THE NAVAL ARCHITECT

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July/August 2011


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Editor Nick Savvides
Assistant Editor Samantha Fisk
Design/Production Manager Sandy Defraine
Group Sales Director John Payten
Assistant Advertisement Manager Daniel Payne
Advertisement Production Manager Stephen Bell
Marketing Manager Josie Pearlson
Publisher Mark J Staunton-Lambert

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The Royal Institution of Naval Architects
Editorial & Advertisement Office:
10 Upper Belgrave Street
London SW1X 8BQ, UK
Telephone: +44 (0) 20 7235 4622
Telefax: +44 (0) 20 7245 6959
E-mail editorial editorial@rina.org.uk
E-mail advertising advertising@rina.org.uk
E-mail production production@rina.org.uk
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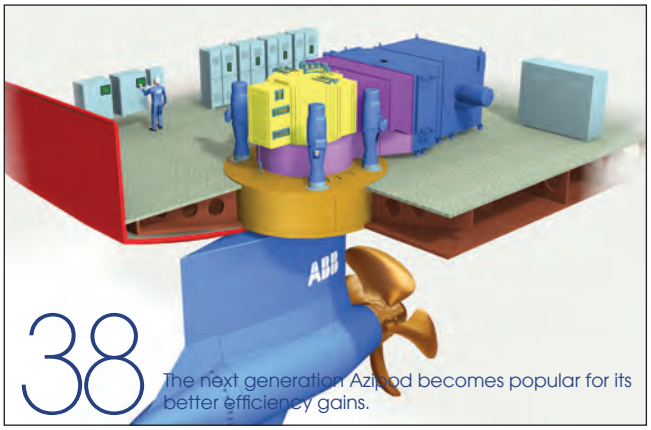

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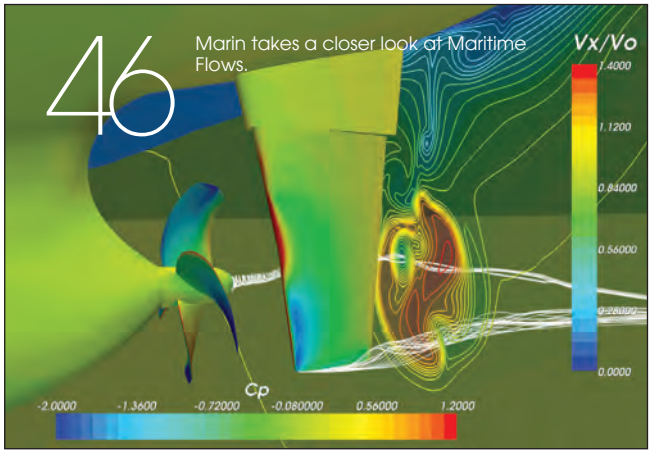


On-line Edition

The Royal Institution of Naval Architects is proud to announce that as of January this year, *Shiprepair and Conversion Technology* journal has gone digital. We are very pleased to inform the maritime industry that each issue will be published online, on the RINA website. Visit www.rina.org.uk/srct and click on the issue cover you wish to view. This means that the entire publication, including all editorials and advertisements in the printed edition, can be seen in digital format and viewed by members, subscribers, and (for a limited time) any other interested individuals worldwide.

SHIP EFFICIENCY 2011

by STG

3rd International Conference

Hamburg, 26 – 27 September 2011

Costs and emissions → How to make ships more efficient

We invite you to attend the third conference on one of the key issues for the future of shipping: ship efficiency. An efficient ship is profitable and environmentally compatible. The aim of Ship Efficiency is to create a forum where all stakeholders learn from each other and return home with plenty of fresh ideas and practical solutions.

To register and to be kept updated on programme details and speakers, go to www.ship-efficiency.org. Please register as soon as possible since the capacity of the conference room is limited.

Ship Operation and Ship Design

- **Regulatory Steps to Ship Efficiency – A View from International Shipping (International Chamber of Shipping, United Kingdom)** Shipping industry view of regulatory measures on efficiency being pursued at IMO and UNFCCC
- **Can IMO-Regulations Initiate Innovations? (Swiss Climate, Switzerland and Ahrenkiel Shipmanagement, Germany)** Swiss Climate and Ahrenkiel Shipmanagement show their experience with the implementation of the SEEMP and the EEOI
- **Efficiency of Maritime Transport - A System Approach from the Logistics Perspective (Fraunhofer Center for Maritime Logistics, Germany)** The ship-port-system as a logistics issue, system efficiency: measures/effects/interactions, strategy implications and outlook
- **A Crucial Analysis of Energy Saving Methods and their Imple-mentation on Board** (Columbus Shipmanagement, Germany)
- **STX Advanced Technologies for GREEN DREAM (STX, Korea)** The practical applications of STX green technologies for merchant vessels
- **Green Bulkers Now and in the Future (Grontmij | Carl Bro, Denmark)** Emission reduction to comply with future legislation, fuel efficiency, energy efficiency
- **Performance Monitoring and Analysis for Operational Improvements (NYK-Line, Japan)** Automatic data logging onboard, performance monitoring onboard and at shore, voyage performance analysis report, combination with weather routing, case studies
- **DSME Green-Ship Technology - BUILD ECONOLOGY (DAEWOO, Korea)** Lower emission, higher fuel saving and advanced environmental friendly design features of DSME containerships
- **Energy Saving Devices/Solutions - A Framework for Decision Making (MARIN, The Netherlands)** Refit options, operational context, assessment tools and outlook
- **Marorka – Empowering Sustainability Winners (Marorka, Island)** Challenges in marine energy management, opportunities in energy management, combining technical solutions and methodology energy management vision

Future Fuels and Efficient Power

- **Development of the Marine Fuel Market – An Overview (TUHH, Germany)** The future of HFO, low sulfur fuels, gas and bio fuels
- **Gas as Fuel - Storage and Bunkering (TGE Marine Gas Engineering, Germany)** Supply logistics, tank concepts, safe and efficient bunkering of gas, shipboard gas supply plants
- **Latest Developments and Experience with Dual Fuel Engines and LNG fuelled Ships (Wärtsilä, Finland)** Dual fuel engine developments, operational experience, LNG fuelled ship concepts, fuel selection for ships operating inside SECA
- **Exhaust Gas Recirculation on 2-stroke Engines – An Efficient Solution for Emissions Compliance (MAN, Denmark)** Description of the technology, R&D activities, installation aspects, operational considerations
- **Engine Performance Optimization by Permanent use of Holistic Expert Condition Monitoring System (AVL, Austria and Kongsberg, Norway)** Engine performance optimization opportunities, concept of AVL EPOSTM as expert condition monitoring system, integration into Kongsberg K-Chief 600 automation system as part of Kongsberg's vessel performance monitoring, field experiences
- **Efficient Turbochargers - Latest Developments (ABB, Switzerland)** Two-stage turbochargers, operation with exhaust gas recycling, heat recovery systems
- **Energy Efficient Gas Propulsion System with Hybrid Shaft Generator (Rolls Royce Marine, Norway)** Introduction of a pure gas engine in shipping, fuel consumption/emissions/methane slip, operational experience and maintenance, hybrid shaft generator concept

Conference Language: English

Venue: Hotel Hafen Hamburg (www.hotel-hafen-hamburg.de)

Special Hotel Rates: If booked prior to August 20 at
Hotel Hafen Hamburg (STG-HH-220911)
Maritim Hotel Reichshof (STG/Ship Efficiency)
Hafentor (STG Ship Efficiency)

Please quote booking code (in parentheses above) when booking.
For booking and rates, see www.ship-efficiency.org

September 26

9:00 – 10:00	Registration and Welcome
10:00 – 13:00	Papers on Ship Operation and Ship Design
13:00 – 14:30	Lunch
14:30 – 17:30	Papers on Ship Operation and Ship Design (cont'd)
19:00	Conference Dinner with Keynote Speaker

September 27

9:00 – 13:00	Papers on Future Fuels and Efficient Power
13:00 – 14:30	Farewell Buffet

Conference Fees:

	If booked prior to August 20	Full fee
Participants*	€ 750	€ 850
STG-Members	€ 590	€ 690
Members of RINA/SNAME/JASNAOE/SNAK IMarEST/SSNAME/IME/HIMT	€ 590	€ 690
Students/Pensioners (STG members only)	€ 150	€ 150

The conference fee includes proceedings on a CD, admittance at all technical sessions, lunches and refreshments, conference dinner and farewell buffet.

The German Society for Maritime Technology
Schiffbautechnische Gesellschaft e.V.

Time zero

Maersk's latest container ship design, the Triple-E, was designed using a range of operational profiles that would maximise its fuel efficiency.

Whatever one might think about Jotun's views on paint technology (see pages 16-20), and it is certain that there will be disagreements, one element of this month's story which does strike a chord and should set some alarm bells tinkling, at least, is the company's view on the Energy Efficiency Design Index (EEDI).

In Jotun's view EEDI is, "A good example of a typical time zero (initial/perfect condition and not representative to actual long term performance) perspective that offers little or no advantages for the existing fleet of vessels."

In other words while EEDI will tell us how efficient a particular ship was when it was delivered new, but it cannot tell us how efficient that ship is after five years of punishing operational service. Nor will it tell us how well maintained that vessel has been. And that could mean that the industry will not know the extent of the pollution that ships are emitting as the ships age. This means that unless there is a constant monitoring of the vessels all emissions statistics based on EEDI will necessarily be inaccurate.

Maersk has rightly made great play of the fact that it has altered its focus and now, when it is designing and building its new vessels, it no longer designs them for a single speed or operational profile, but rather takes into account the range of operational profiles that a ship may encounter during its operational life.

By taking this approach Maersk has significantly improved the design of its vessels and believes that it can substantially reduce the greenhouse gas emissions that its fleet produces as a result.

Efforts by the International Maritime Organization (IMO) to promote the EEDI are also commendable, but the niggling worry expressed by Jotun is that the index will only address a ship's performance at a single point in time and that the Maersk approach, looking at the operational life of the vessel, would be a far more accurate way to measure the greenhouse gas emissions as the efficiency of engines and hulls deteriorate with wear and tear.

If a vessel, pristine out of the ship yard operates at a level that is 20% more fuel efficient than a comparable ship designed 15 years ago will it still be at that level in four years time? In developing the EEDI the IMO produced a formula that will tell us at what level emissions from a new vessel are, but the formula for the continuing measurement of the efficiency of ships and thereby the actual emissions over a given period are lacking.

Is there a solution to this difficulty? Well one solution might be to develop Jotun's method which monitors the torque and rpm of the propeller shaft along with the ship speed through the water using data from the Doppler log.

The system by-passes the need to measure other variables such as wind speed and current say Jotun and it has the added advantage that most ships have already got the necessary equipment for collecting the data installed on the ship.

Norwegian class society Det Norske Veritas (DNV) is set to evaluate the system this summer, but while the company was interested in the methodology and the idea in general terms DNV insisted that it would not endorse the system.

There may be other difficulties with using this system to analyse a ship's performance in the way that would be necessary to understand how a vessel's performance deteriorates over time. For example it may be necessary to measure NOx, SOx and particulate emissions from the funnel.

It may be that the Jotun method is totally useless in dealing with the problem. However, if the maritime industry is serious about reducing greenhouse gas emissions it will need to accurately measure the levels of pollution in the first place.

It could be that the IMO will need to develop an EEDI Plus that will target a vessel's actual emissions rather than just the theoretical pollution from a new ship. Will the costs for such an exercise be prohibitive? At this stage we cannot tell, but with the world's population growing and the need for shipping set to increase the need to make certain that the planet's atmosphere is clean is pressing and the alarm bells should be getting louder. *NA*

BWTS

Aquarius ready by 2012

Hamworthy says its ballast water treatment systems (BWTS) Aquarius UV and Aquarius EC should be type approved by the end of this year following six months of operational testing onboard ships.

Aquarius UV uses ultraviolet light to clean ballast water, while Aquarius EC uses an electro-chlorination (EC) system to achieve the International Maritime Organization (IMO) standard of no organisms larger than 50μ and less than 10 organisms/m^3.

Joe Thomas, MD at Hamworthy BWTS, said that the company "could not decide whether to develop a UV or an EC system after they had evaluated both and so we decided to develop both variations."

Development of the Aquarius systems followed the acquisition two years ago of Greenship Sedinox which had achieved basic IMO approval for its EC system, final approval for the system came with recommendations to verify the system's efficiency at low salinity, "it was unclear how far down the salinity range we could go and EC needs salt to work" said Mr Thomas.

The temperature of the water also affected the efficiency of the system and a by-product of the EC process was hydrogen gas that needed to be vented and so operational restrictions were applied, "so we withdrew the product," explained Mr Thomas.

It became clear following the experience with Sedinox that it would be better for Hamworthy to design its own system and add the necessary design into the new system including a hydrogen venting system that expels the gas before it reaches the ballast tanks. "We tested the system for five days in a holding tank with monitors for hydrogen and there was no build up of the gas," said Mr Thomas.

Joe Thomas, the MD at Hamworthy BTWS, says that buying Greenship Sedinox "was not a mistake", but an investment in R&D.

Failures of the Sedinox system are not considered to be a mistake, even though the Greenship Sedinox acquisition was for €2 million with a further payment of €5 million on final approval.

"We never paid the €5 million because final approval was never achieved," explained Mr Thomas, "but we don't consider Greenship to be a mistake, it was an investment in an R&D project that Hamworthy were just not prepared to take to customers. We learnt a lot from the process though."

Classification

ClassNK: LNG not the best option

Former International Association of Classification Society chairman and president of ClassNK Noboru Ueda believes that liquefied natural gas (LNG) is not the best fuel for the future.

Mr Ueda said: "I think LNG has a great potential for use as ship fuel, especially from the standpoint of emission reduction. However, I do not think it is the best or only option, especially in the short term."

According to Mr Ueda the biggest obstacle for LNG "and other alternative fuels is not technical, but logistical, and so long as logistical bottlenecks remain, the use of LNG as a fuel will remain limited".

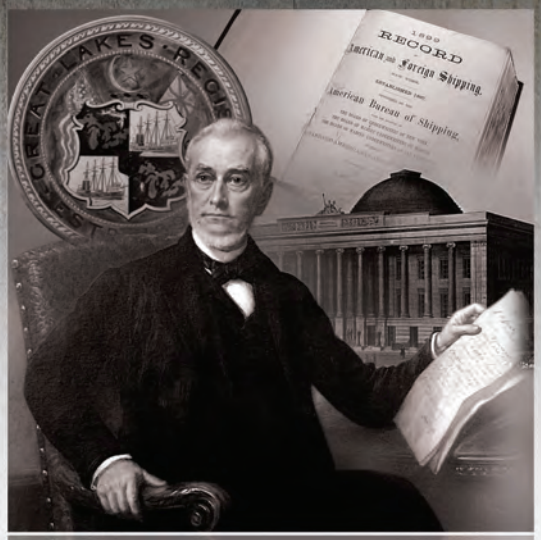
As such the best way for the maritime industry to achieve its emissions targets in the short term is to develop new technology such as more efficient engines, improved hull forms, and new equipment like air lubrication systems.

"Reducing maritime emissions is a very important issue, and meeting emission reductions will be a difficult challenge for the maritime industry. While it is hard to foresee what changes will have occurred in 40 years, I believe that the maritime industry will be able to meet the emission reduction targets for 2050. We have already seen an incredible amount of new green technology development over the past several years, and I think that the greatest developments are still yet to come," he claimed.

Speaking exclusively to *The Naval Architect* at the recent NorShipping event in Oslo, Norway, Mr Ueda added that aside from the environmental issues facing shipping one of the most important tasks for classification societies will be helping the maritime industry address the burden of new regulations. With each new regulation, the paperwork and time required for compliance continues to grow.

This includes developing new software for creating and maintaining Coating Technical Files for Performance Standards for Protective Coatings (PSPC) rules, new inventory management software for compliance with the ship recycling convention, and a new ship construction file archive service in compliance with the Goal Based Standards.

"If we can reduce the time necessary for document development and maintenance, then we can reduce the



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costs of maintenance and in turn help promote the further development of the maritime industry. As the number and scope of new regulations continues to increase, this will be an important challenge for the future," he said.

Newbuildings

HHI halfway to newbuild target

Hyundai Heavy Industries (HHI) announced that it has secured a US$600 million order to build two 155,000m^3 LNG carriers, with an option for a third vessel of the same class from the Greek shipping company Dynagas Ltd.

The first two membrane-type LNG carriers are due for delivery in the second half of 2013 and they will feature dual fuel diesel engines that will allow the ships to operate on oil or natural gas. Due to tightening global regulations on carbon emissions and increasing demand for LNG as an alternative energy source following Japan's nuclear crisis along with the price competitiveness of LNG when compared to current oil prices, Hyundai Heavy expects to see more liquefied natural gas carrier orders in the future.

As a part of the Company's long term strategy for the expected increase in demand for LNG carriers and LNG FPSOs, Hyundai Heavy has been actively developing a special welding system that can work on the thick aluminum plates used for the LNG tanks.

Winning this order brings Hyundai Heavy's total new orders in shipbuilding and offshore & engineering divisions so far this year to 42 ships worth of US$10.5 billion, or 53% of the new order target of US$19.8 billion.

In addition Hyundai Heavy has clinched a US$1.12 billion order to build two drillships for Rowan Companies Inc. with the US company retaining an option to order a third vessel of the same type.

The vessels will measure 229m in length and 36m in width and are rated for operations in water 3657m (12,000ft) deep. They are scheduled to be delivered by the second half of 2013.

Winning this order brings Hyundai Heavy's total drillship new orders this year to nine with a combined value of US$5 billion with options to build three more vessels.

Engines

ME-GI is MAN's flexible friend

Dual fuel engines offer a flexible solution for ships that operate partially within environmental control areas (ECA) which require ships to reduce SOx, NOx and particulate emissions.

MAN launched its dual fuel ME-GI engine, which can run on heavy fuel oil (HFO) or liquefied natural gas (LNG). The ME-GI engine is a gas-injection, dual-fuel, low-speed diesel engine that, when acting as main propulsion in LNG carriers or any other type of merchant marine vessel can burn gas or fuel-oil at any ratio, depending on the energy source available on board and dictated by relative cost and owner preference.

The Danish company said that it sees significant opportunities arising for gas-fuelled tonnage as fuel prices rise and modern exhaust-emission limits tighten and research indicates that the ME-GI engine, when combined with exhaust gas recirculation (EGR) and waste-heat recovery (WHR) can meet both Tier-II and Tier-III regulations.

MAN Diesel & Turbo predicts a broad, potential market for its ME-GI engine, extending from LNG and LPG carriers to other ocean going vessel segments such as containerships as well as ships plying a fixed trade. As such, the ME-GI engine represents a highly efficient, flexible, propulsion-plant solution.

Dual-fuel operation requires the injection of both pilot fuel-oil and gas fuel into the engine's combustion chamber via different types of valves arranged in the cylinder head. The ME-GI engine head is fitted with two valves for gas injection and two for pilot fuel. The pilot-oil valve is a standard ME fuel-oil valve. MAN B&W ME-C and ME-GI engines are broadly similar and share the same efficiency, output and dimensions. In comparison, the ME-GI engine's key components are its modified exhaust receiver, modified cylinder cover with gas5/ 2011 injection valves and gas-control block, an expanding top gallery platform, high-pressure fuel-supply pipes, and mounted gas-control units.

Correction

In the March issue of *The Naval Architect* (The Vossnack Cylinder tanker pp30-38) we said that the tanker had a double bottom height of 4m with a 1m high cofferdam above, as designed for cylinders Nos. 3 – 9, that would prevent any oil spillage through the bottom the event of a grounding. This was misleading and should read as follows:

The probability of a vertical bottom penetration, as defined by the MARPOL 73/78 guidelines, regulation 13F of Annex I (SeeBG 23.7) will be considerably reduced by the cylinder bottom height of 5m above baseline, as compared with a 2.5m high double bottom of a standard double hull tanker. The bottom height of cylinder No. 1 (17.5m) and No. 10 (11.25m) will prevent bottom oil spill completely. For the bottom height of cylinder No. 2 (8m) the probability of a bottom oil spill is very low.

Nur Cahyanto, Captain
Tug "Elyah",
IRSHAD Abu Dhabi

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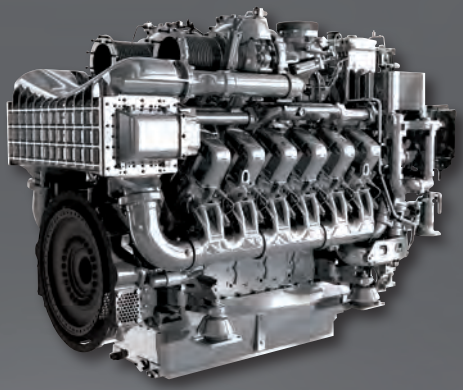

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Classification

ABS launches new guide

American Class society ABS has announced the release of its Guide that assists ship operators in selecting, installing and using systems that monitor local icebelt stresses and alerts crew as to the severity of potential ice impacts.

Monitoring systems are becoming a valuable tool for officers navigating vessels through Arctic waters. The sophisticated programmes provide the crew near real-time data of local stresses, often visually displaying hull and structural loads as a percentage of permissible levels.

The ABS Guide for Ice Loads Monitoring Systems describes the ice loads monitoring process and the procedures for collecting and recording the data. It also provides guidance as to how the information gathered should be processed, evaluated and presented to enable the crew to better measure vessel performance in ice.

"Installing a system to monitor ice loads gives operators a tool that can assist navigators in determining safe speeds and manoeuvre in dense, ice covered waters," said Mr Roger Basu, director, ABS Shared Technology. "In addition to safety, these systems can provide economic benefits through speed optimisation, better fuel economy and less downtime occurring from repairs to damage resulting from ice impact," Mr Basu added.

Ship operators may elect to apply optional notations to their vessels to demonstrate that their system evaluation, implementation and use has been made in accordance to the Guide.

www.eagle.org

Engine

Volvo Penta launches D13 MG

Swedish-based Volvo has announced the arrival of its latest generator the D13 MG marine genset, which will offer more power and high load acceptance, with emission levels in compliance with EPA Tier 3 and low fuel consumption.

The D13 MG has been developed complete with electric generator and onboard electronics, tested and classified.

"The D13 MG is better in every respect, compared to the current D12, which also is a very good engine," sais Gerard Törneman at Volvo Penta. "For the customer the load acceptance and low fuel consumption will mean more efficient operation at a lower total cost."

To keep fuel costs down the EMS 2, the engine control system developed by Volvo, regulates fuel injection and monitors engine conditions. The system controls the unit injectors, one per cylinder, which operate at a pressure of as much as 2000bar and atomise the fuel for optimum combustion. The result of this efficient combustion is low fuel consumption, combined with emissions in compliance with Tier 3.

