THE NAVAL ARCHITECT

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Russia / Mega yachts / CFD and hydrodynamics / Methods and materials / Propellers and thrusters /

July/August 2010

Steel Plates

for Offshore Gas and Oil Platforms

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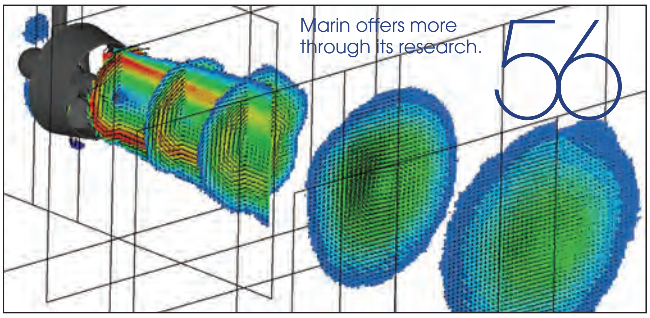

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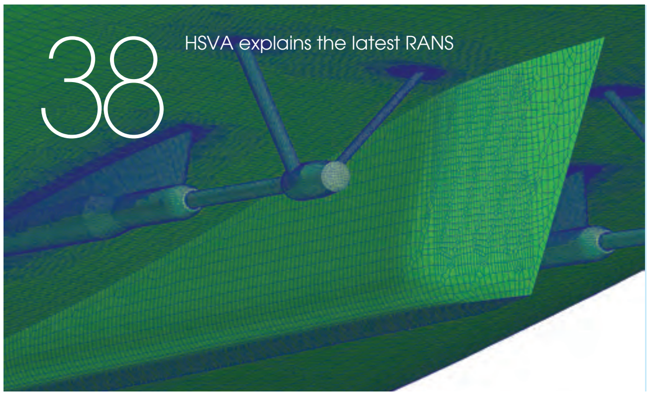

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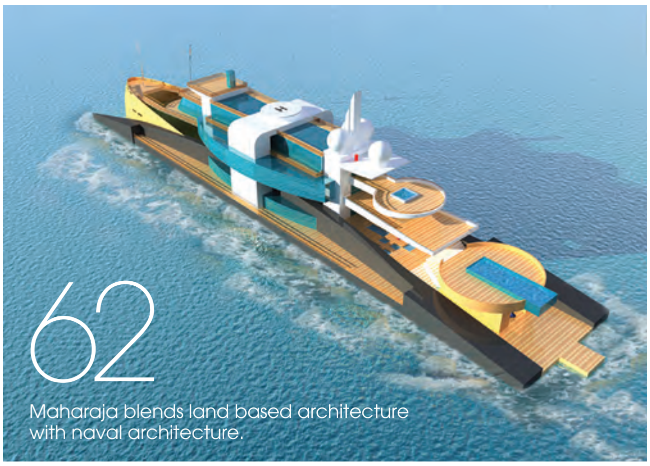
On-line Edition

The Royal Institution of Naval Architects is proud to announce that as of January 2008, *The Naval Architect* 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/tna 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.



62 Maharaja blends land based architecture with naval architecture.

IMO scores with goal based standards

A new era in regulation has begun with the introduction of goal-based standards (GBS) for the construction of tankers and bulkers ships by the International Maritime Organization (IMO). The new standards provide a loose regulatory structure within which, designers must produce vessels that are seen to be safe for the duration of their working life.

New regulation can often be pilloried by those having to adapt their accepted working practices to a new regime. Change can often be stressful and many can find reasons why the new solutions will not work. A case in point would be the introduction of the requirement for double-hulled tankers adopted unilaterally by the US Government following the *Exxon Valdez* disaster in the late 1980s.

At the time the Oil Pollution Act 1990 (OPA 90) was introduced by the USA, some ship crew feared the new double-hulled vessels would be too rigid and they would crack. Others considered that a grounding accident involving a double-hulled tanker would result in greater environmental damage as the cavity weighted by in-flowing sea water would eventually see the vessel break its back. There were also concerns about the accumulation of gases in the ship's cavity.

Ship designers were also sceptical with some concerned that the prescriptive nature of OPA 90 would mean that other, possibly better and safer, vessel designs would never be built as a result of the legislation.

It is now some 20 years after OPA 90 and happily many of those genuine concerns voiced at the time have failed to materialise. Even so International Maritime Organization (IMO) has now started to move towards less prescriptive regulation that it says it hopes will lead to better innovation, through better design.

According to the IMO: "The notion of "goal-based ship construction standards" was introduced to the IMO at the 89th session of the Council in November 2002 through a proposal by the Bahamas and Greece, suggesting that IMO should develop initial ship construction standards that would permit innovation in design, but ensure that ships are constructed in such a manner that, if properly maintained, they could remain safe for their entire economic life."

IMO considered that goal-based standards needed to have four essential guiding principles, they had to be broad, over-arching safety, environmental and/or security standards that ships are required to meet during their lifecycle; the required standard would be achieved by the requirements applied by class societies and other recognised organisations, administrations and IMO; they were to be clear, demonstrable, verifiable, long standing, capable of being implemented and achievable, irrespective of ship design and technology; and specific enough that they are not open to differing interpretations.

Essentially the IMO agreed in principle on a five-tier system and that the first three tiers constituted the goal-based standards to be developed by IMO, whereas Tiers IV and V were provisions to be developed by classification societies, other recognised organisations and industry organisations.

Tier I refers to the goals themselves; Tier 2 is comprised of functional requirements Tier III is the verification of compliance criteria while Tier IV is the technical procedures and guidelines, classification rules and industry standards and finally Tier V is made up of codes of practice and safety and quality systems for shipbuilding, ship operation, maintenance, training, manning, etc.

Implementation of the SOLAS amendment of the rules will come in July 2012, but it is understood that the goal-based standards will only apply to vessels contracted after 1 July 2016 and further extensions could be gained for vessels that are not contracted, but are essentially being built speculatively.

Goal based standards will operate along side existing local regulations such as OPA 90 and will add to the Harmonised Common Structural Rules soon to be announced by classification societies.

The last word should be afforded to the Secretary General of the IMO, Efthymios Mitropoulos. He told the Maritime Safety Committee (MSC) in November 2008 that: "I consider the progress made towards finalising the associated guidelines for the verification of compliance worth mentioning. The tremendous amount of highly technical work delivered in this respect by the Pilot Panel also deserves our commendation, as does the input of IACS. I thank all the experts involved."

This year Mr Mitropoulos opened the MSC meeting that approved goal-based standards in May by saying: "This is a most significant development because what it effectively means is that, for the first time in its history, the Organization will, under the goal-based concept, be setting standards for the construction of ships." *NA*

Shipbuilding

China shipbuilding to overtake Korea

Martin Stopford, the managing director of Clarksons Research said that the Chinese shipbuilding industry was likely to overtake the South Koreans this year.

He told a gathering of assorted journalists, and some dignitaries, that Korean shipbuilders had suffered more through the recession as their orderbooks were dominated by containerships, the hardest hit sector in terms of over capacity.

However, Mr Stopford went on to say that the industry had successfully slowed the delivery of vessels and that this had "helped to take the pressure off the market". In 2009 there were deliveries totalling 117 million dwt and this had risen to an estimated 134 million dwt expected for 2010, but this was considerably less than the 180 million dwt that was originally planned.

He said: "The challenging levels of world fleet growth meant that owners, yards and most importantly the banks have a very important role to play in keeping the whole show on the road."

One message that will cheer the yards, but perhaps not the owners, was that some 8000 ships were ordered "before we got green," said Mr Stopford, "So maybe another 490 milliion dwt will be needed for green ships".

Personnel

Moorhouse joins Sovcomflot

Lloyd's Register (LR) chairman David Moorhouse is to join the board of directors at Sovcomflot from July. Mr Moorhouse said he would continue to serve as the chairman of LR until the end of the year with the classification society taking precedence over the Russian company during that period.

A replacement for Mr Moorhouse will be announced in the autumn, though *The Naval Architect* understands that this decision has already been made.

Mr Moorhouse was appointed chairman of Lloyd's Register in November 1999 and assumed the additional responsibilities of chief executive from May 2000 to July 2007.

