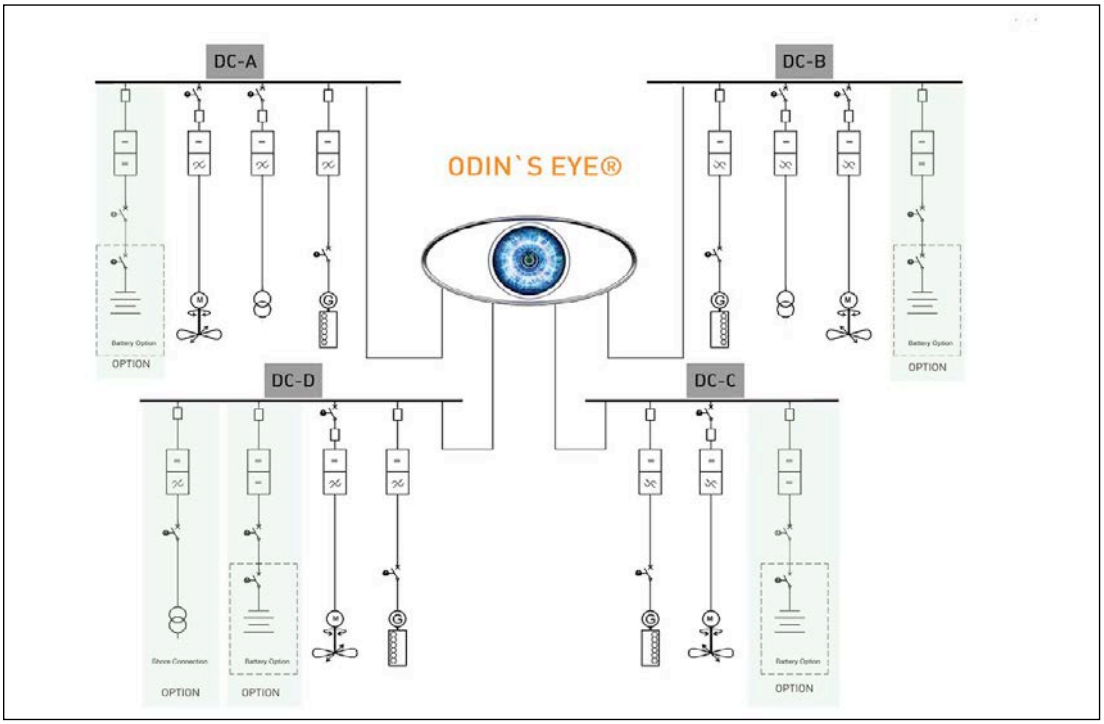
Power systems

New DC grid solution

Norwegian Electric Systems (NES) launches a new electric propulsion system, ODIN`S EYE, that can be used in large and small vessels to increase efficiency and fuel savings.

The DC grid solution allows for the use of variable speed generator sets, but unlike other systems, can offer improved capabilities for less expense, according to the company.

A new DC grid approach for reducing emissions



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Paul Winson, senior vice president of sales for NES, says: "We expanded our frequency converter, the Quadro Drive, and connected it in a ring net solution. Instead of being limited to just a two split switchboard, which means drastically over sizing the generators and propulsion motors, we can now split all the essential equipment up into separate autonomous islands. These islands can be configured to work together with closed bus-ties or independently with open bus-ties."

Costs are reduced with ODIN'S EYE, continues Winson, because the solution uses existing technology that has been honed.

www.norwegianelectric.com

3D Printing

Maritime 4ir takes off

The fourth industrial revolution (4ir) or Additive Manufacturing (AM) as it is sometimes called is set to revolutionise the maritime industry, and, as a start, three partners have researched the use of 3D printing for maritime purposes.

Port of Rotterdam, Innovation Quartered and RDM Makerspace ran a pilot project known as 3D Printing Marine Spare Parts which ended earlier this year. The group were hoping to answer some key questions such as, what size of parts can be printed in metal at this time? Can all requirements be met if these parts are manufactured by means of additive manufacturing (Classification Rules, Statutory Regulations, International Standards)? To what extent is '3D printing on location' a possibility? And are there economic benefits to the AM of spare parts when compared to conventional manufacturing?

Lloyd's Register was also asked to verify that the manufacturing process would be able to consistently meet all applicable requirements.

In the second phase of the project, called RAMLAB – Metal Parts on Demand, the original consortium is being supported by a growing list of partners in what is now a Joint Industry Project (JIP).

"This technology has various technical advantages, and is much cheaper and has less safety and operational issues in relation to comparable laser based systems and other AM systems. The metal parts produced are typically used in a maritime, industrial, oraeronautical context as well as a broad range of other industries," said Lloyd's Register.

www.ramlab.eu

HVAC

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PAROC, a manufacturer of energy-efficient insulation solutions, provides new factory produced bends for efficient and fast insulation of HVAC systems.

Hvac Bend AluCoat T is a non-combustible stone wool pipe section bend for thermal and condensation insulation of pipework in buildings and ships, and comes with a prefabricated layer of reinforced aluminium foil facing and tape in the longitudinal seam.

The product aims to prevent condensation and make it easier to fit the insulation to the existing HVAC pipes, also improving the quality of the pipe insulation. Installers can use these dimensionally accurate, prefabricated insulation components instead of manually cut out pieces of pipe section that have to be laboriously fit to every pipe elbow.

www.paroc.co.uk

Engines

World's first ME-GIE ethane engine completed

Mitsui Engineering & Shipbuilding Co., Ltd. (MES) has completed the world's first low-speed, ME-GIE ethane-operated two-stroke diesel engine.

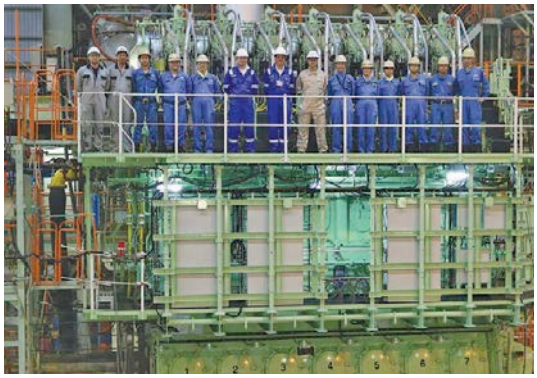
The Mitsui-MAN B&W 7G50ME-C9.5-GIE is the first triple fuel engine in a series of three for installation on three liquefied ethylene gas (LEG) carriers of 36,000m^3 for Hartmann Schiffahrt of Germany and Ocean Yield of Norway that are currently under construction at Sinopacific Offshore Engineering (SOE), China.

Ethane fuelling was selected for these vessels due its more competitive pricing, significantly shorter bunkering times, and improved emissions profile compared with HFO; it contains negligible sulphur, and emits 15-20% lower CO_2 and significantly fewer particles during combustion. However, these ME-GI engines will also be set up so that they can be converted to run on methane.

Eight ME-GIE engines are currently on order.

www.mandieselturbo.com

First ME-GIE ethane engine completed at Mitsui's Tamano Works



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Selektope draws the sting from marine coatings

In the past marine coatings have been seen as causing at least as much damage to the marine environment in its efforts to reduce the harmful effects of greenhouse gases as other emissions. After 15 years of research a new anti-fouling method has been launched onto the market. Selektope takes to the water

As eureka moments go, the flash that sparked the realisation for researchers of the potential for medetomidine as a repellent for marine organisms some 15 years ago could yet be a key moment for the anti-fouling business.

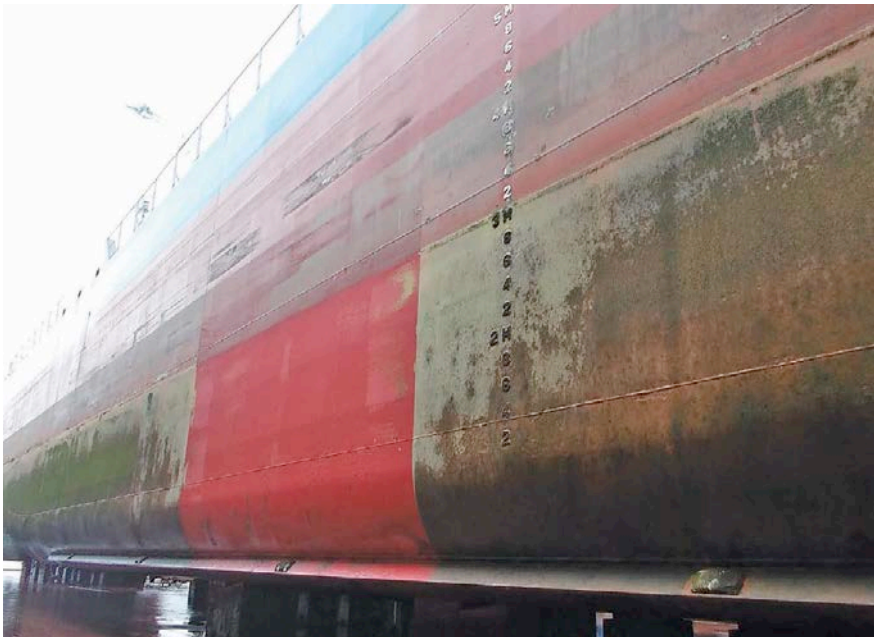
Development of the medetomidine coating additive took 15 years at a cost of between US$20-30 million in total, with the birth of a start-up company, following the discovery of the repellent qualities of the pharmaceutical to marine organisms.

Medetomidine is a substance that excites marine organisms when they come into contact with even miniscule amounts of the material, making it impossible for the organism to attach itself to any structure that is emitting the substance. However, the effect of medetomidine on the organism is temporary and the barnacles, whelks or other marine animals will simply move away unharmed.

Selektope CEO, Philip Chaabane, explains: "The unique repellent mode of action from the active agent," means that when the "organism comes into contact with the [medetomidine] it starts to kick with its legs and has to swim away." This means that the organism never gets the opportunity to attach.

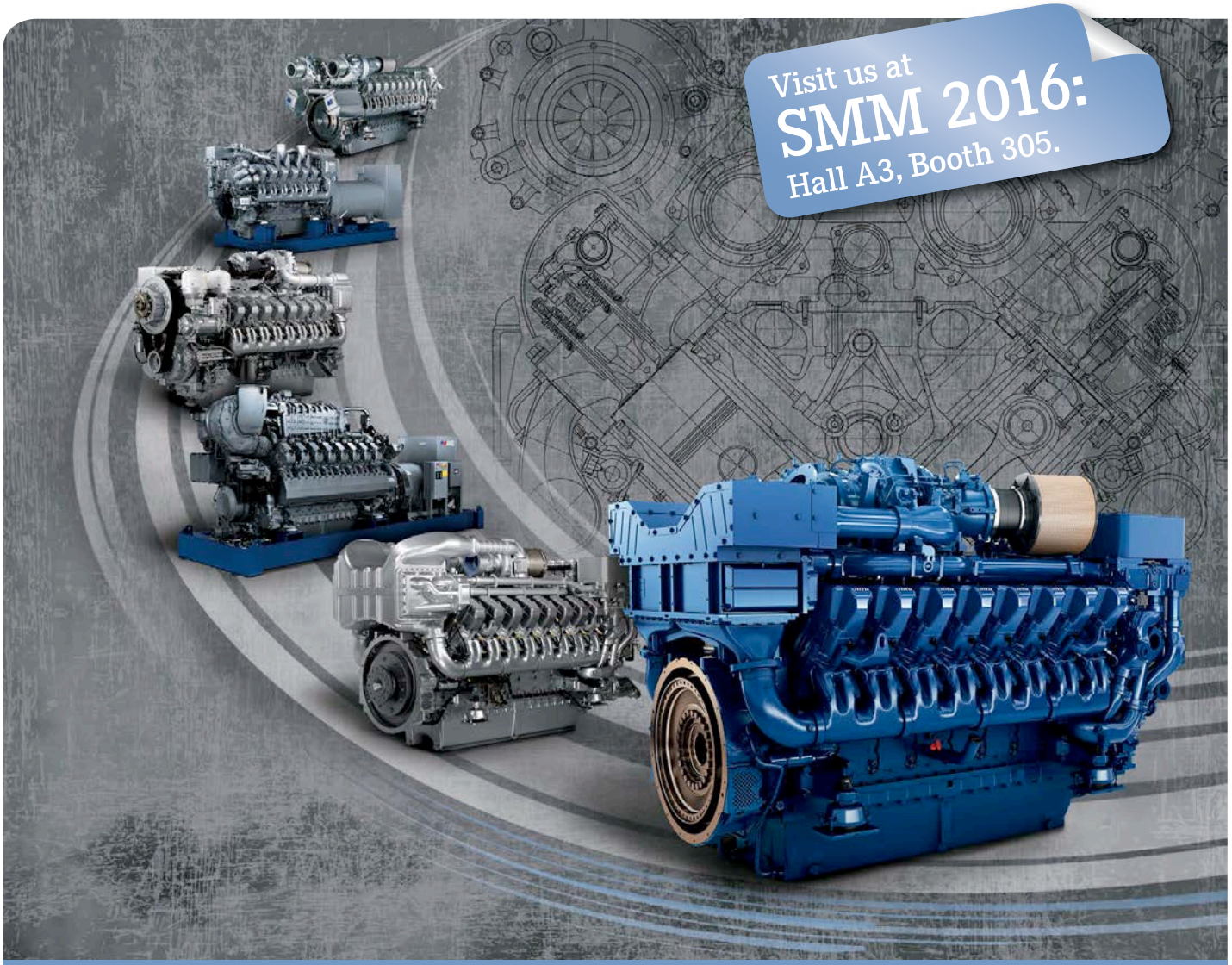
Even very small amounts of the chemical had the desired effects according to researchers at the University of Gothenburg where medetomidine was discovered as a possible new anti-fouling substance. Medetomidine has now been developed into the additive Selektope, which is being marketed by I-TECH.

Chugoku Marine Paints recently launched a new range of SEAFLO anti-fouling coatings, including the first branded product to feature Selektope. Other major coatings companies,



A test patch of Chugoku Marine Paint anti-fouling coating and Selektope after one year on a low activity coastal vessel in Tokyo Bay (high fouling area)

A test patch with Chugoku Marine Paint anti-fouling coating using Selektope on a Japanese coastal vessel after two years



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including PPG, International Paint, Hempel and Jotun are also looking at offering coatings that use the medetomidine-based additive, leading long-term investors to be more than hopeful that Selektope will eventually emerge with a healthy profit.

"Selektope is currently on the market with Chugoku," said Chaabane, where the additive will either replace existing technology or be used in combination with existing anti-fouling technology. Chaabane says that when used in combination with existing anti-fouling agents Selektope's characteristics can also contribute to fuel savings over conventional anti-fouling coatings.

According to Chaabane, Chugoku is the only paint company that officially markets Selektope at this time, and the Japan-based coatings company has three different products on the market with a fourth coming.

"Selektope can replace copper, but in combination with copper, which is a little bit more expensive, the combination of the two is extremely efficient in static performance." Chaabane says: "Selektope can be used as an additive to existing paints in concentrations of 0.1% by weight compared to existing technologies. It is used in tremendously small concentrations."

He adds: "It can be used in all paint known today except in foul release systems that don't contain biocides, but there is research that is ongoing for these paint types also."

Eureka reprise

At the turn of the millennium researchers at the University of Gothenburg had been investigating how a range of non-toxic substances could be used as 'antagonists' to the settlement of hard fouling when dissolved in seawater. That research focused on the barnacle Balanus improvus, and its 'colonisation' of man-made surfaces at the larval stage.

According to records kept by Selektope, an important discovery was made early on in the development of the substance at the panel-testing stage: "Remarkably, a polymer containing medetomidine in a concentration equivalent to 0.02% by weight volume rejected 97% of the aggressive Barnacle improvus after two weeks, and 96% after four weeks. No other macro-fouling organisms were present at all." A further distinction pointed towards medetomidine's potential for its "tendency to accumulate at the solid/liquid interface across the full extent of a surface."

As the organism was transparent it made it "an ideal case for study", and a report by researchers Mia Dahlström, Lena Mårtensson Lindblad, Per Jonsson, Thomas Arnebrant and Hans Elwing set their goal as discovering "adrenoceptor active compounds" that mimicked anti-fouling produced naturally in the marine environment to inhibit invertebrate larvae from settling on man-made structures.

Medetomidine research was distinguished by its reversible effects: "larvae that came into contact with the substance metamorphosed into juvenile barnacles with no apparent ill effect," said the report.

At this time, early 2000s, the IMO had been looking closely at the use of organotin (TBT) anti-fouling systems, which had been in use since the 1970s, but evidence had shown that the leaching effect of TBT was poisoning marine life and in 2002 the IMO regulated against the use of TBTs altogether and the phase out began.

Pressure then mounted on suppliers of marine coatings to find a replacement for TBTs as the principal ingredient used in the anti-fouling products protecting ships' hulls from the attachment of seaweed and slime, but also barnacles.

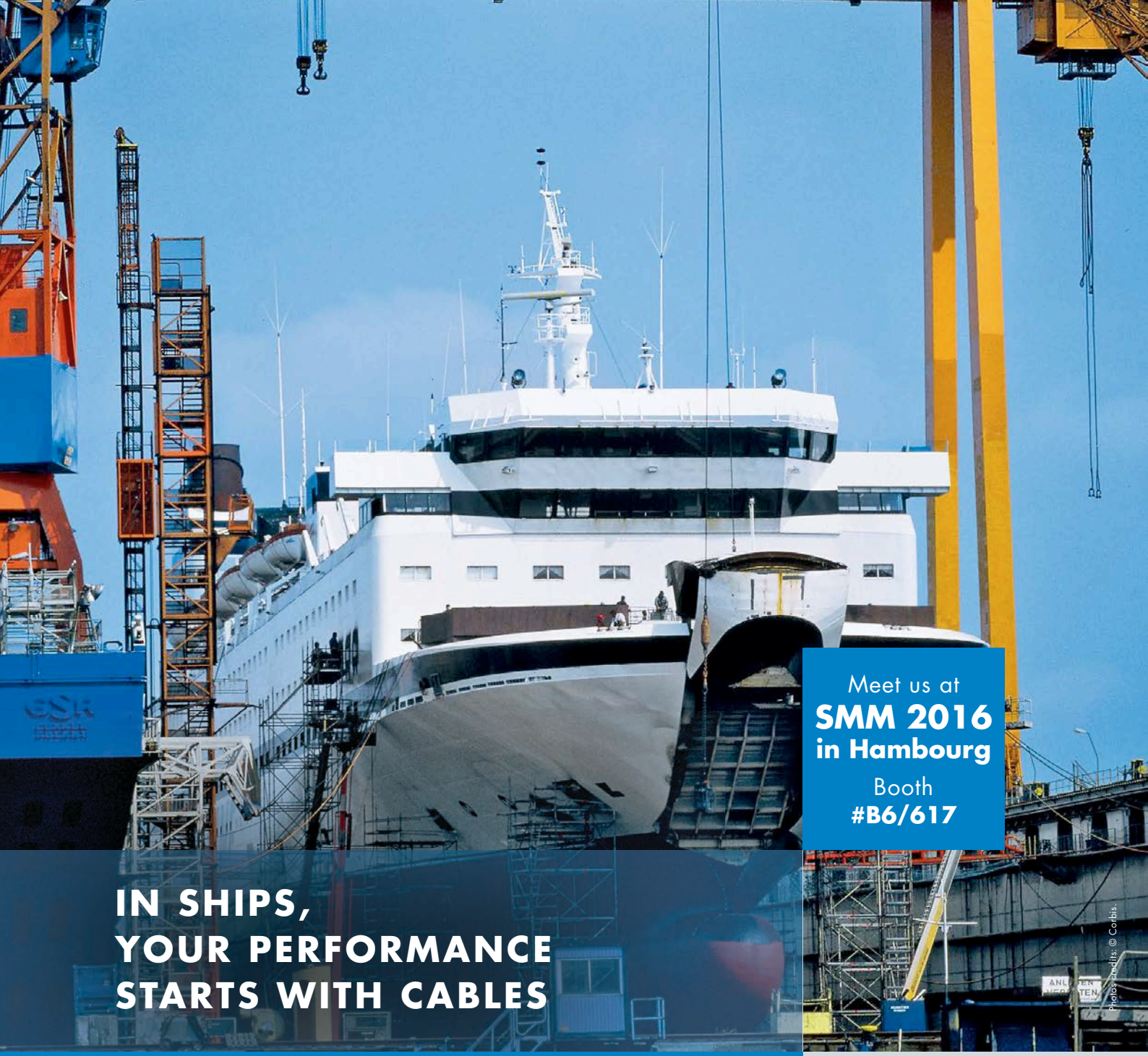
Anti-fouling coatings typically include active compounds that are slowly released into the marine environment to deter the attachment of marine life to ship bottoms. These coatings are 'self-polishing' in that the friction generated by the ship's motion through water causes tiny quantities of the base polymer to leach at a predetermined rate, while the active anti-fouling maintains its performance evenly through the paint's lifetime.

While effective and widely applied to commercial ships from the early 1970s onwards, over time marine biologists gathered evidence of the damaging impact of TBT on marine life. The effects included the poisoning of oyster beds and imposex, where marine pollutants cause female marine gastropod molluscs to develop male sex organs, and were particularly discernible in coastal areas near drydocks that were flushing coatings.

Two years before the IMO enforced the phase-out of organotin, it had been established that medetomidine could offer an approved and verified anti-fouling solution. Over time, the findings would prove to be a turning point for the marine coatings industry. Today, the anti-fouling action of medetomidine has been registered under the Selektope brand, recognising its selective action.

As Gothenburg University researchers confirmed the astonishing anti-fouling properties of the ingredient that would become Selektope, shipping's need to respond to the global ban on TBT as an active biocide was laid out by Dr Robert Townsin, a fellow of RINA, in his study entitled 'The Ship Hull Fouling Penalty' (2002), which included

Barnacles built up on a control test patch after seven months in static condition on the west coast of Sweden using anti-fouling without Selektope



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an approximate formula for calculating the roughness drag penalty, which was adopted by the International Towing Tank Conference in 1990.

"Respected authority Townsin credited Holzapfel as making the first mention of the 'leaching' effect that dominates merchant shipping antifouling solutions today as long ago as 1904. However, it was not until 1971 that ship hulls were able to take advantage of copolymers loaded with tributyl tin as a workable biocide. Subsequently, new products emerged capable of a constant biocide leaching rate to perform over an extended lifespan (up to five years)," says the Selektope report.

According to the same report, research into the mechanism that made medetomidine an effective anti-fouling substance had attracted funding from The Swedish Foundation for Strategic Environment Research (MISTRA) Programme for Marine Paint. After five years of accumulated study, researchers at Gothenburg University were ready to publish their findings for peer review.

As a direct consequence of the peer review, Volvo-owned standalone company Volvo Group Venture Capital offered seed funding for the development of Selektope as a commercial anti-fouling for the marine coatings industry.

Lena Mårtensson Lindblad also emerged as the common thread between the original research and the formation of I-TECH [the Selektope parent company]."

Fouling organism biology itself now provides an answer, the article said. "That can be done by taking advantage of the natural behaviour of the fouling organisms." To achieve these ends, I-TECH stated in public that "a molecule should be potent to maximise the anti-fouling efficacy while minimising the release to the environment or it needs to be highly degradable to minimise pollution."

Minimising friction between the hull and water was more pressing for shipowners by 2009 as fuel oil prices soared. Keeping fuel consumption down offered an environmentally-responsible greenhouse gas benefit.

Since the end of 2014, Selektope has been approved for use as a marine biocide under the EU Biocidal Product Regulation (BPR) (98/8/EC). It has also been approved by relevant authorities in the world's leading shipbuilding nations – China, South Korea and China.

In 2014, I-TECH signed a supply agreement with Chugoku Marine Paints. As an environmentally responsible ingredient, Selektope is now "not only ready for next generation anti-fouling coatings, but it is in service today".

As the company concludes: "Selektope has come a long way; it has answered the biological, chemical and regulatory questions; now, all ship owners need to know is whether Selektope is cost-competitive (it is), whether its action will last up to three years (it will) and how it performs in comparison to conventional biocides (it's better).

"In short, this is a story which ends with the repellent and approved anti-fouling ingredient Selektope available and fully approved for use in marine coatings for the entire shipping market." *NA*

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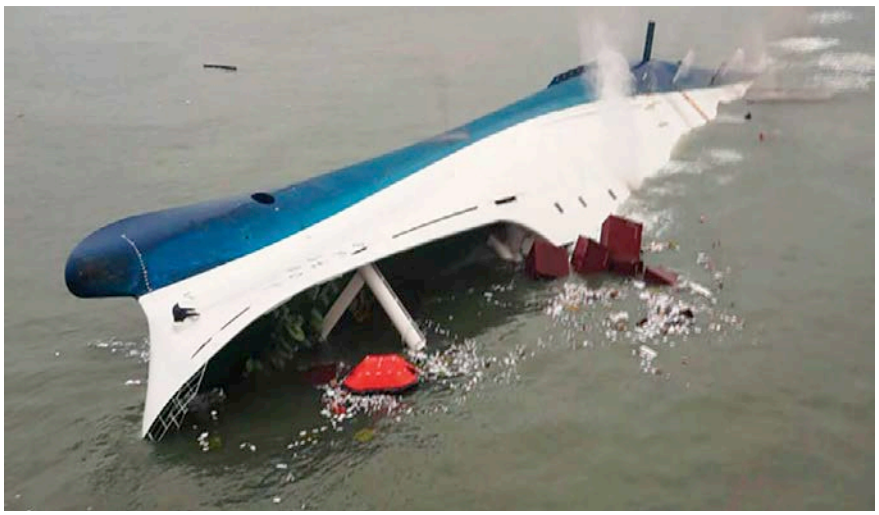
Uncertainty in ship stability

Associate Professor Michael Woodward of the Australian Maritime College, University of Tasmania in Australia, and Keith Hutchinson of Babcock International Group – Energy and Marine Technology, on Tyneside in the United Kingdom, discuss uncertainty in a ship's initial stability and propose an uncertainty analysis procedure for the inclining experiment

Recent high-profile incidents have unfortunately brought uncertainty regarding ship safety in terms of ship initial stability into the public eye.