The D13 is available with keel cooling, heat exchanger or radiator cooling already from the introduction. This means it is ready to use for a number of applications, auxiliary, harbor operations, emergency and diesel electric propulsion.

The noise level of the new D13 MG has been further reduced thanks to variable injector pressure and a new, efficient cooling system. The D13 MG has very low levels of NOx emissions and no visible smoke, regardless of load. This is combined with high load acceptance, due to the advanced and efficient charge air system. The D13 MG is easy to service and has a 500-hour service interval.

www.volvopenta.com

Paints and coatings

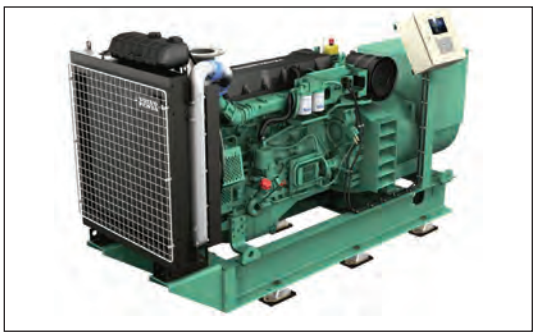
CMP launches its latest paint

Chugoku Marine Paints has introduces its latest anti-fouling technology to simplify and take the management of underwater hulls forward economically, environmentally and innovately. Chugoku are introducing Seaflo Neo.

Seaflo Neo is the result of several years research and development into the design, use of carefully controlled raw materials and a highly controlled manufacturing process.

The development of Seaflo Neo is aimed at meeting the practical requirements met in the drydock when application takes place in some of the most challenging of circumstances, the requirements of the environment by enabling the highest volume of

Volvo gets green with D13 MG.



THE SUPERYACHT PAVILION AT METS 2011

Getting down to business

What is the SYP?

The SuperYacht Pavilion (SYP) with its service-oriented Refit Boulevard form a show-within-a-show at METS. Dedicated to companies that offer equipment and services specifically to the large leisure yacht sector, the SYP is a destination in its own right but also sits at the heart of METS, the world's biggest and best attended leisure marine trade show.

Why you should attend?

The SYP is a meeting point for true industry professionals – superyacht captains, designers, builders, project managers, brokers and owners. The SYP is of interest to nearly half of the 18,500 professionals who visit METS each year and is also a must-visit for all the speakers and delegates who take part in the associated Global Superyacht Forum (GSF) organised by the Superyacht Report and also the Member's Mixer event organised by the ISS (the International Superyacht Society). The result is a varied and appropriate display of products, a vibrant conference programme and networking galore.

What is the GSF?

The Global Superyacht Forum (GSF) is one of the world's leading summits for superyacht professionals. As a conference, it delivers in every way – with top profile presenters and excellent interaction between speakers and delegates. Organised and presented by The Superyacht Report in association with METS organisers, Amsterdam RAI, the GSF attracts around 450 delegates and includes social highlights like the Global Superyacht Party.

Top prize & acknowledgement – DAME

The Design Award METS (DAME Award) has become a famous trophy in the leisure marine industry and is the undisputed design accolade of the year. The DAME is awarded to the most innovative new product design at METS – as assessed by an independent jury. The winning product is displayed at the show, along with all other submitted products, so that you can be amongst the first to see it.

Why METS and the SYP?

The SYP/METS combination is unique. At no other trade-only event can you visit a thriving superyacht equipment exhibition and also have access to over 1,100 other marine trade exhibitors at METS, some of whom also cater to the superyacht sector.

- **18,861 visitors from 94 countries in 2010**
- **Over 1,320 exhibitors (of which 151 SuperYacht Pavilion) from 41 countries in 2010**
- **15 national pavilions**
- **3 specialist pavilions including the SYP**
- **Strictly professional – strictly trade-only**

METS/SYP is held in the modern Amsterdam RAI exhibition halls just 15 minutes from Amsterdam's Schiphol Airport and a ten minute drive from the historic city centre. To help with your planning, Amsterdam RAI can book hotel rooms for you and assist with other travel requirements.

You can attend for free if you pre-register as a trade professional

SYP official magazine: The Superyacht REPORT

SUPERYACHT PAVILION

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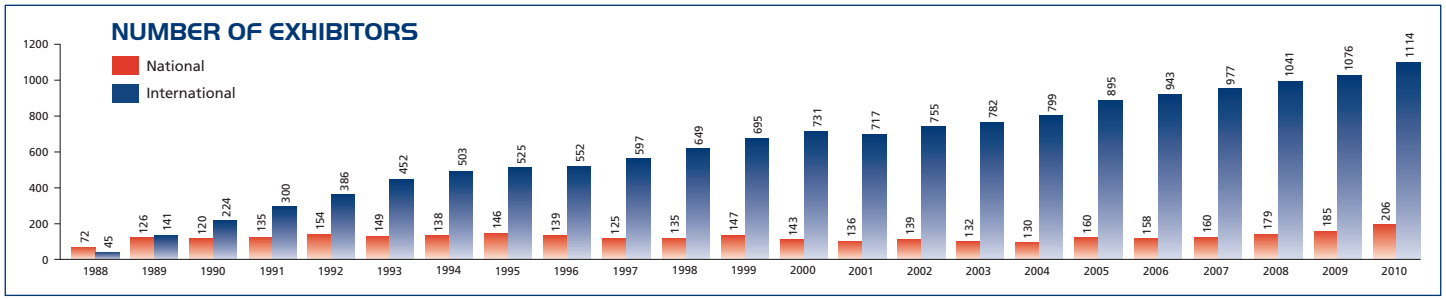

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solids (lowering VOC) from a hydrolsing material and the economics demanded today in terms of fuel savings is indicating fuel savings beyond silyl of the order of 3-5% largely due to the ultra smooth surface it achieves from its unique self leveling characteristics and ability to minimise the orange peel effect and overspray droplets.

Seaflo Neo has been extensively tested and benchmarked against Chugoku's portfolio of antifoulings and the CMP Bioclean low surface energy systems on the double cyclinder friction resistance equipment. This equipment was designed by the Tokyo University of Science with the National Maritime Research Institute and CMP. It is able to look at torque and coefficients of friction at speed normal to ships operation. Hence a practical approach to benchmarking and performance prediction and evaluation.

The results abtained for Seaflo Neo have shown significant advances over conventional as well as high performance antifoulings and has matched the low surface energy CMP Bioclean system.

Seaflo Neo is applied by the usual airless spray conventional methods used in today's drydocks worldwide, meets new building "block squeeze" norms and provides excellent static fouling performance.Further, testing has identified Seaflo Neo to more than fit the bill for 90 months dockings on many vessel types.

The SeaGrandPrix range of products has recently been further enhanced by the introduction of SeaGrandPrix 1000 L, which is fully hydrolyzing, undiluted.

SeaGrandPrix L benefits from being higher in volume solids, economical in the thickness required for in-service periods, uses high quality raw materials.
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Ancillary equipment

McMurdo shines a light

McMurdo has announced the launch of its Smartfind S10 Automatic Identification System (AIS) beacon. This will be the first time that the commercial market has seen this personal safety device, which incorporates both AIS and GPS technology.

When manually activated, the Smartfind S10 uses AIS and GPS technology to give precise location information to aid the recovery of persons in difficulty at sea. It is designed to be carried by divers, boat crews, or anyone who spends time on the water for work or leisure purposes.

The beacon is waterproof, buoyant and has the ability to transmit both AIS and GPS data to all AIS receiver-equipped vessels and land based VTS (Vessel Traffic Services) stations within a four mile radius. The Smartfind S10 AIS Beacon features an inbuilt high precision GPS receiver, and transmits target survivor information, including structured alert messages, GPS position information, and a serialised identity number. Bearing, range and location information are accurately transmitted and displayed on the AIS receiver or plotter screen, giving potential rescuers all the information they require to carry out the swift retrieval of an individual.

The Smartfind S10 AIS Beacon will transmit continuously for a minimum of 24 hours, regularly update position information, and has excellent longevity thanks to its five year battery storage life. Waterproof to 60m it also features a flashing LED light to assist with visual fixing and night-time location; measuring 199 x 51mm and weighing186g. The beacon is easy to activate, with a simple two-stage activation function. The Smartfind S10 AIS Beacon will be available from August 2011.
www.mcmurdo.co.uk

McMurdo launches its latest safety device.

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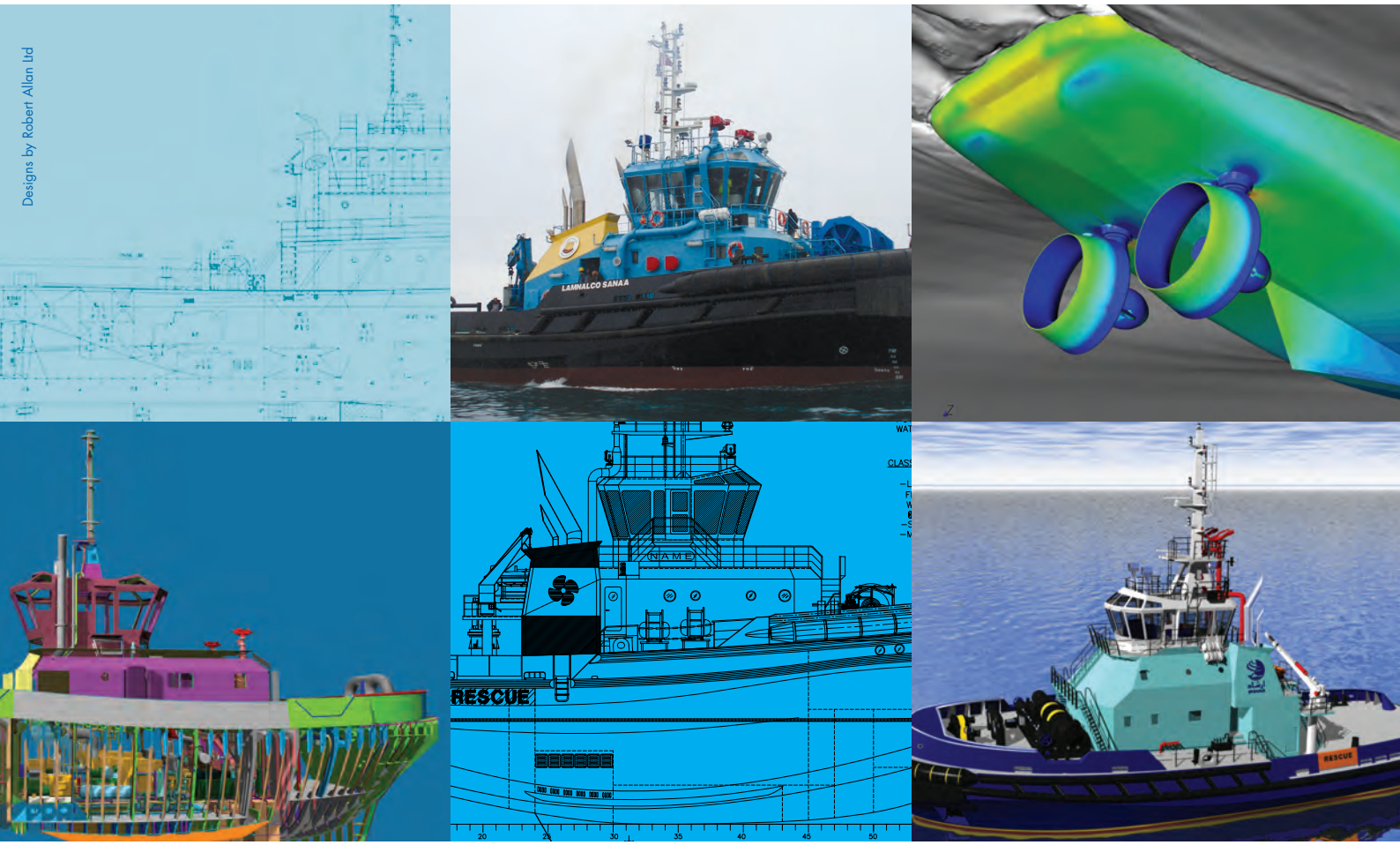

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The illusion of fuel savings

A vessel's fuel consumption throughout its docking cycle depends on several variables; however, most observers believe that fuel consumption increases throughout the docking cycle – even with the best available hull performance solutions (HPS). Why, then, do we talk about fuel savings in the same sentence as hull coatings? Asks Bjørn Wallentin, global sales director, HPS, Jotun Coatings.

The answer to the above is as simple as it is complex – "fuel savings" sends positive buying signals while "reduced loss in performance" will easily be perceived as negative. In this article we will try to offer some insight as to what some of these approaches actually mean in real performance terms.

The environment and how all our actions influence the planet we inhabit are all around us every day. We meet it in newspapers, on television, on signboards and also from our children as they teach us how not to waste water while brushing our teeth for example.

We are faced with lack of agreement/action from the United Nations (UN) Copenhagen summit in 2009 and Cancun in 2010 for global environmental improvements, while individual countries and local authorities take a much tougher approach to reduce their environmental impact and "carbon footprint".

This is the situation and we cannot as individuals avoid being influenced by this massive amount of information and pressure. The global focus on the negative effects of increasing emissions of greenhouse gases (GHG) is one of the key issues on the agenda for the marine environment protection committee (MEPC) and other organisations within the marine industry.

In 2007, shipping was estimated to have emitted 3.3% of global CO_2 emissions, to which international shipping contributed 2.7%, or 870 million tonnes [1]. Vessel owners and operators do take responsibility and many have clear environmental policies well communicated through their organisation. As a positive consequence, of this focus, the whole marine value chain has been developing solutions that aim to reduce emissions.

Bjørn Wallentin global sales director hull performance solutions at Jotun.

This covers the whole range of products from new vessel designs and use of other types of fuels, through to more efficient coating systems for the underwater hull. There actually seems to be an unlimited number of fuel saving devises, that if they all worked as promised, would combined, allow the vessels to operate with no emissions what so ever. Obviously something must be wrong. Some of these technologies cannot possibly perform as promised – but how to select the ones that do?

Instead of developing a performance index that reflects the actual vessel's performance, tools have been developed to compare how vessels could theoretically perform with the basis in vessel data from new build. An example of this would be the Energy Efficiency Design Index2 (EEDI) developed to put focus on improving the performance of new buildings.

We consider this to be a good example of a typical time zero (initial/perfect condition and not representative to actual long term performance) perspective that offers little or no advantages for the existing fleet of vessels. This is a fleet that in actual terms may run more efficiently and with less emissions than a new vessel of the same size. The marine coating industry has adapted to this time zero perspective by offering new biocide free hull coatings that are initially very smooth, thus contributing to a higher initial vessel speed (vref.). However, it is our experience that there is an additional long term fuel penalty as a result of a more dense slime fouling and also animal fouling on the biocide free technologies compared to the high quality biocide containing products.

Observing the above simplified formula for calculation of EEDI we can easily conclude that an increase in vref will contribute to a lower, and improved, EEDI. The above equation promotes a smooth hull (v_{ref}), propelled by a small engine (installed power) running on LNG (C_{carbon}). This seems however, sadly to have little relevance with regards to the vessel performance and fuel consumption beyond the sea trials at the new-building stage. The most efficient way to reduce the emissions is to maintain a clean and smooth hull in service between the dockings. How then can statements of huge fuel savings in the range of 5-10% be made by the paint makers?

The illusion

Jotun's conclusion is that the answer to why these 5-10% fuel savings statements are made lies within the reference used, or lack of such. As a result attention should be drawn to the conditions under which most of the biocide free systems are sold and applied.

Biocide free hull paint systems are normally perceived as quite expensive and to apply these on top of an aging primer system does not make sense with the long lifetime they are designed to last. For that reason most, if not all, hulls/sections are fully blasted down to steel.

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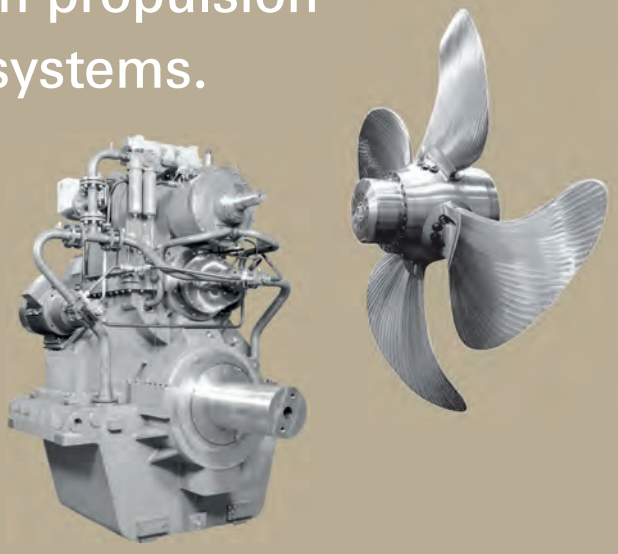

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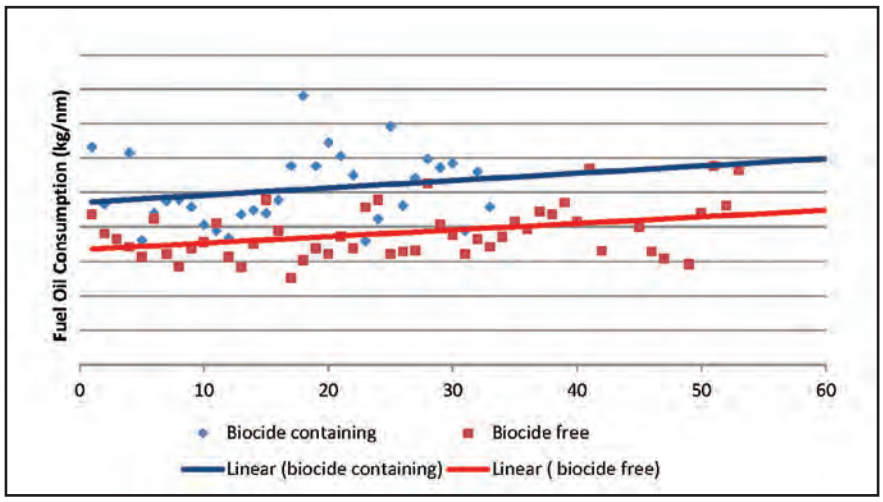


Graph showing fuel consumption before (blue) and after (red) dry-docking.

The owner/operator will then normally select a vessel in their fleet of the correct age range being already scheduled for such surface preparation, regardless of system selected. This would normally be 10-15 years from new-build with an underwater paint system that is quite rough from several dockings with spot blasting and repairs. So the full blast will bring the hull condition from the worst to the very best, from rough and possibly fouled to very smooth and clean.

We know that the improvement in fuel consumption from this surface preparation can be in the range from 25-40%, depending on the prior condition. With this in mind and the fact that the above fuel saving for the biocide free hull systems are, in many cases, guaranteed for only one year after docking, it is quite simple to understand how 7-10% fuel savings can be guaranteed. Even in our performance analysis linked to the positive effects on fuel consumption originating from a maintenance repair docking we see positive effects in the range of 20% improved fuel performance.

The graph above is an example of how fuel savings are sometimes "proven" by measurements of fuel oil consumption in a period before (blue markers and line) and after (red markers and line) docking. The fuel oil consumption resulting from both biocide containing (blue) and biocide free (red) are plotted in the same figure and on top of each other.

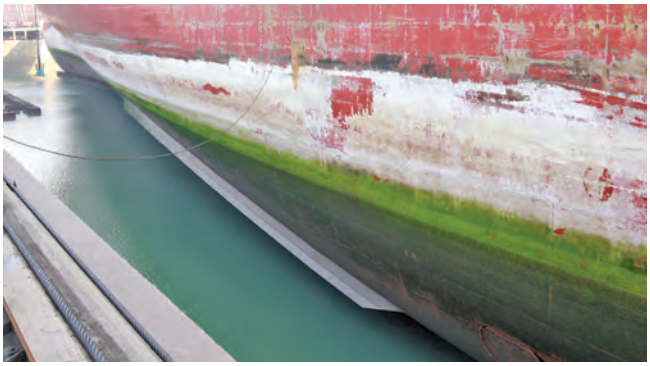
There is a clear reduction in fuel consumption, in this case approx. 10%. This is correct if fuel consumption is measured based on average figures 12-24 months before and 12-24 months after docking. At this point it is easy to forget that the fact that surface preparation by full blasting in dock contributes to an even larger reduction in fuel consumption. In the above example the savings from blasting of the hull coatings resulted in as much as 22% fuel saving.

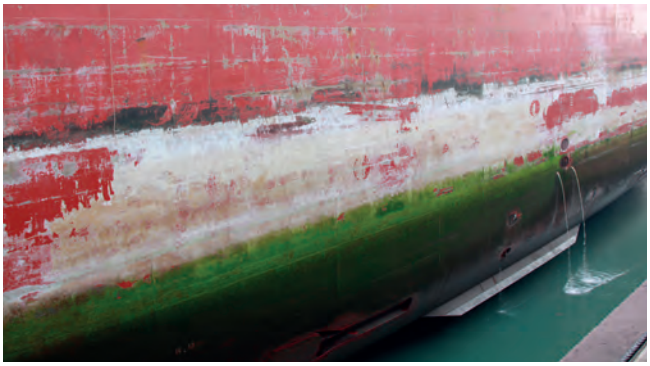
The gradient of the two lines, showing the development of fuel oil consumption over time are also similar, indicating that a freshly applied biocide free technology has the same increase in fuel oil consumption as a 12-15 year old primer system with a biocide containing antifouling as the last coats. In the above example this biocide containing antifouling would not be a high quality product but a medium to low quality one based on the rather steep increase in fuel consumption. Have we just created an illusion based on what we wanted the above theoretical example to prove, or is it based on solid facts? That is the one of the vital questions that the reader should ask him or herself.

The irony is that customers, academics and also environmental bodies are led to believe that the biocide free products are only good for the environment. Paint makers have built this image by statements focusing on how much CO_2 that could have been saved if all vessels used their technology. Jotun is of the firm belief that many customers now realise that this is far from founded on operational experience and that the individual vessel's fuel consumption actually has a significantly larger increase with the biocide free than with most biocide containing products. This increase in fuel consumption is mostly due to the light and dense slime, as shown in the pictures below, showing performance on container vessels.

If these large container vessels are unable to benefit from today's versions of the biocide free technologies then it is hard to imagine what trade, speed and type of vessel that could have fuel saving benefits.

Light and dense slime on the hull of a container ship.