He is Chairman of the Board of Trustees and Chairman of the Lloyd's Register Group and prior to the establishment of the Board of Trustees, in June 2008, he was a non-executive member of Lloyd's Register's Board.

Classification

LR to survey Japanese ships

Japan's government made Lloyd's Register (LR) the first foreign classification society to be authorised to survey Japanese flagged vessels.

An LR statement said that it had been designated a "Recognised Organisation by the Japanese government and is granted delegated responsibility for statutory surveys and permission to issue statutory certificates".

Recognition comes at the end of a comprehensive review of Lloyd's Register's organisation and operations by the Japanese government and takes place against a background of a government-planned expansion of the Japanese fleet over the next five years.

The process required a formal change of policy by the Japanese government, to ensure LR would be eligible to receive formal recognition. An extensive process of 'due diligence' followed, which included a series of audits of LR's offices in Japan and at its London Office to ensure compliance with the Japanese government's criteria for acceptance.

Newbuilding

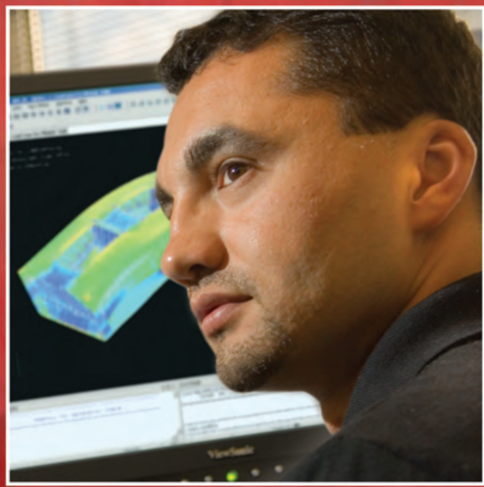
Sovcomflot and Finns break the ice

A Memorandum of Cooperation was signed by FGUP Rosmorport and OAO Sovcomflot that will see the signatories design and build an oil spill combat and salvage icebreaker with a view to tackling oil spill incidents in the Gulf of Finland. The vessel will be able to operate even in icy conditions, said a statement.

The companies said that the vessel will be a multi-purpose ship that will be able to undertake tasks such as, "the rescue of human lives, tug boat operations, escorting transport vessels and specialised floating facilities as well as ice escort services, etc."

Sovcomflot's President and CEO Sergey Frank said: "We view the implementation of this project on the basis of it being a public-private partnership with commercial principles. Adhering to the motto "Safety Comes First", Sovcomflot is ready to act as a catalyst for Russia's maritime authorities in expanding the potential of the Russian Federation's support fleet, to provide effective protection of the marine environment.

Mr Frank said that following agreement with FGUP Rosmorport, Sovcomflot will be ready to provide the technical management of the project, financing, build supervision and further operational and technical management of the ship.



"Taking into account the outlook for the development of Russia's energy projects in the offshore fields of the Arctic and the Far Eastern seas, as well as the emphasis on the issues of safety of navigation and the protection of marine environment, we think that the vessels of this type will be required as one element of an integrated safe navigation system not only in the Baltic sea region, but equally in the Barents sea and the Okhotsk areas," added Mr Frank.

Shipbuilding

T. Mariotti deliver *Seabourn Sojourn*

Carnival Corporation took delivery of the second of three €550million cruise ships in May. *Seabourn Sojourn* was delivered to Carnival's subsidiary Seabourn Cruise Line. The 32,000grt vessel is 198m long, 26m wide and reaches a maximum speed of over 20knots.

The hull of *Seabourn Sojourn* was built at Ci.Mar Costruzioni Navali at San Giorgio di Nogaro (Northeast Italy)- a company owned 50% by T.Mariotti and 50% by the Cimolai Group – then towed around the coast of Italy to Genoa-based T.Mariotti for outfitting and final completion.

The latest Seabourn vessel accommodates 450 passengers in 225 cabins and the company said it offers the highest space per guest ratio in the Industry. Furthermore, a unique detail for a vessel of this size is the addition of a marina on the stern that lowers directly to the sea.

Seabourn Sojourn is powered with the latest technology, including a safety management system control, a computerised system to manage all aspects of safety, and an independent propulsion system - two duplicate engine rooms and drive systems guaranteeing safe travel in case of emergency.

Seabourn Sojourn's sister vessel *Seabourn Odyssey* was delivered in 2009 and the last ship in the series is due for delivery next year.

Tankers

Stena orders one more Suezmax

Stena Bulk has ordered a seventh 160,000dwt Suezmax tanker for US$70million from the Korean Samsung Shipyard. The company recently confirmed that it had ordered six in-house designed Suezmax tankers for delivery in 2011/2012, and following its analysis of the market it Stena said it had has now placed a further order.

The vessels have been designed by Stena's design department in accordance with the most advanced technology available today. The result is dramatically improved energy efficiency, which will, among other things, reduce fuel and bunker consumption by up to 15% compared with most efficient, conventionally designed Suezmax tankers currently in operation.

"Stena Bulk have been patient in viewing the markets these past couple of years, to expand its fleet of Suezmax tankers (160,000dwt). And we have taken the time to integrate our proven track record for innovative tanker design by creating the most environmentally friendly large tanker of its size, with minimal fuel consumption, available today", said Ulf G. Ryder, President & CEO of Stena Bulk.

The seven vessels will be added to the Stena Sonangol Suezmax Pool said the company. "The pool, which is in the premium class of the operating tanker pools, will now further cement its lead with an emphasis on new and environmentally friendly tankers", added Mr Ryder.

Seabourn Sojourn has now been delivered to Seabourn Cruise Line.


EXPERIENCE OF THE CENTURIES
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SCF
СКФ
МИХАИЛ УЛЬЯНОВ
TUG
80t

A US$70million suezmax vessel, one of seven ordered from South Korea's Samsung yard.

Engines

Wärtsilä power makes waves

Wärtsilä has signed a contract to deliver a ship power system for a 38,000dwt semi-submersible heavy-lift vessel for Chinese customer Zhejiang Share-ever Business Co., Ltd. Wärtsilä's solution was selected for its proven reliability and because of the global service support the company is able to provide.

Zhejiang Share-ever Business Co., Ltd is a privately owned company with more than 20 large vessels, including 72m offshore platform supply ships, ocean cargo carriers of between 27,000 and 50,000dwt, and drag-suction dredgers. The company is looking to utilise the latest marine technologies and works closely with domestic vessel design institutes. The Chinese company is a new customer for Wärtsilä.

This vessel will operate in offshore waters around the world, and will be mainly used in loading and transporting large-size offshore equipment required by the offshore oil and gas industry. Such equipment includes large-size steel structures, various kinds of platforms, platform jackets, and main platform blocks, etc. used in prospecting and exploration. The vessel will also assist large commercial vessels and naval ships in re-floating and similar operations. The vessel will be delivered in the end of 2011.

The engine configuration is based on the Wärtsilä 32 medium speed engines. The scope of supply includes three 9-cylinder in-line Wärtsilä 32 generating sets for a diesel electric installation, and three tunnel thrusters.

Wärtsilä's fully diesel electric machinery allows for reliable and flexible power. For example, in order to optimise engine loading, rationalise fuel consumption, and ensure the most economical operation under all conditions, only the necessary number of generating sets will be engaged at any one time. Furthermore, in addition to providing fuel efficiency and cost savings, this flexibility ensures that the level of emissions is automatically controlled.

The 38,000dwt self-propelled semi-submersible vessel will have a total length of 195m with a moulded width of 41.5m. The moulded depth is12m, the designed draft is 8.6m, and its maximum diving depth is 23m. Propelled by electric power, the vessel features automated management, an unattended cabin, dynamic positioning, and a service speed of 13.5knots. It is designed by the Marine Design & Research Institute of China under CSSC for technical specifications, and by Jiangsu Modern Shipbuilding Technology Co., Ltd. for production processes.

THE SUPERYACHT PAVILION AT METS 2010

Getting down to business

What is the SuperYacht Pavilion?

The SuperYacht Pavilion (SYP) and its service-oriented Refit Boulevard form a show-within-a-show at METS. Dedicated to companies who 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. Over 115 exhibitors assembled in the SYP and Refit Boulevard in 2009 – to sell, promote and network. It's busy, it's professional – and it's special.