One of the most tragic recent incidents due to insufficient initial stability, namely transverse metacentric height (GM_T), involved the 1994 built, 145.6m, 6,835GT, ferry *MS Sewol*. On the morning of 16 April 2014, whilst approaching her destination of Jeju, South Korea, with 476 passengers onboard, she rapidly developed a 22deg port list after executing a starboard turn. As a result, cargo shifted and she began to down-flood through the side cargo and stern vehicle doors. Within approximately 10 minutes she was heeling to 30deg and sank 3 hours later. Even though she was within a mile of land, 304 passengers and crew perished, many of them school children. It was subsequently estimated that the ship was loaded with approximately twice the legal amount of cargo and hence without sufficient water ballast to counteract the resultant increase in deadweight vertical centre of gravity (fluid, KG_f), which exacerbated the increases in lightship weight and KG_f due to modifications undertaken since build.

The implications of inadequate initial stability can be catastrophic; for example the loss of the 2006 built, 75.2m, 2,985gt, Anchor Handling Tug Supply (AHTS) ship *MV Bourbon Dolphin* on 12 April 2007. Whilst anchoring the semi-submersible drilling platform *Transocean Rather* in deep water off the west coast of Shetland, a heavy anchor chain that it was handling suddenly slid across the side of the deck and began to drag the ship over. She capsized within seconds, with the loss of eight of the 15 crew onboard. The capsized ship sank three days later and the subsequent Commission of Inquiry set up by the Norwegian government questioned the ship's ability to handle large anchors in such deep water.



MS Sewol capsized and sinking, April 2014, with the loss of 304 passengers and crew

With stringent and well established international and national regulations in place covering initial and large angle ship intact and damage stability, one might be forgiven for questioning how such events can happen. One possible cause, suggested by the authors, is uncertainty in a ship's level of initial stability, GM_T, which as discussed later could possibly be viewed as an 'experimental estimate'. It should be noted that obviously initial GM_T is not on its own a comprehensive measure of stability as many other factors, such as freeboard / reserve of buoyancy, unprotected / protected openings, subdivision etc., play a significant role in a ship's overall intact and damage stability performance. As an illustration that ship design is an often conflicting multiple criteria problem, typically it is not desirable to have ocean-going trading ships which are too 'stiff', i.e. with too large a GM_T, because this may result in unacceptable motion characteristics, specifically roll acceleration. This situation is detrimental with regard to crew / equipment operability, passenger comfort, cargo integrity (such as shifting of cargo, damage / collapse of containers) and consequently overall ship safety. Conversely, too low a GM_T is not just detrimental regarding initial stability, but can obviously also be regarding roll angle in a seaway (in addition to roll due to turning, crowding etc.). It should be noted that whilst passive (e.g. bilge keels) and active (e.g. free-surface or forced roll damping tanks) solutions are available to mitigate roll, the selection of robust dimensions, and to a lesser degree distribution of weights (hence subsequent mass inertia as well as GM_T), in order to 'de-tune' a design is a significantly more elegant and operationally efficient solution.

Research conducted by the authors has found that the determined position of the lightship KG_f (fluid, with systems at operational levels), stated in a ship's trim and stability book / loading instrument and obtained from an inclining experiment, could possibly have a significant level of uncertainty associated with it. With regard to this, the authors have recently published a paper [1] detailing an uncertainty analysis procedure for the inclining experiment; making it

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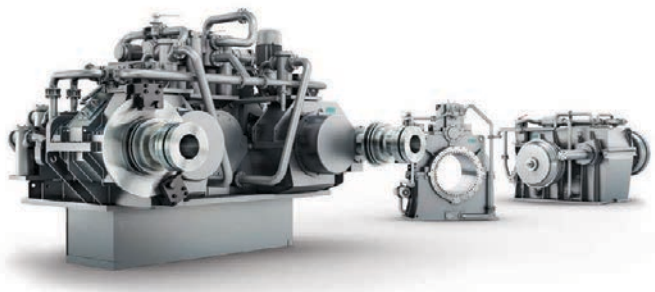

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Error or uncertainty?

So, what is uncertainty? It is important here to make it clear that 'uncertainty' is not 'error'.

An error, for example, may be made when conducting an inclining experiment, resulting in an incorrect lightship - weight, longitudinal (*LCG*) and transverse (*TCG*) centres of gravity as well as KG_f. Such mistakes are always possible. However, appropriate and thorough preparations and conduct of an inclining experiment together with robust quality systems can, and do, reduce the risks to levels that are more than acceptable. Hence, the use of qualified and most importantly experienced personnel, (especially the conducting officer) a robust and comprehensive inclining procedure, internal company procedures, and the appropriate level of oversight and governance by the flag authority (or classification society if empowered to so act) must be viewed as a pre-requisite.

Uncertainty, on the other hand, describes the level of precision with which we can make a measurement. Let's say we wanted to know the length of an engine component to within a millimetre. In this case we might reasonably use a tape measure calibrated in millimetres, and obtain satisfactory results. If, however, we needed to know the measurement to within microns we would need to use a measuring device i.e. a micrometre with a greater degree of precision.

Actually, we would need more information too: we would need to know at what temperature the measurement was made; and, we may also need to tightly define how to support the device whilst taking the measurement. Nevertheless, whatever instrument or method we use, we will only ever have an estimate of the measurement to within some defined level of precision.

For the inclining experiment, the precision with which we take various contributing measurements and how these values propagate through the data reduction equations dictate the precision in our derivation of the as-inclined GM_T and subsequent calculation of the lightship KG_f. This precision limit is what we call 'uncertainty' and, generally speaking, may be thought of as the standard deviation of the mean value in the derived 'experimental estimate' of lightship – weight and, specifically in this case, the KG_f.

Establishing uncertainty

Though thoroughly established in scientific circles, the use of uncertainty analysis seems to be experiencing some difficulty in gaining traction within engineering disciplines, and therefore in applications relating to qualifying and understanding any uncertainty associated with engineering calculations. No reputable scientist would attempt to claim the existence of a new discovery, say a new particle, without first methodically establishing the uncertainty in the experimental data sets supporting the thesis.

Whereas the precision with which a ship's lightship KG_f is established, which is arguably the single most critical value relating to the safe operation of that ship, seems to pass without critical questioning regarding potential uncertainty. It is possible that the perceived or actual reluctance to embrace uncertainty analysis may simply be a lack of familiarity of the subject; 'ironically' a fear of the unknown!

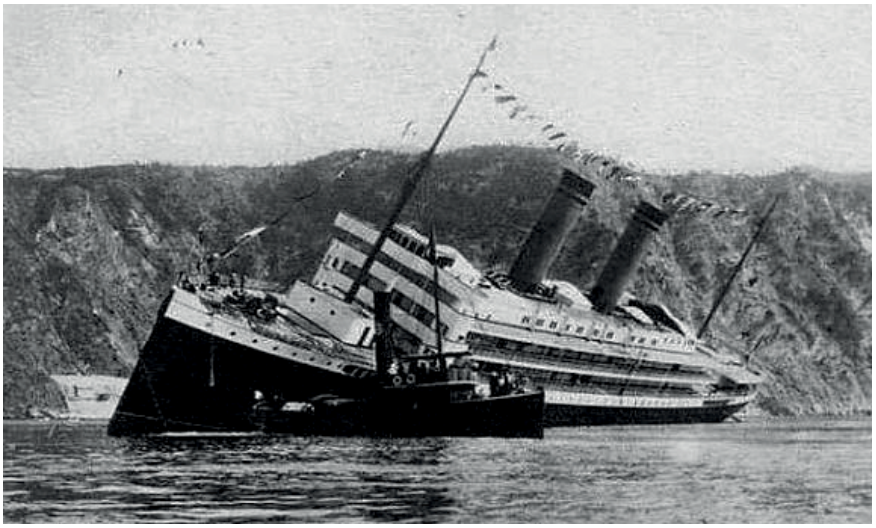
This should not be an issue as the mathematical theory and tools used in uncertainty analysis are surprisingly simple and well within the understanding of any trained and qualified professional engineer or scientist, such as a naval architect. In the most general sense, the uncertainty in an estimated or scientifically calculated value is simply the root-sum-square of the uncertainty in each input variable multiplied by the sensitivity of the result to a change in that variable.

Consider first the uncertainty in the variable. This can typically take one of two forms:

1. If the variable is measured as a function of time, then we would most likely have a sufficiently large sample size to undertake a simple statistical analysis.

   For example, imagine that we have tainted a ship model along a towing tank and measured some resultant generated force. The measured force will obviously fluctuate about some mean value and we would typically take this mean value as our measured result to be used in subsequent calculations. In this case we could reasonably take the uncertainty to be the standard deviation of the mean value.
2. If, on the other hand, we only have a static measurement, then we have to rely on alternative methods.

   This might include information from calibration certificates, past experience or simply based on sound engineering judgement. As an example we could take the uncertainty in an inclining weight group as the value given on the calibration certificate for the load cell used to weigh each of the weight groups – typically, this is undertaken in the presence of the flag / classification society surveyor, during the final preparations for the inclining experiment. That is, the calibration certificate might say that the load cell is accurate to plus or minus some value;



SS Principessa Jolandia capsizing directly following launch, September 1907

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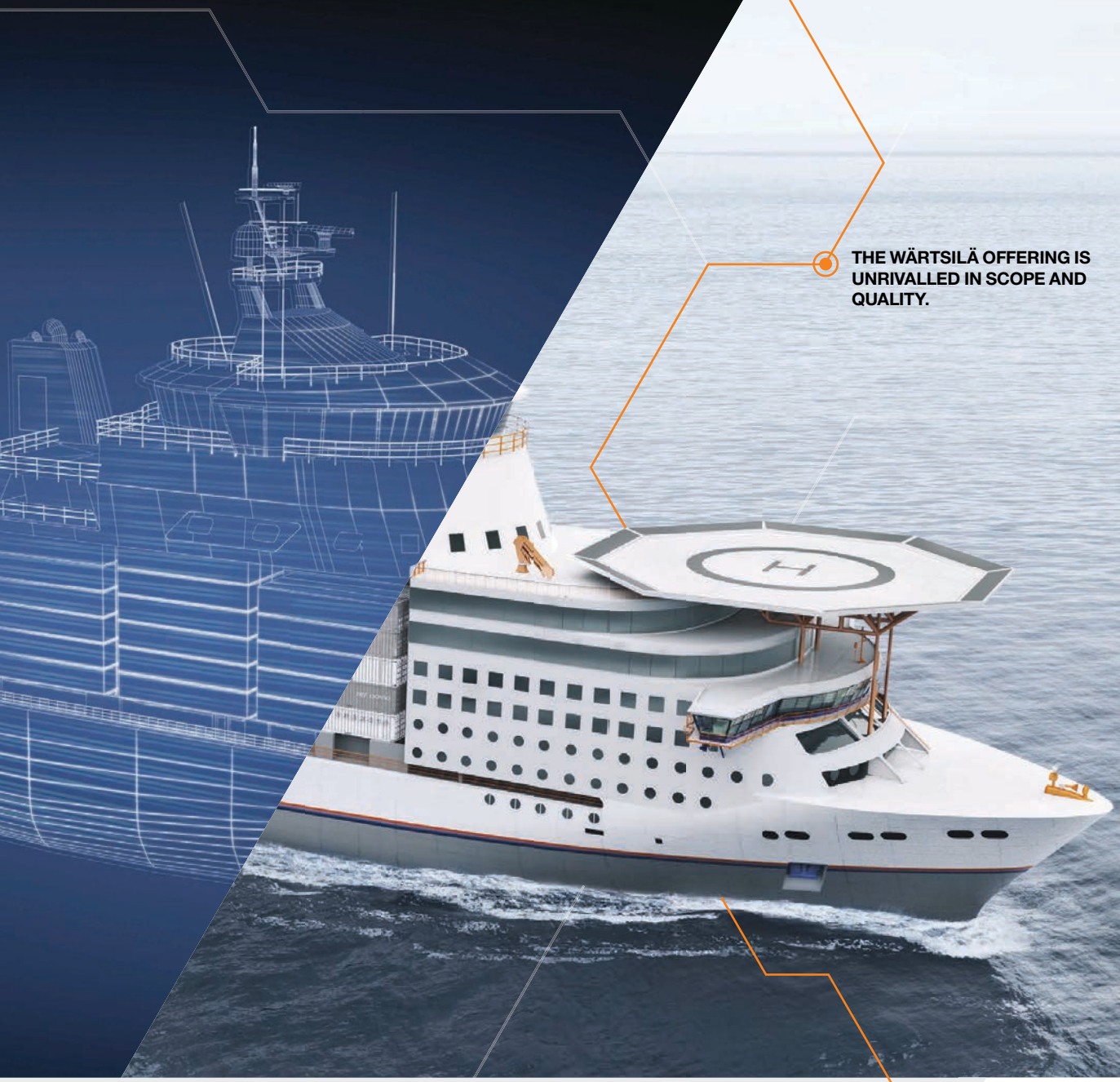

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and we would take that value to be our uncertainty.

As a second example, for an inclining experiment being conducted using solid weights, rather than water shifts via pumping, we might think about the distance we have moved an inclining weight group across the deck of the ship. Though we may be measuring the distance with a tape-measure calibrated in millimetres, it would perhaps be unrealistic to expect an uncertainty of millimetres.

Considering that in order to afford movement using a quayside crane or fork-lift truck, the inclining weight group may be on a wooden pallet and the deck marks that the pallet must be aligned with will more than likely be made with chalk or masking tape, an accuracy of centimetres may be more realistic! In this case it is appropriate that the conducting officer assigns an uncertainty of possibly a centimetre - without the additional consideration of the beam of the ship in question and hence the uncertainty associated with the measurement of the distance over which the inclining weight groups are being transferred.

Establishing sensitivity

Considering next the sensitivity of the result to a change in each variable, though more sophisticated methods exist, this can actually be readily achieved by simply assigning varying realistic values in to the equations and seeing what happens when small changes are made to the values in question.

If for example, as is typical, we have a spreadsheet containing the calculations required for the analysis of an inclining experiment, then the input variables will include a range of parameters such as: the mass and centres of each group of inclining weights (or water ballast, if being utilised); transfer distances for each shift; draught measurements / water densities / temperatures at various positions and depths both before and after (and possibly during) the experiment; pendulum lengths; deflections for each shift at each pendulum; and so on.

The output would be the derivation (our 'experimental estimate') of the as-inclined displacement, *LCG*, *TCG* and GM_T of the ship. Following subsequent quantification of deadweight items to be removed ('offs' such as fluids in tanks, stores, yard dunnage, personnel, etc.) and lightship items yet to be fitted ('ons') undertaken prior to the experiment, the ship's lightship weight, *LCG*, *TCG* and KG_f can be established.

USS Lafayette, ex *SS Normandie*, capsized in New York harbour following fire, February 1942

Taking each of the input variables in turn, we can make a small change in that input variable and record the change in the overall result. Then, dividing the change in the result by the change in the input variable gives us the sensitivity coefficient. This coefficient informs us how sensitive the result is to a small change in the input variable in question.

Combining uncertainty

Once we have estimated the uncertainty for each input variable and calculated the associated sensitivity, we are in a position to establish the estimate of the combined uncertainty.

The first step is simply to take the squared value for each individual uncertainty and multiply it by the squared value for the corresponding sensitivity coefficient. The second step is to sum them and take the square-root of the result.

In its simplest form this is combined uncertainty. In essence, that is all there is to it! Of course many more subtleties can be included for those specialising in uncertainty analysis. Nevertheless, undertaken in this way, the resulting uncertainty can, for all intents and purposes, be thought of as the standard deviation of the 'calculated estimate' of the lightship KG_f obtained from the inclining experiment. Considered as a standard deviation, we can then apply typical statistical methods for exploring the confidence interval of the 'experimentally estimated' KG_f.

Inclining experiment uncertainty

The paper under discussion here [1] explores, through case studies, typical values of the uncertainty in the 'experimental estimate' of the lightship KG_f obtained from the inclining experiment, see Annex 1 of the International Maritime Organization's (IMO) 2008 Intact Stability (IS) Code regarding merchant ships and, for example, for naval ships and auxiliaries Section 5 of the United Kingdom's Ministry of Defence (MoD) Marine Acquisition Publication (MAP) 01-024. The study found that two out of the five ships investigated had an associated uncertainty in lightship KG_f in the order of 0.15m.

The implication is that if one of these ships were loaded in such a manner to give a loading condition with the minimum allowable GM_T of 0.15m there would be a 50% chance of the actual GM_T being smaller than 0.15m and approximately a 16% chance of the ship having zero or negative initial stability, GM_T, resulting in the ship taking up an angle of loll or worse, capsize!

Even before an inclining experiment is conducted to 'experimentally' establish a ship's lightship, it is imperative that the 'calculated estimate' of lightship is as accurate as possible. As every shipyard naval architect knows, the production and maintenance throughout the various stages of design and construction of an accurate and robust lightship 'estimate' is of paramount importance as failure to do so can have extremely serious consequences.

An example illustrating this, from over a century ago, concerns the launching of the 141m, 9,210GRT *SS Principessa Jolandia*. This transatlantic ocean liner was built in Genoa for Navigazone Generale Italiana (NGI) for operation on their South American service. Upon launch on 22 September 1907 she was almost fully completed, even with all fittings and furniture installed! Due to this, and possibly other contributing factors, her launch condition had insufficient stability. Hence,

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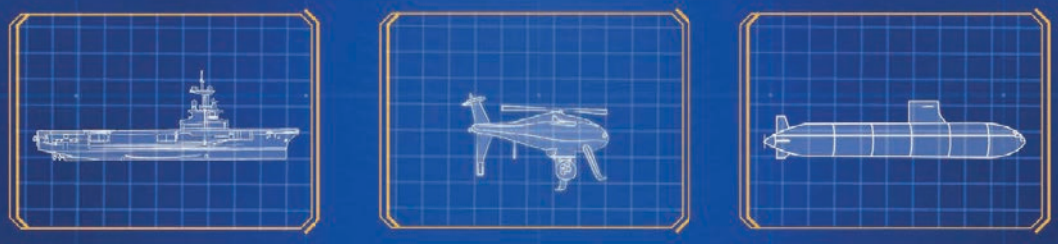

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she heeled sharply to port immediately upon lifting off the launch ways. Despite the efforts of attending tugs to right her, movable fittings shifted, increasing her list further, and she began to down-flood within 20 minutes and shortly after capsized, resting on her port side – fortunately without loss of life.

It is standard practice for a deadweight survey to be undertaken on a new ship following launch / float-out from the building dock. An inclining experiment may possibly then only be conducted upon mechanical completion and commissioning of all systems prior to delivery. However, it is worth noting that inclining experiments may also be conducted at various stages throughout the life of a ship, not just at intervals required by IMO SOLAS Chapter II-1 Part B-1 Regulation 5.

For complex new-builds, it is not uncommon for a shipyard to conduct, at the earliest opportunity, its own 'internal' post-launch / float-out inclining experiment. This may be undertaken for a number of reasons: confirming the as-launched loading condition and hence as-launched lightship; updating the final (as-built) lightship 'estimate' and associated stability calculations; updating stability calculations covering the outfitting phases with respect to water ballast requirements, the maximum amount of firefighting water that can be added to each deck to maintain a suitable margin on GMT and freeboard. There have been a number of examples of ships capsizing during outfit or conversion whilst berthed in a river or basin.

One notable one was the loss of the former SS Normandie, the famous 313.6m 83,423gt transatlantic ocean liner built in 1935 for Compagnie Generale Transatlantique (CGT), whilst undergoing conversion to the troopship USS Lafayette (AP-53) at Manhattan's Pier 88 in New York harbour. Following the outbreak of fire during the afternoon 9 February 1942, which spread rapidly due to the ship's woodwork still being in situ and the fire system being non-operational, fireboats and shore appliances poured water on the blazing ship. As a result of the build-up of firefighting water onboard it began to heel to port and consequently down-flood. Efforts to counter-flood were unsuccessful and shortly after midnight she was abandoned and eventually capsized a couple of hours later, settling on the bottom at approximately 80degs with the death of one dockyard employee. She was finally re-floated in August 1943 and subsequently dry-docked but, due to substantial hull damage and machinery deterioration, she was not repaired and was finally broken up between 1946 and 1948.

Builder's inclining experiments may also be undertaken at other points during the build process such as prior to sea trials and at any juncture that a draught / deadweight survey identifies an unexpected or major change to displacement and hence potentially KG_f.

For ships about to undergo conversion, it is common, especially for older tonnage, for the dockyard or design consultants to conduct an 'internal' pre-docking inclining experiment. This is typically to identify any 'unaccountable' weight growth which has occurred over its trading life. This therefore facilitates confirmation of the 'baseline' lightship on which the conversion 'on's' and 'off's' are applied, and hence the updating of the as-converted lightship 'estimate' and associated stability calculations etc. prior to completion and conduct of the as-converted inclining experiment.

From the above it can be seen that it is imperative that a robust weight control procedure is put in place by the shipyard during both construction and outfitting of a ship and by the dockyard during a conversion or upgrade. Not only must it be in place but most importantly rigorously put into practice with all 'on's' and 'off's, both permanent and temporary, noted and the loading condition weight and KG_f updated on a regular basis. In addition, when afloat, regular draught mark surveys must be undertaken as a cross check. Regarding the preparation for and conduct of an inclining experiment, such accurate information gives the conducting officer a very good indication of what to expect and, most importantly, also to assess in 'real time' the validity of the inclining experiment with certainty.

MV Deneb capsized alongside the quay in Algeciras, June 2011

Loading condition uncertainty

It should be pointed out that the above is purely based on the uncertainty in the lightship alone. It is quite possible that the uncertainty in the loading conditions, as compared to those presented in a ship's approved trim and stability book / loading instrument, may be of greater significance. This is due to the uncertainty associated with accurately establishing the cargo deadweight embarked, either solid or fluid (from radar / pneumatic / manual soundings and / or ullages together with stated densities), the state and variation in the various solid and fluid consumables throughout a voyage, together with any water ballast present at the beginning or added during a voyage.

In the recent past, a potentially disastrous issue was identified in the establishment of the actual deterministic damage stability performance of tankers, in particular product tankers, due to the effect of 'drop-out' of liquid deadweight i.e. that is available for loss due to damage.

This has now been addressed through the introduction of the requirement that a suitable stability loading instrument be fitted to all oil and chemical tankers built after 1 January this year (gas tankers from 1 July) and installed on existing tonnage before 1 January 2021 (gas tankers by 1 July 2021) depending on the date of the next renewal survey. However, due to the amount and distribution of cargo onboard having to be established from soundings / ullages and fluid densities, there is obviously still uncertainty relating to the cargo weight and KGf, and hence the 'simple' compliance with the intact and damaged stability criteria (critical KG_f/ GM_T envelope values) due to the resultant uncertainty in GM_T.

Passenger ship stability is indisputably an extremely important topic, for both national and international regulators, and hence is under constant review. As discussed in May at RINA's international conference on the Design and Construction of Ferries and Ro-Pax Vessels held in London, major changes relating to the SOLAS probabilistic damage stability requirements for passenger ships have just been discussed by the 96th session of the Maritime Safety Committee (MSC 96).

Specifically these concerned changes to the survival $s_{final,\,i}$ factor for the final equilibrium stage of flooding and significant enhancement of the required subdivision index *R*, which will hopefully enter into force for new ships constructed on or after 1 January 2020. Although probabilistic calculations are not performed on actual loading conditions, as is done for most deterministic assessments, the KG_f for each loading condition must be within the 'safe seagoing' boundaries of the combined critical intact and damage KG_f / GM_T envelope values. The critical intact values also provide the KG_fs initially applied for the calculation of the damage case 'bare boat' intermediate and final survival si factors and hence the attained subdivision index *A* for the associated representative range of three draughts considered.

Car Carrier *MV Hoegh Osaka* grounded in the Solent, January 2015

Similar to the loss of the former *SS Normandie* discussed above, a more recent example of the effect of water within the hull was the loss of the passenger ship *MS al-Salam Boccaccio 98*. She was a 131m, 11,799gt, roll-on/roll-off (ro-ro) car and passenger ferry built in 1970. On 3 February 2006 whilst crossing the Red Sea from Duba, Saudi Arabia, to Safaga, Egypt, with 1,418 passengers and crew onboard, an uncontrollable fire broke out. As a consequence, exacerbated by the scuppers not functioning correctly, firefighting water accumulated resulting in the ship becoming unstable. Due to this, and possibly also the weather conditions, the ship began to list excessively and began to down-flood and subsequently sank with the loss of 1,031 lives.

Another major issue which has come to the fore over recent years relates to the actual weight and centres of containers loaded on ships. One such non-fatal example of the consequence of this involved the 1992 built, 101.1m, 3,992GT, feeder containership *MV Deneb,* which capsized whilst loading cargo in Algeciras, Spain, on the afternoon of 11 June 2011. Upon loading a 40' container at height, the ship began to list to starboard. The ship initially heeled slowly, but progressively more rapidly, until at approximately 45degs the containers contacted with the quayside. Harbour tugs were employed to push the ship in to the quay in order to prevent total capsize. The bow and then engine room began to down-flood and within hours the ship was resting on the bottom at approximately 54degs. During the night she finally settled at a heel of 75degs following the collapse of some of the ship's structure in contact with the quay. A subsequent investigation established that approximately 10% of the 168 containers loaded were significantly in excess of the declared weights. For the 16 containers in question, this excess ranged between 1.9 and 6.7 times, equating to them being 278tonnes in excess of their declared 93tonnes– approximately 200% overloaded.