There are a few methods available in the market for analysing fuel performance, but few, if any measure and analyse hull performance. To reduce fuel consumption and subsequent emissions, fuel performance is of course the prime focus, but the largest gain to this is achieved by improving the hull performance. There is an average 15% fuel improvement opportunity [3] in the improvement of hull performance by better antifouling coatings. This potential is available also to the existing fleet of vessels, offering the majority of the short term global fuel savings possible. However, in order to quantify and avoid more adaptive marketing efforts, there is a need for a global standard in hull performance measurement. Such a standard must be available to all and easily understood for the parties involved.

Such a standard should aim to be:

- 100% transparent (all data available, no hidden or secret calculations)
- must be measuring hull performance and not fuel performance
- must be based on automatically logged data and not a selection of "good " data

Fuel performance is important when fuel cost and emissions are calculated, but not when we want measure the effect of initiatives implemented to improve the hull performance.

Conclusion

An illusion of fuel savings achievable from some antifouling coatings, especially the biocide free solutions, has been created. Without the insights into how antifouling coatings and biocide free products do perform it is difficult to assess what is correct or not. We have tried to cover some of the basics in this article, but the question to ask when fuel saving promises are made would be; "fuel savings compared to what?"

As a supplier of underwater hull fouling protection systems we have an obligation to offer the customers our performance evaluation of the proposed solution(s) and offer similar advice when solutions are suggested by our customers. The customer and the supplier's expectations should be aligned.

Another key learning point would be that when fuel savings are promised and guaranteed, the analysis/proof should be based on operational data between the dockings and NOT including the benefits of surface pre-treatment in the docking procedures.

Further, if indexes are the way forward, we should aim for one's that reflect true performance not theoretically possible performance. This because the biggest potential in reducing fuel consumption and emissions lies within the existing fleet of vessels – incentives to reduce their carbon foot print by using higher quality antifouling coatings, proven by a fully transparent hull performance method, would have immediate positive financial and environmental effects.

There is clearly a need for a standard method for analysing hull performance. Jotun has developed such a method, but are open for constructive feedback and questions from all interested parties to help fine tune the collection and analysis methods. Please visit our HPS web site to learn more about it: www.jotun.com/hps. *NA*

[1] ICS, 2009. *Shipping, World Trade and the Reduction of CO_2 Emissions.* International Chamber of Shipping, London, UK.

[2] IMO, 2009. *Interim Guidelines on the Method of Calculation of the Energy Efficiency Design Index for New Ships. Circular MEPC.1/Circ.681.* International Maritime Organization, London, UK.3

[3] *IMO, MEPC59/INF.10, Prevention of air pollution from ships,* page 236

DNV set to appraise Jotun monitoring system

Norwegian class society Det Norske Veritas (DNV) will begin its evaluation of the Jotun monitoring system that will evaluate whether the company's silyl methacrylate SeaQuantum X200 coating will sustain a maximum of 4.5% increase in fuel consumption or no more than a 1.5% speed loss over a five-year dry-docking interval.

So confident are Jotun that its system will work that they have offered a money-back guarantee to owners if their ships fail to meet these efficiency levels. One observer believes, perhaps somewhat cynically, that Jotun are under pressure as their products come at a higher price than some of its main competitors and that the company, therefore, "struggles to sell it products", hence the guarantee.

DNV will evaluate the product over the summer months said Giermund Vage, Service director of Asset Risk Management, "We need to understand the technology," he said. Mr Vage added that the Jotun system collected essential data from monitors on the engine, showing the power used, a measurement of speed through the water and other data such as weather and currents and this information is then analysed using methodology developed by Jotun.

"To approve the system we need a standard and then we must assess the system's accuracy," explained Mr Vage.

Jotun's monitoring system essentially collects data from the propeller shaft and the speed of the vessel through water. By measuring the torque and rpm of the shaft and using the Doppler log to measure the speed through the water the system effectively by-passes any other effects, such as current and wind speeds.

Bjørn Wallentin, global sales director - hull performance solutions for Jotun, explains: "We must first know what the theoretical power to speed ratio is, as supplied by the newbuilding yard, and then we look for variations that will show whether the hull or propeller is fouling".

The company has tested the method on 15 ships of a variety of types, including bulk carriers, tankers, ro-ro ships, container ships and LNG carriers and the system has proved to be accurate to within ±0.3 – 0.4% said Mr Wallentin and most vessels already have the measuring equipment on board, though a data monitor would need to be added to collect enough information for the system to achieve the accuracy required.

DNV expands its eco range of concept designs

Meeting the demands of stringent green regulations both now and in the future may seem daunting for some ship owners, but Norwegian class society DNV hopes that its recent additions to its environmentally friendly designs will be able to smooth the transition.

DNV launched its concept for an environmentally friendly container ship last year, now a year on DNV has introduced a further two vessel designs for an open hatch bulk carrier, which has been developed along with Oshima Shipbuilding Co., Ltd and an ore carrier developed on the same principles that will also have reduced fuel consumption and be more energy efficient.

DNV and Oshima Shipbuilding partner up to create the latest concept for a bulk carrier.

"The concepts are not a tool to sell devices, but to help ship owners who need some guidance about making ships more efficient. We are helping to paint a more realistic picture for the ship owner", commented Michael Aasland, business director – bulk carriers, DNV.

DNV has highlighted that the concepts that they are presenting to ship owners are a platform of innovative ideas. Mr Aasland notes that whilst developing these concepts DNV had interesting conversations with ship owners about what features they would need to look into and which features they should not.

The open hatch bulk carrier designed for Oshima has been designed for trade between Brazil and China and it is expected that it will have a constant flow of cargo to carry, because of this it is expected that this type of vessel will seldom sail in pureballast claim DNV due to the type of route and cargo that this type of vessel will be transporting. "It is believed the vessel once dropping off its initial cargo will have a return cargo to transport", highlights Mr Aasland.

One particular point of interest with this vessel is that it will have an air lubrication system installed. We have already seen Oshima incorporate an air lubrication system onboard *Yamati*, which was delivered last year (See *Significant Ships 2010* – pg110). The system that will be installed on this latest concept is still under development by Oshima and DNV. DNV has said the unit has been supplied by Oshima and with input both from Oshima and DNV the system is being developed further. Mr Aasland has highlighted that this system is beneficial to the design of vessel as, "The vessel is wider than a standard open hatch bulk carrier and is shallower, having a larger surface area for the air bubbles to press against."

The vessel has been designed to run on Liquefied natural gas (LNG) with the propulsion machinery being designed by Rolls-Royce. The design also features Rolls-Royce Promas controllable pitch propellers and rudder. The vessel features one auxiliary engine that can be used either as a generator or an additional propulsor. Along with this the vessel also has hydraulic gib cranes that have a larger capacity, meaning that there is less cranes onboard. The hatch covers are also made from composite materials, which DNV are working with Kockums to develop.

Further, DNV has also introduced its latest concept for a ore carrier Ecore, for trade along the China to Australia route that will have the same energy efficiency enhancements as the open hatch bulk carrier. Once again the design incorporates technology that aims to reduce fuel consumption, reduce ballast and to reduce steel cost.

The design features a V shaped hull with a wider beam and transverse bulkhead, twin propulsion and one centre cargo hold that is fitted with a self loading system, designed by MacGregor. To make sure that the loading of the vessel is done safely a loading monitoring system has been added.

The vessel will be powered by LNG and to save space the LNG tanks have been placed in the wing sections of the vessel, so not to disturb the cargo space. The tanks would be IMO type C tanks and to further enhance and reduce delays DNV has foreseen that this type of vessel could also be refuelled by bunkering barges.

DNV has highlighted that on the EEDI scale this vessel would be 22% lower on the scale than a standard ore carrier. The vessel would be powered by a 2 stroke engine and would be able to fulfil the International Maritime Organization (IMO) Tier II and Tier III requirements for NOx reduction. The vessel will also be able to run on diesel, which would also prevent any methane slip. *NA*

TECHNICAL PARTICULARS

Ecore

Length oa	330m
Length bp	324m
Breadth	70m
Depth	28m
Draught loaded	18m
Draught ballast	7m
Block coefficient loaded	0,68
Block coeffienct ballast	0,63
Deadweight	250,000dwt
Service speed loaded	14,9knots

THE INTERNATIONAL CONFERENCE ON COMPUTER APPLICATIONS IN SHIPBUILDING (ICCAS 2011)

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ICCAS 2011 will be the 15th International Conference on Computer Applications in Shipbuilding. The 2011 conference will be held in Trieste, from 20 - 22 September 2011.

The conference will review operational experience from existing computer applications in the design and build of ships and offshore structures. It will also examine the advances in Information Technology which have contributed to increased productivity in both shipbuilding and maritime operations; including increasing co-operative working between shipyards, marine equipment and system manufacturers, engineering partners and shipping companies.

The conference will cover the full range of topics related to computer applications, including separate programs, integrated systems, knowledge management, simulation and virtual reality applications, for:

- Early design, including concept design, tendering, initial design, general arrangement, cost and work estimation, hull form, hydrodynamic analysis and basic structural design, risk based design.
- Detailed and production design, including structure, machinery, hull and outfitting.
- Parts manufacturing and assembly, including prefabrication, shop automation, robotics, assembly and accuracy control.
- Material management, including material control, supply chain management, logistics and e-solutions.
- Management of shipbuilding projects, including planning, work-flow analysis, PDM and ERP applications Management of co-operative working between different actors in shipbuilding projects, e.g. shipyards and equipment and systems manufacturers.
- Commissioning, inspection and maintenance, including life-cycle maintenance, life-cycle cost management, environmental cost management, parts and systems reliability, inspection standards and risk management inspection standards, risk management and security.
- Skills management, knowledge transfer and other human resource issues.
- Innovation, innovation management and innovation impact assessment, including new materials and eco design including new materials, green ships and eco design.

The conference's papers focus on advances made in information and communication technology with respect to methods, tools, standards and organisational adaptations in the different application sectors of the shipbuilding industry. Where appropriate, papers also describe the potential impact of the innovation described to productivity improvements.

The conference will attract a large international audience and provide a forum and means of professional development for all parties interested in computer applications in shipbuilding. Key dates and up to date information will be displayed on the website at:

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Grasping shipping's Holy Grail

Aluminium foam sandwiches are set to revolutionise shipbuilding. Finnish yard LaffComp and its partner the Fraunhofer Institute in Germany have innovative designs for woodchip, passenger and bulk carrier vessels and a container ship equipped with its own loading and discharging system.

Until now it has been accepted that the hull weight of a ship will be set by the thickness of the steel plate and the amount of steel used in the design of the ship. Fast ships have lightweight aluminium bodies that reduce the power to weight ratio necessary for driving the ship forward.

Lighter ships mean that a vessel can operate at a given speed with less power and that means fuel savings. Finding a material that is light enough to substantially reduce the weight of a ship while maintaining enough strength to operate in icy conditions such as the Baltic or the lake regions of Finland is the Holy Grail for ship designers and that material has now been developed.

New shallow draft designs for vessels able to operate in icy conditions lake areas where the safe sailing draft is only 2.4m with the ability to carry enough cargo to make the vessel economically viable (up to 6900m^3 of peat or woodchips) requires a new lighter material.

Enter the Fraunhofer Institute for Machine Tools and Forming Technology in Chemnitz, Germany, which has developed an aluminium foam compound that with a steel plate either side forms a sandwich creating a metal which when applied to ocean going vessels can reduce the lightweight of the ship by up to 30% and strong enough to allow the ship to be awarded ice class status.

The material itself was first developed in 1961 said Dr Thomas Hipke who helped to develop the material and its possible applications at the Department of Lightweight Structures at the Fraunhofer Institute during the 1990s.

An Aluminium Foam Sandwich (AFS) or a Steel Aluminium Foam Sandwich (SAS) is manufactured by mixing aluminium powder with a blowing agent, in this case titanium hydride, the mixture is then placed through an extrusion machine to produce rods of around 20cm x 25cm.

A cross section of the Aluminium Foam Sandwich and Steel Aluminium Foam Sandwich created by the Fraunhofer Institute, Germany. The material is extremely light weight and very strong, ideal for new ship designs.

By placing these rods between two steel sheets and heating the material to more than 600°C the aluminium melts, fusing itself to the steel and the titanium hydride creates hydrogen bubbles, "it's like baking bread dough" said Dr Hipke as the mixture forms a dough that hardens when it cools, but its properties are immensely strong and comparatively light.

Another property of the material is that it bends more readily which also allows for the flexing of a ship. Two test projects using ALF and SAS are now under way, with the German yard Blohm + Voss developing a rudder and machinery for the drive of a passenger vessel using the foam, but more spectacularly in Finland the Laffcomp Oy yard has a hull design, the Bioship, that can be used as a bulk carrier, a log carrier, a woodchip carrier or a container vessel.

Each vessel will be so light that new and innovative designs will allow these vessels to compete in new markets that were hitherto unavailable to the maritime sector. The container ship will have a gantry crane, also constructed from ALF, mounted on rails on deck with extendable legs that stretch out to the quayside. This crane will allow the ship to handle its own cargo at any shallow port, including river terminals even if the terminal does not have its own gantry cranes.

Ships will be powered by liquefied natural gas (LNG) engines that will further reduce the emissions from the vessel, including SOx, NOx, particulates and CO_2.

Vessel development will be through LaffComp's sister company, BioLaivat KY, which was established to offer transportation "for bulk cargoes, liquid cargo and containers around the inland and coastal waters of Finland, Scandinavia, Europe and Russia," according to Veikko Hintsanen, director at Laffcomp.

RINA - Lloyd's Register
Maritime Safety Award

The Institution believes that the safety of both the seafarer and the maritime environment begins with good design, followed by sound construction and efficient operation. Whilst naval architects and other engineers' involved in the design, construction and operation of maritime vessels and structures do not have a patent on such issues, nonetheless their work can make a significant contribution.

The Institution also believes that it has a role to play in recognising 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 Institution, in association with Lloyd's Register, is therefore introducing a new Maritime Safety Award to be presented to an individual, company or organisation which has made a significant technological contribution to improving maritime safety or the protection of the maritime environment. Such contribution can have been made either by a specific activity or over a period of time. Nominations may be made by any member of the global maritime community, and will judged by a panel of members of the Institution and Lloyd's Register. The Award will be announced and presented at the Institution's Annual Dinner.

Nominations are now invited for the 2011 Maritime Safety Award. Individuals may not nominate themselves, although employees may nominate their company or organisation.

Lloyd's Register

Nominations may be up to 750 words and should describe the technological contribution which the individual, company or organisation has made in the field of design, construction and operation of maritime vessels and structures,

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

or by email to *MaritimeSafetyAward@rina.org.uk*

Nominations should arrive at RINA Headquarters by 31 Dec 2011

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

Sandwich Thickness [mm]	Sheet Metal Thickness [mm]	Total Mass [kg]	Max Deflection by Self- Weight [mm]	Max Comparison by Self- weight [N/mm²]	Max Deflection [mm / 1000 N]	Max Comparison [(N/mm²)/1.000N]	Light Weight Construction Factor LBF = 1/(mass·deflection)·1000
15	2	58.7	0.523	3.99	1.447	14.7	11.8
20	2	63.9	0.299	3.02	0.759	10.2	20.6
25	2	69.2	0.198	2.48	0.466	8.0	31.1
25	3	90.6	0.195	2.42	0.349	6.4	31.6
30	2	74.4	0.144	2.14	0.314	6.7	42.8
30	3	95.9	0.137	2.03	0.233	5.4	44.8

The properties of the ALF sandwich.

Veikko Hintsanen, MD at Laffcomp Oy shipyard.

Finland's new power station, fired up last year, in Jyväskylä on the shores of Lake Päijänne, will, hopefully at some future date, use woodchip as a sustainable fuel source and LaffComp said, "Ship borne transportation of the fuel, wood chip and timber, would yield massive cost savings when compared to road transportation, with the obvious beneficial impact on the environment of replacing dozens of trucks with one ship." Model studies with Lappeenranta University have shown that the emissions of this new innovative ship are 66% less compared to trucking of the same cargo. The savings of energy in transportation is 54%, the driving personnel is one eighth of that required for year-round trucking operations.

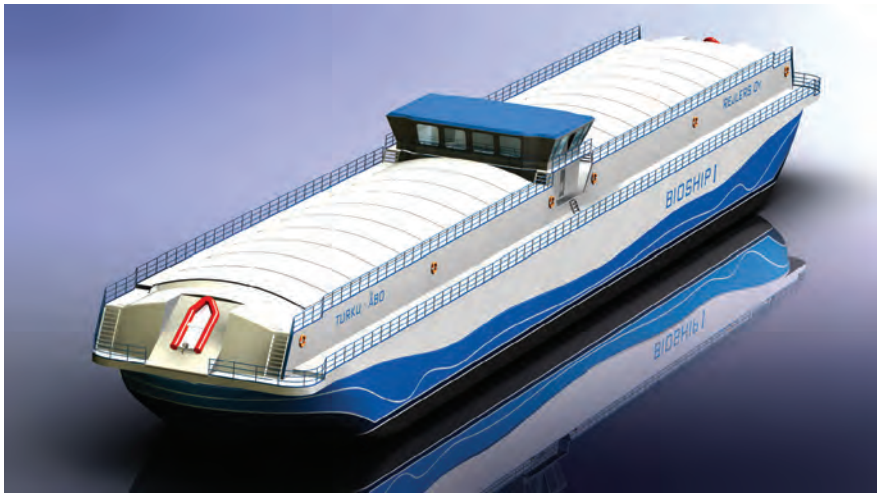
A woodchip carrier constructed from aluminium foam would be capable of operating all year in the extremely harsh sub-zero conditions of a Scandinavian winter. "The BioLaivat can break through 60cm of ice at a speed of 6knots. The engines have been specifically developed and are capable of producing 4000shp, to deliver that amount of power to propellers when the ship has a maximum draft of 2.4m requires special significant design attention and in this case resulted in four independent propellers," LaffComp explained.

LaffComp itself was established in October 2007 and had a rental agreement at the former Kotka Shipyard at Hietanen Port. That agreement was terminated as delays to the project meant that there were no newbuilding contracts. However, LaffComp and its co-operation partners are now in negotiations with a number of yard partners, one is thought to be Savonlinna shipyard for Saimaa max multipurpose vessel construction.

On the LaffComp website only the Bioship design is listed and the company is looking for funding from the European Union (EU) for its innovative design and is in negotiations with a number of ship operators who are interested in developing the lightweight vessel for commercial operations. In fact Veikko Hintsanen, director at Laffcomp, said: "There have been several enquiries and we expect negotiations with these parties should be concluded by the end of this year"

"The crucial domestic market in Finland is to have three bridges up to 8m airdraft in Keitele Päijänne for tens of millions of cubic metres per year of woodchips from forests to power stations. We may not forget also the 150 year 'war' between rail and inland navigation in state budgets whether to get canal- river connections from Päijänne to the Baltic Sea or do we rely on rail and in trucking," said Mr Hintsanen.

Whether the Bioship's first customer is the power station at Jyväskylä with its regular requirement for woodchip fuel, or the crushed stone from Finland to Russia



An artists impression of the 110m, 1000dwt, Bioship multipurpose vessel design, the hull can be adapted for use as a container, bulk, or rail car carrier.

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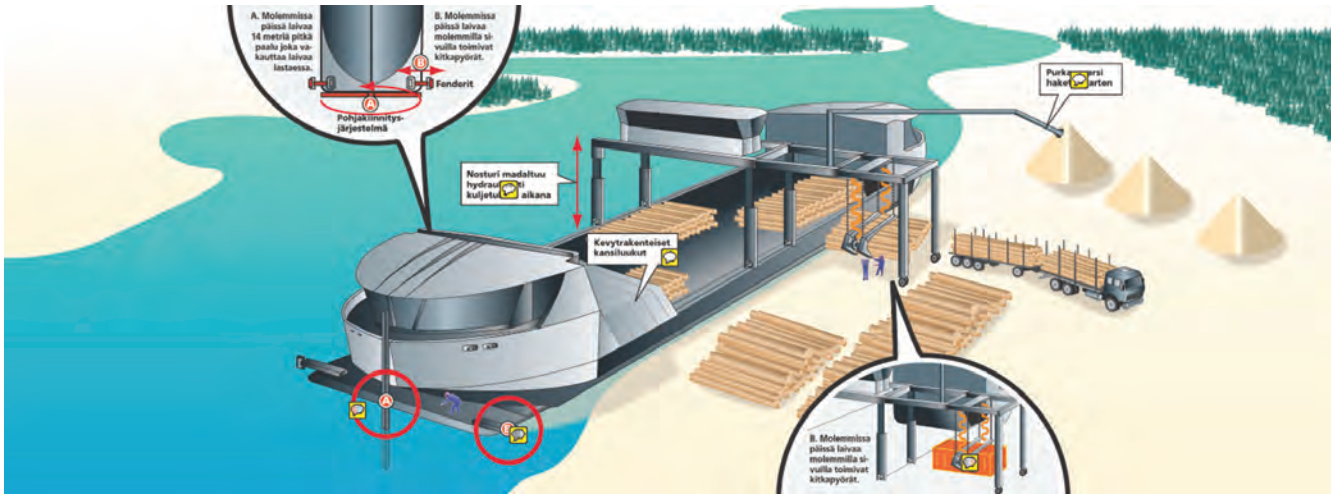
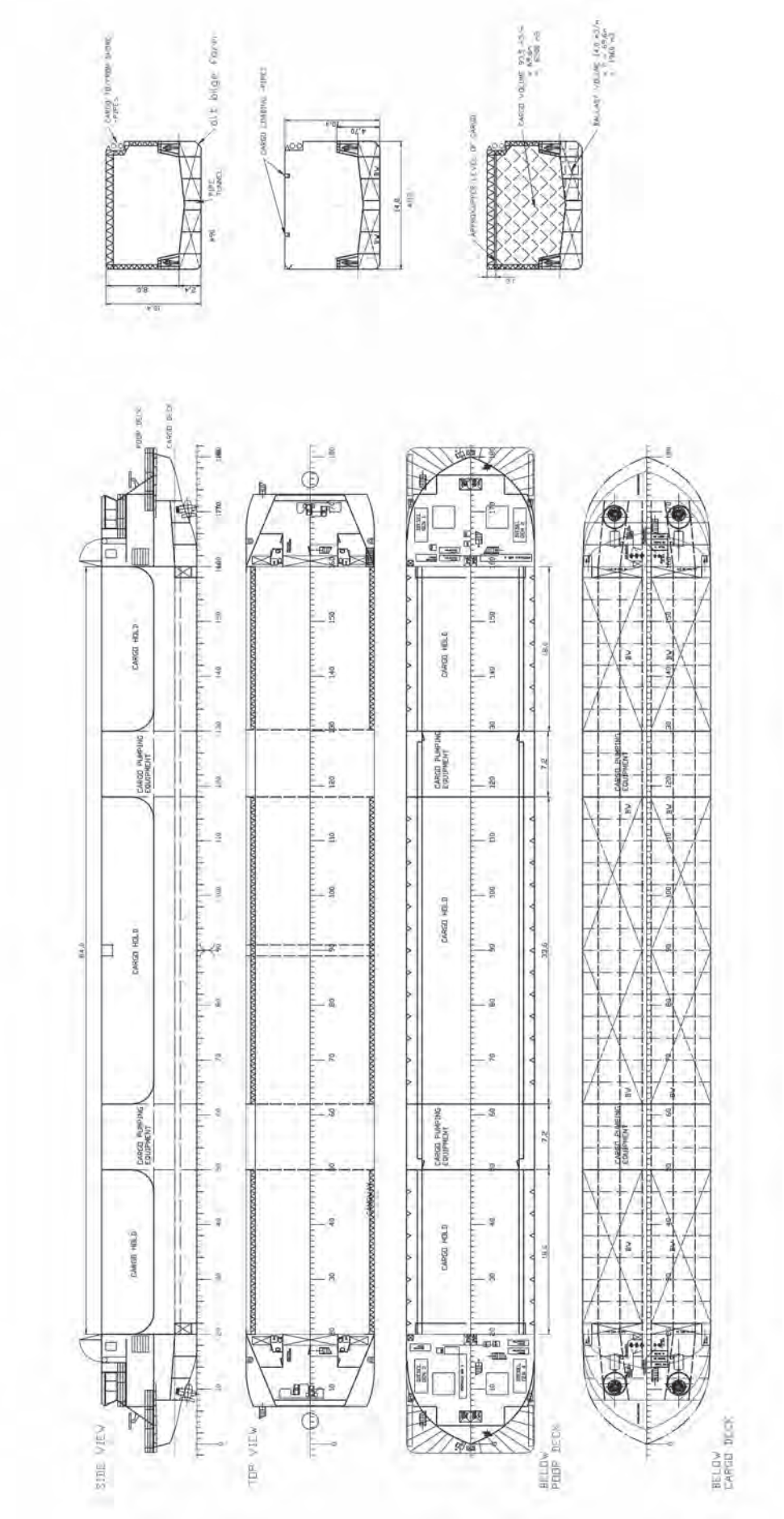


A Bioship carrying logs for the timber trade with its crane unloading the cargo. The crane can be adapted for other cargoes - including containers.

and Estonia; with the return cargo of peat / woodchips back to Finland, what is required in both cases is the ability of the vessels to operate profitably at small and shallow ports using its own gear all year round.