Why special?

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 1,000 other marine trade exhibitors, some of whom also cater to the superyacht sector. It's also a unique launch pad, as Ian Taylor, group sales manager of Quest International, reveals: "As a supplier of new and novel technology we were looking for the right approach to allow us to undertake a technology transfer into the superyacht and megayacht arena. METS provided us with a fantastic platform... and the organisers invited our managing director to be part of the Superyacht Forum. All of this support led to a fantastic reception from the industry and what we believe to be an unprecedented level of interest on the stand."

Why should you attend?

The SYP is a meeting point for true industry professionals - superyacht captains, designers, builders, project managers, brokers and owners, and many others. The SYP is of interest to nearly half of the 20,000 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), the high profile HISWA Yacht Symposium and the Member's Mixer event organised every year by the International Superyacht Society – the society for captains and crew members. The result is a varied and appropriate display of products, a vibrant conference programme and networking galore.

What is the GSF?

The 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 Yacht Report Group in association with METS organisers, Amsterdam RAI, the Global Superyacht Forum attracts around 650 delegates and includes social highlights like the Global Superyacht Party. To register as a delegate for GSF, go to www.globalsuperyachtforum.com.

All GSF delegates have free entrance to SYP. Visitors of the SYP do not automatically have access to GSF.

Register for your free entrance badge

To visit the SYP you need a FREE three-day entrance pass to METS 2010. Please pre-register for this on metstrade.com. To help with your planning, Amsterdam RAI can also book hotel rooms for you and assist with other travel requirements. Go to metstrade.com and click on 'visit' and 'hotel & travel service'. To exhibit at the SYP, please contact the organisers.

METS – at a glance

"It sounds simple but just by attending METS, you will be able to take advantage of networking opportunities. Your contacts will introduce you to other contacts. Remember, the world comes to METS!" Tom Douglas, vice president global sales, Teleflex Marine.

- **18,454 visitors from 86 countries in 2009**
- **Over 1,260 exhibitors from 38 countries in 2009**
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SUPERYACHT PAVILION

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Ancillary equipment

Cramm on deck

Cramm Yachting Systems has announced that it has added two deck crane concepts to its range of hydraulic products. One of the latest features of the cranes is a rotation system that reduces power loss due to friction. To achieve this, Cramm has developed quiet power packs for the cranes. The cranes are made mainly from stainless steel and produced in accordance with Lloyds requirements.

"Our aim was to develop an even better crane for a decent price," says Cramm director Rob Knoop. "And the enthusiastic reactions prove that we succeeded as dozens of orders have been received in no time." The urge for improvement is a constant in Cramm's product development: All products have been or are currently being restyled.

Contact Cramm Yachting Systems BV, P.O. box 510, 8901 BH Leeuwarden, The Netherlands.
Tel +31 518 461 600
Fax +31 518 460 802
www.cramm.nl

Engines

Type approval for more efficient MAN

MAN Diesel & Turbos has launched its first upgraded, twenty-cylinder 28/33D prototype engine, which recently passed a series of tests on the test bed at the company's St. Nazaire, France works, and was awarded type approval by Det Norske Veritas (DNV) classification society.

The V28/33D engine.

The approval has been conducted in compliance with DNV rules for the classification of ships as well as high-speed light craft and naval surface-craft. The type approval covers a rating of 9100kW at 1000rpm for 100% MCR and an additional 10% overload capacity for one hour every six hours of 10,000kW at 1032rpm. The four-stroke, medium speed engine is accordingly the most powerful and fuel-efficient diesel engine in its class worldwide.

The V28/33D engine range has 12-, 16- and 20-cylinder configurations, a state-of-the-art design featuring a high power density, and maintains full compliance with IMO-II and EPA Tier-II legislation.

The 280mm bore and 330mm stroke engine has a minimal number of components and is tailored for three main segments: multiple propulsion applications including all types of fast ferry, naval ships, super-yachts; an STC (sequential turbocharging) edition; and as gensets for offshore applications.

The latest engine is characterised by its balanced ratio between power and weight, high performance, shock resistance, quiet running and high reliability for maximised availability. With its ease of installation and maintenance, it is a textbook example of a diesel engine featuring low operation and life-cycle costs.

Additional design features include the new, in-house-developed safety and control system – SaCoSone – and the high-efficiency TCA33 turbocharger, which has been especially tuned for the V28/33D engine. Due to a higher pressure rate, the turbocharger can reach values of up to 500kW per cylinder.

Type approval from the remaining classification societies is planned for later this year and the first upgraded 20V28/33D engines on order are scheduled for delivery in autumn 2010.

Contact MAN Diesel & Turbo SE, Teglholmsgade 41, DK-2450 Copenhagen SV, Denmark.
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Fax +45-3385 1030
E-mail mandiesel-cph@mandieselturbo.com
www.mandieselturbo.com

Ancillary equipment

Langh adds to range

Finnish-based Langh Ship Cargo Solutions has launched its latest solution to transfer steel coils into containers. The new cradle containers of Langh Ship Cargo Solutions enable easy and secure containerisation, said Langh.


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Langh introduces its latest cargo solution onto the market.

"These containers make it possible to transport coils in ordinary cargo vessels and coils can thus be delivered profitably also, when shipments are small", said product manager Markku Yli-Kahri, who has been in charge of the container development.

Hard Open Top Bulk Cradle Containers are multipurpose, even though they have been optimised for steel transportation. When handling coils the whole roof of the container can be removed. When transporting bulk the container can be loaded through the small bulk hatches in the roof and it can be unloaded through the letter box hatch in the back wall.

"These containers significantly reduce the time used for loading coils and totally remove the need for disposable lashing material", states Commercial Manager Laura Langh-Lagerlöf, who has invented the securing system for the coils.

The container can be used with flexitanks also for liquid transportations. The whole cubic can be exploited, while the properties of the container can take the pressure caused by liquids. The valve gear of the flexitank is easy to handle through the letter box hatch in the back wall. The payload of the container is 40tonnes and the tare weight is 4.8tonnes.

Sales Manager Mika Saarinen considers the multipurpose use of the containers as one of their assets: "With these containers it is easy to transport raw material in the return leg, and thus they don't need to be transported empty."

The 20' Hard Open Top Duplex Containers are made of Outokumpu's Duplex-steel. It has all the qualities of the above presented Bulk Cradle Container, but due to its stainless material it is stronger, lighter and the payload is as much as 50tonnes.

"The life cycle of these containers will be very long, because the properties of the material are almost twofold in comparison with Corten-steel", says David Barker from Outokumpu, "The need for maintenance is very little, and the containers never need to be painted. This reduces the life cycle costs of the container.

Contact Oy Langh Ship Ab, Alaskartano, FI-21500 Pikis, Finland.
Tel +358 2 477 9400
Fax +358 2 479 6222
www.langhship.fi

Ancillary equipment

ESAB flip's up to the job

ESAB has introduced a newly designed flip-up welding helmet, the Globe-Arc. Following the ESAB family design, the new hybrid shell is made from ZyTel material and offers a full head a face protection and is very lightweight. The compact design allows for welding in very tight places, whilst reducing the visible light entering the back of the helmet caused by other welding light.

The new flip visor has an upper retention stop, which eliminates visor drop-down when welding or grinding together with shake proof quarter turn retainers to allow for quick removal and replacement.

The Globe-Arc is suitable for all welding applications as the visor provides effective protection from ultra violet (UV) and infared (IR) radiation when the visor is open and closed, and is available in different shade levels.

The helmet has a wide field of vision through both the large main and flip-up visors which provides increased work safety. The visor has a flat top brow for easy put downs and to prevent scratching.

ESAB's new comfort headgear, which is constructed from quality nylon with a large adjustment ratchet and comfort sweat band, is fitted to the helmet.

Contact ESAB, Hanover House, Queensgate, Britannia Road, Waltham Cross, Hertfordshire, EN8 7T, UK.
Tel +44 800 3893152
Fax +44 1992 788053
E-mail info@esab.co.uk
www.esab.co.uk

Engines

Caterpillar spare's in Germany

With the continued growth of MaK diesel engine sales around the world for marine, power generation, and petroleum applications, Caterpillar has launched a new logistic center located in Henstedt-Ulzburg, Germany. The warehouse, comprising an interior area of nearly 15,000m^2, is the fourth facility in Germany

for Caterpillar Motoren GmbH & Co, and will serve as a hub for MaK spare parts for customers throughout the world. With its close proximity to both the international airport and the port infrastructure in Hamburg, the logistic centre will increase velocity for parts availability to customers and reduce costs.