It has been accepted by the international maritime community that miss-declared container weights have very serious implications for the uncertainty of the initial stability of the loading conditions of containerships and hence compliance with

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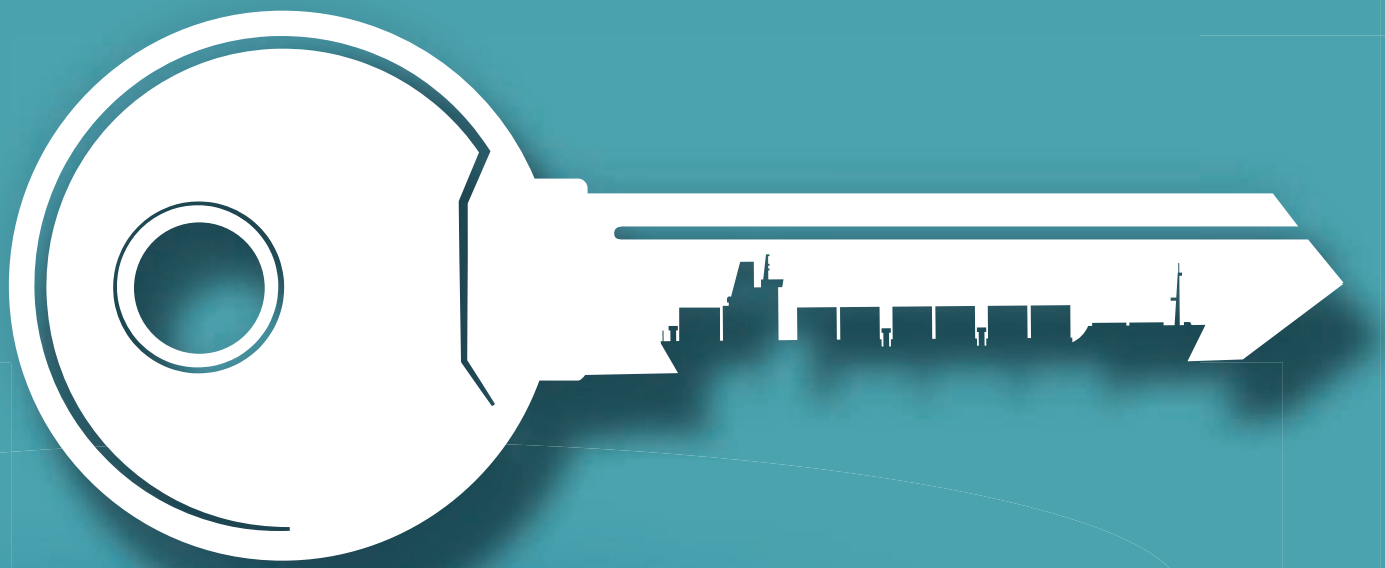

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both intact and damage stability criteria. As a result the mandatory weighing of containers recently entered into force on 1 July this year.

Considering the above, it is surprising that, in 2015, the United Kingdom revoked its Merchant Shipping regulations regarding the weighing of goods vehicles and cargo transported on ships on which passengers are also embarked. These were introduced in 1988 and 1989 as a consequence of the loss of *MS Herald of Free Enterprise*, a 131.9m, 13,601gt, ro-ro car and passenger ferry built in 1980. Just after leaving the harbour at Zeebrugge, Belgium, enroute to Dover, United Kingdom, on the night of 6 March 1987 with 539 passengers and crew onboard, water began to enter the car deck due to her bow door still being open. As a consequence of this Water-on-Deck (WoD) and resultant free surface, her GM_T was diminished and she capsized within minutes with the loss of 193 passengers and crew. Astonishingly, no equivalent regulations for the weighing of vehicles or cargo, in order to accurately ascertain deadweight and *KG* and hence a ship's sailing loading condition and, therefore, establish both stability and longitudinal strength, were introduced by any other countries, either within the European Union or the wider world. As alluded to above, in the decades since significant enhancements have been made to passenger ship stability standards. Much of these were also driven by the loss of *MS Estonia*, a 157m, 15,566gt, ro-ro car and passenger ferry built in 1980, which sank in the Baltic Sea on the night of 28 September 1994 enroute from Tallinn, Estonia, to Stockholm, Sweden, with the loss of all 989 passengers and crew.

A recent incident due to the inappropriate loading of vehicles involved the 2000 built, 179.9m, 51,770gt, pure car and truck carrier (PCTC) *MV Hoegh Osaka*. On the evening of 3 January 2015, shortly after departing Southampton, she developed a severe list after executing a turn to port at 12knots due to her GM_T being inadequate. The upper vehicle decks were full whilst the lower decks were lightly loaded which, together with the state of the bunker oil low down in the ship being light, resulted in a high KG_f. However, for a number of reasons her inadequate stability was not identified prior to departure and whilst she had a positive GM_T upon departure this was less than the IMO statutory requirements. She lost steerage and propulsion as her heel increased to in excess of 40degs and grounded on Bramble Bank in the Solent, which prevented her from capsizing, as due to the heel cargo shifted and breached the hull causing down-flooding. She finally settled at 52degs to starboard and all the crew were able to be safely evacuated from the ship and surrounding waters, and she was subsequently salvaged without pollution to the environment.

SS Flying Enterprise sinking in western approaches, January 1952

What of other ship and cargo types?

There are numerous IMO instruments in force covering the various ship types. These are obviously under constant scrutiny, investigation and revision by the international maritime community – proposed and adopted updates to the intact and stability regulations from 2010 to date for all ship types have been discussed at recent RINA international conferences addressing ship stability.

As illustrated above, the shifting of cargo can induce heel as well as causing breaches in the hull. There have been many examples of the consequences of cargo shifting, but one of the most dramatic involved *SS Flying Enterprise*, whose cargo manifest has been a point of speculation. She was a World War II type C1-B, 120.8m, 6,711gt, general cargo ship built in 1944. On the night of 25 December 1951 whilst in the Western Approaches to the English Channel bound for the United States from Hamburg, West Germany, she encountered a storm. This caused the cargo to shift and on 28 December she issued a SOS by which time she had a list of 45deg to port. Mid-afternoon on 29 December all the passengers and crew, bar the captain, were evacuated, with the loss of one life. By 4 January 1952 when a crewmember of a tug was transferred to the ship she was listing at 60deg. A tow line was finally attached on 5 January from the tug *Turmoil* and a tow to Falmouth, 300nautical miles away, commenced. However, early in the morning of 10 January the line parted, with the list increasing, her captain and tug crewman abandoned ship mid-afternoon and she finally sank an hour later only 41 nautical miles from Falmouth.

The aim of this article has been to highlight and discuss potential uncertainty in the initial stability and hence the safety of a ship. A final example, concerning this time a small and simple ship, is the loss of the *MV Lairdsfield*, a 53.2m, 522gt single hold coaster built in 1953. She had loaded 373tonnes of hollow hexagonal steel columns, tiered between dunnage, and 354tonnes of steel plates on top, at Middlesbrough on the North East Coast of the United Kingdom. As a result of these loading arrangements the deadweight KG_f was higher than the ship was designed for and hence, whilst she did have a positive GM_T, her stability was inadequate for sailing in open water. Hence, when leaving the River Tees fully loaded on 6 February 1970 in moderate weather, possibly whilst undertaking a turn, she suddenly capsized without any distress signal resulting in loss of all 10 crew onboard.

Though the inclining experiment paper [1] does not itself explore the uncertainty in the stability of a loaded ship, it provides a complete and robust tool set sufficient to do so. The implication for various different ship-types could very well be substantial.

Practitioners may be well advised to investigate the uncertainty in the estimate of the loaded seagoing GM_T to identify probable safe working limits.

Similarly, legislators may be well informed by such studies when considering changes to loading rules etc.

Those seeking to update the existing stability standards should also ensure they

consider such uncertainty regarding KG_f. This variation in G may be substantially more influential than, for example, any possible precision improvement gained from reforming the underlying assumption in wall-sided theory regarding the stationarity of the transverse metacentre (M_T) as traditionally applied in the derivation of the as-inclined GM_T.

Summary

What can uncertainty analysis actually do to aid our engineering comprehension and hence our effectiveness as ship designers / builders and practicing naval architects? Well, the important thing to appreciate is that a wide uncertainty band does not 'necessarily' mean a poor measurement; it is all about information.

We might for example arrive at some 'estimated' value, calculated as a function of multiple parameters that we have measured directly. Taking into account the precision associated with each of the values we measure, and accepting how these uncertainties propagate as we calculate the value of interest, we establish the related uncertainty.

If, however, instead of calculating the uncertainty, we choose to repeat the measurement a great many times, we might, if we are fortunate, get sufficiently close to the same value each time. We could then take the uncertainty to be simply the standard deviation of the mean value. We would therefore have a smaller uncertainty and consequently more confidence in our result, but with the associated additional cost in both time and resources, and subsequently money.

Conclusion

So what's the bottom line? Uncertainty analysis can assist us, as naval architects, to effectively decide how to best utilise our time and resources in the most efficient manner in order to improve confidence in the parameters that are of most significance and importance to us, our clients and on the projects which we are undertaking. The parameters that warrant the most attention are those that present the greatest risk; that is risk to persons, property and/or the environment.

Ship stability, as with other critical parameters relating to ship operations, is of paramount importance, and should therefore be dealt with accordingly with an appropriate uncertainty analysis. *NA*

Disclaimer:

The views expressed in this article are those of the authors and not necessarily represent those of the organisations with which they are affiliated and the professional institutions of which they are members.

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Sealed survival

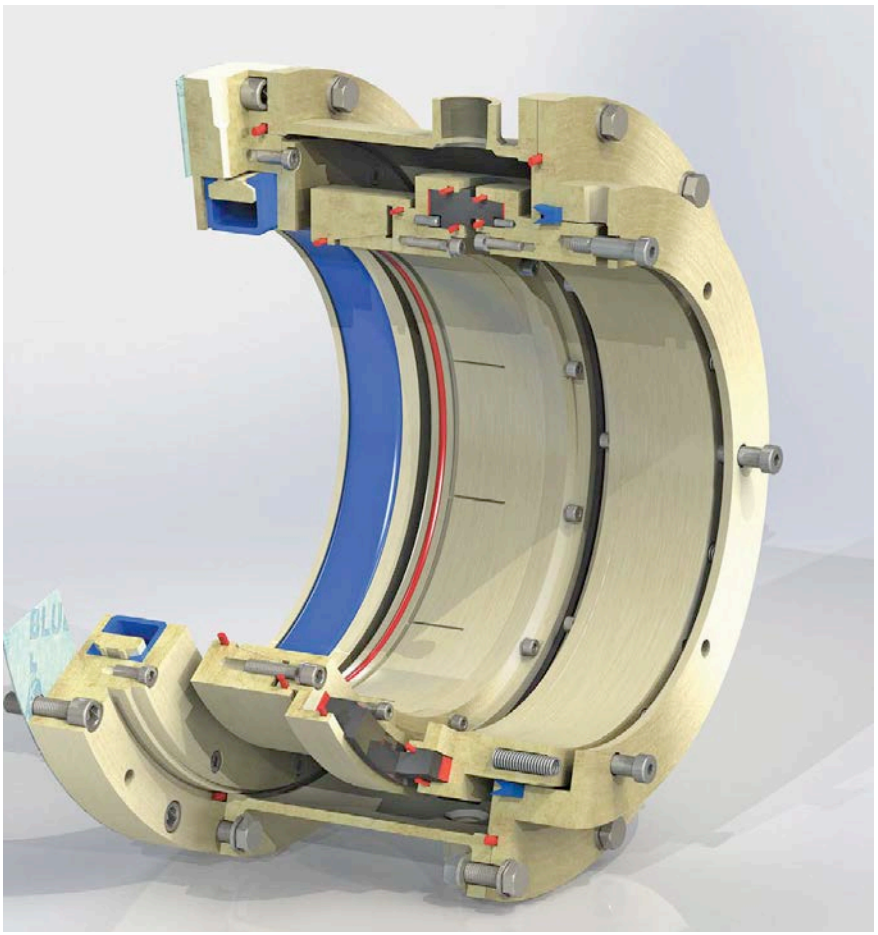
A battle of reliability ensues as Wärtsilä and Thordon Bearings launch new shaft seal systems for their respective water lubricated propeller shaft solutions at SMM. Their mission, to improve reliability and instil owner confidence, is shared; their approaches, however, are quite different

The Canada-based manufacturer, Thordon Bearings, has spent four years of research and development on its new SeaThigor seal, an addition to its COMPAC solution that reseals in the event of failure.

Designed to function as both a static and dynamic propeller shaft seal, SeaThigor (pronounced sea tiger) prevents seawater ingress while allowing the propeller shaft to rotate in both directions through a range of shaft speeds. However, it is its emergency Safe-Return-to-Port function that sets this seal apart from competing systems on the market.

The design incorporates a pneumatically activated inflatable safety seal to prevent water ingress along the shaft should the primary seal fail, allowing for either the repair of the main dynamic seal elements at sea or operation at reduced shaft speeds to provide Safe-Return-to-Port capability.

In this way, the seal raises the bar for the redundancy of vessels that cannot afford to wait for at-sea repairs, such as passenger vessels and military vessels, explains Scott Groves, business development manager, and Craig Carter, director of marketing and customer service at Thordon Bearings. This makes it particularly attractive for single screw vessels looking for greater redundancy.



A cross-section of Thordon Bearings' mechanical face seal, SeaThigor

During trials at the company's in-house marine seal test rig, in Burlington, Canada, the shaft seal test results were very positive, according to Groves, showing no wear on the emergency seal after 15 days of use.

SeaThigor runs two abrasion resistant, hard-wearing Silicon Carbide faces against each other to achieve dynamic sealing and leak free operation.

Thordon found that Silicon Carbide, a compound of silicon and carbon favoured by manufacturers of abrasive machining tools because of its low cost, durability and hardness, also had excellent sealing characteristics, even in abrasive water conditions.

Suitable for 300mm to 650mm diameter water lubricated propeller shafts, the seal is of modular design, with the housing enclosing the rotor components to ensure that no moving parts are exposed to the exterior.

"The modular assembly of the seal facilitates a straight forward installation, while providing operators with a maintenance free system," Groves says, adding the seal can operate for 10 years or more without maintenance. "It is very much a fit-and-forget system."

Thordon's proprietary elastomers are used for both static sealing elements and the safety seal, offering a much longer service life than traditional rubber seals, according to the company.

The seal's internal workings feature a series of precision compression springs that are not affected by water temperature changes. These are used to linearly load the seal faces, ensuring that the pressure is equally distributed to the entire contact surface; a big advantage when compared to the variability inherent in traditional rubber bellows or lip seals.

SeaThigor's emergency seal survived 15 days of use on a test rig

The seal has been designed with an enclosed housing and the rotor module inside the seal so that no moving parts are exposed to the exterior. SeaThigor is unlike other propeller shaft seal currently on the market as this design arrangement also places the pressurised water on the outside of the sealing rings, using the water pressure to keep the faces closed. This is particularly important for deep water operation, when there are pressure fluctuations that can open the faces of traditional seals, causing leaks.

Officially unveiled at this month's SMM in Hamburg, Carter tells *The Naval Architect* that the company is in discussion with an undisclosed shipowner to install the seal during a scheduled drydocking in late 2016.

"Interest in the Product is very promising", says Carter. "The performance and safety benefits of SeaThigor, which will now form a fundamental component of our COMPAC package, are unsurpassed. We are seeing a resurgence of interest in seawater lubricated propeller shaft bearing systems as a way of meeting environmental targets and reducing lifecycle costs. We have estimated that the SeaThigor could save shipowners US$250,000 in maintenance costs alone by eliminating service and maintenance costs using Thordon's proprietary elastomers."

A number of commercial ship operators are said to be in discussion with Thordon regarding the COMPAC solution and Carter believes the introduction of the SeaThigor seal as part of that package will generate further interest from environmentally-conscientious shipowners that require a greater level of redundancy.

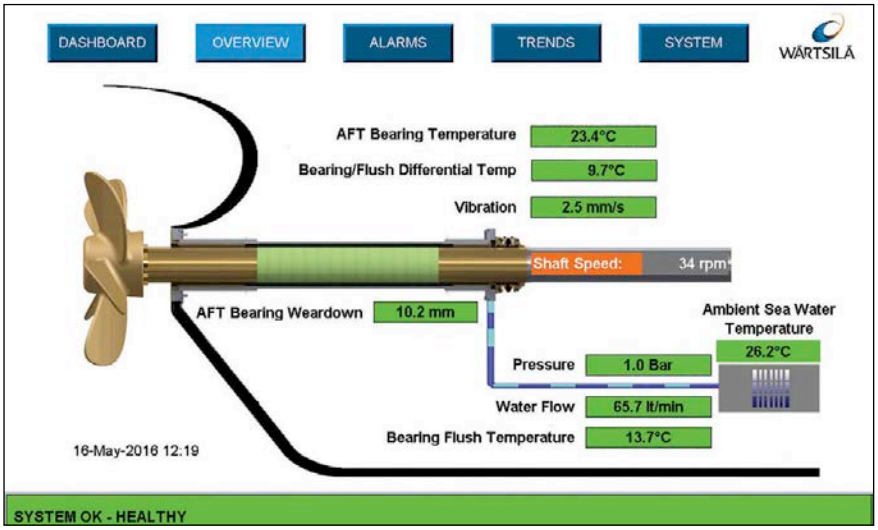
A fork in the road: a digital journey

Wärtsilä have taken a different approach to ensure greater reliability and confidence in their water lubricated propeller shaft solution, developing a condition-based monitoring (CBM) system.

The Sea-Master system, also officially launched at SMM, aims to draw a constant picture of the shaft's condition, giving owners confidence and class societies proof of compliance.

The new product comes in response to the state of the market. At present, a variety of factors are holding back the adoption of water lubricated shaft systems, says John Thornhill, engineering manager, seals & bearings, Wärtsilä. Additional outlay costs in comparison with oil-lubricated systems; issues surrounding potential corrosion of the shaft and stern tube; and, until recently, regulation that meant the shaft would have to be opened up for unnecessary inspections, weigh heavily on owners' minds despite the environmental benefits of water lubricated systems and the potential savings to be made further into a vessel's lifecycle. This latter obstacle has been removed thanks to ongoing cooperation with class societies that have adapted their rules to extend the period a shaft can remain in operation; however, owner confidence still needs to be inspired, says Thornhill, and this new product aims to offer a constant window to the condition of the shaft, stern tube related components and systems.

There is a pressing need to ensure bearings have not been worn and that the shaft coating has not cracked due to the corrosive properties of contaminated water, a clear opportunity for condition monitoring. With the Sea-Master system,



The user interface for Wärtsilä's Sea-Master system

owners will be able to monitor the condition of their shaft to prevent a failure and any subsequent delay to the service of their vessels, which will be more costly, both in terms of repairs and time the vessel is inactive.

The system gives owners a long term insight into the performance of their water lubricated stern tube system by allowing them to set baseline operational parameters and record any variations from them.

Like with CBM on diesel engines, the new system will provide an instant display that is accessible for crew. Matthew Bignell, Wärtsilä's sales development manager, seals & bearings, stresses that the interface has been designed with reduced crews and crews of potentially reduced competencies in mind so that "systems are intuitive", providing data for crews across the board.

Wärtsilä cannot reveal the technical specifics of the technology to be featured in the Sea-Master system at this moment in time, but Bignell says it is proven digital technology with a pedigree. The sensory array, for example, has been used in power generation plants and other industrial process plants, and Wärtsilä has adapted the hardware, which is documented to have long durability according to the company, for marine applications using a combination of its own in-house experience and knowledge and input from a consulting partner.

Pilot work with the technology onboard test vessels is ongoing, but the company studied different arrangements and sensors before arriving at their current offering. Keeping the cost down was a particular focus in the design, Bignell explains, as while the solution needed to be capable technically, it also had to be attractive to potential users who may not wish to buy the latest spectrographic equipment, which is very expensive.

This question of cost opens up an interesting difference of opinion when it comes to regulating the kind of equipment that must be used in CBM for the shaft line.

There are differing approaches to approving sensory arrays, says Bignell, with variations in what the class societies are asking for. Some, like DNV GL, are taking a "simple" and "pragmatic" approach that allows for less expensive systems, while others are requesting that spectral analysis type data should be provided, which is much more expensive. Bignell asks: "Would clients really pay for this?" before answering, probably not. This, he says, is because the industry isn't really ready for the level of technology required to produce the data.

The current downturn has created a trend in which owners want to understand the cost of their vessels based on the cost formula being used, says Bignell, and even as recoveries are made, this approach is likely to continue: "there is a legacy that will live on [from the crisis] and CBM embraces these lessons in it."

Sea-Master is a modular system that can be fully integrated for newbuilds or retrofitted to pre-existing systems. *NA*

The German connection

Jörg Beiler, project manager vice president, Germany North, DNV GL maritime speaks about the maritime industry and DNV GL's position within it in an exclusive Q&A with *The Naval Architect*

Initially we asked, what is your perspective on the global market and German market for newbuilds?

The market both in Germany and globally is very tough across virtually every ship segment. Earnings across most of the segments have continued to decline, in many cases representing levels significantly below operational expenses.

The inactive fleet is growing. This is most notable in the container segment where almost 8% of the fleet is currently laid up. There is a similar situation in the dry bulk and offshore support segments, with a rapidly growing number of bulkers, PSV and AHTS ships without employment.

In response to this situation and the increasing number of enquiries from owners and managers who need to put their vessels into lay-up, DNV GL has developed and issued the first Clean Lay Up notation. Owners who want to lay up their vessels in a way that respects the local environment and the communities around the site can have the lay-up evaluated and assessed in line with the detailed requirements illustrated in the new guideline. It covers the mooring arrangement, the safety and security of the vessel lay-up, emergency preparedness, the procedures in place to prevent pollution, air and noise pollution, as well as the antifouling coating treatment and marine growth. The new declaration can be obtained alongside our current lay-up declaration to ensure that vessels enjoy a safe and responsible lay-up and an efficient and cost-effective recommissioning.

The demolition market picked up momentum again in the first quarter. Prices recovered sharply and there is a lot of activity particularly in the capesize

sector. Most likely there will also be more containerships sold for scrapping as the sector battles severe oversupply.

TNA. What trends is DNV GL identifying, and how is it adapting?

One of the key trends is digitalisation. Taking advantage of digital opportunities is essential for the industry's future and DNV GL has set up a new digital solutions and innovation team located in Hamburg to spearhead new developments in this field. The team is working on many projects – from apps to make it easier for owners to assess their risk to cyber-attack, to new calculation tools and survey techniques to enhance DNV GL's class services, through to data enhanced services to boost operational efficiency, crew performance and safety.

The Hamburg HQ is also the base for the award winning ECO Solutions team, whose ECO insight portal has become the world's most widely used fleet performance solution. ECO Insight provides a comprehensive and easily accessible way to manage the performance of a fleet, including voyage, hull & propeller, engine and systems performance. Eco Insight is continuously adding new aspects to the portal, including a new cooperation with Veritas Petroleum Solutions which resulted in the new Fuel Analytics solution, a tool which for the first time enables a systematic assessment of the impact of fuel quality on vessel performance.

DNV GL has also invested in cybersecurity services by acquiring Marine Cybernetics and with the Integrated Software Dependent Systems (ISDS) standard we are already pioneering this next risk frontier. *Ocean Greatwhite*, the first new-build rig to receive the DNV GL ISDS notation was just launched in July. ISDS are systems whose performance is dependent on the overall behaviour of their integrated software components. DNV GL's ISDS standard helps owners and operators minimise software integration errors and delays in projects involving complex integrated systems.

TNA. What have orders been like for 2016 so far?

So far in 2016, contracting activities have almost come to a halt. The most recent forecast predicts ordering for all of 2016 at just over 900 vessels, which would be the lowest level in 25 years. However, given that we only saw 300 orders in the first five months of the year, even that number could be optimistic. But we do expect there will be marginally more ordering over the second half of the year.

Newbuilding prices continue to fall, but due to lack of new contracts it is difficult to say where the actual price level is. This lack of new orders could even force many smaller yards

out of the market. We are also expecting major shipbuilders to consolidate in the near future.

The future cover of contracts is very short, with the majority of ships due to be delivered in the coming 18 months. Massive slippage and postponements of deliveries reaching 30-45% per annum are also being observed.

Another negative factor is a very limited access to capital. Traditional lenders have become very reluctant to investing in shipping. Only large companies, which can demonstrate strong cash flows, may obtain financing from the banks.

Even so, in shipbuilding there are a few bright spots. Despite the weak market conditions, the newbuilding market for specialised, complex MPVs is still very much alive. The increasing demand for larger vessels with increased lifting capacity has resulted in a wave of specialised newbuilding contracts (or newbuilding plans). The delivery of the DNV GL classed *SIEM HELIX 1* [see question 4 below] is an example.

With passenger numbers increasing by 4.5% per year, the cruise sector is also doing well – especially in terms of vessels designed for the Chinese market. There have also been a number of new orders for Meyer Werft here in Germany. German financing players such as the development bank KfW are supporting this trend, with more than half of its maritime loan book now dedicated to cruiseships. Last year, KfW lent €1.1 billion (US$1.22 billion) to finance pleasure ships.

One of the latest cruiseship deliveries with DNV GL class was made in May, when DNV GL welcomed Royal Caribbean's new vessel *Harmony of the Seas* into class. With 227,000gt and a length of 361m, *Harmony of the Seas* is the largest cruiseship ever to set sail.

TNA. What innovation do you see from the German yards?

The German yards are always at the forefront of technology. They have successfully found their niche in constructing cruiseships, mega yachts as well as ro-ro vessels and naval ships, and DNV GL is the preferred classification society for most of the German projects in these segments.

And one of the reasons that German yards are doing comparably well despite the global downturn is the strength of the manufacturing industry, which is such an integral part of the German maritime industry, and the world's largest - claiming by far the lion's share of the market.

Jörg Beiler, DNV GL, says: "one of the reasons that German yards are doing comparably well despite the global downturn is the strength of the manufacturing industry"

A recent project saw DNV GL award Otto Piening GmbH with a type approval certificate for a new controllable pitch propeller that can be operated using a water-based hydraulic and lubrication system in place of oil. The approval comprises of test bench investigations on water-based operation. They were carried out under DNV GL supervision and a sample propeller design was checked for compliance with DNV GL rules. The propellers are intended for use in the mega yacht market as well as for research, naval and coastguard vessels.