By operating with these vessels the operator obviates the need for the many trucks that would need to deliver the fuel supply to the power station instead, that would in itself offer fuel efficiencies as well as reducing congestion and making roads safer.

Ships of this type could be used in many shallow water ports around the globe and could be a part of the solution to the increasing number of trucks that are clogging up the world's arterial road routes. A key to unlocking the potential of the waterways is lighter ships and this, in turn, requires lighter materials. ALF and SAS could be the breakthrough material. *NA*



GA Plan of the Bioship bulk carrier design.

Driving the adoption of cutting edge technology in shipbuilding

Mark Waldie, Denis Morais, Darren Larkins from ShipConstructor Software Inc. look into the cross over of design standards between different industries.

The shipbuilding industry is full of bright and qualified people yet it lags other sectors such as the plant, aerospace and automotive industries in adopting various productivity enhancing tools such as laser scanning, digital prototyping and shop floor 3D. There are technical, structural and cultural reasons for this lag but fortunately there are strategies and technological developments on the horizon that could assist shipbuilders to cost-effectively implement these cutting edge tools.

Laser Scanning (high definition surveying)

One technology that could be used more often is high definition surveying which is a large scale form of laser scanning. High definition surveying uses a laser beam to sweep across a target object so that hundreds of thousands of closely spaced measurements can be taken in minutes. When these scanned measurements are displayed on a computer, a point cloud of the target results can be viewed. CAD objects can be modelled around this background. Alternatively, the point cloud can be used to generate a CAD model.

Laser scanning in other industries

The oil and gas industry started using high definition surveying in the late 1990s and it has become standard to scan as-built models since about 2005. The automotive and aerospace sectors also use high definition surveying.

Laser scanning in shipbuilding

Shipbuilders have similar reasons to adopt laser scanning as in other industries. Putting the parts and blocks of a ship together is analogous to connecting aircraft assemblies. Accurate measurement helps ensure that everything fits. Quality control is always important but perhaps the biggest benefit comes in repair and refit activities. Today, an average tanker or military ship will be in the water for 35 to 50 years. The majority of these vessels lack basic engineering drawings and blueprints, let alone computable design data for designers and engineers to reference.

A few progressive shipyards such as Meyer Werft Gmbh and Babcock International have adopted laser scanning technology. Another shipbuilder, Signal International, uses a Faro laser scanner on both retrofit projects as well as on new production.

After going through some intermediary software, Signal imports the point cloud information into AutoCAD based ShipConstructor CAD/CAM software to create:

- Accurate bills of materials
- General arrangements
- Pipe arrangements
- Pipe ISO's by system
- Pipe spool drawings
- Equipment details
- Structural arrangements.

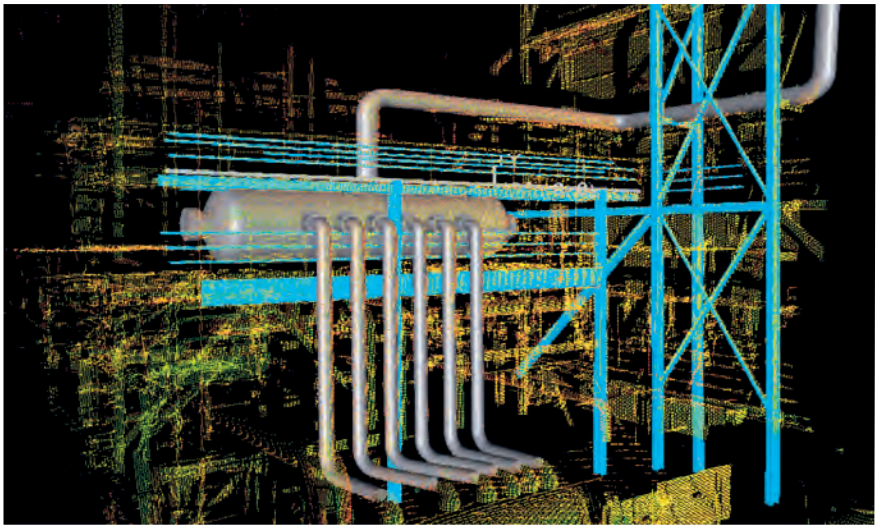
Digital prototyping

Another cutting edge technology that is underutilised in shipbuilding is digital prototyping which means using a digital or virtual mockup. The concept refers to performing as much work, analysis, and communication as possible within a 3D digital environment, rather than in the physical world. This involves using computer simulations more than physical models and viewing videos and fly-throughs, rather than interpreting paper drawings.

Boeing 777 & 787

The aerospace industry is in the forefront of the push towards digital prototyping. Digital mockups appear to have been standard in the industry since the early 1990s. For example, the Boeing 777 was designed entirely on computer in CAD software which allowed a virtual aircraft to be assembled in simulation to check for interferences and to verify proper fit of the many thousands of parts, thus reducing costly rework. Boeing also used digital prototyping to support large-scale collaborative engineering design reviews,

Piping model superimposed onto a point cloud.



The Royal Institution of Naval Architects

Marine Heavy Transport & Lift III

26-27 October 2011, RINA HQ, London

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Second Announcement and Call for Papers

The marine heavy transport and lift sector has enjoyed a buoyant and growing market due to the boom in offshore oil & gas and large project cargo work. Current oil & gas prices have led to an increase in the number of offshore project requiring transportation, installation or removal of a wide range of structures and modules. The project cargo transport market has been growing, particularly power generation and refineries work in US, South America, Africa, India, Pakistan and China.

As the structures and cargo become bigger and heavier and destinations seemingly more difficult to access the market is looking for more and better equipped vessels. There are also increasing safety and greater environmental concerns for all aspects of marine operations. The new generation of heavy lift vessels designs are responding to the demand for higher lifting capacity and larger outreach. There are also an increasing number of new designs concepts aimed at servicing this increasing demand in the marine heavy transport and lift industry.

This conference, the third in the series from RINA, aims to bring together naval architects, operators, project engineers, warranty surveyors and designers to examine the various design and operational issues associated with this industry. Papers are invited on all related topics including the following.

- Current design and operational experience
- Float over and float off; offshore discharge
- Station keeping
- Propulsion system redundant
- Ballast control, stability and stress monitoring
- Weather routing
- Design criteria for short trip scenarios
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production illustrations and other uses of CAD data outside of engineering. Over 3000 assembly prototypes were eliminated and virtually all aerodynamic modelling was done without physical models in a wind tunnel.

Boeing expanded digital prototyping for the Boeing 787 which led to even fewer physical prototypes and saved time and money in other areas as well. For example, at one point, the chief pilot for the 787 was doing a virtual test flight and was able to see some issues related to fin control. Using a digital prototype, designers were able to evaluate 50 new possible fin configurations, test them and make the appropriate changes to the rest of the design in only about four weeks. With the old way of working, Boeing might have only been able to evaluate three or four new fin configurations and it would have taken at least three or four months.

Jaguar Land Rover's Virtual Cave.

Jaguar Land Rover

The automotive sector has not fully integrated digital mockups into their entire organisations as compared to the aerospace industry but several interesting applications of the concept have appeared such as Jaguar Land Rover's Digital Cave, introduced in 2008. It allows engineers to simulate testing in wind tunnels, drive vehicles in a variety of conditions and to design mechanical components. Instead of looking at a computer terminal however, it lets engineers enter a "cave" surrounded by acrylic screens onto which images with 4096 x 2160 resolution are projected. Jaguar Land Rover says this tool has saved more than £8 million in development costs by allowing better communication and understanding.

Digital prototyping in shipbuilding

The shipbuilding industry has started to use some aspects of digital prototyping recently though not as commonly as in other sectors. Shipbuilders are utilising digital prototyping for Finite Element Analysis (FEA) and increasingly for Computational Fluid Dynamics (CFD) calculations. A number of shipyards are also using Virtual Reality for design review. However, none of these tools is used as extensively as in the airline or automotive industry at the moment. With shipbuilding-related CFD for example, despite some quite impressive academic research being generated by academics, shipbuilding CFD is still approximately where FEA was about 20 years ago.

Furthermore, notwithstanding the strides being taken by numerous shipbuilders to adopt the digital approach, simple two-dimensional, paper drawings created in basic software are still the norm in most shipyards. Even when 3D models are used for design review it is usually only managers and engineers who are using the data. Workers in the shipyard rarely participate in these reviews as they do in the aerospace industry. Because of this lack of inclusion, designs are not always optimised for efficient production.

Shop floor 3D: Shintec Hozumi

In other industries, efficiency is enhanced via extending the digital prototyping concept beyond the office to incorporate shop floor 3D. For instance, an example of a company using what a Japanese Manufacturing textbook calls this "familiar use of 3D data at the workplace," is a company named Shintec Hozumi.

Shintec Hozumi manufactures automobile production facilities and factory distribution systems. Large monitors and displays on carts are installed across the plant so that staff can search for required manufacturing information as well as refer to 3D data. As a result, production staff members are able to directly access information that shows the 3D shapes of products being assembled alongside information such as part names, and so on. The company has found that this tool aids in communication and productivity.

Why shipbuilding lags other industries.

There are several reasons why the industry has not adopted these cutting edge technologies as extensively as in the plant, aerospace and automotive industries. A number of monetary, structural and cultural forces reduce the likelihood that time, effort and money will be spent on design and engineering including the facts that:

- Shipbuilding is more complex (far more parts)
- Design & Engineering is a smaller proportion of cost
- Smaller series runs reduce design cost amortisation
- There is a requirement to make money on each ship
- Tendency to build before design is complete
- Lack of payment during the design phase
- Smaller industry reduces influence amongst technology providers
- High fragmentation of the shipbuilding

The Royal Institution of Naval Architects

International Conference on the Education and Professional Development of Engineers in the Maritime Industry

7-8 December 2011, Newcastle, UK

First Notice & Call for Papers

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As the global maritime industry emerges from the its downturn in recent years, the key to its future success will be innovation in every aspect. And in an industry which is technologically led, such innovation will be provided by engineers who have the professional skills to meet its future demands. They will need to have achieved the knowledge and understanding which underpins those professional skills while at university, and to have developed them through training and experience after graduation. But what are those skills which the maritime industry of the future requires, how are universities and colleges to provide the graduates who are able to develop them, and what is the role of industry in enabling those skills to be developed?

The International Conference on the Education and Professional Development of Engineers in the Maritime Industry will bring together representatives of both industry and academia to present and discuss how those engineers who will be the key to the industry's future success will achieve the knowledge, understanding andprofessional skills which industry needs, both today and in the future. The conference will compare the differences in the requirement and delivery of education, training and professional development in different sectors of the industry and in different countries, seeking to both learn and benefit from such differences.

Papers are invited on the following topics:

- Industry's current and future requirements for professional skills
- Curriculum development - mechanisms for ensuring that education providers are responsive to industry requirements
- Collaborative provision, including experiences of educational and CPD programmes delivered by several institutions on more than one site.
- International developments, including: education's global market; the international student experience; programme delivery on a satellite campus
- E-delivery - successes and failures in delivering programmes remotely, including: web based material, video streaming, and live delivery via video link
- Visas and permits - the impact of governmental policies on the provision of educational programmes
- Accreditation - international recognition of nationally accredited programmes, and the future of accreditation

Contributions are also welcomed from graduates on their experience and views on how their education fitted them for their careers.

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industry reduces competitive need for productivity
- There are many Shipbuilding CAD/CAM Software vendors (lack of standardisation)
- There is a lack of large immediate payoff for change.

However, there are trends and technologies on the horizon that could help deal with these issues.

Utilising shipbuilding specific software

One way of helping shipbuilding catch up with other industries is to piggyback on the R&D efforts of CAD vendors focused on other industries. Niche shipbuilding CAD software developers do not have the R&D budgets to help implement cutting edge technologies while larger CAD vendors are more focused on the larger aerospace, automotive and oil & gas businesses. A way to get the best of both worlds is to utilise a CAD software package optimised for shipbuilding yet closely tied to a larger vendor with strong R&D capabilities. For example, ShipConstructor software is a niche shipbuilding application built on top of an AutoCAD foundation from Autodesk Inc., a company that is actively pursuing development of all of the technologies described in this paper.

Cloud computing

The size and complexity of shipbuilding 3D models present technical difficulties for digital prototyping and shop floor 3D but, cloud computing could help solve this problem since cloud computing harnesses the immensely increased processing power of distributed computers around the world, scaling to the needs of usage at any given time. If an entire shipbuilding model was stored on the cloud and all computations were performed on the cloud, only a remote viewer would be needed to download the results so data transfer time would be less of an issue. Furthermore, since cloud computing typically entails a Software As A Service, pay-per-use model, the cost to a naval architect or shipbuilder could be reduced because less hardware and software would need to be purchased. Companies such as ShipConstructor are currently investigating implementing cloud-based solutions.

Display installed in factory shows products being manufactured. Photo from: "Improving Lean Manufacturing Through 3D Data," by Hiroshi Toriya.

Parallel processing

Perhaps the most noteworthy technological development that could solve the complexity problem is the fact that new hardware is increasingly utilising parallel processing. This is happening at the CPU level via multi-core technology and can also be seen with recent trends in Graphics Cards. The performance improvement of the additional processing units is largely dependent on the implementation of the software programme architecture. If CAD vendors adapt their software to take advantage of this development in hardware architecture, performance will be dramatically improved. Both Autodesk and ShipConstructor have recognised this and are developing software in such a way as to utilise the power of the increasing processing units.

Implementing a scalable solution

The main cost of implementing new technology is the cost of developing new business processes and training, not purchasing hardware and software. Therefore, a scalable solution is generally recommended. Costs can be spread out over time and resistance from employees can be lessened if new methods are introduced in a gradual, step by step fashion. Fortunately, there are modular shipbuilding software packages such as ShipConstructor that can be implemented in a scalable fashion.

Conclusion

Shipbuilding is a complex industry with a unique structure. While some shipbuilders are utilising new technologies such as laser scanning, digital prototyping and shop floor 3D, these technologies are not as common as they are in other industries. There are several reasons why this is the case and these reasons involve complexity, culture and money. Fortunately, new technological developments are helping mitigate each of these factors. These factors include scalable shipbuilding software solutions tied to large generic CAD vendors with high R&D budgets, Cloud Computing and Parallel Processing. *NA*

Azipod design reflects unerring drive for efficiency gains

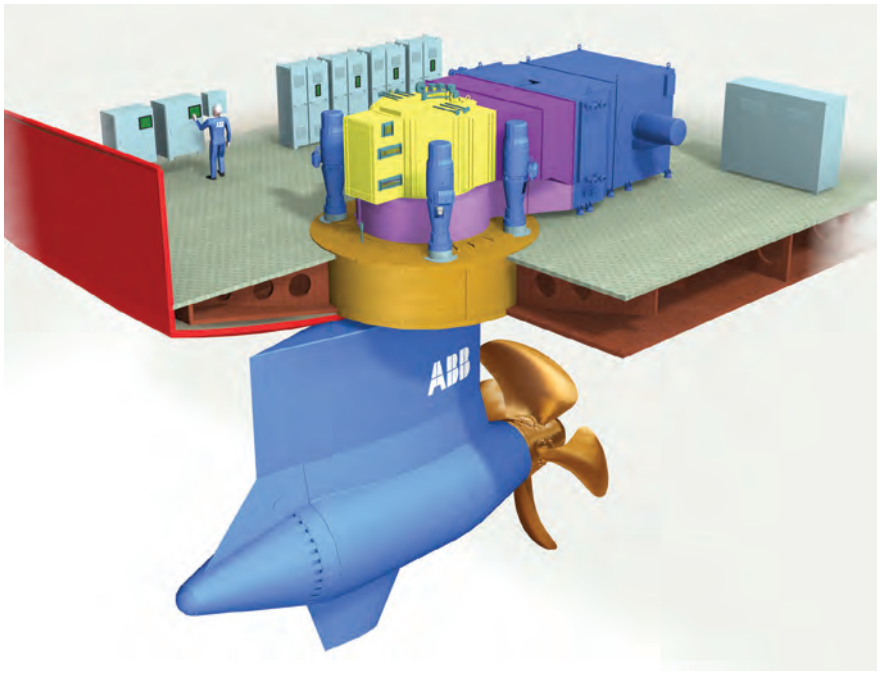
Since the market introduction of the Azipod concept during the late 1980s, the propulsion's hydrodynamic efficiency has been continually improved, and the unerring drive for further gains in performance is reflected in new refinements involving both pod design and operating systems.

The seminal installation of Azipod azimuthing podded electric propulsors on the Carnival cruise ships *Elation* and *Paradise* commissioned in 1998, effectively the start point for the system's widespread adoption in large, luxury cruise vessel newbuilds, drew on favourable technical comparisons. From full-scale measurements with earlier sisterships incorporating traditional shaftlines and propellers, it was demonstrated that the Azipod-fitted *Elation* and *Paradise* offered an increase of some 9% in propulsion efficiency.

"Since then, we have improved the system by another 9%," said Jukka Varis, ABB Marine's vice-president for product management propulsion products, in charge of Azipod R&D.

This enhancement has been achieved over time through modifications to the design, including the use of a fin under the pod, changes in the shape of the unit, and by hydrodynamic optimisation of the positioning and angular placement of the pods once integrated with the hull. The improvement process has most recently been encapsulated in the Next Generation Azipod, launched in 2008 under the Azipod XO brand, which achieves a 1.5%-2% rise in hydrodynamic efficiency relative to the most highly optimised models of the first generation.

The technical evolution of Azipod has thereby delivered an overall progression of some 18% in propulsion efficiency in relation to conventional shaftlines at the time when the first systems were ordered for *Elation* and *Paradise* in the mid 1990s. However, acknowledging that shaftline electrical propulsion systems have also increased in efficacy over this period, ABB has reviewed the basis for its calculations.



Azipod's new-generation XO series of electric podded propulsion systems signals an advance in efficiency.

"Missing in our equation was the improvement in shaftlines during this time. We obtained some results from our clients, but we decided also to compare shaftlines with Azipod propulsion ourselves, through model tests," explained Mr Varis. "These tests, conducted last year by Marin, in The Netherlands, showed that Azipod propulsion, compared to the latest fixed shaftline propulsion designs, still has a 6%-8% lead as regards propulsion efficiency," he said.

The improved hydrodynamic efficiency displayed by Azipod-equipped ships compared with vessels equipped with traditional shaftline propulsion stems from several factors. The elimination of long shaftlines, brackets and stern thrusters, and simplification of the associated hull design, makes for reduced hull resistance. As a 'pulling' unit, the Azipod propeller functions in an optimum environment, where the water inflow to the propeller is undisturbed, due to the absence of any shaft support appendages in front of the propeller.

Moreover, the flexibility afforded by the Azipod units allows the ship designer freedom and precision as to the location of the propulsors on the hull so as to achieve maximum hydrodynamic efficiency.

A new initiative by the Finnish group has been to enter into a joint research and development study with compatriot company Eniram to optimise the energy efficiency of Azipod installations. The result is a product known as the Azipod Dynamic Optimizer(ADO), designed to

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improve sailing economy with a twin- or multiple-pod configuration by fine-tuning the steering toe-in angle of each pod at different speeds, in accordance with prevailing sea and wind conditions.

The tool is based on the incorporation of Eniram's vessel management system into the Azipod unit. ADO complements the static optimisation undertaken at the ship design stage.

By ascertaining the optimal toe-in angle of each pod in real time throughout the vessel's operating profile, it is claimed that the fully-automatic solution can confer fuel savings up to 2%. ADO lends itself to retrofit applications as well as to newbuilds.

Determination of the optimal angle is based on a pre-calculated model taking account of the vessel's speed through the water. ADO outputs the optimal toe angle for use by the steering system. As the technical foundation for the new product, Eniram's vessel management system was initially developed for dynamically monitoring and optimising trim, where even minor adjustments can have a substantial impact on vessel performance.

ABB Marine is bringing its expertise in Azipod technology to an European Union (EU)-sponsored, collaborative research project investigating a way of improving ship energy efficiency by combining three propulsion concepts, including podded propulsors. Known as TRIPOD, the 30-month study was launched last November to explore the feasibility of a novel propulsion system based on the integration of podded propulsion and CLT end-plate propellers, together with the counter-rotating propeller(CRP) principle.