During the opening ceremony in Henstedt-Ulzburg on 21 April 2010, leaders from the Kiel Engine Center (KEC) announced to the local economic and political representatives in attendance that the consolidation of spare parts into one central location was a very wise investment. "The fact that Caterpillar was able to complete this strategic investment in such a short time (beginning July 2009) and in a tough economic year will mean that Caterpillar and the MaK brand will be stronger as our demand retains its growth," explained Dr. Fernando Cantú, Order Fulfillment Director.

The modern warehouse was designed and built according to logistic standards developed by Caterpillar, as well as the manufacturing standards developed through 6 Sigma and Cat Production System (CPS).

Construction of the logistic centre was complete in February 2010 and full operation at the new logistic centre was started on 15 May. Nearly 40 employees at the facility will manage parts stocking and distribution, order processing, accounting, information technology, legal and human resources.

Contact Catapiller, 100 North East Adams Street, Peoria, Illinois USA 61629.
Tel +1 309 675-1000
www.marine.cat.com

Ancillary equipment

Tracer takes in full spectrum

Tracer Products has developed a fluorescent dye TP-3405CS Dye-Lite All-In-One dye, which it claims will improve leak detection in all oil and oil-based fluid systems, including gasoline and diesel engine oil, diesel fuel, automatic transmission fluid, power steering fluid, as well as hydraulic and lubrication fluids. This dye has proven to be 100% effective with all UV and blue light lamps.

TP-3405CS Dye-Lite All-In-One dye assures optimum leak detection because it actually contains two fluorescent dyes. One fluoresces best under UV and the other under blue light. Whatever type of inspection lamp is used, All-In-One dye will glow brilliantly and spotlight every leak in a system.

Dye-Lite All-In-One dye is safe and easy to use. The dye is circulated through the vehicles' fluid system, and will escape with the host fluid through the tiniest leak. When the system is scanned with a high-intensity Tracerline UV lamp, the dye will glow brightly, spotlighting the exact location of every leak. All-In-One is available in standard and concentrated formulas.

Contact Tracer Products, PO Box 483, Westbury, New York 11590, USA.
Tel +1 516 333 1254
Fax +1 516 876 8411
www.tracerline.com

Ancillary equipment

DNV surveys in cyberspace

The Norwegian classification society DNV has launched what is believed to be the first 3D simulator tool designed for training ship surveyors. The new survey simulator is now operational at the company's recently opened Technology Centre in Gdynia, Poland, and will initially be used by DNV to train its own surveyors. Eventually however the company plans to offer the technology for training third parties, including ship officers, superintendents and port state inspectors, and also to roll out the new system to DNV Academies around the world.

According to Olav Nortun, DNV's chief operating officer, responsible for global development: "Over the past few years the number of ships in operation has increased a lot and recruiting skilled professionals to all parts of the industry has become a challenge. Nothing can replace onboard training when it comes to achieving experience and improving knowledge, but the 3D simulator is the closest we can come on shore."

Developed in-house by DNV's own software team, the 3D survey simulator is based on the same principles as those used in latest generation computer games and provides a highly realistic training environment. Trainees are able to navigate all parts of a vessel, from the upper part of the superstructure to the ship's double bottom, and can conduct 'virtual' inspections in onboard conditions that have been replicated with remarkable fidelity.

As Mr Nortun points out: "Our younger surveyors are part of what is described as the 'PlayStation generation' and this tool is intended to better meet their different expectations in terms of training."

At present the DNV 3D simulator incorporates digitised images of a real bulk carrier and an oil tanker. Further vessel types will be added over the coming months, the first being an oil rig simulation.

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FORAN users benefit from 2010 forum

SENER Ingeniera y Sistemas SA hosted the FORAN users meeting (FORUM) earlier this year, highlighting the latest developments of its CAD/CAM software and the experience from users. Eric Tupper reports.

In order to strengthen its links with clients, and ensure new developments are relevant to the industry's needs, SENER hosts a FORAN Users Meeting (FORUM) every other year and the sixth, FORUM took place in Seville on 13 and 14 May.

Delegates were welcomed by Luis Garcia, general manager, marine business unit, SENER, who hosted the event. Then Jorge Sendagorta, president of SENER, gave the opening address. To get the full benefits of the system required a long term commitment on both supplier and user. FORAN has been developing now for some 40 years and has become more international. It benefits from cross fertilisation of ideas between the various disciplines in SENER and the feed back from users.

Next, José Esteban Pérez, President of the Spanish Association of Naval Architects, spoke on *The sea: technology and well-being*. He said that ships were important to world civilisation for navigation, commerce and exploitation of natural resources. The international financial crisis has led to a downturn in newbuild contracts although deliveries have risen because of earlier orders. In terms of order book tonnage, China now ranks first in the world. He spoke of the rise in fuel prices and the need to adapt operational methods. His message for all naval architects was the importance of good technology for the future.

Alfonso Olmos of Navantia, presented *Use of FBUILDS for automatically generating bill of materials (BOM) of fabrication drawings*. Having outlined the facilities and work of Navantia, he described the S80, a new submarine design for which FORAN V60r2.0 is the only CAD/CAM software to be used. Progress on the project is such that the 3D model is 80% complete fabrication drawings 40% complete and building 30%.

A big advantage of using a CAD/CAM system based on a relational data base is the ability to retrieve data in specific forms. One such is the BOM report used to purchase material and initiate work orders for controlling progress in construction. The BOM is related to a specific fabrication drawing and the link between CAD components and drawings is not always maintained by the software. It also depends on the drawing content, purchasing policies, build strategy and the associated IT systems. He argued that the FBUILDS module is flexible enough to take all these factors into account and demonstrated this in terms of the S80 project.

There followed a talk by David Campbell of Babcock Marine on the Queen Elizabeth Class (QEC) aircraft carrier project, after explaining the organisation of, and typical work done by, the Babcock Marine Division, including the design conversion of a bulk carrier to a pipe laying ship. The QEC is a 65.600tonnes aircraft carrier. Two ships are scheduled with delivery dates of 2015 and 2018.

Babcock has more than 100 users working on FORAN these uses include design, modelling, planning, dimension control and weights. Modelling teams include hull structure, seats, weapon systems, pipelines, cable trays, furniture and lights. The QEC is a complex project made more complex by the number of sites involved in fabricating units which will be finally assembled in Rosyth, Scotland. It poses many challenges and FORAN is to be used in conjunction with TRIBON and AUTOCAD with Windchill PDM as the information "backbone".

Virginia Marcos of SENER reviewed FVIEWER which is a new approach to the 3D virtual reality tool. Such tools have been in FORAN since 1997 when they were released as part of v30. The early system had a number of limitations such as inability to handle huge models, the user interface and the handling of annotations. Advances in software and hardware since then have made it necessary to replace the module rather than continue to upgrade it. This has resulted in FVIEWER which will be available in v70r1.0. This will be a 64bit system able to handle a huge amount of geometric data, based on a hierarchical structure, with a smaller memory footprint and an ability to use more than 4GB of RAM. It includes new features such as clipping planes, overview map and advanced search tools. Enhancements are provided in the areas of lighting, dismantling spaces, annotations, textures, operators and detection of interferences. Future developments envisaged include a 3D mouse, 3D displays and a tactile screen.

Jim McLauchlan, Engineering Systems Manager, BAe Systems, described the use of FORAN V60r2.0 in BAe's business system and manufacturing facilities. They have some 250 general licences and over 300 users interact with FORAN. Work has been done in-house to rationalise the interfaces with other CAD/CAM systems. One challenging interface was that with the robotic bar cutting machine.

Gregorio Galán, Ghenova ingenieria, presented *Process continuous improvement: feedback from engineering*. A lot of effort goes into creating the 3D model of a ship and with a little additional effort FORAN enables engineers to gather data which would allow shipyards to improve efficiency. He exampled the percentage scrap plating and data showing how this, and associated cost, varies with a ship's block coefficient – 16% at CB of 0.5 to 5% at CB of 1.0. It was found that the number of parts in the main steel structure increased with increasing length x beam x depth and that the cutting length in metres was about three times the number of parts.