The new propeller is a development of Otto Piening's Type PCP (Piening Controllable Propeller) controllable pitch propellers. The hub has been improved in respect of its hub/diameter ratio while taking hydrodynamic aspects into consideration and its structure has also been revised to allow easier assembly and disassembly of the blades and pitch control mechanism.

A further new feature is that the blades can be mounted to the inside or outside of the hub using bolts – as required or pursuant to regulations. The requisite components are identical for clockwise and counter-clockwise rotating propellers. This reduces the part count. Highly flexible seals at the blade roots together with the exclusive use of corrosion-resistant materials further characterise this type of propeller. DNV GL was on hand to supervise and witness testing of the design using a five-blade controllable pitch propeller mounted on a 650mm hub - the forces originating during testing equated to an output of 3,300kW at 440rpm.

TNA. Are you working on the approval of any new vessels that feature particularly innovative solutions or have unique design features?

One of the most notable vessels is the recently delivered well-intervention vessel *SIEM HELIX 1*. This was delivered by Flensburger Schiffbau-Gesellschaft (FSG), Germany, to owner Siem Offshore AS in June. For FSG this is the first delivered unit completely built and tested according to offshore standards.

This unit was delivered as a mobile offshore unit. The operator Helix Well Ops UK Ltd. hopes to use it to recover more oil from subsea wells and increase the cost effectiveness of drainage and well intervention operations. Setting up on Dynamic Positioning (DP 3) keeps the vessel on well point with minimum oil consumption. Its speed at 17knots allows the cost of mobilisation and transit from well to well to be minimised.

SIEM HELIX 1 was awarded the CRANE class notation. Equipped with a 250tonne offshore crane, *SIEM HELIX 1* may serve as a crane vessel for the installation and removal of subsea equipment and structures. The vessel also holds the DNV GL class notation COMF-V(2)C(3), which covers noise and vibration as well as the indoor climate onboard ships. Certification to this standard demonstrates the highest standard of comfort for the ship's crew and personnel onboard. *NA*

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Holistic design approach gets EU funding boost

New rules and regulations and a growing complexity in ship design for vessels built in European yards has led the EU to award a consortium of 40 companies and research institutes, together known as HOLISHIP, an €11.4 million (US$12.67 million) grant to focus on solutions for the problems in vessel design and operation

Ship design is changing, with vastly increased complexity for European built ships as well as a growing number of regulations that call for novel concepts and product design, says Dr Jochen Marzi, director of CFD & Research at German Towing tank HSVA.

The four-year research programme began on 1 September and HOLISHIP (HOLIstic optimisation of SHIP design and operation for lifecycle) will address these challenges in today's ship design and operation, focusing in particular on future requirements by developing a holistic approach to ship design capable of meeting tomorrow's challenges.

HOLISHIP has benefitted from the European Commission's call for projects under its Horizon 2020 Transport Research Programme, which was announced last year and has a €6.34 billion (US$7.06 billion) budget.

Horizon 2020 aims to "Boost the competitiveness of the European transport industries and achieve a European transport system that is resource-efficient, climate-and-environmentally-friendly, safe and seamless for the benefit of all citizens, the economy and society."

According to HSVA: "Most maritime products are typically associated with large investments and are seldom built in large series. Where other modes of transport benefit from the economy of series production, this is not the case for maritime products which are typically designed to refined customer requirements increasingly determined by the need for high efficiency, flexibility

Figure 1

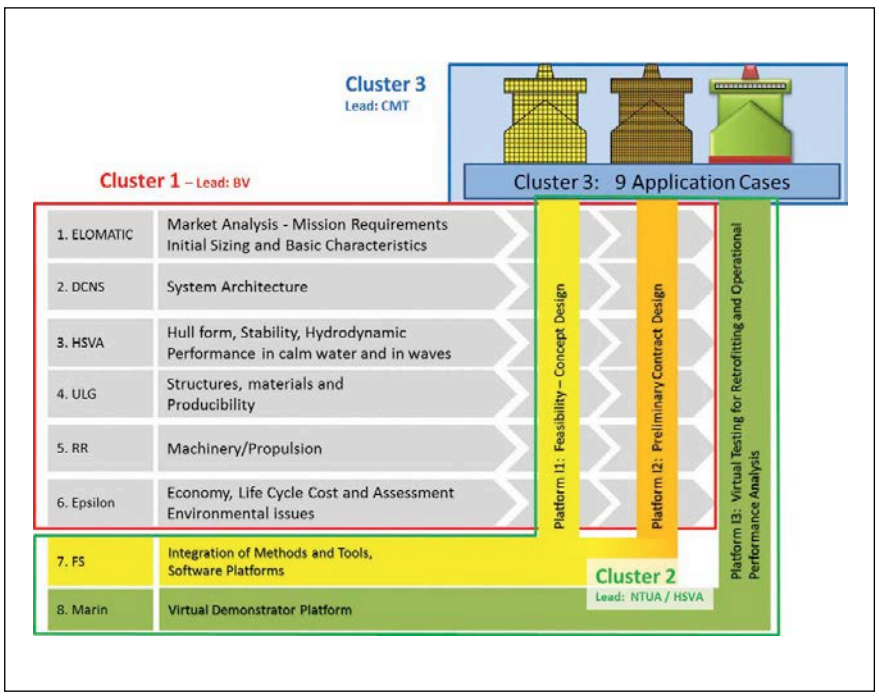

Figure 2

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and low environmental impact at a competitive price."

Up to now product design in the maritime sector has been "subject to global trade-offs among traditional constraints (customer needs, technical requirements, cost) and new requirements (lifecycle, environmental impact, rules)".

For HOLISHIP one of the most important objectives is to minimise the total cost over the operational life of the vessel including all operational, maintenance and environmental costs associated with the vessel.

"The trade-off among all these requirements must be assessed and evaluated in the first steps of the design process on the basis of customer/owner specifications," explains Marzi.

Flexibility is crucial to modern vessel design in order for vessels to be able to "adapt to profound, sometimes contradictory requirements" over the operational span of the ship.

To meet these modern day demands there is a requirement for improved design tools that include multi-objective optimisation and virtual testing of the overall design and its components.

"HOLISHIP addresses these urgent industry needs by the development of innovative design methodologies, combining design requirements (technical constraints, performance indicators, lifecycle cost, environmental impact) at an early design stage and for the entire life-cycle in an integrated design environment. Design integration will be implemented in practice by the development of integrated design software platforms and demonstrated by digital mock-ups and a large range of industry led application studies on the design and performance of ships maritime structures," says Marzi.

In taking a multi-disciplinary approach, combining tools that not only model the vessel design, but also take into account optimisation over a range of disciplines and objectives that include market analysis as well as efficiency and hullform design, it will form a "rational foresight analysis for the viability of the product model over its lifecycle ("from cradle to cradle"). It considers all fundamental steps of the traditional "ship – design spiral", which, however, are better illustrated today by a systemic approach, which is herein implemented in practice by a "shell/synthesis of integrated design software tools," says HSVA, as is illustrated in Figure 1.

By integrating computer aided engineering processes with a number of other calculations, techno-economic databases and optimisation modules along with software tools, the HOLISHIP will construct a Virtual Vessel Framework (VVF) that will allow for testing before the physical construction of a ship.

Coverage of the ship's systems will extend to all relevant major onboard systems and components and will include an assessment of its expected lifecycle performance, which will develop further knowledge that is suitable for outfitting details; "this being a highly relevant aspect especially for the outfitting-intensive products of European Shipyards".

This means that HOLISHIP will concentrate on the development of three main areas: Tool Development, software tools designed for individual design aspects and which will be integrated into the automated HOLISHIP design platforms; Software Integration, an integrated platform that includes the VVF and design platforms; Application Demonstrators with software platforms that are applied to actual vessels and that will demonstrate the benefits of the HOLISHIP approach.

The overall project structure is outlined in Figure 2 with a further detailing of the concept of the Application Case Cluster in Figure 3.

More detailed information will be available in due time through the project's dedicated website at www.holiship.eu. First background information will be available at the coordinator's site: www.hsva.de/our-research/ship-design/HOLISHIP.html *NA*

HOLISHIP partners:

HSVA (coordinator), ALS Marine, AVEVA, BALANCE, Bureau Veritas, Cetena, CMT, CNR, Damen, Danaos, DCNS, DLR, DNVGL, Elomatic, Epsilon, FhG-AGP, Fincantieri, Friendship Systems, HSB, IRT SystemX, ISL, Lloyds Register, MARIN, Marintek, Meyer Werft, Navantia, NTUA-SDL, RR-AS, RR-PE, Sirehna, SMILE FEM, Starbulk, TNO, TRITEC, Uljanik, Univ. Genoa, Univ. Liege, Univ. Strathclyde, van der Velde, IRT-Systemx

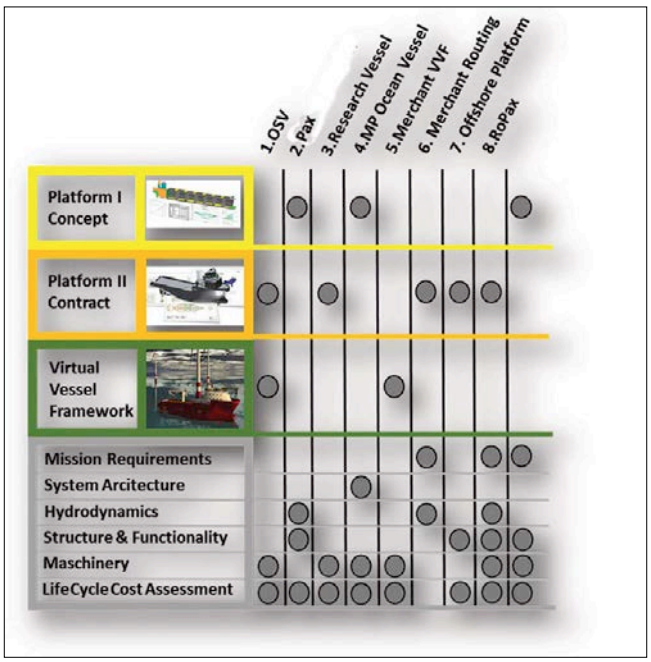


Figure 3

Satellite yards for Asian cruise industry specialist

The recent acquisition of three German yards by Malaysian-owned corporation, Genting Hong Kong, will drive production in Germany and offer a boost to the wider European cruise shipbuilding industry

Genting Hong Kong, the owner and operator of Star Cruises, Dream Cruises and Crystal Cruises, purchased and agglomerated three shipyards in the German state of Mecklenburg-Vorpommern during April of this year, bringing the construction of its next generation cruise vessels in-house and under one daughter company's purview, MV Werften.

The new commercial enclave partners Wismar, Rostock and Stralsund yards, and is reported to have cost €230.6 million (US$257 million) in a deal with the yards' previous owner, Nordic Yards. This comes following Genting's acquisition of 100% of the shares in Bremerhaven's Lloyd Werft at the start of this year, which will continue to focus on repairs, conversions and the building of megayachts.

"Ownership of the shipyards will free the company from both the delivery timing and pricing uncertainties associated with the cruiseship order book cycle," says Genting.

Nordic Yards had been analysing the cruiseship market since early 2014, according to a spokesperson from the company, concentrating on this segment in response to the stagnation in offshore wind, offshore oil and gas and the Russian market. This activity drew the attention of Genting, which ultimately led to the yards' acquisition.

Genting's original investment shows a firm commitment as well as confidence in the purchased yards' capabilities, but further funds are also being mobilised to ensure the venture's success. Chairman and chief executive of the Genting Group, Tan Sri KT Lim, says: "To make MV Werften into one of the world's most modern and efficient cruise shipyards, we will invest €100 million [US$111.6 million] in a thin plate laser welding line, a cabin module factory, a new covered section block building hall, the modernisation of manufacturing control systems and new executive and employee offices and facilities."

Wismar shipyard (top) and Stralsund shipyard (below), as well as Rostock shipyard, have been purchased to form one yard group, MV Werften

European expertise and experience are key for Genting, and the company's move to set up shop in Europe shows a valuable lesson learnt following the Koreans' failed attempt to enter the cruiseship market at around the time of the 2008 downturn, where insufficient expertise in the hotel portion of a vessel's construction led to delays and a rapid escalation of costs.

The corporation has appointed Jarmo Laakso as managing director of MV Werften as part of their strategy to build on existing

expertise. Laakso has more than 35 years' worth of experience in building passenger ships and has worked for Meyer Werft and Royal Caribbean International. Remarking on the importance of experience, he says: "We will build on the strength of the 1,400 employees of MV Werften…[and] have hired and are still hiring more people with cruise shipbuilding experience."

Meyer Werft has previously been entrusted with vessels for Genting, such as *Genting Dream* (to be delivered this autumn), but the rise of MV Werften will provide Genting with its own, tailored shipbuilding facility that will snuff out orders that may have fallen to other European yards in the past. Its schedule already looks busy with the first of four Crystal River ships to be delivered in 2017, the first of a series of 20,000gt Crystal Endeavour Class polar expedition yachts in 2018, and the first of a series of 200,001gt Star Cruises Global Class cruiseships in 2020.

"The planned annual output of MV Werften will be stepped up in future years to eventually build two Neo-Panamax cruiseships of over 200,000gt each and one Panamax cruise vessel," adds Genting. This will provide vessels for Genting's fleet, but also for other cruiselines and yacht owners.

Global Class inches closer

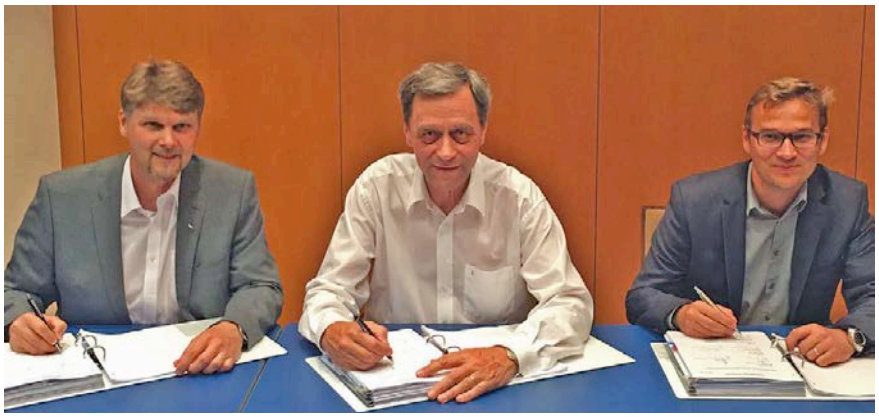
MV Werften signed contracts with Finland-based companies Deltamarin and Elomatic for the basic and detailed design of Star Cruises' new Global Class cruiseships on 28 July.

The first in series will be the largest cruiseship to be built in Germany at over 340m long and 45m wide, and will utilise the experience of MV Werften's new engineering partners, who have previously worked on mega passenger ships such as *Oasis of the Seas* and *Allure of the Seas*, to ensure its successful completion.

"The idea is that Deltamarin and Elomatic will share design responsibilities for the vessel although the yard will retain ultimate responsibility," says Mika Laurilehto, managing director of Deltamarin.

This partnership reflects MV Werften's desire for a reduced number of collaborators on the project, according to Laurilehto, a departure from wider practices in which numerous engineering companies are employed for work on a vessel of its size.

Laurilehto explains that Deltamarin's and Elomatic's experience will be used to support the yard, as although the yard has demonstrated its capabilities in the construction of different types of vessel over the years, such as ro-pax for Stena and two cruiseships for Aida (*AIDAvita* and *AIDAura*), it has not constructed a vessel of Global Class size before. This is evidenced in the yard's ongoing development of the construction methodology to be used for the vessel.



Contract signing from left to right: Mika Laurilehto (managing director Deltamarin), Jarmo Laakso (managing director MV Werften), Patrik Rautaheimo (CEO Elomatic)

The scope of work for Elomatic and Deltamarin includes engineering for the basic and detail design phases in all engineering disciplines, and both companies will provide technical site services for the shipyard during construction. The partners are currently splitting the workload, finalising the exact scope and schedule for each aspect of the build.

Laurilehto adds: "[The project] will have a long-term positive effect on employment at Deltamarin and we look forward to delivering the high quality technical expert services that such a vessel requires."

Genting has plans for a fleet of 10 vessels in its Global Class, and Deltamarin is prepared to continue to work on the series' subsequent vessels considering the majority of design work will be undertaken for the first vessel.

Beyond providing a boost for the respective companies, both Laurilehto and Elomatic's CEO, Patrik Rautaheimo, believe the engineering contract will make it easier for Finnish suppliers to participate in the project, positively affecting the whole maritime cluster.

A further Finnish designer, Foreship, played a part in the project's initial stages, providing consultancy services for the owner, Star Cruises. The company aided in the development of the vessel's general arrangement, which was finalised in June.

The vessel's design is on trend with fuel efficient and environmentally sound industry demands, deploying technologies that are already in use by the industry.

Steel cutting for the first in series vessel is expected to begin in late 2017, with delivery scheduled for 2020. *NA*

Star Cruises' new Global Class vessel will be the largest cruiseship to be built in Germany

Plan to sacrifice growth for quality making its mark

VesselsValue examines the current state of Chinese shipping from a valuation perspective, analysing the latest Five-Year Plan and the effects of the global recession on the wider economy and policy in the shipping and shipbuilding sectors

As with all industrial, economic and social activity in China, shipping and shipbuilding operate under the guidelines and aims of the latest Five-Year Plan agreed by the central committee of the ruling Communist Party of China.

The Five-Year Plan directs the economic and social development of the country, and has a significant impact on everyday life. For example, under the Tenth Five-Year plan (2001-2005), primary industries like steel making and shipbuilding were tasked with achieving growth rates of 13%. Releasing the brakes on steel production saw demand for iron ore imports increase significantly, and this was a major driving force in the Capesize boom that followed. This was brought to a halt by the Financial Crisis and culminated in the dry bulk market crash of October 2008.

In June 2016, the central committee released the Thirteenth Five-Year Plan (2016-2020). The plan focuses on the development of an internal, consumer-driven economy at the expense of the previous economic model based on serving the external globalised market. China's industrial production is tasked with moving up the value chain and away from heavy industry, with high tech industries located in new inland cities to create a greener, less polluted environment. The Thirteenth Five-Year Plan calls for China to grow the economy by 6.5% and to increase service industries from 50% to 56% of the economy by 2020.

Overall, the latest Five-Year plan is more concerned with the quality of growth, not the pace of growth. Shipping is hardly mentioned directly in the plan, but is lumped in with heavy industry and state-owned enterprises (SOEs), which are told to consolidate and streamline in the face of what is expected to be falling demand for their services in the new economy.

PROFILE OF THE CHINESE FLEET (RANKED BY VALUE)

	Number	Average Age	Value (USD m)
CONTAINER	572	7	20,856
BULKER	1,967	8	20,686
TANKER	890	8	17,262
SMALL DRY	933	14	3,373
LNG	24	6	2,928
OSV	354	13	2,385
LPG	123	14	2,142
GRAND TOTAL	**4,863**	**12**	**69,632**

Source: VesselsValue

Figure 1

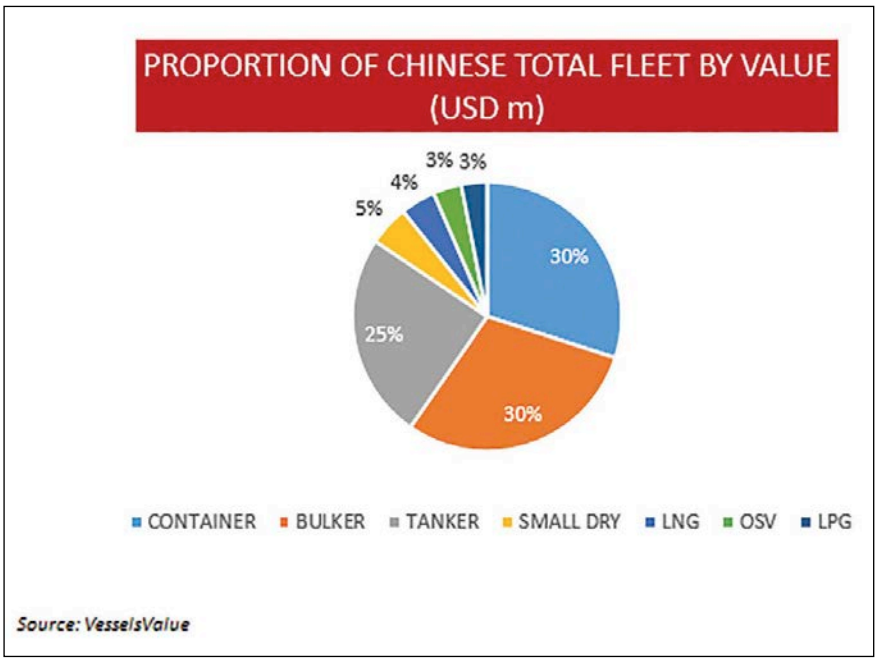


Figure 2

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Indeed, in July 2016, the State Council (which implements the Five-Year Plan) issued a decree that shipping and shipbuilding SOEs that make losses three years in a row will be liquidated. The impact of the Five-Year Plan will be felt globally. According to the Oxford Institute for Energy Studies (a University of Oxford research centre), the Chinese economy accounts for almost 15% of global GDP, 13% of global trade, and around 30% of global oil demand growth.

The Chinese fleet

China has the third largest fleet (by value) in the world, after Greece and Japan. The current fleet and orderbook has a current market value of US$70 billion, according to VesselsValue and consists of 4,863 vessels (tankers, bulkers, small bulkers, containers, LPG and LNG carriers, and OSVs – see Figure 1).

The Chinese container fleet has a market value of US$20.8billion, followed by the bulker fleet, which is 32% of the value of the Chinese fleet (see Figure 2).

One surprising aspect of the Chinese fleet is the average age. The Chinese fleet is relatively young, with most sectors dominated by vessels under the age of 10-years (see Figure 3).

Why the surprise? The bulker sector is one of the least externally regulated in shipping, and there is little incentive to replace older tonnage, but the Chinese bulker fleet has relatively few vessels over the age of 15-years. Of course, given the size of the Chinese fleet, this still amounts to a bulker fleet with a value of US$1billion, which is equivalent to the current value of the Italian bulker fleet. The age profile graph (Figure 3) illustrates the distribution of the age of the Chinese fleet.

Under the Five-Year Plan, the state-owned shipping companies have been consolidating, creating a fleet profile of a few companies owning a relatively large number of ships compared to the global fleet (see Figure 5).

In the dry bulk sector, the newly formed COSCOCS Bulk Shipping now controls 22% of the bulker fleet by value, and the top 10 companies control 46% of the bulker fleet. This includes VLOC Maritime Holdings, which is a joint venture between ICBC Financial Leasing (ICBC) and China Merchants Energy Shipping (CMES - number two in the list of top three bulker owners – see Figure 5). VLOC Maritime Holdings operates four VLOCs in the water, plus another 10 on order in China, and it is said that the other VLOCs bought from Vale of Brazil, and now operated

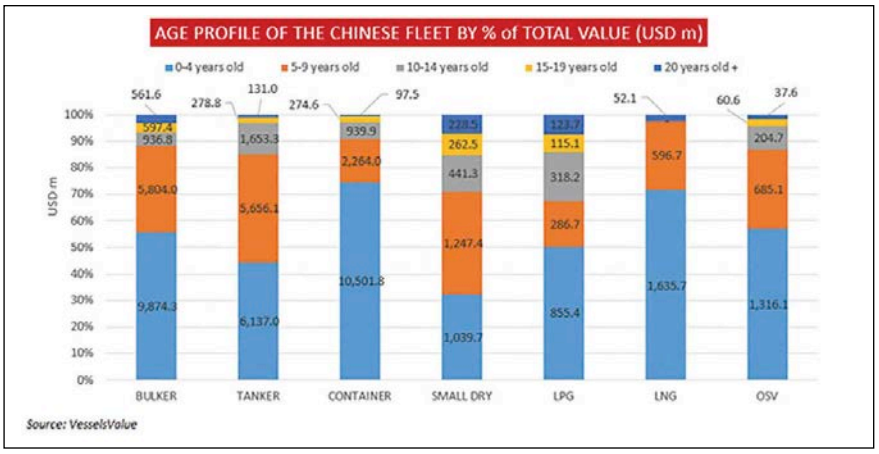

Figure 3

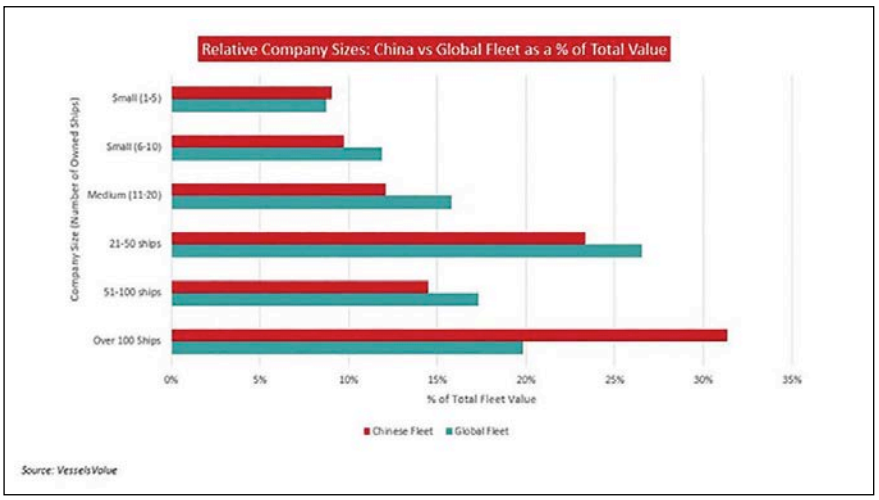

Figure 4

Top Three Chinese Bulker Shipowners Ranked by Value

	Company Name	Number	DWT m	USD m
1	COSCOCS Bulk Shipping	370	36.6	4,479.8
2	China Merchants Energy Shipping	36	7.8	1,054.5
3	Pacific Basin Shipping	100	3.8	780.3

Source: VesselsValue

Figure 5

Top Three Chinese Tankers Shipowners Ranked by Value

	Company Name	Number	DWT m	USD m
1	COSCO Shipping Energy Transportation	129	19.4	4,474.7
2	China VLCC	53	16.4	3,450.6
3	Sinochem	63	2.4	1,223.8

Source: VesselsValue

Figure 6

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 Lloyd's 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 2016 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 **31st December 2016.**

The Award will be announced at the Institution's 2017 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

by state-owned companies (COSCOCS Bulk Shipping, ICBC and CMES), will be consolidated under VLOC Maritime Holdings. Under this consolidation process, as many as 46 VLOCs will be under the control of one Chinese company.