Besides ABB, the research consortium comprises the Spanish company Sistemar, famed for its CLT(contracted and loaded tip) propeller technology, plus VTT Technical Research Centre of Finland, shipowning group A.P.Moller-Maersk, Spanish hydrodynamic centre CEHIPAR, and design system specialist Cintranaval-Defcar.

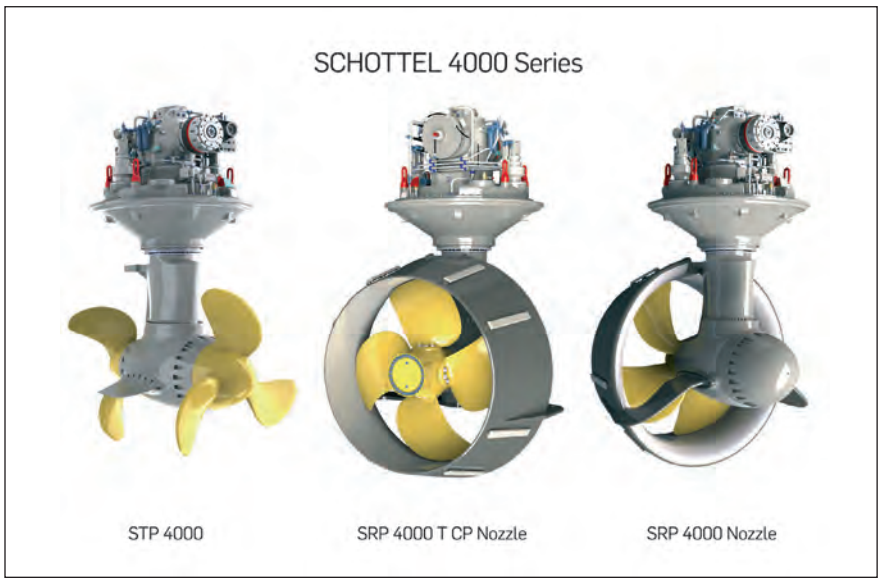
Central to the TRIPOD study and its EU funding is the possibility of improving the energy efficiency of commercial vessels through improved propulsion arrangements. *NA*

Schottel raises its game with enhanced range

Constancy in its commitment of resources to research and development, has a signal bearing on the scope and competitiveness of the propulsion solutions offered by Schottel.

The product portfolio has been substantially augmented and enhanced since last year with the release of new models of proprietary SRP Rudder-propellers and STP Twin Propellers, controllable pitch propellers and transverse thrusters. The SRP and STP series are based on the same operating principle, whereby rotation can be made through 360degs, to deliver the requisite thrust in any direction and confer precise vessel manoeuvring and position-keeping capabilities.

The STP thruster is equipped with two propellers rotating in the same direction, and incorporating the same diameter. The configuration increases the active propeller area and efficiency while reducing propeller load and associated noise generation. The relative arrangement of the 'pulling' and 'pushing' propellers is such that the vortex of the front propeller passes between the blades of the rear propeller without the cavitation swirl created by the blade tips of the former striking the blades of the latter.



Schottel's 0320 series of thrusters is the uprated successor to the SRP/STP 110 models. The new range includes the first Rudder-propeller of its size to be offered with a nozzle.

A compact new generation of azimuth thrusters has been added to the Rudder-propeller offering, in the shape of the SRP 4000 type. Particular attention to structural mechanics and hydrodynamic

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design has resulted in a 20% weight reduction compared to units of the preceding series of azimuth thrusters.

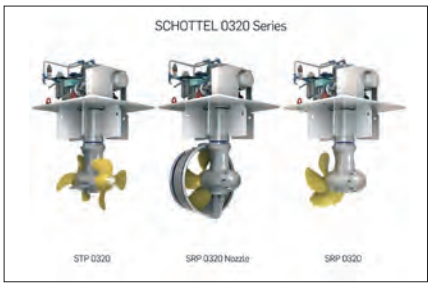
Other features of the SRP 4000 include integrated steering hydraulics and a noise-optimised gearbox designed for a large range of input speeds and requiring about 35% less in the oil charge. A propeller nozzle tailored to the new design has been prepared for high speed applications, while the SRP 4000T variant has been developed for terminal tugs of 80t bollard pull capacity or more.

The SRP 4000 can be used in Schottel Twin Propeller(STP) configurations where a relatively high service speed is required, as with ferries and offshore supply vessels.

The company has also released a new, small Rudder-propeller thruster, the SRP 0320, suited to power applications of 150-220kW at 1800/2300rpm, and additionally available for STP Twin Propeller applications. The design reflects close consideration of the specific requirements of the small-vessel market as regards not only operation, but also installation and servicing. For instance, an integrated hydraulic system makes for a 'plug and play' fit, eliminating work aboard the vessel.

One version of the SRP 0320 Rudder-propeller can be supplied in a nozzle. This is the first time that a Rudder-propeller of such small size has been available with a nozzle, and has been developed to give more thrust and manoeuvrability in shallow waters. The new series is the successor to the SRP/STP 110 models.

Furthermore, Schottel has introduced a completely re-engineered series of transverse thrusters covering the power band from 600kW to 1500kW under the designations STT 1-STT 5. The research and development programme for this range has resulted in more efficient, hydrodynamically optimised propeller design, with lessened noise and reduced losses at low or zero propeller pitch.



The 4000 series represents an entirely new generation of azimuth thrusters, and reflects Schottel's R&D work in structural mechanics and hydrodynamic design.

Demanding criteria for dynamic positioning of offshore vessels have been taken into particular account. Propeller blade tip speed and propeller load have been reduced to the practical minimum, in the interest of the service life of drive seals, bearings, propeller hub and blades. *NA*

Advanced Mermaid system chosen for Germany's cruise ship

Up-market operator Hapag-Lloyd Cruises has endorsed the Mermaid podded electric propulsion solution, ordered by shipbuilding contractor STX Europe for the German company's 39,500gt luxury vessel *Europa 2*.

Larger than the company's current flagship, the 1999-built *Europa*, the newbuild has been specified with two Mermaid pods, each using 7.25MW synchronous electric motors and PWM(pulse width modulation) converter technology.

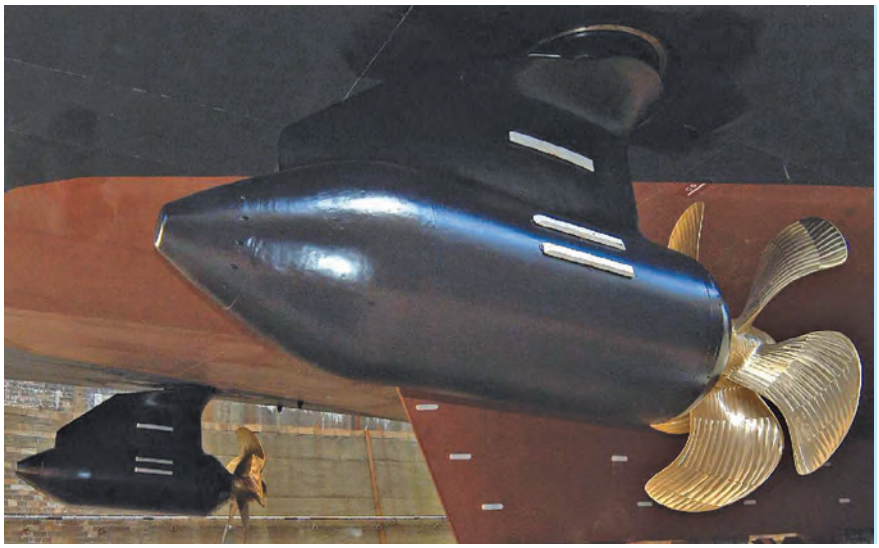
Europa 2 is scheduled to join the Hapag-Lloyd fleet in 2013, following delivery from the St Nazaire shipyard in Loire-Atlantique. The French industrial input to the project includes major elements of the electric drive system.

Jointly developed by Converteam and Rolls-Royce, and applying and melding the two groups' strengths in the electrical, mechanical and hydrodynamic disciplines, the Mermaid system has undergone a number of refinements impacting on power density, operating efficiency, compactness and reliability.

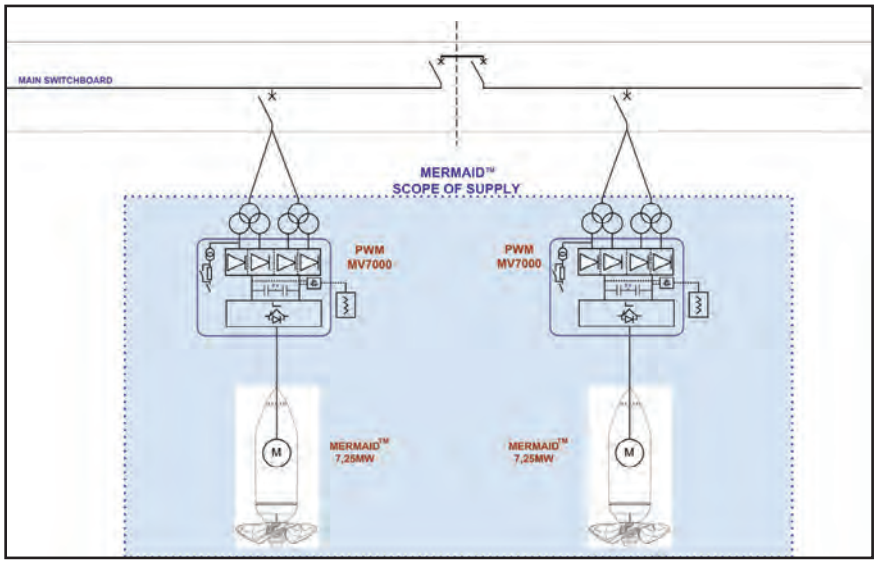
The Hapag-Lloyd project demonstrates the receptiveness from a highly respected quarter to the attributes of the latest generation of pod and the nature of the drive technology employed. It provides a vitally important new reference for Mermaid in the face of stiff competition from the market-leading Azipod brand. In fact, the current Europa had been among the first recipients in the cruise sector of the Azipod system.

The current range of Mermaid pods offers five frame sizes from 1850mm to 2770mm motor stator diameter, covering the 5MW-27MW power band. As a consequence of advances in electric motor power density, pod diameters can be reduced, allowing a more streamlined form for the nacelle, improving efficiency. Both induction and synchronous motors can be used, although the latter have a somewhat higher efficiency.

The solution adopted for Hapag-Lloyd's nascent cruise ship combines Mermaid optimised hydrodynamic performance with the latest PWM converter technology to meet the owner's requirements as to reliability, robustness, system compactness, and low levels of noise and vibration, as well as manoeuvrability and overall efficiency.



Two 7.25MW Mermaid pods have been specified for Hapag-Lloyd Cruises' luxury newbuild *Europa 2*.



The Mermaid propulsion systems for *Europa 2* use the latest converter technology, offering benefits in efficiency, availability and compactness.

The PWM MV7000 converters allow electrical energy to be converted from a given level of voltage, current and frequency to another through the use of high-grade switching components, in the

shape of press-pack insulated gate bipolar transistors(IGBTs). With an intrinsic capacity to limit any overcurrents and a high switching frequency capability, the IGBT technology makes the drive easy to control and results in a very compact design.

The main benefit of this type of inverter arrangement is the low level of current harmonics, resulting in reduced motor electrical losses and AC supply harmonics, and power factor optimisation. Consequently, motor efficiency is high and harmonic filters are no longer necessary. It is claimed that a Mermaid system based on PWM-type MV7000 converters improves compactness and layout flexibility of the propulsion system as a whole and lessens installation and maintenance time and costs.

Converteam's marine technical director Loic Leclere claims that Converteam's PWM MV7000 drives using press-pack IGBTs have taken pod propulsion a step forward. Press-pack IGBTs are regarded by the company as among the best high voltage components available today. The technology has already been used on recent vessels such as Norwegian Cruise Line's St Nazaire-built, diesel-electric, propeller-driven *Norwegian Epic*.

The 7.25MW synchronous motors for *Europa 2* will be manufactured at the Converteam plant in Nancy, while the power converters will come from the group's Massy drive factory. Mermaid mechanical and hydraulic parts will be produced at Rolls-Royce's Kristinehamn facilities in Sweden, and final pod assembly and tests are scheduled to be undertaken at Nancy next spring.

The immediately preceding order for a Mermaid system arose from the French Navy's investment in a third Mistral-class amphibious assault, command and force projection ship. Under construction at St Nazaire, and due to be commissioned in 2012, the all-electric Dixmude is to be fitted with two 7MW Mermaid pods.

Whereas PWM technology has been chosen for Hapag-Lloyd's *Europa 2*, the synchronous motors in the Dixmude will be fed by synchroconverters. The same arrangements were adopted for the first two ships of the class, *Mistral* and *Tonnerre*, completed in 2006 and 2007, respectively.

In parallel with the Mermaid 'pulling' pod system, Converteam offers another design of podded electric propulsor using a 'pushing' propeller and based on the pump jet pod concept. Developed in concert with French naval defence group DCNS, the system is known as Inovelis and serves a similar power range to that covered by Mermaid.

Compact in form and promising high efficiency due to the nature of its integration with the hull, Inovelis employs induction motors fed by PWM converters. It is an untried system as yet.

Converteam says that the choice between Inovelis and Mermaid is dependent on the specific vessel application and owner's criteria, and that the group's track record in podded propulsion and electrotechnical engineering allows it to support a yard and client in defining the right pod solution and optimising integration of the propulsor with the hull. *NA*

Clutch of orders for next generation Azipod

ABB's second-generation Azipod system has been endorsed by Norwegian Cruise Line for the company's latest stage of fleet development.

Two 17MW Azipod XO units have been chosen as part of a comprehensive power and propulsion package for each of two 143,500gt newbuilds ordered at Meyer Werft. The 4000 passenger-capacity vessels will be the largest cruiseship ever to have come from a German yard.

Market receptivity to the enhanced design was previously expressed in Celebrity Cruises' nomination of the system for a new Solstice-class vessel contracted with Meyer Werft, and in a Japanese project thought to involve a brace of ro-pax ferries.

The 126,000gt *Celebrity Reflection,* the fifth Solstice-class newbuild from the Papenburg yard, had originally been specified with first-generation Azipod VO drives, as selected for the four preceding ships in the series. However, once the new version became available last spring, the order was changed to a pair of XO pod systems. The vessel has a double-occupancy passenger capacity of 3030 passengers and is due to be handed over in November 2012.

The decision to change the specification was largely influenced by the possibilities offered in reducing both fuel consumption and equipment costs, since the use of XO drives enabled power to be reduced to 2 x 17.5MW from approximately 2 x 20MW.

Maximum speed is about two knots less than that of the earlier Solstice-class vessels, although the lower speed is partly a factor of the slightly larger dimensions of the fifth newbuild. The difference in power input has been achieved through the higher efficiency of the XO pod in spite of the reduced torque of the motor and the smaller propeller diameter.

No details have as yet been officially released as to the Japanese project involving the first order for the new design of Azipod, although this is believed to involve an Azipod CRP propulsion configuration for each of two newbuild ro-pax ferries. In such an arrangement, an X-series pod would be mounted directly behind, and with its integral propeller counter-rotating in relation to, a mechanically-driven shaftline propeller. The concept was first employed on the exceptionally fast, Shin Nihonkai ferries Hamanasu and Akashia, completed by Mitsubishi Heavy Industries in 2004.

Shin Nihonkai has booked two similar ro-pax ferries from Mitsubishi, for delivery in 2012. As with the earlier pair, the new ships will be distinguished by a high service speed of at least 27.5knots. *NA*

Addressing challenges of station-keeping in ice

With offshore exploration taking vessels out to further inhabitable places, being able to place the vessel exactly where you want it is of vital importance.

Increased investment in exploration and development of oil and gas resources in the Arctic region, including projects in deep water areas where mooring is either costly or impractical, presents new challenges and opportunities for station-keeping solutions. The environmental matrix with which drill ships, support vessels and icebreakers have to contend in day-to-day operations is intensified by ice and ice drift.

While considerable experience has been accumulated by the marine industries as regards dynamic positioning(DP) for exploration and production in open waters, practical know-how is as yet limited with regard to extended-period, precise position-holding in difficult, heavy ice conditions. Moreover, emerging market demand points to a need for increased facilities offering DP systems for ice model testing to investigate the station-keeping behaviour of ice-going vessels and offshore units incorporating extensive thruster systems, notably drilling vessels.

Against this back-drop, a collaborative research project known as DYPIC(Dynamic positioning in ice-covered waters) has been launched under the European Union (EU's) Era-Net Martec programme, with financial support provided by the German Federal Ministry of Economics and Technology(BMWi). The project consortium has the remit of examining the performance of DP systems in ice, and delivering guidelines and procedures that will benefit future operations and technology.

DYPIC is a 30-month study due to be completed in December 2012, in which Hamburg Ship Model Basin(HSVA) is playing a central role. The German organisation is joined in the project by French research institute Sirehna and Norwegian partners NTNU, Kongsberg Maritime, Det Norske Veritas, and Statoil.

Once DYPIC has been completed, HSVA will be equipped to carry out the most demanding model tests to evaluate station-keeping in ice conditions worldwide. This will allow systematic investigation of the boundaries of operations in different ice scenarios, and consequently enable industry users to better examine the feasibility of planned operations and solutions. *NA*

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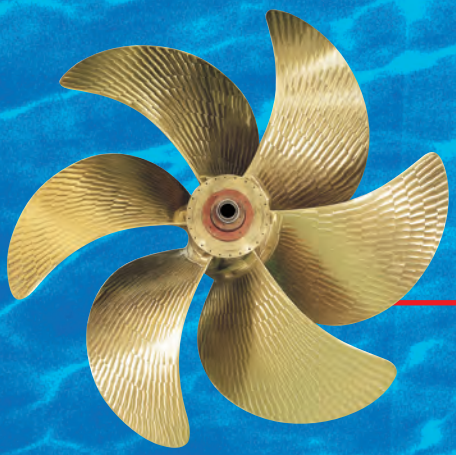

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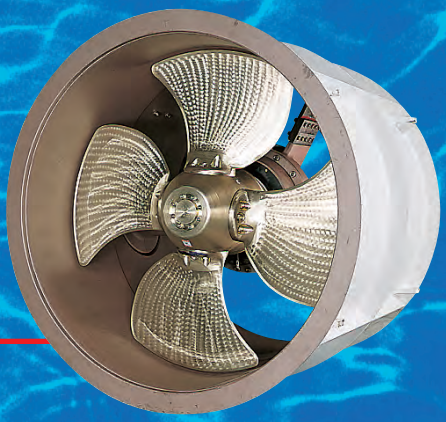

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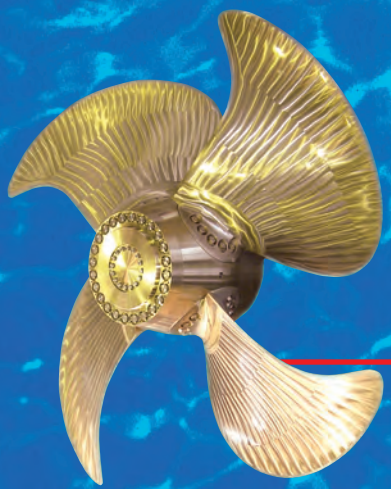

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ABB services boosts Azipod appeal

Azipod specialist ABB is now offering customers more through its service centres.

Long-term service agreements are now being offered for Azipod propulsion systems wherein designer and manufacturer ABB Marine provides customers with an undertaking for overall service costs during the period involved. "We tell the client that we believe service will cost a certain amount during the first five years, and this much during the following five years, including drydocking service, work and spare parts. If it costs more than expected, the customer will not see(incur) this," explained Antti Ruohonen, the company's director for propulsion product services.

Under such agreements, ABB offers complete shaft line maintenance and repair, including bearing changes, with the aim of ensuring product reliability in operational service, reducing maintenance costs and clarifying responsibilities. All maintenance tasks, spare parts, and service plans are agreed beforehand, in a single package. The approach is intended to raise the efficiency of the service programme, reduce costs and avoid delays.

In addition to the global network of marine service centres covering ABB products, the company also has dedicated Azipod regional service centres, located in Houston, Shanghai, Murmansk, and at the Azipod factory in Helsinki.

Besides increased hydrodynamic efficiency, and engineering enhancements including fully electric motor steering and a new, hybrid thrust bearing technology, improvements expressed in the new Azipod XO series include better internal accessibility, and an aggregation of measures claimed to offer the potential for reductions of up to 50% in lifecycle costs.

From the outset of the development of the second-generation product, simplified service was a key consideration. According to Antti Ruohonen, it was felt that it should be possible to service, and even replace, the most critical components without drydocking the vessel. New bearing and seal arrangements have been devised which allow service and, if necessary, replacement to be effected from within the pod, on larger units.

"We developed a new type of shaft sealing which can be replaced from inside the pod, without the need for drydocking. We developed the sliding thrust bearing in a way that allows the wearing parts, the thrust pads, to be replaced from inside the pod," confirmed Mr Ruohonen.

The hybrid bearing at the aft, non-drive end of the Azipod shaft, carrying the system's thrust loads, is a new innovation by ABB, combining the advantages of two different bearings. It utilises proven roller bearings for radial support of the shaft line, and slide-type bearings to accommodate propeller thrust loads. The slide thrust bearing's white metal pads can be changed by hand from within the pod. The previous design used spheroidal roller bearings.

The new shaft seal solution increases the integrity of the pod and reliability of operations. Known as the interspace concept, this feature makes it possible to service the seals from inside the pod. Access for the technician is afforded by way of three small openings in the Azipod's forward area.

It is claimed that shaft seal replacement at the drive end can be accomplished in one day, and that changeover of thrust bearing components can be effected in about eight hours, thereby allowing critical parts to be replaced during the course of a regular port call.