He went on to show how data on pipes – length, diameter, whether straight or not – can be extracted. Having fewer, longer, pipes would reduce costs. By extracting such data from the model management has information to guide them in improving cost effectiveness.

Carlos Malheiros Santos of the Brazilian Navy said that whilst much effort was put into creating 3D product models in design the data is seldom used beyond the production stage. He discussed the use of the model data in the maintenance and operation of ships

International Conference

THE DAMAGED SHIP

26-27 January 2011, London, UK

First Announcement & Call for Papers

The conference will focus on the assessment and analysis of stability, strength, sea worthiness of a ship damaged by collision, grounding, structural failure, fire or explosion. It will also consider procedures to minimise risks for passengers, crew, ship, environment and to develop safe countermeasures including sequences for transferring, offloading cargo and ballast water for salvage operations.

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

A number of organisations already offer ship owners a range of Emergency Response Services (ERS) including shore-based expert assistance and computer-based contingency planning systems. The aim of this conference is to bring together designers, operators, classification societies and legislative government bodies to consider the present state-of-the–art and future developments. Papers are invited on all aspects of assessment and analysis of the damaged ship, including but not limited to:

- Damage assessment
- Stability and seakeeping of the damaged ship
- Global and local integrity of the damaged ship
- Modelling of the damaged ship
- Flooding simulation tools
- Stability in waves.
- Pollution mitigation
- ERS planning and decision support systems
- Regulation on damage stability
- Education and training on damage stability

Royal Institution of Naval Architects

http://www.rina.org.uk/damageship2011

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using a landing craft as the reference design in which FORAN had been used. He concluded that putting the design data together with repair records, technical documents, and maintenance and operations records, provides a powerful tool allowing operational and maintenance processes to be optimised. It enables builders to offer additional service to owners and operators.

Raúl Serrano, SENER discussed the management of compartment design using the new FGA module being developed in FORAN. Producing the general arrangement (and associated compartment layouts) is a vital activity in early design and it is useful in all stages including operations and final disposal. 2D models can be produced from little initial information and can be modified quickly. 3D models need more data to create but can be integrated with calculation and analysis tools and data can be used in later design stages. Design changes can be made most easily in the early design stages. The FORAN approach combines the advantages of both approaches using advanced modelling and visualisation techniques and integration with other modules.

Juan Arrospide, talked about the Rio Santiago Shipyard and its experience with FORAN. V10 was first used in the late 80s and V50 was introduced in 2004. Update to V60r3.0 was in 2008. V50 has been used in designing a 45tonne tug and refitting the *Frigata Libertad*. V60 is being used for a new 47,000dwt product carrier and a tug with 100tonne bollard pull. He illustrated the generation of macros for 3D modelling of bollards, light fittings and rudder.

Applications of FORAN in Chinese ship design were described by J. Song, from UFC. The current popular ship software in China is CATIA/CADDS5 for general purpose and AVEVA/FORAN for ship design. MAXSURF is used but only for form generation. FORAN was used on a 60m, 800tonnes, maritime patrol craft (delivered 2010). Lines comparison between FORAN and MAXSURF was very good and minor differences in hydrostatics can be explained by differing simplifying assumptions. Stability comparisons were consistent. Module FHULL was used for shell, decks and internal structure. Overall he concluded that FORAN is suitable for the design process, helping to guarantee design quality and reducing man-hours by 30%. FORAN is now being used for the 3D design of two more projects and is likely to be used more widely. China would like to see an improved interface with AUTOCAD and support for Chinese characters.

Y. Ananiev of the Severnoye Design Bureau, St. Petersburg, described the set up of his company, founded in 1946, its facilities and commercial and naval ships designed including those for foreign countries. The CAD system used is CAD-VESSEL which has FORAN as its nucleus. It issues electronic documents and transfers design data for production. They now have a 3D modelling department, have recently developed conceptual designs of LNG-carriers and are now preparing a classification design for such a vessel, using mainly FORAN.

Carlos Gonzalez, SENER, explained that a new module, FNORM, is being introduced in FORAN V70 in place of NORM, with which it is fully compatible. FNORM has a new 2D kernel, an integrated general engineering design (GED) graphics editor and a user interface similar to other F modules. It feeds into FHULL and other modules. Amongst other improvements, the new module allows a hierarchical organisation of parametric standards with the user able to define intermediate levels to make easier the access from other environments (e.g. from auxiliary structures in FPIPE). The user friendly GED editor is fully integrated with the 2D graphical area. Messages help solve inconsistencies and interactive checking is provided by reprocessing with different variable values. Better identification is possible using 12 characters.

Antonio Valderrama, SENER, described new tools to facilitate the import/export functionality of FDEFIN. In early versions of FORAN outfitting data was transferred using ASCII files managed by OS windows. This was partly upgraded in V60 to XML files. V70 will have a new way of managing standards, affecting not just their definition and handling but their transfer as well. Two new top level commands will give full access to all import and export capabilities. The six earlier lower level commands will still be available if needed. Transfer files are XML based. Improved information integrity is provided by two controls actively checking and, if needed, completing the transfer. Data now includes HVAC standard sections and ship particulars.

Sergey Kokovin outlined the experiences of SMART Marine Ltd in using FORAN Electrical Design. SMART Marine is implementing FCABLE in "standalone mode". Normally FCABLE would use data generated in other FORAN modules such as FHULL, FPIPE, etc. Having described how the data can be generated from other systems for input to FCABLE, the speaker concluded that the FORAN Electrical Subsystem can be used effectively in projects developed by means of a third CAD/CAM system. This enables a design bureau to work more efficiently using systems in which they have already invested.

Rafael de Gongora outlined SENER's vision for V70 and beyond. There will be greater internationalisation and higher performance due to using 64bits and 4GB RAM. New generation replication used by ORACLE will reduce volume of data transfers with improvements in control and checking. A new 2D kernel will be compatible with AUTOCAD. Based on this kernel there is to be a new GA model, FGA, working in 2D/3D. Stability calculations will be able to handle intermediate stages of flooding. The new FNORM will give improved hull structure modelling as described above. Other improvements include a new algorithm for curved plates; automatic generation of supports for sloping pipes; commercial HVAC cross sections available in calculations; importing/exporting of HVAC components; better management of penetrations; 3D models of equipment as external files; historical record of every cable modification.

Beyond V70 SENER envisage a new geometric approach for hull forms; keeping abreast of changes in regulations; links with FEM systems; improved 3D modelling; links to electrical calculation tools; more effective drawing generation. SENER will use advances in technology to provide a system that will enable better, faster, cheaper ships to be built.

The conference was closed by Luis Garcia who said we must be optimistic for the future in spite of the current global recession. Many use FORAN as their preferred system and SENER will continue to develop it to meet clients' needs. He hoped the new V70 system would be launched in November 2010. *NA*


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Martek targets fresh market for water ingress monitors

As rules making water ingress monitoring mandatory for all types of dry cargo tonnage approach entry into force, Martek Marine sets out the case afresh for Bulksafe, the water ingress detection system which has already proved itself as a means of enhancing ship and crew safety onboard bulk carriers.

Water ingress monitoring was among a number or measures adopted by the International Maritime Organization (IMO) to enhance the safety of bulk carriers in the wake of a spate of losses in the early 1990s. Such detection and alarm systems are designed to provide the maximum possible early warning of a cargo hold flooding condition that might seriously threaten a ship's survival by giving a reliable indication of water reaching a pre-set level.

Flooding can mark the beginning of sinking and should be the highest alert condition onboard, asserts BIMCO.

Designed for stowing large volumes, the cargo holds of bulk carriers represent the potential for a significant loss of hull buoyancy in the event of flooding. Additionally, there is the possibility that the cargo in the holds may be small in volume but of high density, thus allowing a larger volume of water to enter the hold than is the case with ships carrying lighter cargoes that occupy higher volumes of internal space.

Bulksafe enhances bulk carrier safety.