On the tanker side, the percentage of the tanker fleet owned by the top 10 owners is even higher, at 71%, and is dominated by state-owned companies such as COSCO Shipping Energy Transportation (CSDC), and Sinochem (see Figure 6). CSDC was formed by the merger of China Shipping Group and COSCO. CSDC is the largest tanker company in the world by number of tankers, capacity (DWT) and value (US$ million).

But the highest concentration is in the container sector (see Figure 7), where one company, China Lines (the newly created company from the merger of COSCO Container Lines and China Shipping Container Lines) has a fleet equal to over 40% of the Chinese containership fleet. China Lines is currently the third largest containership owner in the world, behind AP Moller Maersk and MSC.

Top Ten Chinese Container Owners Ranked by Fleet Value

	Company Name	Number	DWT m	USD m
1	China Lines	197	13.8	8,278.5
2	Bank of Communications	21	2.7	3,168.9
3	Greater China Intermodal Investments LLC	23	2.8	1,964.7

Source: VesselsValue

Figure 7

Purchases by Top Three Chinese Owners in the Last Year

Owner	Total Number of Vessels	Total Value (USD m)
ICBC Financial Leasing	18	868.8
VLOC Maritime Holdings	4	197.2
Bank of Communications	4	140.0

Source: VesselsValue.com

Figure 8

Sales by Top Three Chinese Owners in the Last Year

Seller	Total Number of Vessels	Total Value (USD m)
Guangdong Lanhai Shipping	8	68.1
HOSCO	3	55.9
Sainty Marine	2	39.8

Source: VesselsValue.com

Figure 9

S&P activity

As mentioned above, there has been a round of consolidation within Chinese shipping and second hand purchases, driven by the dictates of the Five Year Plan. As a result, Chinese shipowners have been prolific buyers of secondhand tonnage. The main buyer has been state-owned ICBC, which bought 18 vessels (mainly VLOCs) for just under US$870 million. Four of the VLCCs were subsequently sold to the VLOC Maritime Holdings (see Figure 8).

The ICBC acquisitions corresponded with the purchases of four VLOCs by VLOC Maritime Holdings for a total of nearly US$200 million. The back story to these deals is the long running attempt by Brazilian mining company, Vale, to ship iron ore to China on 400,000dwt VLOC's. This now runs counter to China's desire to control at least 50% of the trade.

Sales in the last twelve months (to the end of June 2016 – see Figure 9) centred around the auction of various collapsed shipping and shipbuilding enterprises. Top of the list was the sale of the Chinese-built Guangdong Lanhai Shipping fleet, which consisted of five Supramax and three Panamaxes, which were sold at auction by China Construction Bank. It is understood the vessels were purchased by a Greek buyer for a reported US$68 million.

Shipbuilding

Chinese shipbuilding is dominated by small shipyards producing a small number of ships. The Lorenz Curve chart (see Figure 10) shows the output of all Chinese shipyards by the value of the vessels in the fleet. As can be seen, 95% of the cumulative share of Chinese shipyard production was worth around 40% of the value of the total output to date. Or in other words, 5% of the Chinese shipyards produced 60% of the value of the output. This is inefficient compared to South Korea, where the value of the output is more evenly spread, and the equivalent figure is that 5% of the shipyards produce only 40% of the value of the output.

The main issue in Chinese shipbuilding is the number of small shipyards, which flourished in the pre-financial crisis boom, but many have since failed to win new business. In 2013, over 70% of the vessels delivered that year were produced by shipyards constructing between one and five vessels. By the end of 2015, 67% of output was produced by shipyards constructing between one and five vessels. So far in 2016, the number of vessels produced by this selection of shipyards is down to 52%. This suits the aims of the current Five-Year Plan.

The Chinese forward orderbook has a value of US$25 billion in 2016, which is considerably higher than the value of the output of 2015 (US$14 billion). Therefore, it seems highly unlikely that this schedule will be met, and slippage and cancellations are likely to be a feature of the Chinese orderbook going forward.

Of course, what Figure 11 does not show is the issue of quality in Chinese shipyards. The VesselsValue methodology for scoring shipyards has been discussed before in *The Naval Architect* (February, 2016, p26). To explain briefly, VesselsValue scores shipyards according to actual

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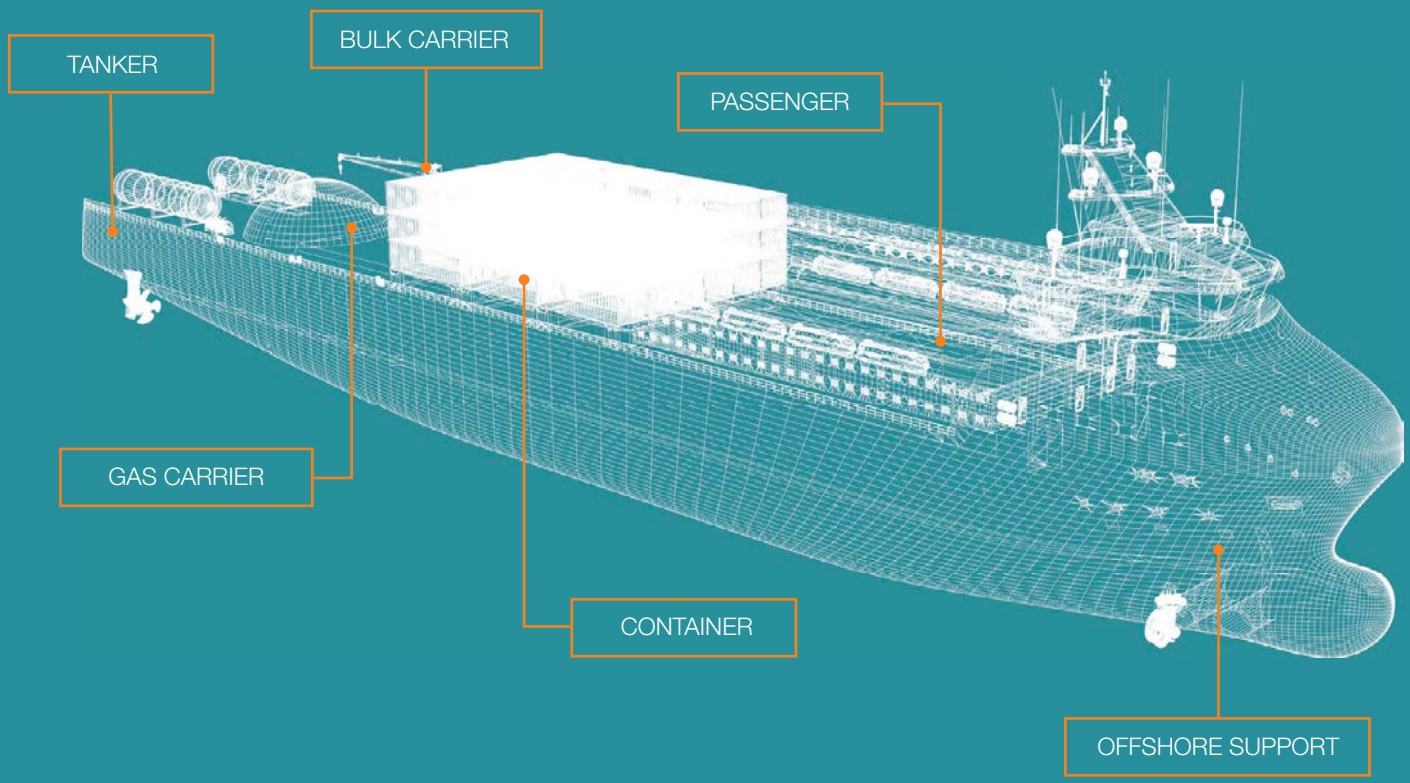

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transactions and prices achieved, and normalising for all other factors, regressions are run to determine the scoring for all vessel specifications. Under the current scoring system, the highest rated Chinese shipyard scores at least 4% below the reference Japanese shipyard, and other Chinese shipyards considerably lower.

Conclusion

The outlook for Chinese shipping and shipbuilding over the next two or three years can be described as centrally-planned turmoil. Having done their jobs under the previous globalisation-orientated Five-Year Plans, both industries will be consolidated and streamlined under the latest inward-looking economy plan.

This is already taking place, with the consolidation of COSCO and China Shipping to form China Lines, but this is just the start. By 2020, each shipping sector will be managed by one main SOE controlling a huge fleet composed of internal merger and consolidations, and possible significant overseas purchases. A similar process will take place in the shipyards. If all goes to plan (pun intended), by the 100th Anniversary of the Chinese Communist Party in 2021, the leaders of the party will direct control over the largest shipping and shipbuilding entities across all sectors. *NA*

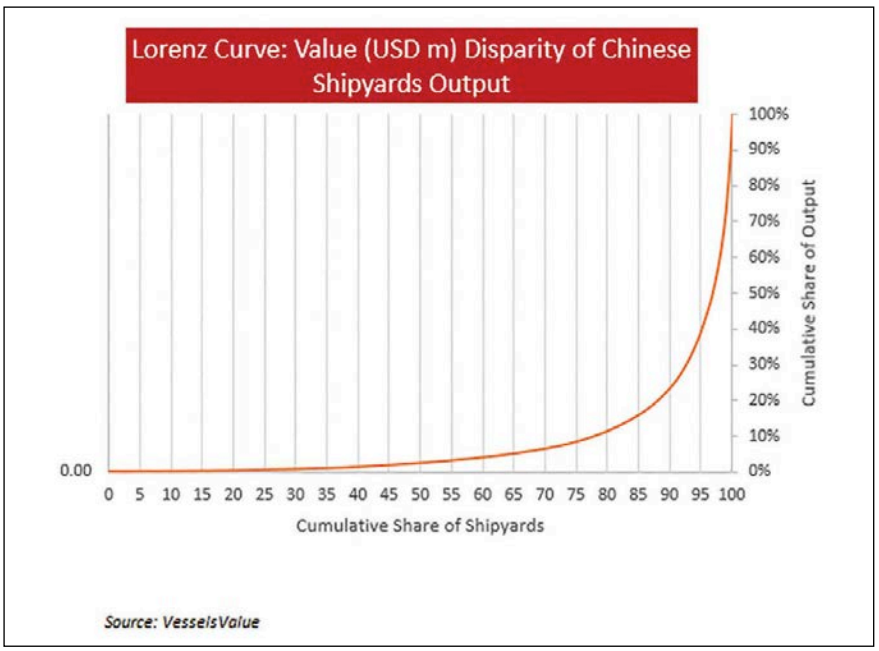

Figure 10

SHORT TERM DELIVERY SCHEDULE of VESSELS ON ORDER IN CHINESE SHIPYARDS (USD m)

Ship Type	2016 (USD m)	2017 (USD m)
BULKER	10,166	3,493
TANKER	5,422	5,867
CONTAINER	3,081	5,059
OSV	3,604	785
SMALL DRY	628	197
LPG	1,429	502
LNG	897	833
Grand Total	**25,227**	**16,735**

Source: VesselsValue.com

Figure 11

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Naval architecture evolves with the changing market

Building ships has become a tricky business as owners find a contracting market is a tough place to sell into and even second-hand sales have taken a nose-dive over the last year. China's industry is adapting to this new reality fast as the yards and manufacturing companies try to draw in buyers with offerings of new technology

Further challenges to the global economy are not needed as the world's shipbuilding industry is still reeling from the latest setbacks, with the price of oil still hovering in the low to mid-US$40's per barrel and consumer confidence on the wane yards are clearly suffering.

As if this was not enough the challenge posed by the vote in the UK to leave the EU will play out over the coming months and years; it is a known unknown and will see both industry and consumers operating with caution.

Equipment manufacturers such as crane designers and builders are, predictably, also suffering from the global economic melt-down, but some companies are responding with the development of new products that they hope will be of interest to owners and will win those orders over their competitors.

One such company is TTS BoHal Machinery in Dalian, northern China, a subsidiary of the Norwegian company TTS Group which founded TTS BoHai as a joint venture with China`s Dalian New Shipbuilding Heavy Industry.

TTS BoHai has for some time been developing what will be only the world's second electric cargo deck crane. Testing of the crane has taken place and further tests are required, but TTS BoHai's general manager Walter Wang says the "electric crane is 99% ready."

Essentially, the electric crane converts AC current to DC through Siemens electrics. However, there are a number of challenges for the company to meet before the crane can be marketed. The 30tonne crane has a 26m outreach. The 127kW hoisting motor is supplemented with two luffing motors of up to 70kW.

One of the problems that TTS must address is the jerky movements of the jib when the brake is released or applied, which could cause the operator to lose control of the load. In addition, the crane needs a cooling fan that is on a separate electrical feed to the rest of the crane as the motor that drives the crane will not always be operating and certain electrical components will become hot and need cooling.

Ironically, in extreme weather the cold will mean that the operator and some crane parts will need to be heated. But perhaps one of the main appeals of the electric crane is that it has a variable speed, other gantry cranes have a single speed which is "easy to do" says Wang, "but if you want frequency control, this is more complex".

It is a frustrating situation for Wang and his staff as they await the engineers from the German motor and electrical component manufacturer to arrive in northern China, along with TTS engineers from Norway, leaving the project on hold. TTS is now the subject of a takeover bid by Palfinger, which is listed on the Vienna stock exchange and is headquartered in Salzburg, but is also listed in Frankfurt, Germany and New York in the US.

The bold move by Palfinger, whose stated aim is to grow through acquisition and to be one of the top three marine equipment suppliers in the world is set to play out over the coming months, according to managing director Karl Oberreiter.

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In the meantime Wang told *The Naval Architect*: "We have had a few enquiries regarding the electric crane from customers and there was some demand two to three months ago, there is an Indonesian owner that showed an interest in the electric crane even though it is more expensive than a standard crane."

Cost for shipyards is crucial, but with the overcapacity in the yards it is essentially a buyers' market with the owners, reportedly, making demands that in the periods when the yards were full were not possible for the yards to fulfil, or for the owners to press for.

As the change has occurred prudent owners have prepared for the downturn and have set aside funds that they can use for 'distressed' sales or very low priced newbuildings. That newbuilding business is also being fought over by the various design houses and MARIC, the Marine Design & Research Institute of China, is also in the throes of changing its offerings to customers.

Shen Weiping, MARIC vice president, says: "We will focus on the ships with a high level of technical competence required and a high price."

According to Shen the key to being successful in this market is to offer flexibility so that the ships can be utilised in various ways. "Flexibility is the key to staying alive," he says. This includes designing and building vessels that are LNG ready, with space for double walled piping and fuel tanks and engines with dual fuel capability.

In addition, MARIC believes that the ships must be able to switch trade lanes, so that if a vessel moves to the South American trades, for example, the need for extra reefer space will be met in the original design.

However, MARIC also believes that the era of large vessel orders of large containerships seen last year has come to an end. In the first instance much of the 2015 ordering of the 17,000TEU plus containerships was aimed at avoiding new Tier III NOx emission regulations that came into force in January this year.

MARIC also believes that the larger containerships will prove less popular in time as the vessels have little flexibility to move out of the major trade lane between Asia and Europe. "Maersk and CMA CGM made money in 2013 because of the economies of scale offered by the larger ships," observed Shen, "but MSC also made money and they did not have the larger class of vessels, they operated with 13,000 to 14,000TEU ships."

MARIC believes that the flexibility of these smaller vessels will be the key to making this size the workhorse of the Asia to Europe trades, while other restrictions, such as terminal length currently at a maximum of 400m and beam at 71m are at the extreme of what terminals can do in terms of handling ships. In addition, many ports will be pressed to handle the volumes of cargo delivered by the larger ships.

A five vessel order made by COSCO last year will see three built at the Shanghai Waigaiqiao Shipyard and two in Dalian. COSCO, however, has since merged with China Shipping Lines to form China COSCO Shipping Corporation (COSCOCS) earlier this year.

"Market forces for larger containerships are not so strong, the next stage is flexible ships that can operate in different trades and that are able to cope with different cargo mixes," says Shen.

MARIC claims it is China's oldest ship design house and it is a subsidiary of the China State Shipbuilding Corporation, CSSC, which also owns another major designer SDARI, the Shanghai Merchant Ship Design & Research Institute. As consolidation is being ordered by the Chinese Government for major state owned enterprises such as the shipping lines and the train producers, it is likely that rumours of CSSC's merger with the other major state owned shipbuilder China Shipbuilding Industry Corporation (CSIC) will be realised.

It may not be too far-fetched in this context that the two major CSSC owned ship designers could also see a merger. In the prevailing economic climate such a move would make as much sense for the yards and designers as for the ship operators. *NA*

Source: Vessels Value

Buying, ordering and scrapping activity H1 2015 VS H1 2016

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Deck cranes receive risky diagnosis

Chris Dyson, a partner and marine engineer at Brookes Bell LLP, discusses deck crane design and crane failures with *The Naval Architect*

There are not many problems with crane designs themselves, says Dyson, but there are wider issues that implicate design factors in crane failures. These can include irregular crane controls, the inadequate use of existing regulations, and a conflict of interest between shipowners and yards that can lead to inappropriate crane selection.

The advent and widespread implementation of software-controlled equipment is taking a toll on the functionality of cranes, which are adapting to the technological shift. Simple, direct systems have been replaced by more complex, computer-controlled crane systems in an effort to improve safety and efficiency, but they may be unnecessarily complicating the process at a premature stage in their development instead, says Dyson. In this sense, lack of synchronisation and incorrect software operating profiles can lead to premature wear on mechanical components and ultimately failure, for example of gearbox assemblies.

Control problems have led to interlinked system failures where the relationship between software and mechanics has failed, and Dyson ultimately believes that in a number of cases the systems have not been tried and tested to the level of older systems.

Efforts to improve the design of cranes with double-layered winch drums have also backfired, explains Dyson. The initial intention was to reduce the necessary size of the winch and so reduce costs; however, this change has commonly had the effect of accelerating wire rope wear because of the way the rope is wound back on itself in the opposite direction on the second layer. For such an arrangement, commonly used basic left and right hand lay ropes are no longer ideal and are likely to sustain premature wear. More elaborate and expensive ropes are consequently required that increase an owner's operating costs for the crane in service – although even these ropes may still wear prematurely. As a result, "someone has advanced the design, but not for the better", says Dyson.

A bulk carrier where the jibs of all four cranes were removed following ongoing issues arising after delivery. It documents an extreme case of failure to rectify design issues that ultimately resulted in the cranes being taken out of service after only a few years in operation

Catastrophic failure of a hoisting winch gearbox

The premature roll-out of new models by manufacturers is also having an impact. Insufficient testing time has meant that ships are being used as test cases. Dyson says that while only a small fraction of cases may lead to failures, it can be a big problem, putting lives and a lot of money at risk, not to mention the auxiliary cost associated with a crane's loss of use.

Fitting the bill

It is unlikely that shipowners have the expertise to ensure that they take delivery

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of the most suitable cranes for their vessels' operating profiles, explains Dyson. They may have an idea, but they are ultimately reliant on the contracted shipyard and provide only loose specifications. This reliance is problematic as the yards themselves are not crane experts and will turn to an approved list of manufacturers that may or may not offer the best solution for the shipowner.

A conflict of interest then worsens matters as it is often the case that "shipyards wish to go with the lowest cost they can get away with, but the owner is goaled towards a long term satisfaction of needs," according to Dyson.

In consequence, shipyards get what they pay for, while owners seem to be unaware of exactly what they're getting for their money. The fact owners can commonly have no direct contact with manufacturers is a corollary issue.

Dyson proposes that more detail should be included in the specification agreed between shipowners and the shipyard to remedy the situation, specifying three key points for consideration:

1. A crane's safe working load and outreach must be assessed and suitable for desired trade.
2. The required lifecycle use of the crane should be carefully defined.
3. Design rules and guidance should be correctly stated and specified for intended use.

He also adds that there should be consistency and transparency at the contractual stage, between the cranes specified between owners and the shipyard and those ordered from the manufacturers by the shipyard, to ensure the two are compatible.

Making regulation work

At present, cranes are generally type approved. However, the approvals are commonly generic in nature and concern only basic structural requirements. In this respect, type approval does not ensure that a crane is suitable for a specific required service task or lifecycle.

Class approval is largely peripheral for regulating cranes because the crane (above the fixed pedestal) is likely to fall under flag or statutory standards and not to be directly considered as a class item at build. Class can be involved, but it is rare for them to supervise the build of a crane as their interest effectively stops above a crane's pedestal in most cases.

Owners may request the input of a regulatory body approved by the flag administration. However, this is commonly applicable to the latter stages of the build, immediately prior to delivery, when the vessel is registered to a flag state. Flag states also commonly adopt ILO standards with regards to cranes, which are seen as the lowest common denominator and are all too often administered by organisations whose own standards fall below those of classification societies and their rules. It is therefore often considered that ILO standards represent the lowest accepted level of regulation, says Dyson. This means that all sorts of organisations are approved to regulate cranes that are not as capable as the class societies, which have greater expertise and capabilities.

Class societies are happy to certify on behalf of the flag state, and the shipowner can ask for a higher level of assurance by having the vessel's classification notation include that for cargo handling appliances, says Dyson. However, the reality is that these measures are rarely put to use.

"All the measures to improve things are there, but they aren't taken up", says Dyson. This, he explains, is commonly because of the additional costs involved, especially against the backdrop of a depressed economic shipping climate that makes both owners and yards alike supremely cost-conscious. People are spending less money initially and are ultimately missing out on the best long term solutions, which may in time lead to failures and additional costs.

When asked if it would be simpler and more efficient for cranes to be included as a class item, Dyson said: "It probably would be better to apply class requirements by means of including notation for cargo handling appliances from build, as it would remove the worst people able to certify."

Dyson also believes that more thorough tests and inspections should be conducted of cranes and their wires (the most prevalent cause of failure) in order to reduce negative outcomes. Current operational and visual tests carry little meaning, he says, because they only really test if the crane is working at that moment and not the crane's ongoing condition i.e. the state of its component parts. "It is a practical reality that the present regime of annual and quinquennial surveys administered through the flag states falls well short of ensuring the continued reliable operation of a ship's cranes during the periods between inspections," concludes Dyson. *NA*

Crane collapse during cargo operations resulting from a gearbox failure

Palfinger set to acquire TTS Group

Austria-based marine equipment supplier, Palfinger, is poised to take over Norway's TTS Group, including all of its joint ventures in China. Acquisition of the Norwegian company will propel Palfinger from a top-10 equipment supplier into a top three company

Oslo's stock exchange has already approved the proposed takeover of 100% of TTS Group's shares by Palfinger, but stock-exchange rules require 90% of the shareholders to approve the move also.

Palfinger has offered NOK5.6 (US$0.68) per share valuing the company at around NOK600 million (US$72.63 million).

TTS Group's board of directors has already recommended that shareholders accept Palfinger's offer with the TTS Group CEO Toril Eidesvik suggesting that the acquisition "will give large synergies" to the companies. At the time of writing, shareholders had until 12 August to declare their intentions and some 66.3% had already acquiesced to the sale.

As well as the approval of the shareholders Palfinger and TTS Group must get EU approval from the Competition Commissioner for the companies to merge.

Palfinger Group has a turnover of €1 billion (US$1.11 billion) per year of which around 15-20% is provided by Palfinger Marine, according to Karl Oberreiter, managing director of Palfinger Marine, who added that as well as growing through acquisition the company would like to see organic growth. That target may need to be put on hold, however, as the oil price in particular and the global economy in general would need to see greater growth for that to happen.

Oberreiter added that the marine division was expanding rapidly with the acquisition of several companies over the preceding years; including Netec Holland, in 2010, Danits Lifesaving and Dreggen both in 2012, MCT of South Korea in 2013 and Norwegian Deck Machinery in 2015. On 1 March the company unified all of the acquired companies under a single Palfinger Marine Brand.