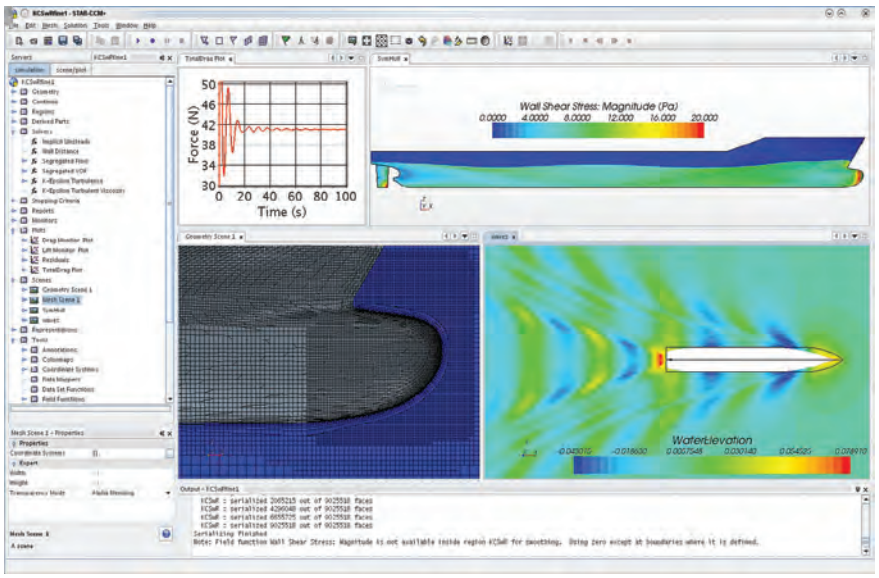
Moreover, the turning shaft seal, located between the hull and the vertical pod structure, can now be changed from below. Provided the vessel can be trimmed so as to sufficiently raise the upper part of the pod above the water surface, this can obviate the need for drydocking.

Azipod XO includes a sophisticated propulsion condition monitoring system(PCMS) to oversee all critical parts, including the propulsion drives and the bearings. PCMS collects data from multiple sources, processes the information and produces displays of the system's status for the crew. It registers the condition and wear of key components, and delivers early indications of maintenance needs, improving the predictability of ship operations. The system also allows remote diagnostic monitoring from technical offices ashore. *NA*

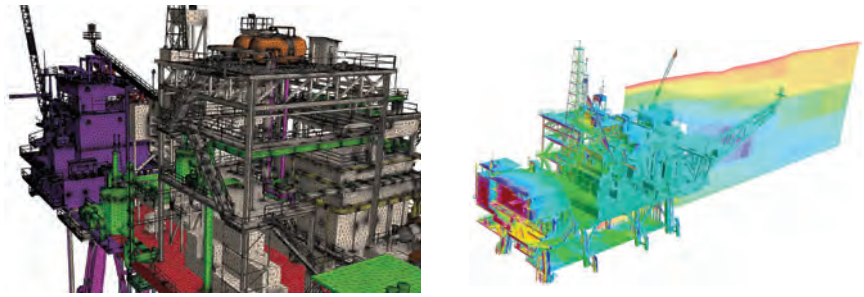
Setting the trends for CFD for Maritime Flows

Increased hardware power and progress in various aspects of the flow solvers allow more sophisticated applications and wider scope of applications. Milovan Peric, CD-adapco and Volker Bertram, Dept. Mech. Eng., University of Stellenbosch explore the trends in CFD applications for maritime flows.

Computational fluid dynamics (CFD) projects today are often noticeably shorter than they were two decades ago. This is due to considerably improved pre-processing and post-processing. The progress in user-friendliness is perhaps best illustrated in the case of integrated design environments, which have lowered the thresholds in using CFD for designers. For example the Friendship Framework combines freeform hull description using parametric modelling, interfaces to most modern CFD solvers including STAR-CCM+, several optimisation algorithms, and software to handle process management and user interface. The design engineer can then work on simulation driven designs (e.g. of hulls, appendages or propellers) with one integrated user interface from model generation to post-processing.



Integrated design environments allow simulation driven designs (Friendship Framework).



Re-meshed surface of a complete oil rig after surface-wrapping (left) and simulated air flow field around the oil rig (right).

Many more aspects have advanced the wide acceptance of CFD in industry:

- The ability to handle complex geometry with all relevant details, including moving parts
- Efficient simulation process (from geometry to solution, parametric studies, optimisation studies, user interface...)
- Adequate modelling of turbulence, free-surface effects and cavitation
- Coupled simulation of flow and flow-induced motion (and in some cases deformation) of bodies.

These are discussed in more detail in Peric and Bertram (2011).

Key aspects in CFD for maritime flows

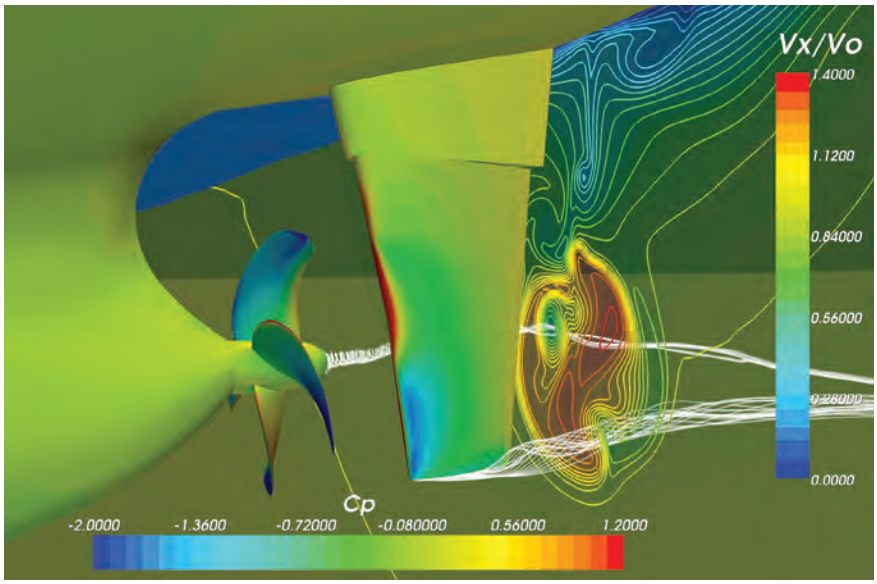
Grid generation has improved, making it easier to generate high-quality grids for accurate CFD simulations. A key aspect for complex geometries consisting of many components (such as offshore platforms in the maritime context) is geometry recognition. The software then recognises automatically cylinders (with extrusion along centreline, using prismatic cells) and thin solids or gaps, with projection from one side to another, using prismatic cells.

More sophisticated analyses for ships and offshore platforms employ a variety of techniques that have become widely available (through commercial and open-source software).

- The ability to handle moving parts using morphing, sliding interfaces or overlapping grids (e.g. propellers, rudders etc.)
- The ability to model complete systems rather than single parts (e.g. ship with all appendages, complete oil platforms, etc.)
- The ability to easily replace geometry and perform a new simulation (automation of simulation process; e.g. ship with and without a wake equalising nozzle).

Turbulence modelling

For most applications in industry, the



Ship with rudder and propeller illustrating the trend towards modeling complete systems.

standard k-ε or k-ω turbulence models are adequate. In order to predict secondary flows better, more sophisticated models are needed. The Reynolds-stress model (RSM) is frequently a popular and appropriate option. A special turbulence model is needed to predict transition from laminar to turbulent flow, e.g. when predicting resistance of a competitive sailing yacht. Such models are also available. For predicting noise sources, wall vibration etc., large-eddy-simulation (LES) or detached eddy simulation (DES) type of analyses with special subgrid-scale turbulence models are used. These are subject to research.

Modelling free-surface effects

Free-surface flows (wave resistance, seakeeping, slamming, sloshing) are of prime interest for naval architects. Interface-capturing methods allow the simulation of highly nonlinear free-surface flows. Resulting quantities of engineering interest, e.g. induced loads in tanks with sloshing, are so well predicted that such simulations are widely accepted by classification societies for load determination in strength analyses. Despite the significant progress in free-surface modelling, research continues in this field, as the modelling of breaking waves can still be improved in terms of air mixing and turbulence interaction with the free surface.

Cavitation modelling

In most propellers and several rudders, cavitation is unavoidable. If cavitation cannot be avoided, its effect on performance needs to be assessed. Despite theoretical shortcomings, cavitation models based on bubble dynamics have proven robust and sufficiently accurate for most industrial applications. RANSE simulations with cavitation modelling have become part of modern design procedures for advanced propulsors. Rudders behind highly loaded propellers are susceptible to cavitation and associated erosion which endangers the ship. CFD is by now regularly employed to predict location and extent of cavitation on rudders in these cases. The concerned regions are then often built in more enduring steel, unless local redesign avoids the formation of cavitation erosion.

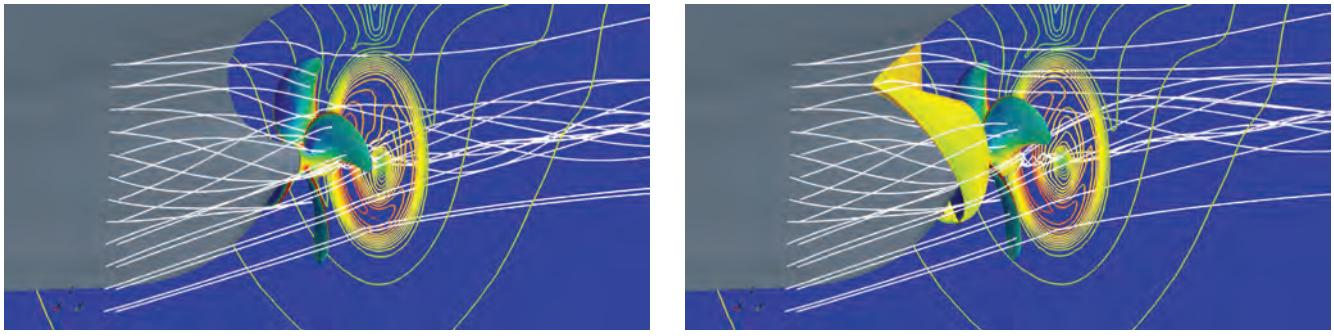
Motion of floating bodies

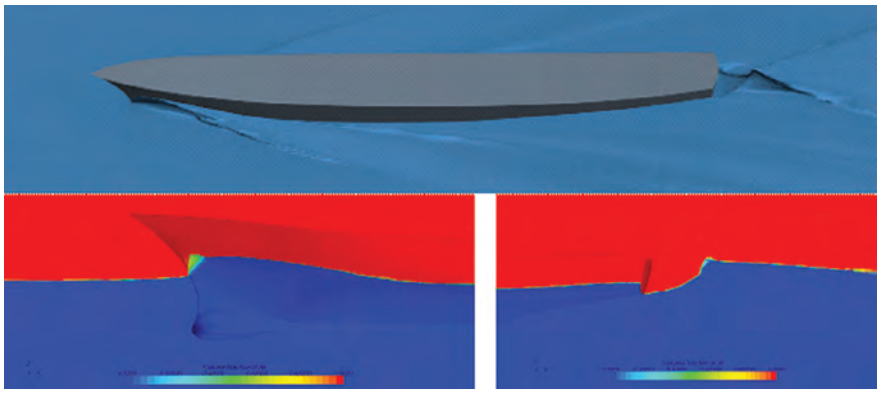
For a variety of seakeeping problems, simulations of flows and flow-induced motions of floating bodies (ships or offshore structures) are desired. Highly nonlinear motions (e.g. launching of free-fall lifeboats with subsequent water entry and resurfacing) are possible due to implicit simulations. Rigid-body motions of freely moving ships have been presented for a variety of applications including many industry projects. The simulations can handle in principle all complexity required in maritime applications, including multi-body configurations moving relative to each other, possible coupling between bodies (via elastic moorings, rigid connections, or flexible links with constraints), inclusion of external forces (e.g. thrusters, mooring, towing), or relative motion of system components (e.g. propellers).

Fluid-Structure-Interaction (FSI)

Coupled simulation of flow and flow-induced deformation of solid structures have evolved more recently for

Analyses of ship without (left) and with (right) nozzle to assess quantitatively the fuel saving effect.





Computed wave field around destroyer geometry; smeared surface at bow and stern where waves break, sharp surface elsewhere.

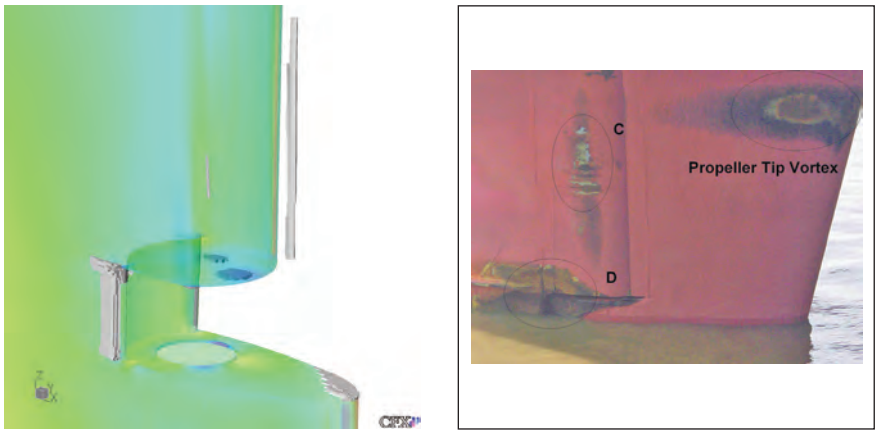
marine applications. FSI is important for relatively soft structures, for very large ships (e.g. whipping and springing) and offshore structures (like floating airports) as well as for better prediction of impact loads (slamming and sloshing). So far, coupling of RANSE CFD codes and finite-element codes (for the structural analyses) is usually explicit, making the computations inefficient and not applicable to most practical problems. Implicit coupling (as already in place for rigid-body motions in waves) is required for robustness and computational efficiency. On the other hand, the structural model can be simplified (e.g. treating the ship as a beam subject to bending and torsion). Such simplified structural models with implicit coupling have already been implemented.

Trends

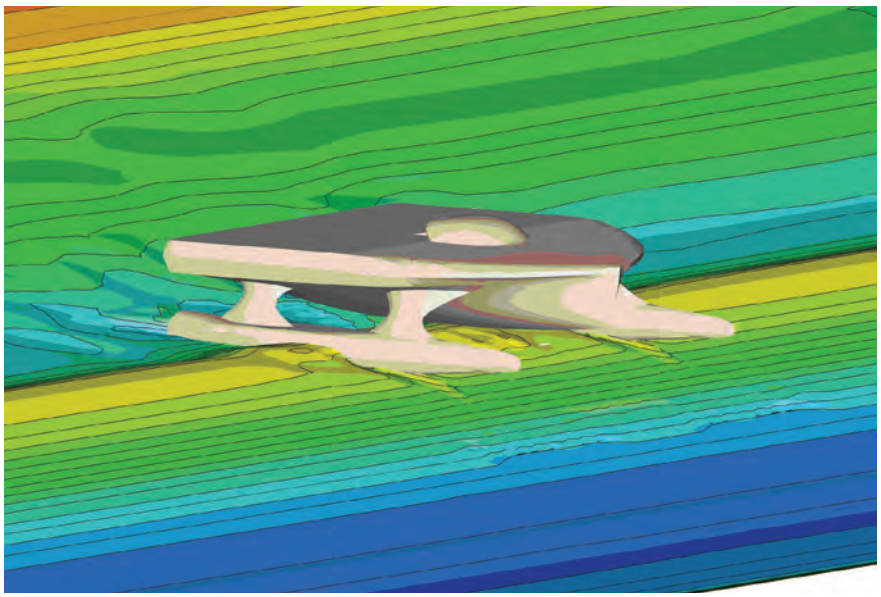
Computer hardware continues to become more and more powerful. Highly parallel computing environments have become affordable even for small and medium enterprises. The appetite grows at least as fast as the more powerful capabilities become available. Higher demands from simulations come in various forms:

- More complete system analysis, with all geometrical details
- More transient simulations
- Prediction of pressure fluctuation and noise sources (turbulence, cavitation)
- More fluid-structure-interaction and other multi-physics application
- Simulation of full manoeuvring tests already in conceptual design
- Simulation of interaction (ship + ice, ship + platform, ship + ship etc.).
- More optimisation studies...

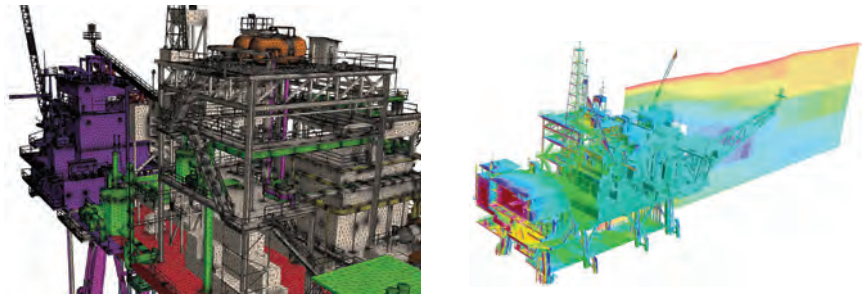
Of the many developments on the horizon, we select for illustrative purposes, namely coupling CFD with formal optimisation in



CFD prediction of rudder cavitation (left) and observed erosion at actual ship (right).



CFD simulations for ships in waves capturing slamming and green water on deck are by now widely applied in industry projects.



Model tests to determine hydrodynamic coefficients (left) are now replaced by CFD (right).

ship design and coupling CFD in simulators for training and assessment purposes.

Design optimisation

In optimisation, the main difficulty lies in the expressing all objectives and constraints in mathematical functions of sufficient accuracy and numerical efficiency. This task requires.

- a smart engineer, who is able to model the problem at hand with just the right level of detail and sets up a design search space that is large enough to find significant improvements, yet small enough to allow efficient exploration
- a tool to help the engineer to convert his model into an efficient optimisation process.

Care is needed when changes in candidate designs are small, as then the required accuracy in turn is high. Fortunately, often the task is to find the design that is optimum, rather than an accurate determination of the object function (e.g. required power) for this design. Thus if the relative ranking is right independent of (similar or constant) errors in objective function the task can be solved even with usual discretisation or model errors. Optimisation software is available to guide an automated simulation process towards a (near) optimum design, combining automatic generation of parameterised geometry, automatic mesh generation, automatic CFD simulation and analysis, and subsequent automatic determination of new parameters.

Simulation of experiments

CFD can be used to generate data sets for subsequent fast evaluation in design and operation. One example are ship simulators, used to train ship crews in the handling of ships. The manoeuvring coefficients for these simulators used to come from dedicated model basin tests. More recently, Voith has replaced model tests by CFD simulations to determine the manoeuvring coefficients.

Final remarks

No matter what the software can do, it remains just a tool. How quickly and well problems get solved depends on the craftsman using the tool – the engineer remains indispensable. In the end, the engineer is paid for his modelling skills, choosing the model that offers reliable and sufficiently accurate answers obtained with minimum cost (in terms of time and money). *NA*

PERIC, M.; BERTRAM, V. (2011), *Trends in industry applications of CFD for maritime flows,* 11th COMPIT Conf., Berlin.

Human Factors in Ship Design and Operation

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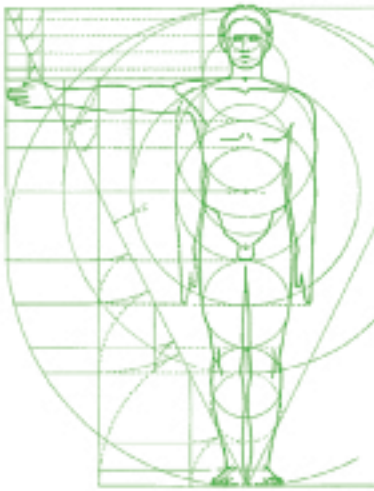
- Design for occupational heath and safety
- Habitability



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Accurate model and full-scale viscous flow computations on propulsors

Marin's Douwe Rijpkema & Guilherme Vaz explain the importance of accurate model and full scale viscous flow computations for propulsors.

A substantial part of hydrodynamic research is related to the design of high-efficiency propulsors. Any increase in propulsor efficiency leads to a reduction of fuel costs. In addition to the optimisation of conventional propulsors, such as (ducted) propellers or water-jets, new innovative concepts are realised, e.g. biomechanical propulsion, large area propulsion and pump-jets. In all cases an accurate prediction of propulsor performance for design and off-design conditions is essential. Viscous Computational Fluid Dynamics (CFD) methods are able to provide invaluable knowledge about the propeller performance and corresponding flow field.

The open-water characteristics (thrust, torque and open-water efficiency) of propulsors are traditionally determined experimentally. Next to experiments, the use of numerical methods in the propulsor design process is increasing. Lifting line methods or boundary element methods (BEM) are still the industry standard and applied in daily practice for propeller design. Recent developments in numerical methods and computational capacities show a shift towards viscous CFD solvers, RANS (Reynolds-Averaged Navier-Stokes) or LES (Large Eddy Simulations) [1]. The advantages of viscous CFD include the improved modelling accuracy, the amount of detailed information extracted from the simulations and the possibility of full-scale analysis.

At the recent The Royal Institution of Naval Architects (RINA) symposium Developments in Marine CFD 2011, a paper was presented by Rijpkema and Vaz [2] of Marin on numerical simulations for propellers in open-water conditions. The main points are summarised in this article. For the calculations the Marin in-house CFD code ReFRESCO was used [3]. ReFRESCO is an unstructured finite volume method, parallelised and targeted for HPC clusters, and solves the multiphase unsteady incompressible RANS equations. It is designed, optimised and validated exclusively for hydrodynamic applications.

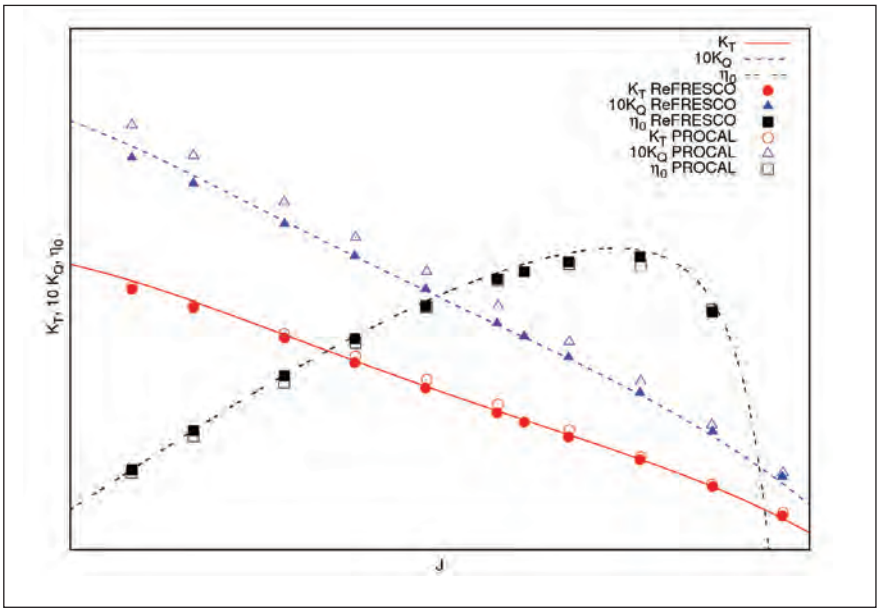


Figure 1: Normalised open water diagrams for a skewed propeller. The lines represent a fit through the experimental values, the filled symbols the ReFRESCO (RANS) results and the open symbols the PROCAL (BEM) results.