Serving a similar function to a fire alarm, a water ingress monitor warns of a condition that requires immediate attention that could – if allowed to progress – eventually dictate evacuation of the ship. Monitors should make it possible from the bridge to know the condition in each hold without the need for local investigation.

Systems not only monitor for the presence of water in the cargo hold spaces but the speed of ingress as well via a two-stage alarm: one warning at a low level in the hold, the second at a higher level.

Adopted in December 2002 by the IMO's Maritime Safety Committee, SOLAS XII Regulation 12 called for water ingress detection systems to be fitted on all bulk carriers, regardless of their date of construction, not later than the date of the first annual, intermediate or renewal survey carried out after 1 July 2004.

A final standard defined a number of key additional functional requirements for water ingress detection systems:

- A separate and distinguishable audible alarm to be provided at the control panel covering the 0.5m pre-alarm and 2m alarm levels in the cargo holds
- Equipment to be corrosion resistant for all intended cargoes
- Time delays to be incorporated in the control and alarm system to prevent spurious alarms due to sloshing effects
- Detectors to be capable of in-situ functional testing
- Filter elements fitted to the detectors should be capable of being cleaned before cargo loading.

Water level detectors fitted in each cargo hold are required to signal audible and visual alarms: one when the water level above the inner bottom in any hold reaches a height of 0.5m and another at a height not less than 15% of the depth of the hold but not more than 2m. (On bulk carriers to which Regulation 9.2 applies, only the latter alarm needs to be installed.)

The visual alarms must clearly discriminate between the two different level detectors in each hold, which are fitted in the aft end of the spaces. The audible and visual alarms are located on the ship's bridge. An alarm over-riding device may be installed in cargo holds that are used for carrying water ballast.

A water level detector must also be fitted in any ballast tank forward of the collision bulkhead (under Regulation II-1/11) and arranged to give an audible and visual alarm when the liquid in the tank reaches a level not exceeding 10% of the tank capacity. An alarm over-riding device may be installed for activation when the tank is in use.

Any dry or void space other than a chain cable locker, any part of which extends forward of the foremost cargo hold, also requires a water level detector to give an audible and visual alarm at a level 0.1m above the deck. Alarms need not be provided, however, in an enclosed space whose volume does not exceed 0.1% of the ship's maximum displacement volume.

Monitoring the situation

UK-based Martek Marine anticipated the new requirement by offering its Bulksafe water ingress detection system, fully complying with all aspects of the IMO performance standard. The water level detection and alarm system resulted from three years of development and surveying of numerous bulk carriers of diverse designs to create a solution suiting all ship arrangements and individual customer preferences.

Fully type-approved in accordance with SOLAS XII Regulation 12, UR S24, the IMO performance standard for water level detectors and IACS UI SC180, the system is based on a central Bulksafe control and alarm panel interfacing with intrinsically safe MMS900 water level detectors installed in each compartment. A control and alarm panel indicates the alarm status for each named compartment, with discrete signals for the 0.5m and 2m alarm levels.

Extensive testing in the presence of all major classification societies earned type approval for the system from Lloyd's Register, DNV, Bureau Veritas, Germanischer Lloyd, ClassNK, ABS, the Russian Maritime Register of Shipping and the Indian Register. Bulksafe was subsequently rewarded with major shipping industry awards for innovative design, outstanding performance and contribution to maritime safety

Among the key features distinguishing Bulksafe from competitor systems, Martek Marine's Steve Coulson highlights: no corrosion of the water detectors thanks to an advanced polymer construction; remote water testing and cleaning from the deck; no recalibration required (digital signal only); and simplicity of installation.

A reportedly unique design enables the MMS900 detectors to be installed totally isolated from the cargo and protected from mechanical damage during cargo handling. Furthermore, each MMS900 level switch is completely corrosion proof, protected against dust ingress and - like the sensors - underwritten by a lifetime corrosion warranty.

Bulksafe is claimed to be the most compact and simplest system on the market to install, with all sensor cabling included in the delivery. Installations can be executed without any structural alterations or piping work within the cargo holds and commissioned by ship's staff.

User-friendly maintenance-free operation is promised. An optional facility incorporated in the system provides a fully automatic in-situ functional test of all the detectors, even when cargo is present in the holds. All LEDs, audible alarms and relay outputs can be tested by a 'panel test' pushbutton.

Water ingress monitoring systems also became mandatory from 1 January 2007 for smaller new and existing single-hold dry cargo ships under a change to SOLAS Regulation II-1/23-3, which widened the legislative umbrella beyond bulk carriers to include container ships, general cargo and timber carriers. The new rule required the fitting of an IACS type-approved system to existing ships of less than 100m in length built before 1998 and to all new and existing ships of less than 80m length built after that date.

Bulksafe's popularity in both market sectors is reflected in a reference list currently embracing some 700 bulk carriers and 500 general cargo ship installations, the latter all retrofits.

Among the customers is the leading German shipping company Reederei Erwin Strahlmann, which has fitted 47 Bulksafe systems in its fleet.

"After evaluating various offers we selected Martek Marine's Bulksafe system because it was simple to install and operate; it is the most reliable and durable water ingress detection system available," explains the company's safety and security director Krzysztof Giza.

The market window for small single-hold dry cargo tonnage has now closed but the number of ships required to comply with the relevant SOLAS bulk carrier sections on water ingress monitoring will be further expanded under Annex 13 of IMO Resolution MSC.277(85), adopted in November 2008.

Under this annex, water ingress detection and alarm systems will become mandatory from July 2010 for all types of dry cargo ship newbuildings, including general cargo and container tonnage, that wish to carry dry cargo in bulk, even if only occasionally.

Based on previous years – and assuming the shipping industry recovers from the slump – Steve Coulson anticipates an annual newbuilding market for water ingress monitors from this source of some 300 ships.

Bulksafe system installations for bulk carriers and dry cargo ships are essentially similar, although some dry cargo vessels may have segregated holds that may be deemed by authorities to need a detector per segregation.

Reliable operation in an arduous environment - vital for such a role - has been well proven in service, Martek Marine reports, and a number of design refinements have enhanced the system's merits since its launch: safety barriers can now be installed in junction boxes adjacent to the cargo holds; savings in new conduit/pipework run on deck or in pipe tunnels significantly reduce installation costs; full mimic screens for ballast control rooms; and serial communications outputs for voyage data recorders (VDR). *NA*

Finding the right software system

Patrick Couser and Walter Bertrum presented, *Aspects of Selecting the Appropriate CAD and CFD Software Systems*, at this year's COMPIT conference. In this article the authors select the key notes from the paper.

In highly complex industries, such as modern shipbuilding, CAD (computer aided design) and CFD (computational fluid dynamics) systems play a fundamental role in allowing a company to achieve and maintain a competitive advantage.

In this paper we discuss some key aspects that should be considered when selecting such systems. Many of the recommendations are adapted from previous consulting experience and from guidelines relating to software selection in the German automotive and mechanical industry, VDI (1990). The term CAD will be used in a wide sense, including the broad spectrum of all modelling and simulation software used in the design process.

Even before selecting a CAD system, a more fundamental decision needs to be made: whether the engineering task should be performed in-house or outsourced. This decision is perhaps more relevant to CFD/simulation analyses than to CAD. If these engineering tasks are undertaken infrequently, there can be large savings to be made by outsourcing. This is due to the high fixed costs of: hardware, software, and especially training.

However, if the computations are frequent, considerable economies of scale can be achieved. A general rule of thumb is that: if the annual use of the software is increased 10-fold, then the unit cost is reduced by 80%. This makes in-house CFD computations for occasional users far more expensive than buying the services from third parties who themselves can profit from these considerable economies of scale.

CFD software market overview

The CFD software market is beginning to mature; the problems with early CFD software can be attributed to the features typical of highly competitive, immature markets which can be summarised as follows:

- Customer confusion due to contradicting statements from different software providers
- Poor product reliability and quality
- Hesitant customers waiting for the next (cheaper and better) release
- Lack of standards and compatibility
- High fixed costs and low turnover for the providers, leading to high investment costs and insufficient development power.

Fortunately these problems have been largely overcome. A consolidation process has reduced the number of serious suppliers to a point where stable conditions, benefiting the whole industry, appear feasible. However, there is always the opportunity for "new players" to arrive on the scene. This is particularly true of universities who can often, relatively cheaply, develop new products that reflect the latest research and are often superior to existing software in terms of functionality.