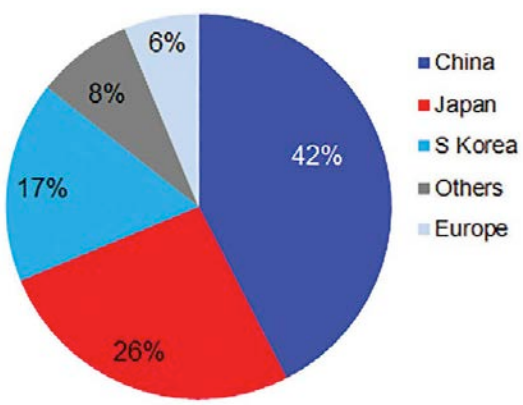
According to Palfinger Marine: "The Group has production and assembly facilities in Europe, North and South America, as well as in Asia. The pillars of corporate strategy comprise innovation and the further internationalisation as well as the growing flexibility of products, services and processes. Palfinger is regarded not only as the market leader, but also the technology leader, in the global market for hydraulic loader cranes." *NA*

Clarksons Research: Historic and Scheduled Delivery

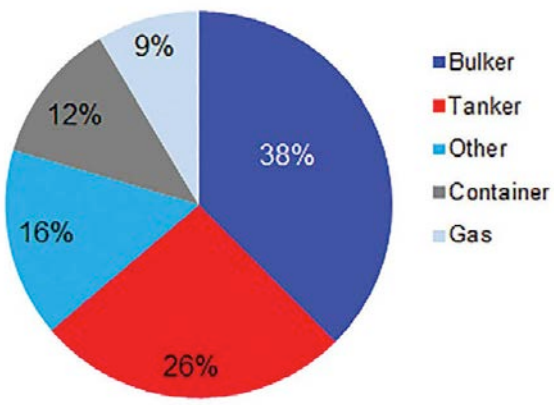
Data extract from World Fleet Register available at https://live.clarksons.net/wfr2/

Vessel Type	2005		2006		2007		2008		2009		2010		2011	
	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half
VLCC >= 200,000	15	16	5	13	15	14	18	23	32	21	30	24	35	27
Suezmax 120-200,000	16	9	14	12	15	10	9	5	22	23	28	13	25	18
Aframax 80-120,000	35	30	29	21	28	28	24	44	62	34	37	31	28	31
Panamax Tankers 60-80,000	24	21	25	20	26	15	16	27	26	12	15	16	18	8
Products 30-60,000	51	48	59	56	68	66	73	92	91	67	63	43	45	23
Products 10-30,000	3	5	2	9	8	10	7	6	5	5	6	7	9	8
Chem & Spec. 10-60,000	35	41	56	45	62	62	81	104	107	71	79	63	52	45
Tankers < 10,000	27	27	20	26	31	43	59	88	68	69	60	43	51	48
Capesize > 100,000	22	25	32	28	29	27	20	24	34	77	101	112	128	123
Panamax 80-100,000	6	11	22	23	22	16	15	17	27	21	60	60	82	97
Panamax 65-80,000	41	35	36	26	22	22	23	20	18	15	18	33	39	46
Handymax 40-65,000	52	48	53	40	50	50	66	59	86	100	168	168	195	198
Handysize 10-40,000	32	38	33	33	43	54	65	60	89	117	142	156	160	170
Combos > 10,000	0	0	0	0	0	0	0	0	0	0	3	2	2	0
LNG Carriers	7	11	12	16	16	16	25	26	22	17	15	12	5	10
LPG Carriers	4	3	9	15	15	20	27	33	25	18	18	19	16	14
Containers > 8,000 teu	14	18	34	28	20	17	25	25	22	13	30	33	46	25
Containers 3-8,000 teu	38	54	45	56	60	70	72	61	62	57	79	41	33	26
Containers < 3,000 teu	63	79	87	115	105	121	140	109	69	51	56	25	32	29
Offshore	5	6	4	5	3	18	14	14	13	14	24	26	30	26
Cruise Vessels	2	2	5	1	7	3	6	3	3	6	9	4	4	2
Ro-Ro Ferries	13	6	8	6	5	8	16	5	9	7	10	8	11	8
Other	74	77	102	123	148	133	150	148	143	151	163	177	176	172
TOTAL	**589**	**613**	**699**	**718**	**810**	**835**	**971**	**1,008**	**1,066**	**1,004**	**1,230**	**1,131**	**1,232**	**1,158**

Orderbook by Builder region (No. Vessels > 100m LOA)



Orderbook by Sector (No. Vessels > 100m LOA)



2012		2013		2014		2015		2016	Scheduled Orderbook		
1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2nd Half	1st Half	2016	2017	2018
27	22	21	9	14	10	9	11	22	33	56	29
31	16	25	6	4	4	8	3	6	26	69	10
29	14	13	5	4	13	21	10	28	33	81	37
8	6	6	4	3	1	2	1	7	21	31	12
25	30	49	27	48	49	57	55	54	53	80	16
12	2	6	2	2	7	3	1	1	2	8	2
41	11	12	16	13	13	38	31	48	69	103	49
65	34	29	25	22	19	7	12	11	29	26	3
148	65	63	40	56	38	46	42	64	57	96	40
140	95	100	68	62	35	57	40	71	68	153	29
54	39	34	43	44	23	22	4	1	11	11	0
226	146	147	118	96	98	139	122	118	172	293	32
211	113	111	73	89	68	101	84	83	137	139	39
0	0	0	0	0	0	0	0	0	0	0	0
1	2	4	13	14	18	17	16	13	25	55	41
13	7	23	16	14	14	24	39	44	44	92	12
50	28	51	33	59	41	59	62	36	32	92	55
40	19	46	29	26	24	19	6	2	3	22	11
33	38	29	16	22	27	26	34	37	44	97	43
34	17	15	19	31	30	28	12	18	32	85	28
6	1	6	0	3	2	5	1	7	3	11	11
11	8	5	6	12	5	11	5	4	19	18	9
190	90	98	86	71	52	60	46	44	103	140	45
1,398	**805**	**893**	**655**	**716**	**597**	**763**	**637**	**719**	**1016**	**1758**	**553**

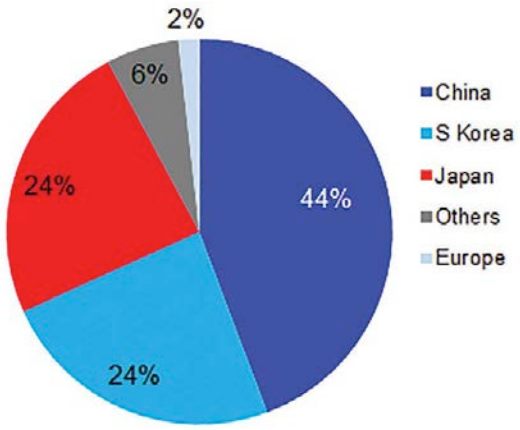
Data includes all vessels with LOA estimated at >100m

Where scheduled month of delivery is unknown an arbitrary month of build has been applied for orderbook data

The orderbook by year of delivery on this page is based on reported orders and scheduled delivery dates and does not necessarily represent the expected pattern of future deliveries

All data taken as of 1 July 2016

Orderbook (DWT) by Builder region



Source:
Clarksons Research

New designs and future headings

A new dual fuel vessel for Baltic ferry operator, AS Tallink Grupp, draws close to completion. This provides food for thought, and Su Len Quach of Deltamarin ruminates on LNG powered ferries and possible futures for the ro-pax industry in a wider discussion with *The Naval Architect*

The "revolutionary new hull design" of Tallink's new fast ferry is still closely under wraps, but Jean-Jacques Juenet, passenger ship manager at Bureau Veritas (BV), provides a window on the enigmatic vessel soon to undergo sea-trials following its construction at Meyer Turku, Finland.

The 212m long vessel, *Megastar*, is a classic LNG dual fuel ship, says Juenet, but it will be one of the first to be certified using the new Code of Safety for Ships using Gases or other Low-flashpoint Fuels (IGF code), which comes into force on 1 January 2017. The operator made a conscious decision to adopt the new code despite its keel date falling within the enforcement period of the old IGF code.

The vessel will be equipped with two large stainless steel LNG tanks under the main deck, with a total volume of 600m^3.

Megastar's general arrangement is currently unavailable, but, as one might expect, it has been tailored for the Helsinki to Tallinn route on which it will operate and reflects a bolstered focus on shopping opportunities during the passage, reveals Juenet. This, he explains, is because Finnish passengers are able to buy products at cheaper Estonian prices onboard and the ferry operator is looking to maximise the commercial opportunities.

Previous incarnations of Tallink's vessels have had large provisions for shopping, but this will be even bigger, featuring "a special design with a large possibility for shopping", according to Juenet. The largest shopping area is situated in the Traveller Superstore, located on decks 7 and 8 in the aft of the ship and offers a 2,800m^2 shopping area.

Additional onboard facilities and features include open-layout dining areas, new sitting lounges, 105 cabins for crew and 47 cabins to cater to the vessel's 2,800 passenger capacity, the same as Tallink's current largest cruise ferry, *Baltic Queen*. Upgrades have been made to the vessel's cargo flow too, with two-level loading that enables passenger vehicles and large cargo units to enter and exit from different levels, improving car-deck logistics.

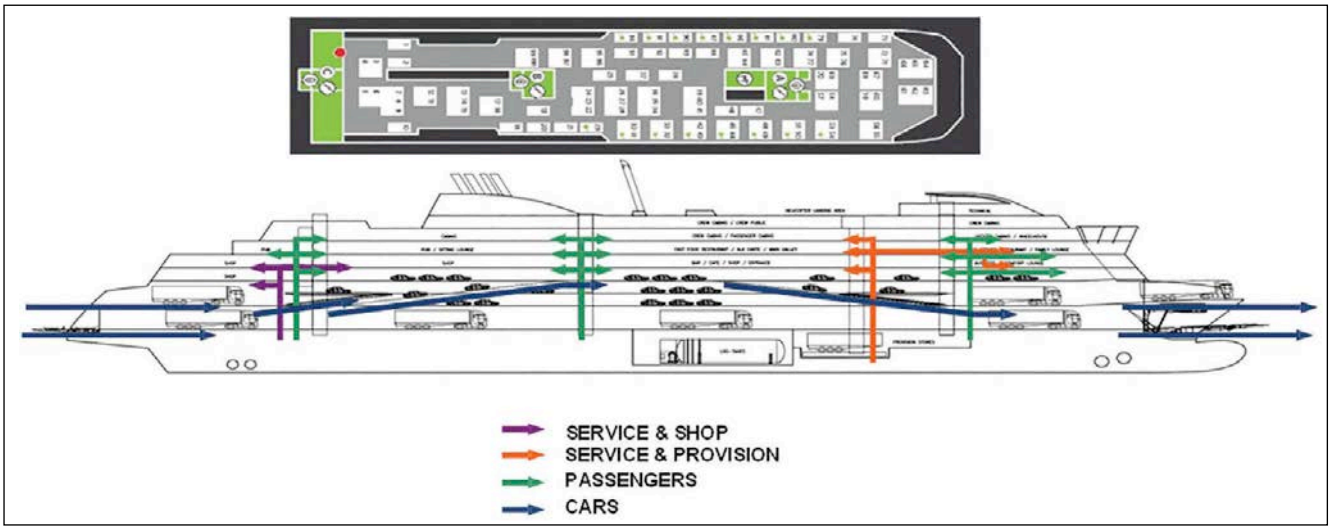
The vessel's hull has been designed by Meyer Turku Yard's naval architects, who evaluated approximately 35 different hull forms in the process. Key benefits include low resistance, small wave formation and good performance in ice.

Megastar has an Ice Class 1A notation in order to deal with the Baltic's icy environment and as such features a reinforced hull in the fore and a reinforced belt around the waterline, as well as reinforced scantling.

The route also poses a unique safety scenario. Due to the short, 20nm distance between the ferry's ports it is possible to use a different kind of lifesaving arrangement that is accounted for in SOLAS. This allows the ferry to operate without lifeboats and instead use marine evacuation systems (MES) and battery-powered rescue boats – *Megastar* features four instead of the mandatory two.

This is currently an uncommon scenario as ro-pax vessels have used a mixture of lifeboats and MES in the past, but it is not unheard of. A similar

Megastar's two-level loading offers advantages for passengers and crew



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provision has been included on two ships for P&O operating between France and the UK, and Juenet emphasises that such a provision has been laid out in SOLAS and is not an exemption.

The vessel is scheduled for delivery in February 2017.

Cooperative designs

Speaking more widely on ro-pax design, Su Len Quach, a project engineer in conceptual development at Deltamarin, says the market for ro-pax vessels is constantly changing due to strong growth in passenger numbers as well as the new emissions regulations, and this characteristic is spurring a collective design approach that pulls emerging technologies together for the better.

This approach incorporates architects and a diverse range of specialist equipment providers as part of a holistic design process in which the naval architect harmonises an array of energy saving and environmentally friendly solutions.

Last summer's *DeltaChallenger* project, the ro-pax of the future according to Deltamarin, already evidences the success of pooled technological resources at the initial design stage in terms of better performance and environmental savings (see The Naval Architect, September 2015, p.44); however, Deltamarin has ceased development of the concept in order to research even more advanced designs.

In particular, *DeltaChallenger*'s design places a great deal of emphasis on the use of LNG, which is growing in importance. Deltamarin introduced a new kind of general arrangement where the cargo flow is made as easy as possible considering the position of GTT's LNG membrane tanks in the design (Figure 1). This arrangement mitigates the issue of having LNG tanks quite high up in the vessel, which can divide the cargo space, deploying adaptable ramps that allow the fore part of the vessel to have cargo space.

Alternative alternatives

LNG is continuing to rise in popularity – as seen with Deltamarin's *DeltaChallenger* and Tallink's *Megastar* – especially for operators who must stay within the bounds of emission regulations such as ECAs. Quach marks this trend, stating that LNG dual fuel systems will likely dominate the design of large ro-pax vessels for the present and near-future.

However, LNG is not the end point, and Quach ruminates on the emerging future of alternative, zero emission fuels, which will necessitate new ro-pax designs.

Increasing environmental demands are pushing the industry on its way to zero-emission vessels, he explains. Battery hybrid vessels are becoming more prevalent, particularly with regard to small ferries, but Quach believes a broadening of such solutions' use will occur as the power density of batteries rises and prices decrease – one only has to look at Tesla to see the progress made in this field. However, the problem, he says, is that battery power solutions are currently less attractive to owners because of the deflated price of oil, which sits at US$39.51/barrel for WTI Crude Oil and US$41.80 for Brent Crude Oil at the time of writing. So while zero emission vessels are undoubtedly attractive, economic realities are still winning out for the moment.

Asked if large ro-pax vessels might use alternative fuel sources such as a battery hybrid solution over short distances, for example on a route like *Megastar*'s, Quach said it could be possible for such a route given the right circumstances; the price of batteries, incentives, the vessel's energy consumption profile (fluctuations), main machinery components, etc. would all have to be taken into account.

Hydrogen fuel cells could also be used in the right circumstance following suitable development of the technology. Adoption of this kind of powering solution would depend on the variety of operations and route of the vessel in question, explains Quach. Time spent in port would have to be considered, as well as the bunkering provision for the fuel, which, due to hydrogen's highly calorific but low density characteristics, would have to be quite sizable. Production of hydrogen would also have to be studied and appraised in the context of fuel deliveries, associated logistics, vessel designs, and of course cost.

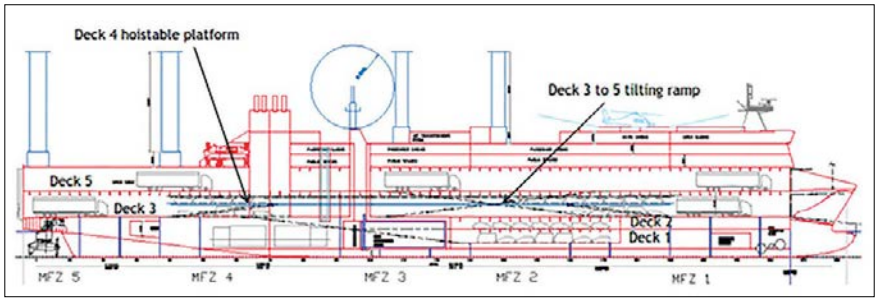
While it is currently very expensive to produce, a feasibility study by Kawasaki will shortly be underway in Australia testing a new, cheaper method of extracting hydrogen from brown coal; such development seems indicative of a new zero-emission fuel horizon and could hail the first important step towards a partly hydrogen-fuelled future.

At present, though, a number of rather substantial hurdles obstruct its realisation. In terms of regulation, the fuel source is still outside of current regulation and is not accounted for in the IGF code, says Quach. People's views concerning the fuel are at an immature stage and various permissions from flag states, courts, the IMO and all other concerned parties, will have to be collected.

Quach says naval architects will also have to take into account that four times more fuel in volume will be needed compared with HFO and even LNG; a fact that will lead to fundamental changes in the layout of vessels as more space will be required, leading to larger vessels. In addition, the temperature needed to transport hydrogen in its liquid form is approximately -253°C (LNG is transported at -163°C), which raises the engineering problem of how best to keep the fuel cool.

In effect then, the road ahead for ro-pax design is not without added difficulty, but the chance CO_2 emissions might be removed from the shipping equation is pushing alternatives to LNG in to view, and, as seen with Kawasaki's venture, closer to reality. *NA*

Figure 1: *DeltaChallenger* makes the most of its onboard space with adaptable ramps



Decision support system advances ro-pax safety

A system that automatically activates when flooding is detected, provides status awareness, predictions on survivability, a timescale of expected flood progression, and takes into account ro-pax specific issues, such as possible accumulated water on the vehicle deck, could prove invaluable for crew onboard a stricken ro-pax vessel

Modern ro-pax ships offer fast and efficient transportation services all over the world. The safety of ro-pax ships has evolved throughout the history of commercial ro-pax traffic, but accidents happen. Fires seem to occur quite regularly, but fortunately seldom lead to casualties. Capsizing and sinking on the other hand are quite rare events, but the characteristic rapid capsizing of a ro-pax ship may lead to a high number of casualties, as seen with Herald of Free Enterprise, Estonia and Sewol.

In many ways the structure and damage stability behaviour of a modern ro-pax vessel resembles that of a modern cruiseship, with a dense subdivision under the bulkhead deck. However, ro-pax exhibit some remarkable differences too, namely the large undivided vehicle deck and a possible large lower hold below the bulkhead deck (Figure 1).

The possible shifting of cargo due to excessive heel of the ship, as well as the large water tight (WT) doors in the bow and stern for easy loading and discharging, are factors that must also be taken into account when assessing damage stability characteristics of ro-pax.

Recent rule development work carried out by the IMO regarding passenger ship operational safety has been more focused on "pure passenger ships", i.e cruiseships of a considerable size. However, the majority of passenger ships covered by the rules are smaller ferries and ro-pax vessels. Many passenger ship rules are common for cruiseships and ro-pax, and one of these is SOLAS II-1 Regulation 8-1.3 requiring the provision of operational information to the master for safe return to port after a flooding casualty.

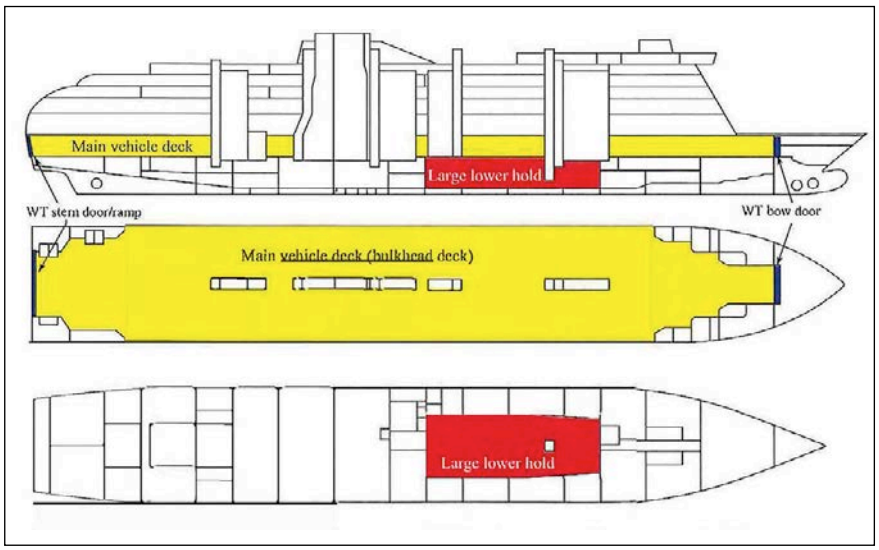


Figure 1: Important characteristics of a ro-pax ship for damage stability and survivability assessment

Mapping the concept

With this in mind, the concept of an integrated decision support system that utilises existing sensor data for automatically initiated damage assessment and prediction could be launched to good effect. The general system concept can be described as comprising two distinct modes of operation:

- Vulnerability monitoring for increasing the safety awareness onboard an intact ship
- Survivability assessment and Decision Support in case of a flooding emergency

This system needs to constantly monitor the vulnerability of the ship to flooding hazards based on operational status, number of open WT doors etc. Its implementation would increase the awareness of the crew about risks related to the current condition. In cases where floodwater is detected, the system automatically presents the flooding extent and severity of the situation, and simultaneously calculates a prediction of survivability for the people onboard the ship.

Vessel TRIAGE (Table 1) can be used by both vessels and maritime emergency responders to assess whether a vessel can provide a safe environment for the people onboard, producing a clear and simplified breakdown of a vessel's condition.

In an emergency situation, the decision support system should really support the user, not the other way round. This means that the required input data from the user must be minimised. Almost all of this data is already available through sensors serving various systems onboard, and all these signals, as provided by the tank gauging, flood level sensors, machinery automation, navigation system and the loading computer, can be integrated into the decision support system (Figure 2).

The output of the system must be very clear and unambiguous, minimising the need for the user to perform any detailed interpretation of the calculation

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With ever more complex systems and technology, greater improvements in safety can be achieved through a better understanding of human/system dynamics. A greater awareness of the role played by management structures, culture, procedures and regulation in safe and effective operation is also important to the effective running of the vessel and wellbeing of the crew.

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GREEN	Vessel is safe and can be assumed to remain so
YELLOW	Vessel is currently safe but there is a risk that the situation will get worse
RED	Level of safety has significantly worsened or will worsen and external actions are required to ensure the safety of the people aboard
BLACK	Vessel is no longer safe and has been lost

Table 1: Vessel TRIAGE categories

results. Simple graphs and colour codes are preferable, and the Vessel TRIAGE methodology should be applied to ensure common understanding between the crew onboard the damaged ship and those engaged in the rescue operation.

The input data for the system needs to include the actual loading condition at the time of the accident. The online gauge data for the tanks is easily available, but for ro-pax ships the real weight and centre of gravity for the cargo may be difficult to estimate accurately during loading. Therefore, a ship's type specific loading computer with ro-ro cargo loading features is preferred. In addition, the user may need to provide some vital information that must be made as clear and simple for them to input as possible.

The permeability of the vehicle deck depends on the loading condition and it is difficult to estimate it visually. SOLAS II-1 Regulation 7-3 provides two separate values for permeability of the ro-ro spaces, namely 0.90 for loaded conditions and 0.95 for unloaded (ballast) condition. Both can be used in an onboard decision support system, with the applied value selected based on the loading condition.

Finally, in collision cases, an approximate location of the impact is needed for more realistic assessment of the possible accumulation of water on the vehicle deck.

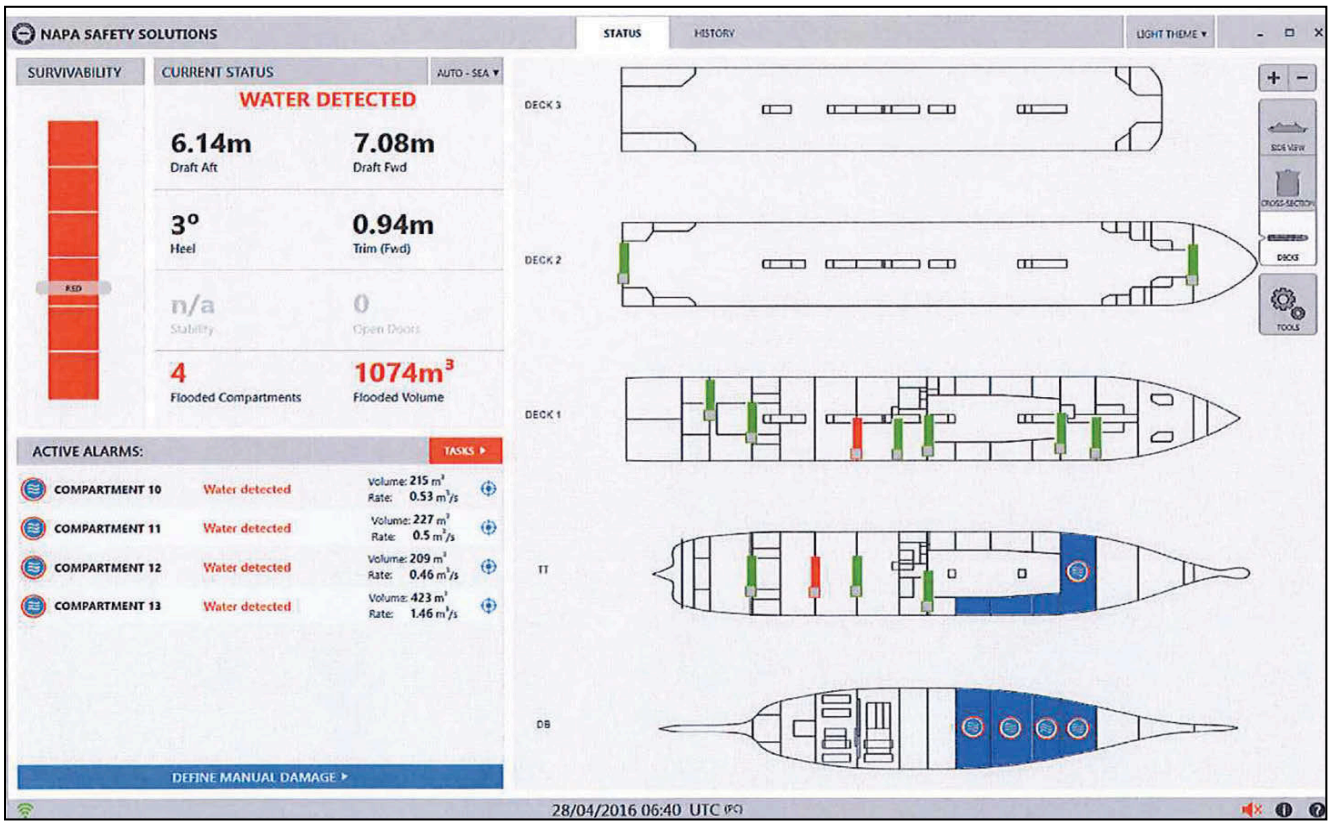
A crucial requirement for correct assessment of the survivability level is a fast detection of floodwater, which means the ship must be equipped with a sufficient number of well-placed level sensors. Simple on/off switches are not suitable since it is essential to get an estimation of both the volume of floodwater and the flooding rate. This issue needs to be considered during the design of the ship since retrofit installation of flooding sensors is both difficult and expensive. Based on the level sensor data an approximation of the breach can be made, Ruponen et al. [2].

Flooding detection on the vehicle deck(s) is a technical challenge as a very large volume of water can still result in minimal water heights at the sensor locations. Consequently, a decision support system for flooding emergency must also allow for manual input, e.g. based on visual observations. A binary input on whether the vehicle deck is flooded or not should be enough if the amount of accumulated water can be approximated on the basis of significant wave height.

On the basis of the current loading condition (fetched from a vessel type specific loading computer) and the detected breaches in the hull, a time-domain prediction of progressive flooding can be performed. The status of the doors (open/closed) is also necessary, especially for the WT doors. Fire doors with unknown status are considered to be open in order to achieve a certain degree of conservativeness.