For the open-water analysis there were presented, three propeller geometries which selected with varying design characteristics: 1) the INSEAN E779A propeller, a well-known and documented test case [4] with a relatively simple blade geometry and small variations in pitch angle, skew and rake in radial direction, see Figure 3 (top); 2) a contemporary propeller with moderate skew, see Figure 3 (bottom left) used in the European project Leading Edge and tested at SSPA [5]; 3) a ducted propeller as shown in Figure 3 (bottom right) tested at MARIN. The presence of a duct adds additional complexity to the grid generation, the calculation, and the flow. For the latter an investigation of scale effects was made.

Open-water results

The open-water characteristics for the three propellers have been determined both experimentally and numerically. A comparison of open-water characteristics for the skewed propeller is presented in Figure 1. The RANS and experimental results are in good agreement, the trends in the open-water diagram are closely followed and the difference is in the order of 2 to 3% near the design condition and within 5% for off-design conditions. A similar accuracy was obtained for the E779A and ducted propeller in open water for model-scale.

Additional to the CFD and experimental results, a comparison with the potential flow method PROCAL [6] is included. PROCAL is a MARIN BEM potential-flow tool for propeller flow analysis. The potential-flow results presented in Figure 1 also show a good agreement with the experimental results. However, larger deviations are found with experiments than for the RANS results for complex geometries (high skew) and at off-design conditions, especially at higher loadings where viscous effects are not negligible.

Figure 1: Normalised open water diagrams for a skewed propeller. The lines represent a

fit through the experimental values, the filled symbols the ReFRESCO (RANS) results and the open symbols the PROCAL (BEM) results.

Verification and validation

Since the use of any numerical method requires a thorough analysis of the numerical errors involved, an example of the estimation of the numerical error and uncertainty is here presented. The uncertainty of a numerical calculation can be addressed using well-established procedures for verification [7]. There are also modern validation procedures [7], with permit quantitative comparisons between numerical and experimental data. These are also here applied.

For the E779A propeller an uncertainty analysis has been performed at the design point for which a range of geometrically similar grids with varying grid densities was required. The variation of thrust, torque and open-water efficiency for the different grids, ranging from 1.5 to 24 million grid cells, is presented in Figure 2. The corresponding values of uncertainty for different open-water characteristics follow from the numerical uncertainty procedure and are in the order of 3-5% for the design condition.

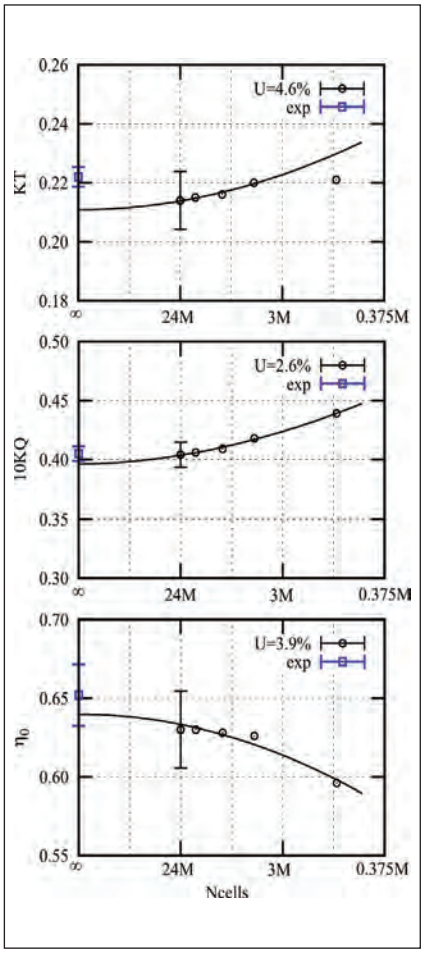


Figure 2: Variation of thrust (KT), torque (KQ) and open water efficiency (η0) with number of grid cells Ncells in (M)illions. The variation for different grids is used to determine the numerical uncertainty (U).

From Figure 2 it follows that for different grid densities a considerable variation in thrust and torque characteristics was found, especially for the torque on coarse grids. For practical purposes a grid of about 10 million cells (full propeller) was chosen for evaluation of the open-water diagram. The open-water characteristics differ only slightly compared with the results for the finest grid, but the computational effort is greatly reduced.

The simulation can be considered validated when the difference between experimental and numerical result is within their combined uncertainty. The uncertainty of the experimental results is assumed to be 1.5% in thrust and torque, based on in-house studies taking into account the reproducibility of different test runs, manufacturing tolerances and uncertainties of the sensors. The deviation between ReFRESCO and experimental results for the design condition was in the order of 1-4% for the open-water quantities, see Figure 2. This is within the combined uncertainty, therefore, validating the numerical solution for this condition. Considering a similar level of uncertainty for the other advance ratios, the open-water results are validated for the major part of the open-water diagram.

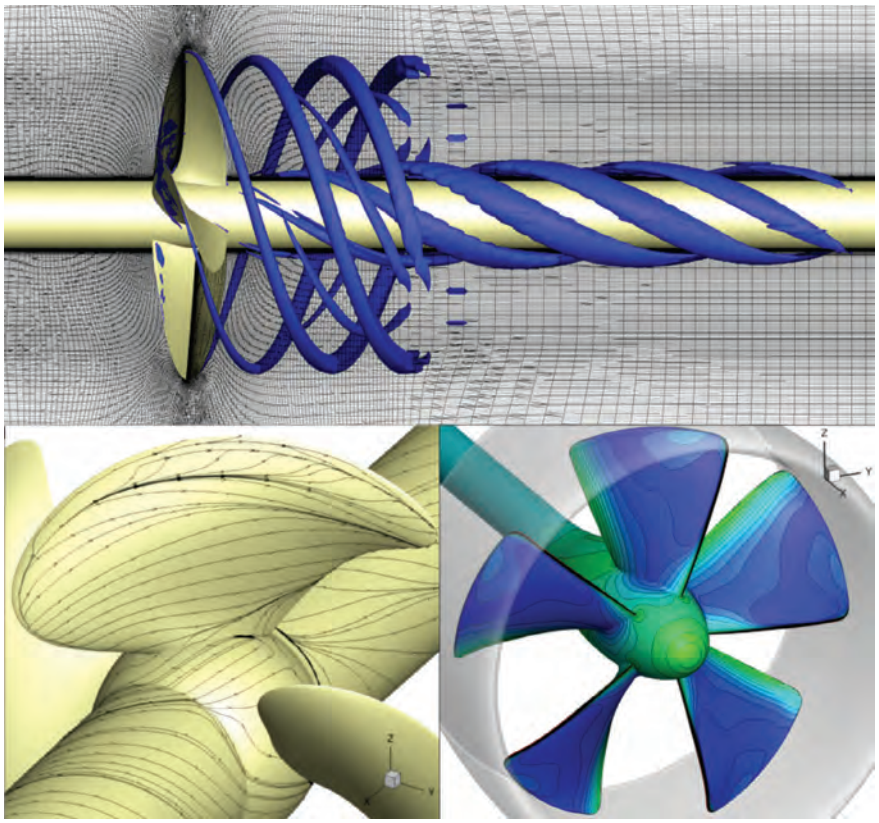


Figure 3: Flow field analysis of E779A (top), skewed (bottom left) and ducted (bottom right) propeller. For the E779A propeller the development of vortices in the numerical domain is visualised. For the skewed and ducted propeller the limiting streamlines and pressure distribution, respectively, are shown.

Flow field analysis

A great benefit of CFD is the amount of detailed flow data available from the numerical simulations. Next to propeller pressure distributions and field velocities, viscous-flow related phenomena, such as separation areas and the development of vortices can be visualised and studied.

Examples of flow field data from the ReFRESCO propeller simulations are presented in Figure 3.

Figure 3 (top) shows the development of tip and blade-root vortices of the different blades for the E779A propeller. The vortex is moved downstream and diffusion of the vortex core is visible. Notice that the tip vortex continues until about ¾ of a revolution, after which the vortex region disappears. This is due to insufficient grid resolution in the downstream part of the domain. Refinement of the grid in the vortex area would be required to follow the vortex more downstream. The blade-root vortex can be followed almost to the end of the domain due to higher (boundary-layer) resolution close to the hub.

Separation, flow re-attachment and the location of vortex formation can be visualised with limiting streamlines. The limiting streamlines, tangent lines to the surface shear stress vector, show (re-) attachment and detachment patterns. In Figure 3 (bottom left) the limiting streamlines are presented for the skewed propeller subjected to a high loading. Separation can be observed on a large part of the leading edge reattaching further downstream. Close to the blade-root at the trailing edge another area of separation is observed. Near the tip detachment lines are visible that show the location where the tip vortex detaches from the blade.

The pressure distribution on the blades and hub for the ducted propeller, shown in Figure 3 (bottom right), provides information about the loading distribution on the blades as well as the location of low pressure areas where cavitation might occur. Clearly, the detailed visualisations of CFD results can provide important clues for further design improvements.

Full-scale simulations

Experimental open-water characteristics are measured for model-scale Reynolds numbers. Usually, these results are afterwards extrapolated to full scale, in order to correct for the different scale of the propeller. Most extrapolation methods only consider that the drag at full scale is lower than for model scale, which results in a slightly higher thrust and lower torque at full scale. Especially for complex propulsors, such as ducted propellers where interaction between the different propulsor components plays a large role, this correction is not adequate and viscous CFD methods can provide a more detailed analysis of the difference between model-scale and full-scale flow.

The change of Reynolds number between model and full-scale has several effects on the flow around a ducted propeller: 1) variation of the lift and drag of the propeller/duct sections due to different boundary layer thickness and separation locations; 2) variation of the induced velocities upstream of the propulsor, consequently changing the local angle of attack of the propeller/duct sections; 3) changes on the interaction of the duct boundary layer with the tip-vortex which consequently alters the loading of the propeller.

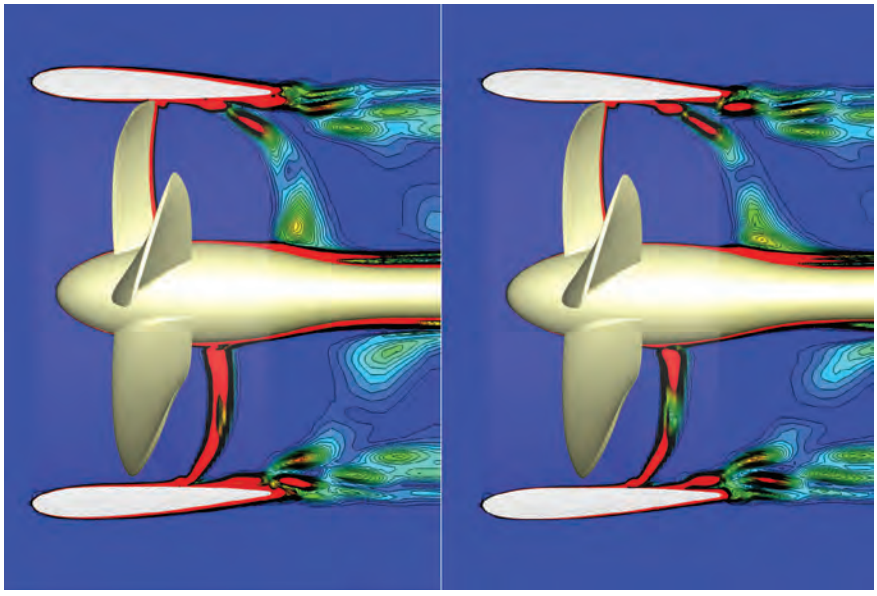
A numerical comparison between model-scale and full-scale open-water results for the ducted propeller show that for full scale all open-water coefficients increase: propeller thrust, duct thrust, propeller torque and total open-water efficiency. Only for highly advanced ratios, the duct thrust is lower than for model-scale. Since the increase in thrust is larger than for torque the efficiency increases for full scale. The gains in efficiency are between 4 and 10%, the highest values occurring for the lowest loadings. Even if these large values have to be considered with some caution, the trend is clear: the complete propulsor unit is more efficient for full-scale than for model-scale with a significant gain.

Conclusions

The capability of the viscous CFD method ReFRESCO for propeller open-water flows has been demonstrated using three different propellers. For all propellers the open-water simulations were compared with experimental and with propeller potential-flow results. From this study is concluded that:

- The thrust, torque and open-water efficiency is well captured. Thrust and torque values for all propellers show differences with the experiments in the order of 2-3% around design condition, and within 5% for off-design conditions.
- A verification and validation analysis procedure for the E779A propeller showed that the numerical uncertainty for thrust and open-water efficiency is in the order of 4% and 3% for the torque, for the propeller design condition.
- For thrust and torque predictions around design condition, PROCAL (BEM) potential-flow results showed a good comparison with the measurements. The added value of RANS method for propellers is the more accurate prediction at higher propeller loading where viscous

Figure 4: Comparison between model-scale (left) and full-scale (right) vorticity. Notice the difference in pitch of the tip vortex and interaction with the boundary layer between model and full scale.



effects are more important. For more complex propeller shapes (high skew) a better result is obtained with RANS than with a BEM. Additionally, viscosity related flow features such as separation and the development of vortices can only be captured and analysed using a viscous-flow approach.

- For the ducted propeller a comparison between model and full scale computations was made. Propeller thrust, duct thrust, propeller torque and total open-water efficiency were all larger at full scale. The gains in efficiency vary between 4 and 10% for different loading conditions.

The wealth of information obtained from viscous CFD calculations allows for a more detailed analysis of propeller design than in the past. This, in combination with the possibility to do both model and full scale computations, provides the propeller designer with knowledge that can lead to further gains in propulsive efficiency. The logical following topic is the analysis of a propeller operating behind a ship, both in model and full-scale. Marin is currently enhancing the CFD tools for taking the complete ship-propulsion system into account. *NA*

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Russians bring experience to winter navigation safety

The increased danger that vessels face when travelling through severe ice has seen the Russians instigate a study of winter navigation in Northern and Arctic seas.

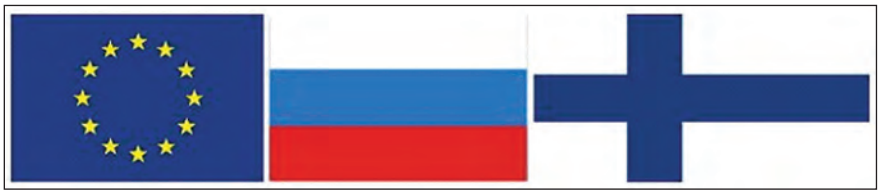
In Russia, winter navigation carries out sea transportation routes in the Baltic and Okhotsk Seas and along the North Sea Route (Arctic Seas), with the most intensive winter traffic taking place in the Baltic Sea. Winter traffic along the Barents, Pechora and Kara Seas (western part of the North Sea Route) is gradually increasing to provide further exports of crude oil, natural gas and other resources.

Professor Vadim K. Goncharov, doctor of Engineering, Saint-Petersburg State Marine Technical University, Klementieva Natalia Yu., candidate of Engineering, and Sazonov Kirill E., doctor of Engineering, Krylov Shipbuilding Research Institute, summarise the gained experience of ice navigation which will provide a base for development of cargo traffic in the winter conditions under the European Neighbourhood and Partnership Instrument (ENPI) project.

To support the safety of winter navigation following the main accident-prevention measures the following has so far been applied to vessel design: strengthening of hull and propeller-rudder complex the design stage of vessels and ice management (including, navigation requirements and icebreakers pilotage).

Steady ice cover in the Baltic Sea (Finland and Vyborg Gulfs) exists three to four months of the year and it can reach a thickness of 0.75m. The most difficult conditions for ice navigation are on the North Sea Route (NSR): one-year ice and old pack ice (thickness more than 3m) can cover almost all the water areas of the Arctic Seas in the winter-spring period. In the summer-autumn period one-year ice cover near the coasts melts, pack ice drifts on North and, as result, fractures are formed that can be used for navigation.

The Russian Maritime Register of Shipping has established ice class requirements for vessels navigating in ice conditions. Table 1 and 2 present these requirements: speed of navigation of different ice classed vessels in different ice conditions and methods to overcome ice cover.



The study is carried out under the ENPI programme.

Ice class of the vessel	Acceptable ice thickness (m) for navigation		Mode of maintenance
	Unassisted in broken spaced out ice	Following an ice-breaker in the canal in compact ice	
Arc1	0.40	0.35	Periodically
Arc2	0.55	0.50	Regularly
Arc3	0.70	0.65	Regularly

Table 1. Navigational conditions of ice classed vessels for weak ice conditions.

Category of vessel	Speed, knots	Compactness and type of ice	Ice thickness, m		Methods to overcome ice cover
			Winter - spring	Summer - autumn	
Arc4	6 - 8	Open one-year ice	0.6	0.8	Continuous motion
Arc5		Open one-year ice	0.8	1.0	
Arc6		Open one-year ice	1.1	1.3	
Arc7		Compact one-year ice	1.4	1.7	Episodic raids operation
Arc8	10	Compact one-year ice and two year ice	2.1	3.0	Regular raids operation
Arc9	12	Compact multi-year ice	3.5	4.0	Episodic raids operation on the areas of compact ice

Table2. Acceptable speeds and navigational methods of ice classed vessels depending on ice condtions.

The special "ice passport" has been put into place to characterise the capability of the vessel to navigate in ice conditions. The Ice passport as a document includes the following sections:

- General characteristic of the vessel and its ice capabilities; mark of ice category of the Russian Maritime Register of Shipping; main dimensions; peculiarities of the hull shape; ice reinforcement; data on the power plant, propellers, rudder and their ice protection.
- Diagrams («in loaded condition» and «in

Kind of damage	Year								Average
	1981	1982	1983	1984	1985	1986	1987	1988	
Dents with cracks	21,5	26.8	32.7	32.9	30.9	55.9	23	31	31.8
Dents, corrugation without cracks	55.7	46.5	31.9	50.7	54.4	31.5	45	32	43.8
Holes in plating	10.1	19.7	25.7	5.4	7.4	4.7	6	12	11.4
Damage to rudder blades	6.3	5.6	8.8	9.6	2.9	4.7	9	7	6.7
Damage to shafts, deadwoods	1.3	-	0.9	1.4	2.9	2.4	2	4	1.9
Damage to steering arrangement	5.1	1.4	-	-	1.5	0.8	8	6	2.9
Damage to other shipboard equipment	-	-	-	-	-	-	7	8	1.9

Table 3. Statistics (%) of accidental ice damage in winter navigations.

ballast») determining possible safe speed in case of unassisted navigation in ice. These diagrams involve all kinds of ice cover that vessels are capable of overcoming without icebreaker assistance.

- Diagrams determining the parameters of safe ice pilotage when a vessel rides after an icebreaker. They are used also to select the power plant operation mode.

The tactics of ice navigation is an outline of special methods to provide safe transit in ice conditions of single vessels without assistance of an icebreaker or as part of a caravan (a group) of vessels under the icebreaker's navigation.

The actions of navigators who choose the route, mode and speed of the vessel, determine the safety in ice. Navigation in very open pack ice is less challenging (compactness 1 - 3 points), as the vessel can easily manoeuvre, passing by separate ice floes. Navigation in open pack ice (4 – 6 points) requires skills to choose in-time directions of open-water canals (fractures) located closed to the general course of the vessels. The task of navigation in close pack ice (7 – 9 points) is to detect and use the weak ice areas to pass. Such areas can be the strips of open pack ice, small fractures and water paths in compact pack ice, strips of less strength, less hummocked and more broken ice.

Icebreaker navigation is still the main way to provide vessels with successful and safe winter navigation in heavy ice conditions. Icebreakers carry out navigation of single vessels and caravans as well as the creation and maintenance of the navigational ice channels in areas near ports.

The task of the icebreaker master is to minimise losses of navigational speed of a caravan that consists of different types of vessels. Choosing the route depends on the information about the real ice conditions on the route and the forecast (ice and wind) for the passage period. The master should choose the general direction of motion and then divide it into separate parts depending on its ice conditions. On each part of the route, the master can apply their own tactical methods of navigation and pilotage. Well-planned routes provide for the successful traffic of cargo vessels in icy conditions. If the ice conditions are complicated or suddenly gets worse, the ice navigation of a big caravan becomes impossible, and it is necessary to determine a place of moorage for a vessel or a group of vessels in advance.

Tactics of ice navigation of a caravan of vessels is based on using all the available information, including the technical data of the vessels in caravan and their amount, ice conditions and its forecast, means to provide assistance and communication, weather information, amount of icebreakers, their technical characteristics. Experience of ice navigation of a piloted vessel's crew is very important to avoid possible accidents.

During Arctic ice navigation an icebreaker executes navigation, anything from one to three or more transport vessels (in autumn). The route of navigation of vessels has a large range to cover: more than 1000 miles, including a river section of about 300 miles.

Caravans consist usually of vessels of different types, power and hull strength. To pilot such a caravan, the main principle is that under collection of a caravan: the vessel with the highest strength hull should precede the vessel with a weaker hull. If several icebreakers navigate the caravan, the weakest vessels proceed after support icebreakers. The more powerful and higher strength vessels travel after the main icebreaker. To avoid delays in navigation due to ice chipping around the weak vessel, icebreakers should tow the weak vessel so that the speed of the caravan does not decrease.

Prominent features of arctic winter navigation that is necessary to take into account to provide the safety of transport vessels are as follows:

- Polar night demands application of the spotlighting within caravan and eliminate helicopter surveillance of ice conditions.
- Low air temperatures (up to -40°C) decrease the strength of metal, including tugs and strings that complicate all towing operations and cargo handling.
- Snow and ice coating of the hull and superstructures worsens the stability of vessel and complicate all deck operations.
- Jamming of an icebreaker in a difficult ice area that demands a long time to free slows down the assist for vessels nipped by ice.