The high complexity of today's software products and customer service requirements favour established software development companies. We may see a trend similar to the aviation industry where, in the end, only a handful of companies have survived.

In the long run, this should be beneficial for the industry as a whole: fewer suppliers mean more customers per supplier, i.e. more development power and the burden of development costs shared by more shoulders. It also means that agreements on standards and data transfer between different products are easier to achieve.

Software selection process

The selection task can be broken down into two phases: *preliminary analysis* followed by *assessment and decision*. The analysis and decisions can be facilitated by examining the smallest sensible areas of application. However, it is also worth considering the global view to ensure a homogenous software system that ensures the smoothest possible data transfer and workflow through the project lifecycle.

Preliminary analysis

During the preliminary analysis, both internal and external aspects should be considered. The external aspects consist of the state of the software market and would include a survey of available software products. Internal aspects cover the company's business strategy and product spectrum, both current and future. Human aspects should also be addressed: it is vital to include the end-users in the software selection process; this will facilitate acceptance of the new software.

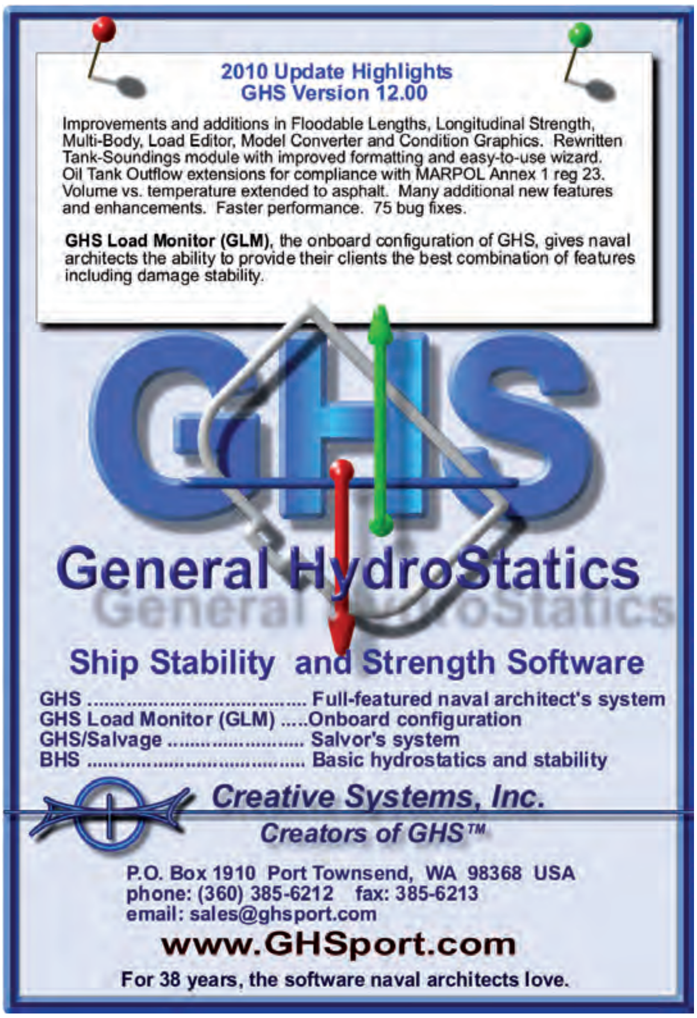
Internal: Where are we now and where are we going?

- *Where are we now?* Analysis of internal aspects should serve to provide a profile of the desired CAD or simulation software that is required to achieve the company's strategic plan. A good starting point is a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis.
- *Where do we want to go?* The requirements for the CAD or simulation software system that are needed to achieve the company's goals should be grouped in categories, using, for example, the MoSCoW system:

M	MUST have.
S	SHOULD have if at all possible.
C	COULD have if it does not affect anything else.
W	WON'T have this time but WOULD like in the future.

External: Market Analysis

A broad review of the software market should be made. A first impression of the market: the available products and their relative capabilities may be gained by visits to other users, technical brochures and websites, exhibitions, conferences, and external consultants. Obvious starting points are COMPIT (www.compit.info)


2010 Update Highlights
GHS Version 12.00
Improvements and additions in Floodable Lengths, Longitudinal Strength, Multi-Body, Load Editor, Model Converter and Condition Graphics. Rewritten Tank-Soundings module with improved formatting and easy-to-use wizard. Oil Tank Outflow extensions for compliance with MARPOL Annex 1 reg 23. Volume vs. temperature extended to asphalt. Many additional new features and enhancements. Faster performance. 75 bug fixes.
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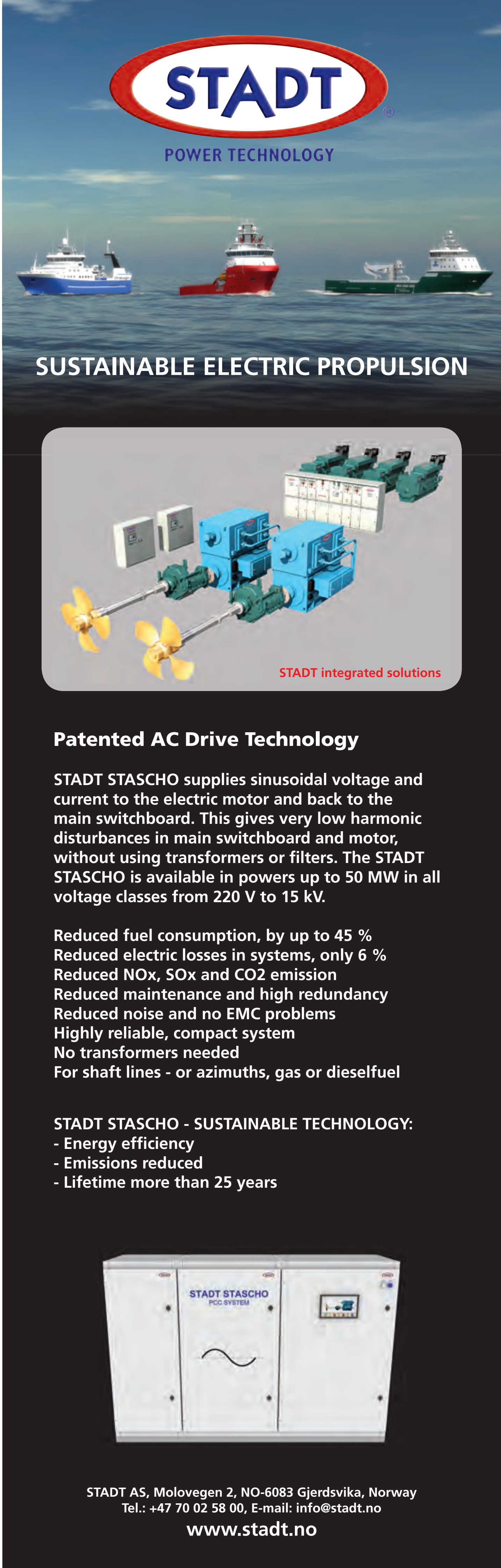
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for marine CAD systems and Numerical towing Tank Symposium (NuTTS) for marine CFD applications.

Economic assessment

In order to determine if the software investment is financially viable, an economic assessment should be made. The differences in the functionality provided by CAD and simulation software means that their assessment must be treated differently.

Economic benefits of CAD Software

For a first estimate of the expected economic benefits due to the implementation of a new CAD system, a simple cost-benefit comparison may suffice. For this simple analysis, costs can be seen as global sums and the benefits considered as reduced man-hours. To be beneficial, the reduced man-hours must, at least, compensate for the additional costs. In addition, the effects of CAD on profitability include:

- Improved product quality for constant capacity
- Improved productivity, i.e. unless staffing levels are reduced, CAD results in extended capacity; if there is no corresponding increase in demand and staffing levels cannot or must not be reduced, CAD investments will not pay off
- Flexible work hours increase CAD profitability.

Economic benefits of Simulation Software

The simplistic estimate described above considers only the direct costs and benefits due to the implementation of the CAD system but, neglects possible indirect benefits and savings due to reduced errors etc. For simulation software, like CFD, this simple approach does not work and the expected additional income through the ability to offer a wider scope of services must be also considered.