These predictions are then updated at regular intervals so that measured floodwater is included in the initial condition for the next prediction.

Figure 2: Concept of the user interface, indicating the flooding extent and the predicted survivability level



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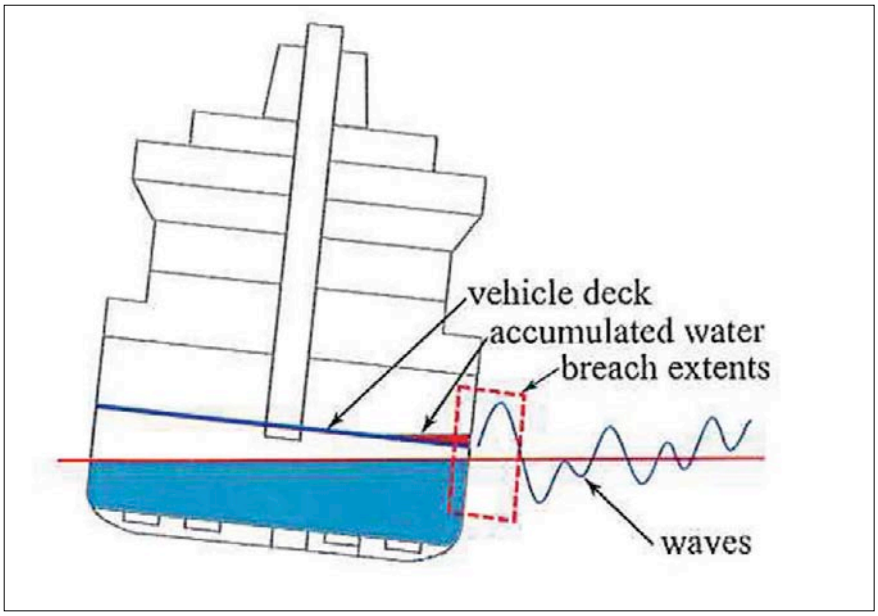


Figure 3: Accumulation of water on vehicle deck due to the waves following collision damage

The applied calculation method for the prediction is a pressure-correction algorithm, described by Ruponen in "Progressive Flooding of a Damaged Passenger Ship" (2007) and "Adaptive Time Step in Simulation of Progressive Flooding" (2014), that has been fully validated against measurement data from full-scale flooding tests (Tsakalakis et al., "In Pursuit of Passenger Ship Survivability Quantification", 2010).

The survivability level of the people onboard the damaged ship is based on both the current situation and the latest prediction of progressive flooding and the development of the stability.

Previously, the described decision support system has been developed especially for cruiseships. The applied methods for survivability assessment on the basis of the flooding extent and stability of the damaged ship have been presented by Ruponen et al. [2].

For ferries and ro-pax ships, compartments below the main vehicle deck are usually very similar to those of cruiseships, and in principle the same methods for prediction of progressive flooding can be used.

However, two separate stability failure modes have been identified for a damaged ro-pax ship, Tsakalakis et al.:

- Accumulated water on deck (WoD)
- Flooding of large lower hold (LLH)

The latter one is related to insufficient reserve buoyancy. Thus the same treatment of floodwater as in other compartments below the bulkhead deck should be enough to provide a correct assessment of the survivability.

Accumulated water on the vehicle deck requires a specific approach. The revised guidelines on operational information for masters of passenger ships for safe return to port (IMO MSC.1/Circ.1532), in paragraph 27 simply state that for ro-ro passenger ships: "there should be algorithms in the software for estimating the effect of water accumulation on deck." The first approach to handle this extremely important issue in a decision support system is presented below.

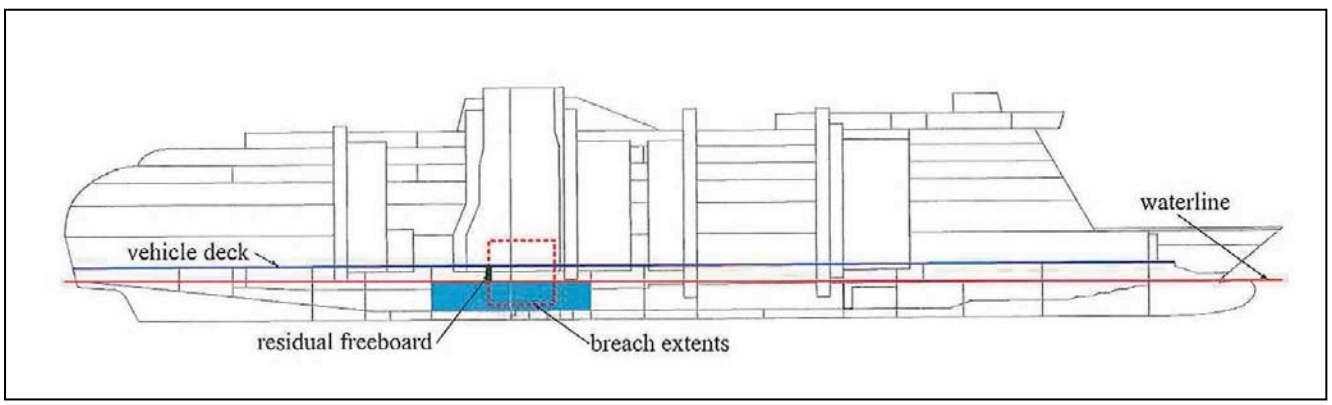
In decision support for flooding emergencies in ro-pax ships, special concern needs to be paid to the WoD problem. The vehicle deck can be flooded through a pumping effect of waves if the hull is breached above the vehicle deck, e.g. due to a collision (Figure 3). The European Gateway accident, thoroughly studied by Spouge ("The Technical Investigation of the Sinking of the Ro-Ro Ferry European Gateway", 1986), is an example of this kind of scenario, where the vehicle deck was flooded due to a large transient heeling angle. The vehicle deck can also be flooded through the bow doors (as with Herald of Free Enterprise and Estonia), or even by firefighting water, as described by Krüger et al. in "A New Approach for the Water On Deck Problem of the RoRo-Passenger Ships" (2015).

Considering the past accidents, detected or predicted water on the main vehicle deck should immediately trigger the Vessel TRIAGE colour code RED.

For stability calculations the amount of accumulated water may be approximated with the same approach as in the so-called Stockholm Agreement (European Union Directive 2003/25/EC), Figure 5. However, this requires some manual user input:

- Approximated significant wave height

Figure 4: Definition of residual freeboard following collision damage where the vehicle deck is breached



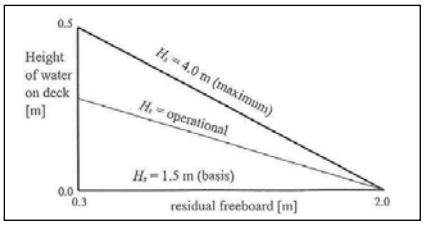


Figure 5: Height of accumulated water on the vehicle deck based on residual freeboard and operational significant wave heights (H_s) for the Stockholm Agreement

- Damaged side and approximate longitudinal extent of the breach to the vehicle deck (Figure 4)

Applying the minimum vertical distance between the vehicle deck edge and the sea level as the residual freeboard works as a worst case scenario, and should ensure conservative results if the breach extents are unknown.

The calculation procedure for the Stockholm Agreement is deterministic, thus often considered as non-suitable to be done together with the probabilistic damage stability calculations of SOLAS. However, for use onboard a damaged ship, the deterministic approach is actually very appropriate.

Recently, an alternative method for accounting for the effect of water on deck has been proposed by Krüger et al., based on the fact that accumulated water increases the roll period of the ship.

The Vessel TRIAGE methodology recognises two separate threat factors for a damaged ship, flooding and listing/stability [1].

The extent of flooding is critical information, and the severity of the case should be proportional to the size of the ship. In practice this means that damage to two compartments is more dangerous for a 100m ro-pax than for a 300m cruiseship.

The effect of damage stability on the survivability and safety level can be assessed based on the stability of the damaged ship. The s-factor in SOLAS Chapter II-1 Reg. 7, with proposed changes regarding flooding of ro-ro spaces, is applied:

$$s_{final} = K \cdot \left(\frac{GZ_{max}}{TGZ_{max}} \cdot \frac{range}{Trange} \right)^{\frac{1}{4}}$$

where GZmax is limited to TGZmax and range is limited to Trange. If the damage case involves a ro-ro space TGZmax = 0.20m and Trange = 20°, otherwise TGZmax = 0.12m and Trange = 16°. In this context, also the possible LLH is considered as a ro-ro space, and if it is flooded the more stringent requirements are used.

The effect of the heel angle ø is accounted with the coefficient:

$$K = \sqrt{\frac{15° - \phi}{15° - 7°}}$$

when the heeling angle is between 7° and 15°. With smaller heel angles K = 1 and if the heeling exceeds 15° then K = 0. This approach is supported by the SOLAS requirement to be able to lower the lifeboats at a heeling angle up to 15°.

The range is limited to the angle where the first unprotected opening is immersed. Only real unprotected openings above the bulkhead deck should be considered in order to avoid a too conservative approach that would limit the reserve buoyancy of the hull. On the other hand, if no limitation of the range is used, the results could be too optimistic.

The threshold values for the Vessel TRIAGE colour coding can be defined based on the s-factor, as presented by Ruponen et al. [2].

The presented ideas for accounting for the flooding of the vehicle deck in the assessment of the survivability and safety level still need to be tested with several realistic damage scenarios. These should also include cases where the watertight integrity is not lost but the flooding of the vehicle deck is caused either by an open/lost bow door or firefighting water. Based on these tests the final approach to the problem can then be selected.

In the event of damage leading to flooding, it is essential that the crew is well aware of the severity of the situation. This is an important prerequisite for making the correct decisions.

It is crucial that the relevant information is immediately available with minimum manual intervention or data input. Preferably all input should be automatically available. The relevant status and prediction information must be presented in an unambiguous way without need for the user to make further analysis of them. The flooding extent is a vital part of this information, especially for ro-pax where flooding of vehicle decks can occur.

The presented approach to a decision support tool for flooding emergencies constantly updates the calculations for the survivability level so that, for example, detected flooding to an undamaged compartment immediately results in a reduced survivability level. This kind of integrated decision support can avoid situations in which a Captain's overconfidence can lead to the wrong decision being made in an emergency. If the damage really is minor, unnecessary evacuation can be safely avoided. On the other hand, for serious situations, the evacuation and orderly abandonment of the ship can be started early enough.

Despite the fact that the presented concept utilises advanced calculations with state-of-the-art methods, all complexity should be hidden from the user. In order to increase the user's confidence towards the system, detailed information is available, for example for training purposes. Manual input and relevant results, however, must be kept on a simple and clear level. Application of Vessel TRIAGE standard colour codes helps in the decision making and communication much more than presenting the righting lever (GZ) curves, which requires user interpretation. This should be taken into account in the rule development work and it should be made sure that the rules do not prevent development of more advanced systems in the future. *NA*

Authors

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EEDI review may force IMO to row back on regulation

If unchanged, entry of phase II of EEDI ro-ro rules in 2020 will be too challenging for ro-ro vessels attempting to meet the tougher restrictions on carbon emissions. In a recent meeting of ro-ro vessel operators and designers the view was that the data supporting the requirements needs to be amended to better reflect the real world and that certain parameters underpinning the calculation are incorrectly applied

The IMO is currently in the process of reviewing the applicability of the forthcoming Phase II Energy Efficiency Design Index (EEDI)-reduction scheme, all in line with the review clause of EEDI-regulations as given in MARPOL Annex VI. The aim of this review is to investigate whether the current status of technological developments in ship design will allow for the stricter energy efficiency requirements which are to become effective as of January 2020; or if amendments will be necessary with regard to the reduction time periods, reference line parameters and/or to the reduction rates.

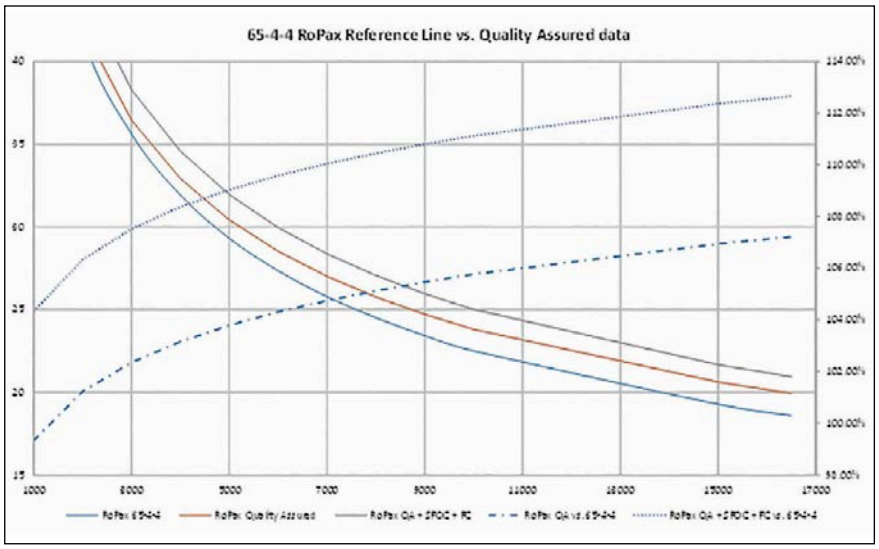

Figure 1

For the purpose of facilitating such a review process, the IMO has established an EEDI-database containing relevant information on new ships being constructed in compliance with the EEDI-regulations. Even though an assessment of the current contents of the database clearly indicates that compliance with the Phase II requirements is achievable already today for most ship types, the database does not contain one single ro-ro passenger ship and only four ro-ro cargo ships (or actually Con-ro's), all of which contracted before the entry into force of the EEDI-requirements for ro-ro cargo and ro-ro passenger ships. The reason here is that the EEDI-requirements (regulation 21 of MARPOL Annex VI) for ro-ro cargo and ro-ro passenger ships came into force later than for other ship types, as recently as 1 September 2015. Hence, the currently available information in the IMO EEDI database does not offer any support to conclude on the capability of current designs of these ship types to meet the Phase II reduction requirements.

Nevertheless, following the entry into force of the EEDI-requirements also for ro-ro cargo and ro-ro passenger ships, alerts were raised by designers, shipbuilders and shipowners indicating that the Phase II requirements (-20%) in the year 2020 seem to be far from achievable, without utilising extensive and wide-reaching innovative technology and/or alternative fuels.

In response to these alerts, a first assessment of the respective ro-ro cargo and ro-ro passenger ship EEDI reference lines revealed that existing acknowledged "good EEDI-performers", all of which included in the respective original ro-ro cargo and ro-ro passenger ship datasets, would face difficulties to comply with the Phase ll requirements, even though an adequate margin with regard to the Phase III requirements had been confirmed for the absolute "best performers" during the development of the existing reference lines. Hence, it could be concluded that the parameters as applied for the establishing of the reference line are not adequately representing the "physical" properties as applied in the calculation of the attained EEDI.

In addition, a joint stakeholder workshop on the review of the applicability of the EEDI-requirements for ro-ro cargo and ro-ro passenger ships was arranged by CESA and Interferry in June 2016. During this workshop it was acknowledged that the reference lines for the ro-ro ship segments are biased in relation to the achievable attained EEDI.

Furthermore, although some concerns on the correction factor, fj_{roro}, were expressed, the general opinion

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was still that some means for providing comparable conditions is a necessity for these diverse ship types. Given the limited number of available ship particulars, the current method seems to fit its purpose reasonably well and should, therefore, be retained as is for the time being. It was reminded that the correction methodology should not be regarded as an empirical speed-power prediction tool, but merely as a fleet normalisation mechanism, and moreover that tuning the methodology by means of empirical prediction instruments would lead to a calibration of the correction factor towards statistics that originates decades back in time.

Nonetheless, it was concluded that the correction factor (the normalisation mechanism) fjroro as applied for the ro-ro cargo and ro-ro passenger ship segments respectively results in a significantly more stringent EEDI-methodology than compared to a non-normalised approach, narrowing down the standard deviation to a limited bandwidth. This together with the fact that required available data for these ship types (the size of the statistical volume) is very limited, render a pronounced sensitivity for inconsistencies and erroneous datasets. A data validation effort was deemed a necessity, an undertaking that was acknowledged and pursued by CESA and Interferry.

Based upon a second assessment of the currently available information in terms of the quality assured data, an off-set of the reference lines, mainly induced by systematic inconsistencies between parameters as applied when developing the EEDI-reference lines and the 'physical' properties as applied in the calculation of the attained EEDI, is evident. The following parameters need to be considered in more detail:

Reference Speed, V_{ref} – From an EEDI-perspective the IHS Fairplay database contains a systematic inconsistency in terms of reported service speed, which for the majority of the ships is given for a design condition whereas the attained EEDI-value per definition shall be based on the maximum deadweight loading condition defined by the summer load draught as certified in the approved stability booklet.

CO_2-conversion factor C_F – While the CF conversion factor is to be taken as 3.114 t-CO_2/t-Fuel when calculating the estimated EEDI-values constituting the basis for the reference lines, the guidelines on the method of calculation of the attained EEDI and the 2015 Industry Guidelines for calculation and verification of EEDI clearly stipulates that the conversion factor CF is to be taken from the engine test bed results as recorded in the parent engine NOx Technical File. In other words, the fuel grade used during the engine test sets the attained value of the CF conversion factor. As all test bed measurements of conventional marine diesel engines are carried out using MDO/MGO as fuel, a CF-value of 3.206 t-CO_2/t-Fuel must be used in the calculation of the attained EEDI instead of 3.114 t-CO_2/t-Fuel which is applicable for HFO.

Specific Fuel Oil Consumption, SFC – As a direct consequence of engine tuning aiming at full compliance with the NOx Tier II requirements, effective as of January 2011, without the need for any exhaust gas after-treatment, a general increase in marine diesel engines' specific fuel consumption has been noted and acknowledged, in particular at the "EEDI-condition" corresponding to 75% MCR. This increase does not impose any influence on the EEDI of two-stroke engines, which already have a considerable margin up to the SFC-value of 190g/kWh which shall be applied when calculating the estimated EEDI-values constituting the basis for the reference lines. However, for four-stroke medium speed engines, which are normally selected as both prime movers as well as auxiliary engines onboard ro-ro cargo and ro-ro passenger ships, the higher SFC may in many cases have to be considered when calculating the attained EEDI.

Auxiliary Power, P_{AE} – For the purpose of calculating the estimated EEDI-value the contribution of the Auxiliary Power, PAE, is determined by means of generic equations, in principle a function of the installed Main Engine Power for ro-ro cargo ships and a function of the gross tonnage for ro-ro passenger ships. Whereas, for the purpose of calculating the attained EEDI, a determination of PAE by means of an electric power table is normally requested by the EEDI-verifiers; even though the method for determining the contribution of the Auxiliary Power to the attained EEDI does not influence the establishing of the reference lines, it should be noted that a PAE–value as derived from an estimated electric power table must be considered a highly uncertain value which may inflict severe consequences whenever the resulting attained EEDI renders a limited margin with regard to the level of compliance.

In the graphical comparison (Figure 1), new curves have been drawn based on 1) only improved data quality and 2) improved data quality in combination with more representative CF and SFC values. Still missing in this graph is the influence of correct reference speed as this inconsistency is ship specific and requires either relevant sea trials data, model test results, or the use of qualified calculation methods e.g. CFD-analyses for each respective ship. Nonetheless, the overall magnitude of the reference line off-sets seems to be at least 15%, a level that reasonably well corresponds to a standard at which the existing acknowledged good performers will be compliant with the forthcoming phase II requirements, whereas the phase III requirements would, with only a few exemptions, still require some additional energy efficiency improvements.

Furthermore, with the exemption for some con-ro's, the statistical volume for ro-ro cargo ships includes only a few ships of a capacity exceeding 20,000dwt. Consequently, the application of the EEDI power law regression line might prove to be problematic for future larger ships. Therefore, an upper limit of the application could possibly be considered until relevant data for larger ro-ro cargo ships has been derived. *NA*

Authors: Jan Bergholtz, naval architect at Kattegatt Design and Johan Roos, director of regulatory affairs at Interferry

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Shipowner takes aim at EEDI

For some months now *The Naval Architect* has reported on the difficulties surrounding the EEDI regulations for ro-ro and ro-pax vessels. The strength of feeling around the issue is illustrated by owner Jonathan Blackman

Shipowners in the ro-pax and ro-ro field are facing unprecedented problems as a direct result of IMO's ill thought out and hastily introduced EEDI requirements. With many years of under-investment, the sector has finally started to experience consistent profitability which happily has coincided with a downturn in other shipping sectors.

Hardly surprisingly, there are an unprecedented number of newbuilding projects being discussed with shipyards but the choices facing owners are far from simple. In the last months, some projects have become firm orders with owners such as Stena, DFDS, Cobelfret and Toll leading the way, but many others plan to follow. However, behind the scenes, many of these projects have faced serious issues with EEDI compliance.

The problems that were faced by Scandlines at P+S Werften have been well documented but they underline the reluctance of ro-ro and ferry owners to order at inexperienced shipyards. Familiar ferry building yards such as Van der Giessen, Flender, Finnyards, Fosen, Stocznia Gdansk, Apuania and others have disappeared leaving very few with any recent knowledge of the sector.

Those that are left have focussed on the more lucrative cruise business, which is also running at a high level of activity. This is forcing shipowners to consider building in the Far East. Many consider Stena's recent order at AVIC Weihai to be very speculative seeing as the yard has built nothing more than bulk carriers up until now, but the trickle of orders to inexperienced Far Eastern yards will become a stream as owners wake up to the dearth of capacity in Europe.

An unwelcome and unexpected issue is the EEDI rules, introduced from 1 January this year, which seem to have been conceived with little understanding of the real issues facing shipowners.

As has already been well documented this year in *The Naval Architect* (see April pages 20-21 and May TNA pages 36-41) the desire to reach a common "one size fits all" solution has spectacularly backfired. To lump all ro-ro ships into one pot – just because they have a common feature of an opening in the stern – is manifestly illogical.

There are different rules for bulk carriers, general cargo ships and containerships despite the fact that they all have hatch openings, so why should ro-ros be treated any differently? On one end of the scale are the recent ACL con-ro newbuildings. Large and with a relatively low Froude number, no comparable tonnage has ever been built before. Despite being considerably more energy efficient than the vessels they replace, the new *Atlantic Star* and its sisters do not achieve the requisite EEDI.

At the other end of the scale are the more common shortsea ro-ro vessels engaged on dedicated services transporting relatively lightweight cargo such as trailers and new cars. To maintain a daily roundtrip, these vessels have a set service speed with sufficient margins to cope with bad weather conditions. Typically, the ports are far from ideal with both length and draft restrictions. To maintain manoeuvrability, such vessels are usually equipped with twin screws. To try and force both vessel types into a common formula that works and fulfils its intended purpose is impossible.

Many ro-ro ships are built to iceclass standards. Reefer trailers and containers are routinely transported, powered by shaft generators in many cases. These factors are not adequately considered in the EEDI formulation. From the shipowner's perspective, the whole EEDI issue has become an unnecessary bureaucratic burden. It certainly does not encourage energy efficiency.

Even if a hullform is designed that achieves the desired EEDI, the shipowner now faces a series of unexpected hurdles in the shipbuilding process. In any shipbuilding contract, the shipyard usually takes the risk to achieve a specified speed and deadweight. There is considerable risk involved especially with prototype vessels. While the Scandlines project has received widespread publicity, there are many examples of both ro-pax and ro-ro vessels not reaching their projected deadweight due to optimistic lightweight calculations.

To mitigate the risk, shipyards obviously include margins. With the addition of EEDI, another risk factor appears which also depends on both speed and deadweight. Is it any surprise that extra margins are added on top with the only people set to gain being the lawyers and certainly not the environment?

This state of affairs is untenable and the IMO must recognise that the EEDI is not fit for purpose. It is ironic to see some yards and consultants boasting about how well their designs perform in EEDI terms, but this is rather to be seen as a failure of the formulation.

The tendency for IMO to force through new legislation without adequate industry feedback is becoming ever more prevalent. It is now generally recognised that the data set used for the formulation of both ro-ro and ro-pax EEDI formulae was both riddled with errors and very incomplete.

The number of ro-ro ships that were tested with the EEDI formulae prior to its introduction were limited to a handful of vessels, mostly pure trailer vessels. This is reminiscent of the hasty introduction of common rules for cargo vessel damage stability. Only a single European ro-ro vessel was tested, which happened to be an Italian built vessel that suffered from very high levels of GM. The ro-ro was subsequently converted with the addition of one complete extra ro-ro deck without the need for extra sponsons.

While shipowners are ultimately not responsible for lobbying their national IMO representatives, the harsh economic climate of the last decade has forced most ferry and ro-ro owners to be reactive rather than proactive. Fortunately, groups such as Interferry are becoming more vocal within IMO, but shipowners now fear that they are trying to close the gate after the horse has already bolted. The next session of IMO's MEPC in October is due to discuss the issue and for the sake of the future of the ro-ro and ro-pax sectors, owners need to be very involved. ***NA***

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Compliance with US maritime regulations remains a risk for operators

As the tide shifts towards further deadlines for environmental regulation, companies have been gearing up for the implementation of the new rules although the US remains one area where compliance continues to cause problems. Sandra Speares reports

US regulations on ballast water treatment systems are a case in point as manufacturers chase US Coast Guard (USCG) approval for new systems. The risk remains that when the USCG interim procedures for operating ballast water treatment systems in the US under Alternative Management Systems arrangements expire, the systems will no longer be viable for use, leaving owners and operators potentially facing a wasted investment.

The Coast Guard Marine Safety Center denied an appeal by four ballast water treatment system manufacturers to use an alternative testing method for Coast Guard type approval of their ultra-violet based ballast water management systems in July, saying that the proposal by suppliers to use a test based on the most probable number (MPN) method did not meet the requirements for alternative methods outlined in USCG regulations.