The newly raised problem of arctic navigation is rendering icebreaker navigation to large-capacity tankers, which have a larger hull breadth and so increases the breadth of icebreakers, and consequently

Circumstances of ice navigation	Year										Average
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	
With icebreaker assistance, totally	85	80	84	92	86	86	96	86	78	84	85.7
- icebreaker pilotage	44	52	65	57	47	54	44	56	27	23	46.9
- towing vessel	24	19	8	18	15	25	38	21	41	42	25.1
- ice chipping around beset vessel	7	8	7	2	4	1	2	2	2	3	3.8
- collision	10	1	4	15	20	6	12	7	8	16	9.9
Without icebreaker assistance, totally	15	20	16	8	14	14	4	14	22	16	13.9
- unassisted navigation	8	9	9	4	8	12	4	10	20	16	10
- being beset in ice	6	10	7	4	6	2	-	4	2	-	4.1
- other circumstances	1	1	-	-	-	1	-	-	-	-	1

Table 4. Statistics (%) of circumstances of ice damage in winter navigations.

the width of navigable ice channel. One obvious variant is to use two icebreakers. Another prospective variant is the motion on the parallel course when a tanker breaks ice cover and moves ice floes in the ice canal after the icebreaker, as a result, ice resistance to the tankers motion reduces considerably. The effective tactics for icebreaker navigation of large-capacity tankers will be developed in future.

Unfortunately, accidents occur during the winter navigation in ice conditions. Accessible and detailed statistics of accidents of vessels have existed for the past 80 years. This data presented in Tables 3 and 4 give us the possibility to analyse the causes and after effects of accidents in these conditions and it is possible to consider that the data is typical for the present situation.

Vessels were listed by damage as a result of accidents:

- disastrous damage to hull (big hole sustained as a result of a collision or ice compression)
- dents and corrugation of outer plating of the hull with deformation of the hull framing
- dents of outer plating with cracks in it
- holes in the outer plating
- destruction of the superstructure
- damage or loss of propeller blades
- loss of propeller
- damage to propeller shaft and deadwoods
- twisting of rudder.

Ice damage can be divided into two groups: damage to the hull and damage to the propeller-rudder complex. The first group is up to 80 –90 % of all accidents. Among the hull damage 60% are dents of the outer plating, 30% are dents with cracks and 10% are holes. Among the damage to the propeller-rudder complex about 60% is damage to the propeller blades, 30% is damage to the steering arrangement and 10% is damage to the deadwoods and propeller shafts.

When studying the materials presented in Tables 1 and 2, attention is drawn to the fact that the greatest number of accidents in the case of caravan navigation takes place if the vessel rides after the icebreaker and when in close towing. When unassisted navigating of vessels without an icebreaker the number of accidents is considerably less; this is connected, first, with the fact that unassisted navigation in ice happens more seldom and in relatively weak ice conditions.

The number of accidents are also affected by the area of navigation, the North Sea Route (eastern or western), season, age of vessel and other factors come into effect. However, current statistics of ice accidents do not allow for the detection of any regularity owing to insufficient volume. At the same time, these materials can be used as a pattern to assess safety of ice navigation.

Summing up the above previously mentioned, it is possible to state that the gained experience of winter navigation in Russia on sea routes provides safe cargo transportation in an acceptable range. Increasing capacity of transported oil and oil products performed by large-capacity tankers in the basin of the Baltic Sea and Arctic Seas as well as intensifying total traffic require search and development new tactics and methods of rendering icebreaker navigation of vessels for providing safe navigation.

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Authors

1. Goncharov Vadim K. Professor, Doctor of Engineering, Saint-Petersburg State Marine Technical University, Department "Ocean Technique and Marine Technology",
3, Lotsmanskaya str.,
Saint-Petersburg, 190008, Russia,
e-mail: vkgonch@mail.ru.
2. Klementieva Natalia Yu.
Candidate of Engineering,
Krylov Shipbuilding Research Institute,
Ice Basin Laboratory,
44, Moskowskoe sh.,
Saint-Petersburg, 196158, Russia,
e-mail: nklem@mail.ru.
3. Sazonov Kirill E.
Doctor of Engineering,
Krylov Shipbuilding Research Institute,
Ice Basin Laboratory,
44, Moskowskoe sh.,
Saint-Petersburg, 196158, Russia,
e-mail: kirsaz@rambler.ru.

Large yacht market stays buoyant

Ownership of a superyacht may be considered to be one of the ultimate financial status symbols and while cruise lines may have reined back their newbuild programmes, there is no shortage of new orders for superyachts, whether traditional in design or ultra-modern.

This month [June] sees regattas being held in Newport, Rhode Island showcasing the 1930s version of the superyacht, the splendid J Class series. Two of the originals, *Velsheda* and *Shamrock V* will race against a replica J Class, Ranger.

Needless to say, superyachts have now become mega yachts or even giga yachts and projects abound for vessels of more than 100m. Open bridge configurations vie with traditional designs with a modern twist.

Dykstra & Partners is also working on a major project for Turkish Dream Ship Victory Shipyard for a 141m four mast schooner *Dream Symphony*, an all laminated wood construction which the company says will be the largest sailing yacht ever built. Obviously with a ship of this kind there is no question of heli-pads and the like. Dykstra has always gone down the route of having classic exteriors coupled with the latest in naval architecture technology, which means the ships are basically lighter "with a modern waterline" and offer a higher performance with a classic exterior.

Blohm + Voss's Hamburg-based operation has also been developing its extensive expertise in the yacht building market, not only with refurbishment of superyachts like *Lady Moura* – a well know sight for any visitor to Monaco – but with newbuildings like the *Vintage*, which, like the J Class replicas, takes designs from the 1930s and develops them to include all those features demanded by the 21st century owner.

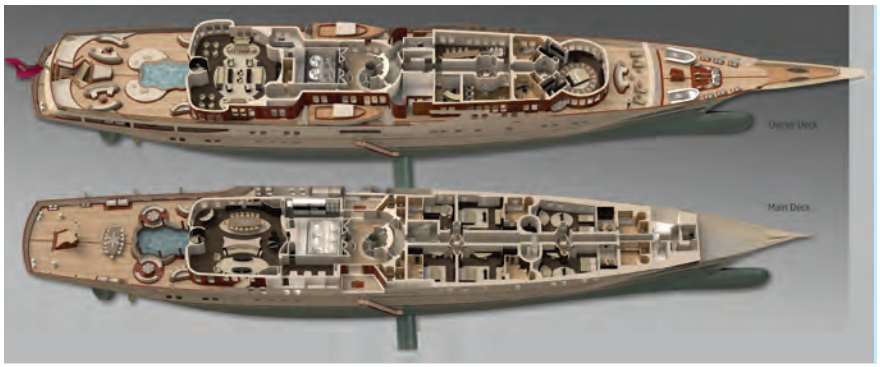
Traditional and modern features are blended with a bow sprit and classic shaped cruiser stern alongside modern style bridge wings, a helicopter landing deck and davit-launched tenders. The ship is 111m long and 15.6m across the beam with a maximum speed of 17knots. Propulsion is provided by two 2560kW diesel engines with controllable pitch propellers. The vessel is equipped with three 960kW gensets with soot particle filtration, one 500kW bow thruster and one 220kW stern thruster.

Other superyachts in the Blohm + Voss stable include a new 110m power yacht modelled on the 74m Eco, which was designed in the early 1990s to be the fastest of its size. The 110m version has nearly 110,000hp to call on and is capable of a maximum speed of 40knots with two MTU engines coupled to Wartsila 9000 water jets and two gas turbines linked to a further two waterjet boosters. The yacht has two 870kW diesel generators, and a 500kW bow thruster.

Other custom yachts include a 120m exploration yacht with a range of 5000nm at 16knots, which boasts a diesel electric propulsion system powering three pod drives allowing a maximum speed of 18.5knots.

The yard was joint winner of best motor ship of the year at the 2011 World Superyacht Awards for the 162.5m *Eclipse*, built for billionaire Roman Abramovich, while Diana Yacht Design

Blohm & Voss' latest fast mega yacht, *Vintage* that has been modelled on the previous Eco design.



Decks onboard *Vintage*.

picked up the best rebuild award for the 101m *Attessa IV*.

Lurssen's German yard is just reaching the final stages of construction of the 147m *Topaz*, although many details of the project have been kept under wraps. *Topaz* is the second largest Lurssen yacht to date, after the 155m *Al Said* which was built in 2008.

Italian yard Fincantieri has been building up its presence in the superyacht market with the delivery of *Serene* in September last year. At 134m, *Serene* was the largest yacht ever built in Italy at Fincantieri's La Spezia yard.

Serene has seven decks, a hangar and two helicopter landing pads. The vessel also features a large sea-water swimming pool, which can accommodate service craft and a submarine with a diving depth of up to 100m. There are 4500m^2 of interior space including 2700m^2 designed by Pascale Reymond from Reymond Langton Design. Monaco-based naval design architect Espen Oeino provide the concept.

Work on an even larger yacht also started last year – the 140m *Victory*, which Fincantieri believes is the first mega yacht over 100m to be ordered since the onset of the financial crisis in 2008. Yacht broker Camper & Nicholsen will be representing the owner during the construction period.

Based on a new, unique concept which again is the brainchild of Espen Oeino and the Paris based interior designer Alberto Pinto, the *Victory* project has been developed by the Fincantieri Yachts team – set up to place Fincantieri as a force in the superyacht market.

Victory, Fincantieri said: "will be one of the world's most advanced vessels in terms of safety onboard". The yacht has seven decks, six pools of up to eight metres long and an internal floodable dock for a 14-metre tender."

Giovanni Romano, head of Fincantieri Yachts, commented at the start of the project that: "This mega yacht is the start of another adventure which proves we were right to enter this area of the market, an exclusive niche where we set out to base our success both on product quality and the efficiency of our construction process. Today, drawing on our experience with our first mega yacht and having further refined our expertise in managing complex processes, we are in a position to guarantee excellent performance levels thus meeting the needs of a market which, we trust, is on the road to recovery".

There is no word of who has commissioned the 102m yacht C.2157, which is under construction at Perini Navi in Italy. It is 16.3m across the beam with a draught of 6.5m (keel up). Equipped with CAT3516C engines she has a maximum power of 2240kW at 1800rpm. The hull is steel with aluminium superstructure and she has a maximum speed of 19.5knots.

"Yachts for visionary owners" are promised by naval architects Oceanco, who have a number of projects in train for superyachts in the 100m plus range. One such is the 120m PA122 project with exterior designs by Nuvolari & Lenard ,which Oceanco says resembles a "real ship" rather than a superyacht. Classed by Lloyd's Register the yacht has a steel hull with aluminium superstructure and is equipped with four 4830hp MTU engines, with a maximum speed of 20knots. Other projects include the Elie Saab designed 117m PA126.

Another radical new design concept is Igor Lobanov's 100m plus. The model's bow shape resembles that of an ancient Greek galley while the open deck is enclosed by a gallery effect similar to that found in Middle Eastern architect. Unusually for a sailing yacht design the concept includes a helipad aft.

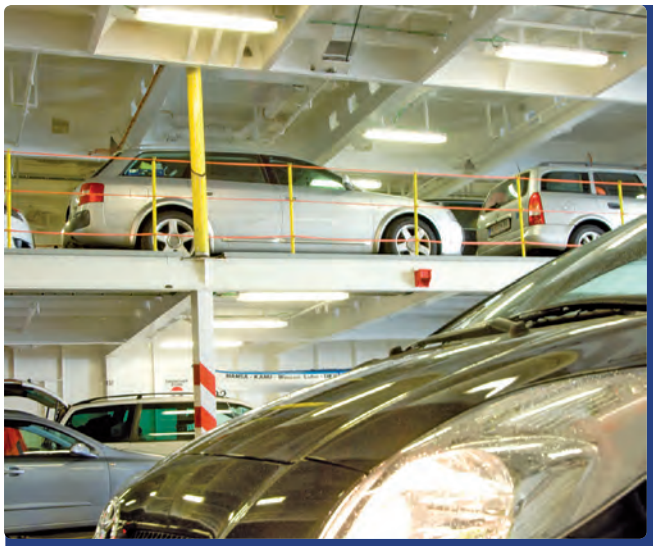
Design Unlimited and Reichel Pugh Yacht Design revealed their new 100m yacht design at the Monaco Yacht Show last year and the designer claims it will be the largest luxury sailing yacht ever built. Design Unlimited specialises in yacht interior design and exterior styling for both custom and production yachts. Founded in 2000 by Mark Tucker the team has worked on some of the most well known sailing and motor superyachts afloat today, as well as working in conjunction with many famous brands including Sunseeker and the Hanse Group.

Yacht design Ivan Erdevicki has recently given details of his new ER100 superyacht concept. At 100m long, the aim is to get away from the "typical mega yacht design cliché and create a design that really makes its own statement with styling, but at same time remains truly seaworthy, usable and buildable," the designers said. The design has a traditionally raked bow.

What is certain, given the number of advertisements for superyachts in the latest version of the London Times rich list, super yachts attract, as do classic designs alongside the more modern hull formations.

With the 2011 Monaco Yacht Show due to take place in September this year, the organisers say that enquiries were at a high level following last year's show, particularly in the 80m plus bracket.

"Demand for superyachts is recovering, but capacity is still ahead of contracts meaning that shipyards and suppliers are eager to display their finest examples of their work. Exhibits at this year's show will demonstrate their desire to outdo each other in quality and value." *NA*



Mist opportunity

Cars on a ro-ro ship with the Marioff Hi-fog Sprinkler system visible in the ceiling.

Fires at sea can be catastrophic; there are no fire brigades to call and no extra man power to rely on. Even if help was available, it is often hours away. One only has to glance at the archives of Lloyd's casualty reports to find numerous examples of fires that have overwhelmed crews due to the inadequacy of the fire preventative measures onboard, resulting in huge casualties in monetary terms and even loss of lives.

Water mist suppression systems are an effective method of preventing such accidents. It uses a fine water mist combined with high pressure in the region of 80 – 120bar to extinguish fires without any danger to people or the environment. For the fire suppression systems to work correctly and effectively a clear distance around the head has to be maintained. If items are stored too close or too high there is not enough room for the fog/mist cloud to form, impairing the effectiveness of the system.

When a sprinkler head is activated, several small high pressure jets of water are produced by the specially designed spray heads which causes the water to enter the space as fine fog or mist. The small water droplets rapidly evaporate, displacing the oxygen at the seat of the fire, which then quickly cools the surrounding air efficiently suppressing and controlling the fire before it can spread or reignite.

The rival to the fog system is the traditional and much cheaper water sprinkler. Each sprinkler head has an individual heat sensitive bulb filled with a fluid consisting of a non-toxic proprietary glycerine solution. When the sprinkler head is heated by a fire, the fusible element will break at the preset temperature, releasing the cap which seals the water orifice and water is immediately discharged out onto the fire. The rose plate at the bottom of the sprinkler ensures some of the water droplets hit the deckhead before falling like rain on to the surfaces around, ensuring a complete spray pattern is achieved. As the sprinkler heads operate individually, the number of sprinklers activated is limited to those near the fire, thereby maximising the available water pressure over the point of the fire's origin. However, as the pressure required for the system is a low one, usually 8bar, a lot more water is needed compared with the mist system. The extraction of the heat too is at a far slower rate further reducing its effectiveness.

One of the favoured water mist suppression systems in the cruise industry is that supplied by Marioff. Their Hi-fog sprinklers are used wherever automatic fire prevention activation is required. The sprinklers are compact, precision manufactured components made of chrome-plated brass and equipped with seven nozzles. Each sprinkler is protected by its own dedicated strainer to prevent clogging of the nozzles. The sprinkler bulb is protected from outside damage by a metal cover with narrow openings which has a separate socket attached to the piping. As the heads are sensitive to contamination and dirt, care needs to be exercised when handling and cleaning them as both the bulb and spray head nozzles are fragile. When the temperature in a space reaches the response temperature of the heat sensitive sprinkler bulb causing the bulb to break, a valve spool is released. The water pressure and a spring push the valve spool down, causing the water to flow into the sprinkler nozzles. The fog created by the 1760 times expansion is propelled out at high speed, its strong cooling effect serves not only to fight the fire but also to protect people and property against the radiated heat. The high pressure water mist rapidly suppresses the fire while limiting the spread of smoke. This is achieved by the water droplets binding to the particles of smoke so that they fall to the floor, effectively halting the spread. Since the Hi-fog system also uses far less water than traditional sprinkler systems, up to 90% less, two more benefits are obtained. The damage from water and the subsequent clean up is less extensive. Also, the reduced volume means vessel stability is not an issue.

With all the positive aspects of the hi-fog system, the writing may well be on the wall for the traditional water sprinkler system. *NA*

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www.middleeastworkboats.com

October 11-14, 2011
Fundamentals of Contract & Change Management for Ship Construction, Repair and Design, international conference, London, UK.
E-mail conference@rina.org.uk
www.rina.org.uk/fundamentalsoctober2011

October 11-14, 2011
Basic Drydock Australia, training course, Melbourne, Australia.
E-mail conference@rina.org.uk
www.rina.org.uk/drydockaustralia2011.html

October 17-20, 2011
Basic Drydock Singapore, training course, Singapore.
E-mailconference@rina.org.uk
www.rina.org.uk/drydocksingapore2011.html

October 26-27, 2011
Marine Heavy Lift & Transport III, international conference, London, UK.
E-mail conference@rina.org.uk
www.rina.org.uk/heavylift2011

October 26-29, 2011
Kormarine, international conference, Busan, Korea.
www.kormarine.net

November 8-11, 2011
Europort, international conference, Rotterdam, The Netherlands.
E-mail info@europort.nl
www.europort.nl

November 16-17, 2011
Human Factors in Ship Design and Operation, international conference, London, UK.
E-mail conference@rina.org.uk
www.rina.org.uk/humanfactors2011

November 18-19, 2011
Developments in Marine CFD, international conference, Chennai, India.
E-mailconference@rina.org.uk
www.rina.org.uk/marine_cfd_india.html

November, 2011
The President's invitation lecture, dinner, London, UK.
E-mail conference@rina.org.uk
www.rina.org.uk/presidentsinvitationlecture2011

November 29 – December 2, 2011
Marintec, international conference, Shanghai, China.
E-mail sales@seatrade-global.com
www.marintecchina.com

November 30 – December 2, 2011
Workboat, international conference, New Orleans, USA.
www.workboat.com

December 7-8, 2011
International Conference on the Education & Professional Development of Engineers in the Maritime Industry, international conference, Newcastle, UK.
E-mail conference@rina.org.uk
www.rina.org.uk/educationandprofessionaldevelopment

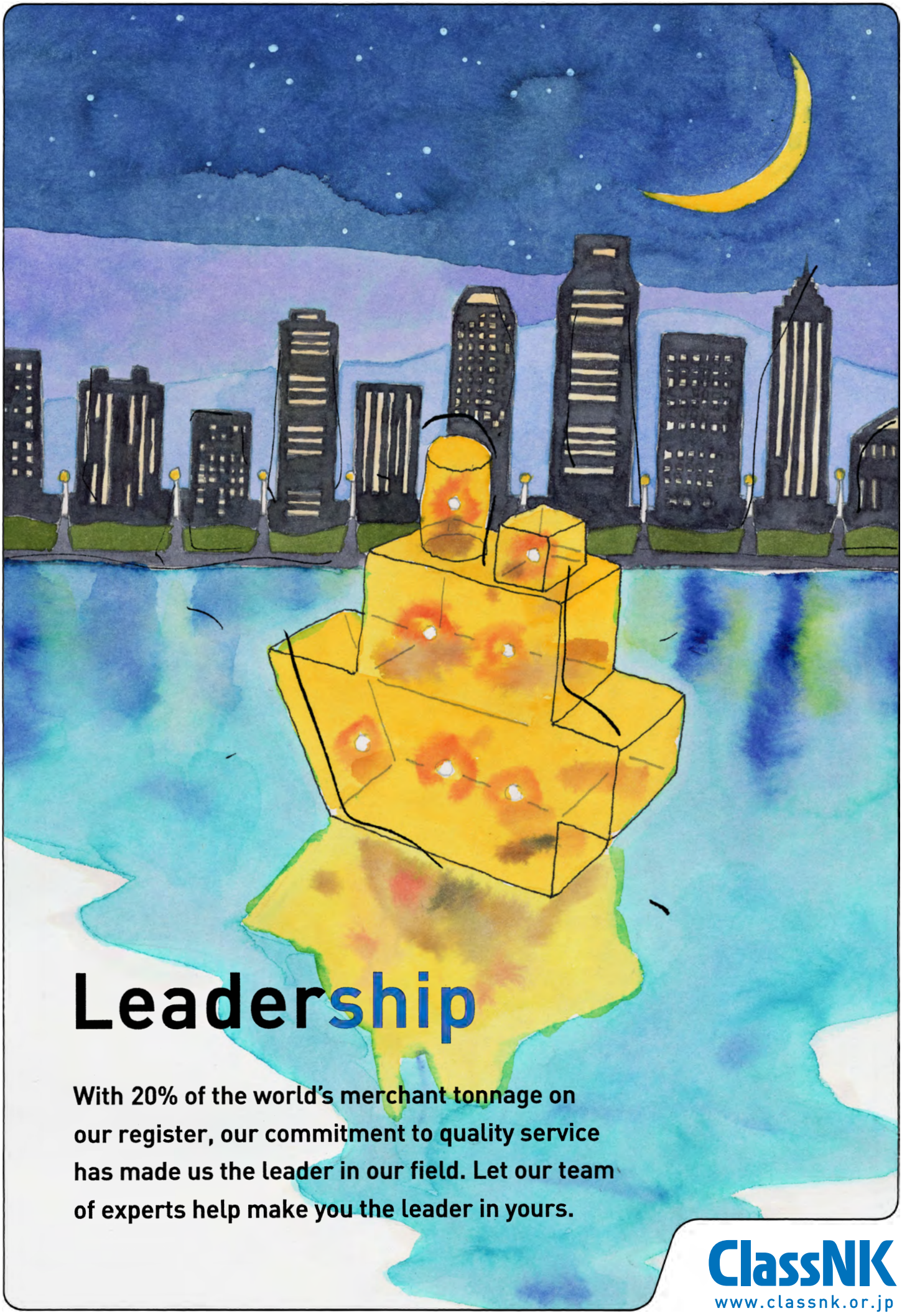
December 8-9, 2011
ICSOT: Technology Innovations in Shipbuilding, international conference, Kharagpur, India.
E-mail conference@rina.org.uk
www.rina.org.uk/ICSOTINDIA2011

January 25-26, 2012
Managing Reliabilty and maintainability in the Maritime Industry, international conference, London, UK.
E-mail conference@rina.org.uk

January 27, 2012
Marine Coatings – Risk Management Course, training course, London, UK.
E-mail conference@rina.org.uk
www.rina.org.uk/marinecoatingscourse

January 31 – February 2, 2012
PACIFIC 2012, international maritime conference, Sydney, Australia.
E-mail conference@rina.org.uk
www.rina.org.uk/pacific2012.html

February 28-29, 2012
The Environmentally Friendly Ship, international conference, London, UK.
E-mail conference@rina.org.uk
www.rina.org.uk/environmentallyfriendlyship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