The use of a MPN method is being considered by the Environmental Protection Agency but no conclusion has yet been reached and the understanding is that if the technical panel considering the issue does say that the MPN method can be used, Coast Guard rules will need to be changed to take this into account.

The Coast Guard has emphasised the appeal decision did not mean that all UV systems or MPN would be rejected and there are several UV-based systems currently undergoing testing for Coast Guard approval. The systems presented by the four suppliers can still be used as Alternative Management Systems and, as such, extensions to compliance dates for companies using those systems can still be applied for.

The Coast Guard is working with the IMO on testing procedures to harmonise the international G8 Guidelines with US type-approval processes. Revisions to IMO type approval guidelines will be considered at the Marine Environmental Protection Committee meeting in October.

Mark Kustermans, market manager at Trojan Marinex, one of the four companies

KR and one of its partners, Korea Marine Equipment Research Institute (KOMERI) celebrate the completion of the extension of its BWMS testing facility last month. The test facility has been expanded through the addition of three further units, and it now offers a total testing capacity of a maximum of TRC500m^3/h with four testing slots

involved, commented: "The US Coast Guard's stated willingness to harmonise its testing protocols with those of the IMO is critical to resolving the very challenging situation that global shipowners face. As the IMO reaffirms its definitions and testing protocols in the next few months, the objective scientific evidence and international support for the MPN method will become increasingly apparent and as such we anticipate that the Coast Guard will, with appropriate guidance from US Congress, also soon apply standards and test protocols that facilitate type approval of eco-friendly UV-based ballast water treatment systems."

Meanwhile, the US Vessel Incidental Discharge Act (VIDA) is another that has been attracting attention and the International Chamber of Shipping (ICS) recently wrote to the US Senate on the issue.

ICS said that it supported the Act. "This will help establish a single US regulatory framework for a number of vessel discharges, including ballast water (and the related benefits for environmental protection) by greatly simplifying what is currently an overlapping and inconsistent regulatory situation. This is a situation, moreover, which is not fully compatible with the mandatory rules adopted by the IMO, with which all internationally trading ships will soon have to comply once the IMO Ballast Water Management Convention enters into force worldwide."

The convention has yet to reach the necessary percentage of international shipping to enter into force although it is very close to doing so. Many large flag states have been holding fire pending a decision on which systems comply with USCG rules.

"As well as the IMO Ballast Water Management Convention, the global shipping industry is currently subject to regulatory requirements imposed by the EPA, the US Coast Guard, and several individual US States. VIDA would greatly alleviate this often inconsistent and impractical patchwork approach to maritime regulation, as well as the uncertainty caused by the EPA's current Vessel General Permit," the ICS wrote.

The Korean Register meanwhile has announced an expansion of test facilities for Ballast Water Management Systems by opening a new specialist facility.

Manufacturers who have already secured BWMS type approval from their administrations or have developed new equipment and want to secure USCG type approval testing are currently facing long delays because there are not enough test facilities.

As a result, there is a significant 'bottle-neck' of manufacturers seeking USCG type approval testing, the Register says. KR and one of its partners, Korea Marine Equipment Research Institute agreed to work together to establish and to build additional test facilities to meet this demand.

The test facility, which already offered the largest capacity for BWMS testing of anywhere in the world, has been expanded through the addition of three further units, and it now offers a total testing capacity of a maximum of TRC 500m^3/h of BWMS together with four testing slots.

The new facility will be approved by the USCG in September and will become fully operational for land-based testing for USCG type approval as well type approval testing for other administrations under the IMO's G8 guidelines. *NA*

There's no future in ship recycling rules

Ship recycling is another sector that has been the subject of attention from the European Commission and has raised significant concerns within the industry. Sandra Speares analyses the issues surrounding the disposal of vessels

If the Hong Kong Convention's entry into force will have implications on the use of hazardous materials onboard owners also have to face issues relating to where and how their ships are recycled.

After its entry into force the Convention will forbid the fitting (or refitting) of certain hazardous materials on new and existing ships and materials are listed in Appendix 1 of the HKC.

Also, new ships will have to record the locations and quantities of certain hazardous materials to be found in Appendix 2, while existing ships will have to record the locations and quantities of hazardous materials also listed in the convention appendices.

Materials that are banned from use are also listed and these are also banned by other Conventions, such as SOLAS, the Montreal Protocol, and the AFS, which controls harmful antifouling products.

The controlled materials in Appendix 2 are more specialist and they can continue to be used, but they will have to be identified in the Inventory of Hazardous Materials for new ships - existing ships do not have to list them.

The Convention has lengthy requirements on the environmental protection that will be required at recycling yards and recycling is now being looked at again by the European Commission.

A recent European Commission report suggested the introduction of a Ship Recycling Licence which all ships visiting EU ports, irrespective of flag, would be required to obtain.

A contribution would be charged to the shipowner when applying for the licence, partly to cover the administrative costs of issuing it and partly to provide a contribution to a central ship recycling fund. The capital amount accumulated during the operational life of the vessel would be set aside for the ship and only paid back to the last owner of the vessel as a premium if the ship was recycled in a sustainable facility approved by the EU.

The 2013 EU Ship Recycling Regulation requires all vessels sailing under an EU flag to use an EU approved ship recycling facility, but environmental groups suggest that a major shortcoming of the regulation is that "shipowners can circumvent the law by simply flagging out to a non-EU flag. At end-of-life, cash-buyers act as intermediaries and sell the vessels to substandard yards in South Asia often using flags of convenience which are grey- or black-listed by European governments under the Paris Memorandum of Understanding.

"EU shipping companies should not circumvent EU environmental laws and not utilise practices that would never be allowed in Europe. EU flag-neutral measures which apply equally to all ships calling at EU ports are necessary to increase environmental protection," says Sotiris Raptis, shipping and aviation officer at Transport and Environment.

"The upcoming EU list of approved ship recycling facilities will function as an important market differentiator for yards that have already invested in proper occupational health and safety and environmental standards. The use of the EU listed facilities will however depend on the introduction of an effective financial incentive that forces irresponsible shipowners towards better practices," adds Ingvild Jenssen, policy director at the NGO Shipbreaking Platform.

If environmental groups and Europe-based operations find the licence idea attractive, it has been rejected by others. "Proposals to compel ships, regardless of flag, to pay for European Union ship recycling licences when calling at EU ports, will undermine efforts by the IMO to improve working and environmental conditions in developing nations, where most ship recycling yards are located," the International Chamber of Shipping (ICS) and the European Community Shipowners' Association (ECSA) said recently.

Commenting on the recycling fund they said the money would only be returned at the end of the ship's life when ownership might have changed and only on condition that the ship is recycled at a yard approved by the Commission.

"As well as being unduly complex, widely impractical and very difficult for the EU to administer, the establishment of such a fund will be an affront to the international community which has adopted the Hong Kong Convention on ship recycling, whose standards have already been incorporated into a similar EU Regulation," says ECSA Secretary General, Patrick Verhoeven.

They argue the EU should concentrate its efforts on getting EU Member States to ratify the IMO Hong Kong Convention, and to recognise the efforts being made by recycling yards in Asia to gain certification in accordance with IMO standards.

Nikos Mikelis, non-executive director, Green Ship Recycling Program at GMS described the idea of having a ship recycling licence as being like "Alice in Wonderland". He believes the system will not work and its motivation is political. One issue he mentions is not how the money levied is collected, but what is done with it. This he says is "the most difficult question".

How much money will actually be recouped by the shipowner is set out

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in the report in bands according to the vessel's deadweight. If converted from deadweight to light tonnes, the amount comes to approximately US$22 per tonne, he estimates. The final owner of the ship will get this money back if the ship is recycled in accordance with the list of approved yards.

The difference between recycling in a South Asian yard as opposed to Turkey or China currently is about US$80-100 so the US$22 will not cover the gap if a Turkish or Chinese yard were used.

The question is really whether the Commission is actually seeking to exclude Asian yards in favour of Turkish or Chinese ones, he says. There are ship recyclers in South Asia that have spent a lot of money building their yards up and there the differential between using a good yard or a bad one could be more like US$30. "It would be very welcome if the Commission was to approve all good yards regardless of location. If they only approve Chinese and Turkish yards then the gap is much bigger".

He believes that Turkish and Chinese yards are in fact being targeted for the business. All the indications suggest, he says, that the Commission is not going to approve beaching yards when it publishes its list before the end of the year. At the same time, he believes the Commission will not follow through with the licence proposal because they will realise that it is unworkable.

Ship recycling practices in Alang, India, are gradually improving according to ECSA. It says the European Commission should acknowledge this positive development under the EU Ship Recycling Regulation. Adopting an overly restrictive approach will discourage first movers and further delay the entry into force of the IMO Hong Kong Convention.

ECSA visited a number of yards in the area and according to Patrick Verhoeven: "It is obvious that the implementation of standards differs considerably, but an increasing number of yards have clearly taken the responsible path towards full compliance with the Hong Kong Convention, both in letter and spirit. We want to ensure that the other yards are following these first movers so that the bar can be raised overall."

Shipowners like Maersk emphasise efforts already made to improve conditions in traditional ship recycling countries like India and Bangladesh, and have made commitments to helping yards in places like Alang to upgrade facilities. Currently, four yards in Alang are certified to the standards of the IMO and Hong Kong Convention, Maersk says.

Dr Mikelis describes Maersk as a "game changer" because it sought to make sure that by going to selected yards in India it would at the same time satisfy its own sustainability and quality requirements. He says what he wants to see is the Commission approving one yard in India for its list. "If one satisfies them then other yards can satisfy them."

The use of beaching during the ship recycling process has been under the spotlight and is something of a grey area under the new EU regulation.

Dr Mikelis explains that while the regulation was being negotiated in 2012 there were two versions of the text, one advocating an outright ban to beaching, and one, like the Hong Kong Convention, opposing it.

While all direct references to banning beaching were deleted during the final negotiations, some "imprecise and ambiguous terms", such as a requirement that "yards shall operate from built structures" were introduced because of political sensitivities, wrote Dr Mikelis in the Hong Kong Shipowners Association annual report.

The regulation also requires that "hazardous materials and hazardous waste must not come in contact with permeable floors", for example soil or sand, he explained. "Inexplicably, after the final version of the text was agreed between the Council and the Parliament there was an underhand intervention and the text in some European languages, including English, was changed in essence to require that: 'wastes and hazardous materials must not come in contact with permeable floors'. As in European regulatory circles an end-of-life ship is 'waste' (but not necessarily 'hazardous waste'), it follows that the changed text requires that nothing must touch the beach, not any clean steel blocks, and not even a table and chairs from the ship". He maintained that point of detail was "obviously invented as an impassable obstacle to beaching."

Dr Mikelis says that differences in beaching methods between Asian, Turkish and Chinese yards do not justify the Commission's favouring one geographic location over another. In all cases some residue is likely to be left on the soil or sand or seabed/riverbed and he believes the Commission is inventing reasons for not using Asian yards because the regulation specifically does not ban beaching.

Five Indian yards already comply with Hong Kong Convention requirements with a further eight to 12 going through a compliance process which he believes is being damaged by people in Brussels playing politics. He sees no reason to exclude yards that have made every effort to improve their processes.

Without the demand that is currently filling the convention, compliant yards in South Asia, one of the major driving forces for change, would be removed, a state of affairs "not at all in line with the HKC's high goals of raising standards at all yards across the world."

Failure to approve the best yards in South Asia "will block European flagged ships from using much of the world's recycling market. It is very likely that most of these ships will change flag and go for recycling to South Asia, thus electing to ignore Brussels." Even if the European ships do not re-flag but choose to comply with the ban, the Commission would have scored a "hollow victory", he maintains. By preventing the European market from using Hong Kong Convention-compliant yards in South Asia, the EU regulation would torpedo the progress that has taken place so far.

"By the end of 2016 we should know whether sense has prevailed and the European Commission has approved one or more of South Asia's HKC compliant yards; or conversely whether it stays indifferent to the realities of the market by deciding to stick to its unworkable interpretation of the European Regulation and damage in this way so much of the good work that has taken place." *NA*

Stability, sustainability and safety; ClassNK's new president looks to the future

Classification societies in particular and the maritime industry more broadly have a number of fundamental challenges that they currently face, explains ClassNK's new President, Koichi Fujiwara. In this exclusive interview with *The Naval Architect* he describes the task ahead of him and the industry as a whole

There is no greater challenge for the world than preserving life on Earth as we know it, and we all need to play a part if the environmental challenges that we face are to be successfully met.

Sustainability, like market stability and safety are among the broader challenges that the maritime industry faces as a whole, but these challenges will only be met if each person and company plays a role in making certain that we change the way we do things. Business as usual is not an option for Koichi Fujiwara.

In this sense education is a key element for the next generation of naval architects and engineers, and education must reflect the changing demands of an evolving industry.

Education has featured prominently in the development of Japanese industry and it was one of the first issues raised by Koji Sekimizu, the secretary general of the IMO from January 2012 to 2016, who insisted at the time that he took office that a key issue for his tenure would be the funding of the World Maritime University in Sweden.

It is no surprise then that Koichi Fujiwara should raise the issue of new recruits and education, particularly with regards to the falling numbers of engineers entering the trade, on taking the helm at ClassNK.

"Taking Japan as an example, where ClassNK has its roots, the number of naval architect courses in university has been declining. I dare to point out that the foundation for maritime education and research has been declining here. I know a significant number of people in the industry share the concern and together with them I would like to consider how to sustain and develop the global maritime cluster. One of my commitments is to make ClassNK play an even more active role in the industry's collective approach to increase the number of competent engineers and raise their standard," Fujiwara said.

Playing a part in educating future generations is a key element of Koichi Fujiwara's plans as ClassNK's president

Part of that commitment is to maintain the level of funding for research projects with the continuation of its joint R&D for Industry Program, which was established in 2009 with the aim of broadening the research scope and to develop collaboration between different sectors in the maritime industry.

"Since the Programme's inception, ClassNK has been involved in more than 250 projects. Recent highlights, which have been commercially applied by our partners, include the application of highly ductile steel to ship structures for improving collision safety without substantial cost or an effect on the design/production process, and a propeller made with carbon-fibre reinforced polymer (CFRP), contributing to a significant reduction in weight and fuel costs. ClassNK will maintain its engagement in R&D including, but not limited to, IoT [Internet of Things] and emission control," explained Fujiwara.

ClassNK's commitment to reducing greenhouse gas (GHG) emissions is not in question, but Fujiwara fell short of giving the IMO's flagship policy on emission reduction a ringing endorsement. Instead there is a feeling that the major changes for the maritime industry will come through the development of the IoT and other major technological developments.

Asked if EEDI could be successful in reducing GHG emissions from the industry through the better design of ships, Fujiwara said: "We assume that 'the industry' means shipowners and ship operators. There are some voices claiming the discrepancy between EEDI and actual operational efficiency. However, this is unavoidable because EEDI expresses the efficiency in limited operational conditions; e.g. 75% MCR, full draft, calm sea, etc. On the other hand, actual operational conditions may vary from the conditions during EEDI calculation. Therefore, to pursue fuel efficiency under their actual operational conditions, owners and operators need to communicate with shipbuilders from the basic design phase to achieve [a] proper design matching the expected actual operational profile."

Pressed further on whether EEDI could aid the maritime industry to meet the targets set out at COP21 in Paris last year, Fujiwara's response was guarded: "As stated earlier, the purpose of the implementation of EEDI is to improve the transport efficiency of individual ships. Once the extent to which the maritime

industry should contribute to further GHG reduction has been established, then we can begin to look at the necessary evaluation."

If Fujiwara was muted in his acclaim for EEDI, the same cannot be said for his view of IoT: "Utilisation of Big Data or IoT will no doubt have a huge effect. Those new technologies will give us the chance to gain insight into what we previously could not see. In particular, enormous volumes of various data collected during actual voyages have been already utilised as feedback for more practical onboard machinery maintenance and discussions are currently underway to see how Big Data can be further applied in the shipping industry. This could positively impact the entire industry including classification."

However, Fujiwara believes the most pressing issue faced by the maritime industry at the moment is the downturn in both the shipping and shipbuilding markets. Combatting this downturn will need planning and he says that ClassNK has a strategy that will help the company ride the recessionary period.

"Firstly I'm going to make ClassNK a more stable and sustainable organisation through strengthening corporate governance and optimising expenditure while maintaining capable human resources so that we can continue providing the best possible technical services. ClassNK's mission remains 'ensuring the safety of life and property at sea, and preventing the pollution of the marine environment'. At the same time, we should meet the changing demands of the industry and I am enthusiastic to expand our functions to better serve the maritime community."

Just how the company will expand its services is not explained, but a clue to its future direction may lie in the fact that new technology along with the development of systems to deal with GHG emissions are significant issues for Fujiwara.

"ClassNK, as a neutral and long-standing technical organisation, will facilitate the implementation of necessary new technologies by ensuring their compliance with requirements and/or standards of safety, performance, and effectiveness through our surveys and certification services."

However, Fujiwara points out that "While the international shipping industry shares the ultimate goal laid out in the COP21 Paris agreements, the extent to which the maritime industry should contribute to further GHG reduction has yet to be established."

It is expected that the IMO will play a key role in establishing GHG reduction requirements and that when this happens new technologies will be developed to meet this new challenge.

"As necessity is the mother of invention, a framework providing concrete requirements will prompt the development and application of new technologies to meet the COP21 Paris agreement. The climate change challenge is likely to continue for some decades, but I believe in the industry's strength to overcome constraints at every step, including the economic difficulty."

Economic constraints on the maritime industry remain a cause for concern for all, but Fujiwara denies that the classification societies have engaged in a price war. "ClassNK's mission is not business expansion, but ensuring the safety and environmental protection with our high-quality services. Though I do not refuse competition between class societies, I would not call it a price war," said Fujiwara. "We provide trusted technical services with 24/7 support anywhere in the world. To our clients, who demand only the best when it comes to classification, this is far more valuable. As a non-profit third-party organisation, ClassNK's commitment will continue to be to provide best-in-class surveys, certifications, and other related services."

The game changer for Fujiwara, then, is the as yet unknown nature of the measures taken to curb carbon emissions by IMO. The expectation is that all the sectors of the maritime industry will be capable of raising its game to meet the challenge of new rules set by IMO. If this is indeed the case then the question is will that be sufficient to make a meaningful contribution to limiting global warming to temperatures that will sustain life on Earth? And the answer to that remains uncertain.

ClassNK is, however, clear that it will continue to build on its R&D programme in support of the global programme to cut GHG emissions. *NA*

The PartnerShip – concept to reality

The Naval Architect investigates the story behind the development of the PartnerShip – an innovative 'virtual ship' designed to build awareness of shipping, to provide a unique online educational tool for the industry and the public, and to raise funds for good causes

The PartnerShip concept is innovative and based on a hybrid vessel formed from six major merchant vessel types - offshore support, passenger, container, bulk carrier, gas carrier, and tanker.

The web-based platform provides the hub for all activity where visitors to the site can track the progress of the build, development of the educational elements including information on the sponsored ship components and services, and the level of funds raised through sponsorship, personal donations and special 'live' events at any time during the initial two-year project cycle.

When the project officially launched at the Posidonia exhibition in Athens in June 2016 it caused quite a stir. When the question was posed to those with inquisitive minds at the exhibition and on social media as to what type of vessel the PartnerShip is, opinions varied, influenced by the seamless design. The responses from industry including ship's masters, chief engineers, and shore-based managers ranged from a design for a dedicated offshore accommodation vessel to a multi-purpose vessel.

Mike Porter, Director at Podium 4 Ltd and founder of the PartnerShip knew then that the perfect educational platform had been created to gain the interest of those in the shipping industry, to engage the next generation, and to showcase the vast array of technology, knowledge and expertise required to build and operate today's merchant fleet.

"The project has been a few years in the making and originated during my earlier career as a Ship Designer and as Technical Director at The Royal Institution of Naval Architects when there was a need for a single source of information providing better representation of the ship and the components and services required to operate today's merchant fleet. Despite the huge amount of information now available on the web, a single effective portal to clearly explain everything from a widget to a main engine using rich content including text, visuals, videos and white papers still didn't appear to exist," says Porter.

It was at Posidonia 2014 that Porter spotted a hybrid ship visual, displayed on Wärtsilä's exhibition stand to promote their vast array of marine solutions, which reflected his ideas for a generic design to capture the interest of all industry stakeholders and the public. Andy Ford, general manager marketing, Europe, Americas and Africa for Wärtsilä realised that the PartnerShip concept offered not only an innovative approach to promoting and educating people about new and emerging technologies, but also provided the appropriate platform to link with its recently re-issued Encyclopedia of Marine Technology.

Wärtsilä became a project partner, and along with community engagement specialists Podium 4, marketing and PR company Wake Media, and web development consultants Oakwood Media Group, these four partner companies collectively brought their different areas of expertise together to make the project a reality.

As the exclusive ship design service provider for the project, Wärtsilä Ship Design worked with Mike Porter over a number of months to refine the design and create the wireframe model based on their existing ship type designs. The final form was then used as the basis for the design on the website with a key requisite being the ability to divide the ship into recognisable compartments in which the components could be easily allocated and identified.

Wärtsilä is also continuing the significant support given to the PartnerShip at Posidonia by providing promotional opportunities for the project to coincide with their marketing campaign for SMM in Hamburg, 6-9 September, and will include visual display and personal representation on their stand during the exhibition.

Since the project launch at Posidonia international support for the project has continued to grow with RINA, IMarEST, the Nautical Institute and the Maritime HR Association joining the International Chamber of Shipping as official supporting organisations. The maritime media is also fully behind the initiative with 15 key industry publications, including *The Naval Architect*, coming together to support the three project objectives of building awareness, educating and fundraising.

The PartnerShip is unique in that, unlike other shipping awareness projects, it focuses on the ship as the key element in the supply chain to reach out beyond the industry. At a time when shipping is going through a challenging period the PartnerShip offers maritime businesses a refreshing opportunity to satisfy their marketing needs, their educational strategies, and their corporate social responsibilities (CSR) on a single platform.

CSR is becoming increasingly important across all industries but the shipping industry is lagging behind when it comes to CSR awareness. According to the Shipping CSR500 Survey report released earlier this year by SAFETY4SEA, on average less than 50% of the industry fully commits to CSR related activities. The PartnerShip offers a real chance to help address this with all benefactors - corporate sponsors, personal donors and fundraisers - making the decision on which charities they would like their money to support.

To discover more about the project visit www.themaritimepartnership.com. *NA*

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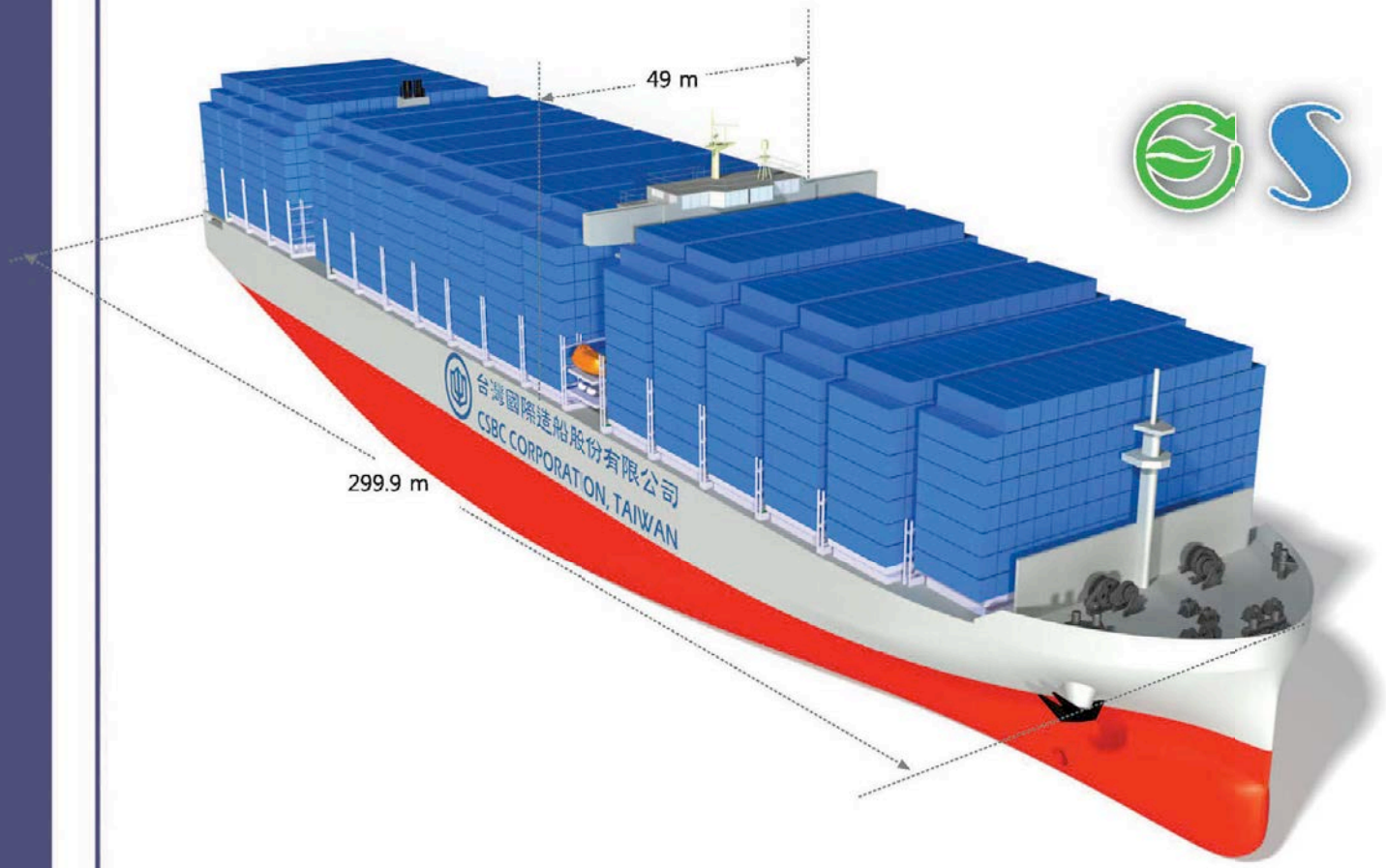

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