The value of computer technologies can be classified according to time, quality and cost aspects. The main benefits of CFD in these respects are, according to Bertram (1993):

- Problems solved more quickly than when using conventional approaches, due to better (direct) insight into design aspects. CFD analyses of ship hulls and appendages before final model testing are now standard practice in ship design. CFD can also help with much faster trouble shooting in cases where problems are found
- Improved designs through detailed analysis and/or formal optimisation
- The speed of CFD now allows its applications during preliminary design. The use of CFD early in the design phase reduces the potential risk associated with the development of new ships. This is especially important when exploring niche markets for unconventional ships where the design cannot be based on previous experience
- CFD does not significantly reduce the cost of the actual design process, but it improves quality and helps with the early detection of design flaws and this can lead to significant cost savings. Within the first weeks of design, 40% to 60% of the total ship production cost is determined, Johnson (1990). The costs of design modifications increase by orders of magnitude the further into the project they are made; ideally no fundamental modifications should be made after the conceptual design phase. Achieving this goal can be greatly facilitated by the use of CFD. If CFD is employed consistently to determine the final hull form at an earlier stage, numerous decisions that influence the production costs can be made earlier in the design process, thus reducing the risk of expensive design modifications being necessary later in the project. This is especially important in the context of modern workflow methodologies (e.g. concurrent engineering and lean production).

When assessing the economic benefits of CFD, merely considering cost aspects will, therefore, lead to incorrect strategic decisions. We can assess the benefits of CAD by using an analogy with another computer technology: CIM (Computer-Integrated Manufacturing), aptly put by Dietrich (1988);

"In other words, when taking CIM decisions, the question of 'What will we save in the short term?' is not the right one to ask. The real issue is rather; 'How will

OpenFOAM

Recently, the open-source CFD package OpenFOAM, has attracted a lot of attention in the maritime CFD community, Schmode and Bertram (2009). In the hands of well-trained users, OpenFOAM yields good results for a variety of complex maritime flows (seakeeping with six degrees of freedom; cavitating flows around propellers; sloshing with breaking waves; etc.), see for example, the 2009 Numerical Towing Tank Symposium, www.uni-due.de/imperia/md/content/ist/nutts_12_2009_cortona.pdf. Zero licensing fees, wide scope of applicability and access to source code for personal modification make OpenFOAM very attractive, particularly in the academic environment. Industry users, on the other hand, should take a more prosaic perspective: savings in license fees may be far less than the added costs of training. Experienced CFD users have reported (in personal communication) that it took them several months to two years to come to terms with OpenFOAM. Nevertheless, Germanischer Lloyd has decided to employ both commercial CFD software (STAR-CCM+ developed by CD-adapco) and OpenFOAM in parallel. The investment of considerable resources in a "free" software package was motivated by co-operative projects with several academic partners. However, it is fair to say that the bulk of professional consulting work continues to be based on the use of commercial software products.


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our operational situation develop if we do not introduce CIM?' "

Training requirements

The training requirements (time and direct cost) for the new software system should not be underestimated. During formal training, the costs for each user include: the appropriate fraction of the cost of the trainer; the operating costs of the CAD system used for training; opportunity costs since the trainees cannot work productively during the training period. Where users are self-taught, the costs arise due to low user productivity during the training period. Training time and costs are frequently underestimated. Amounts suggested by vendors and other users are generally too low. In many cases several man-months are needed for staff to become fully productive using the new software. The disparity in the training costs of different systems (due to, often considerable, differences in user-friendliness, technical support and quality of training) may significantly outweigh the differences in the licence fees alone. Cheap software frequently turns out to be expensive if all costs (including training and opportunity costs) are considered.

Training requirements can often be significantly reduced if the software has a good user interface. Effective and well-designed user interfaces generally facilitate acceptance and reduce transition costs in introducing new software. Bruce (2009) aptly describes the problem, albeit for a different application; "A bigger obstacle has been the interface to the user. All too frequently, GUI's (graphical user interfaces) reflect the needs of the software developer, rather than the needs of the user. They cause user confusion and distrust which hamper adoption. The art of GUI design is maturing to a point where genuinely friendly interfaces are available."

Assessment and Decision

Once a broad view of the strategic development planned for the company has been realised, the software requirements to achieve these goals have been determined and a broad view of the software market has been established, it is possible to perform a more detailed analysis and assessment of the software systems before making a final investment decision.

Finally, it should be remembered that software investments often bind a company to their selected product/vendor for more than one decade! Disregard of strategic aspects is one of the most frequent reasons for fatal IT investment decisions. It is crucial to contemplate the following points:

- Development capacity of CAD vendor
- Economic situation (market position) of CAD vendor
- Number (present and development) of installations
- Training and after-sales service provided by the CAD vendor.

Conclusions

A systematic approach to software selection is recommended. The outlined procedure is intended to prevent important items from being overlooked. Specifically, labour costs associated with training and lack of productivity are frequently underestimated. Companies should select software based on how long training will take and how much man-time will be required for a trained user to complete a typical project. This in turn depends on user-friendliness, software user community networks, vendor support, etc. For key software, strategic considerations are important to ensure long-term support by vendors.

The original paper, along with the other papers presented at this and previous COMPIT conferences, may be downloaded free of charge from www.compit.info. *NA*

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CFD and Submerged Waterjets

Tom Dinham-Peren, chief hydrodynamicist at BMT Defence Services, discusses the issues of using computational fluid dynamics (CFD) to evaluate the performance of fully submerged waterjet units.

Propeller driven hull forms are traditionally dominant for low to medium speed vessels and transom mounted waterjets have proved effective for higher speed vessels. However, development in submerged water jet technology now presents an alternative, which may be an effective and efficient solution for vessels which operate between these two speed regimes.

For Naval vessels this technology may also offer advantages in underwater acoustics, which would be suitable for vessels with anti-submarine warfare roles. In the commercial environment applications could include those vessels which are required to operate in shallow waters (therefore constrained by draught), or environmentally sensitive areas where reduced underwater noise is needed.

Rolls-Royce Naval Marine (RRNM) has developed a fully submerged waterjet (the Advanced Water Jet for the 21st century or AWJ-21) which is a candidate system for both Naval and Commercial applications. While RRNM has carried out considerable development on the design of the propulsor, little research has been undertaken to explore integration of the system into a concept design. BMT Defence Services (BMT) and RRNM carried out a joint project to explore these issues and the results were presented in a joint paper given at INEC 2010 (Reference 1).

The paper investigated the application of the AWJ-21 to a Naval vessel design and looked at the overall design integration, the whole ship propulsion efficiency, through life costs and space requirements in comparison with a conventionally propelled vessel. As part of this project a CFD study was undertaken to investigate the design issues and powering performance of the AWJ-21 concept. While the paper is based on a warship study, the findings of the CFD study are not warship specific and would also apply to commercial vessels.

As the purpose of the study was to compare an AWJ-21 propelled vessel with an equivalent conventionally propelled vessel, two hull forms where developed. For the AWJ-21 concept consideration was given to the number and layout of the waterjets prior to development of the hull form. Candidate solutions included the use of two or three waterjet units, the degree of integration with the hull and the fore and aft position. For the triple waterjet option there was also the issue of whether all three units should be inline or mounted in some form of staggered configuration. These options are summarised in Figure 1.

The degree of integration was also a major consideration in the design and there were four factors involved, the nacelle drag, the wake gain effect, the uniformity of the inflow and the induced drag on the hull and flow losses.

With higher integration, the nacelle drag is expected to reduce, the wake gain effect to increase, the inflow to become less uniform and the induced drag on the hull and inlet losses to increase. Whether the overall effect is beneficial will depend on whether the benefits to be gained from lower nacelle drag and a higher wake gain effect are cancelled out by higher induced hull drag and inflow losses. The design might also be non-viable due to excessive cavitation and vibration due to the non-uniform inflow.

On balance, a decision was made to study a design with a high level of integration as while there was some risk that this arrangement might not work, the potential gains if it could be made to work are large. On the basis of preliminary cost and efficiency calculations a twin installation was selected.

The remaining decision on the fore and aft position of the waterjets was made on the basis that a far aft position would place the waterjet close to the free surface with

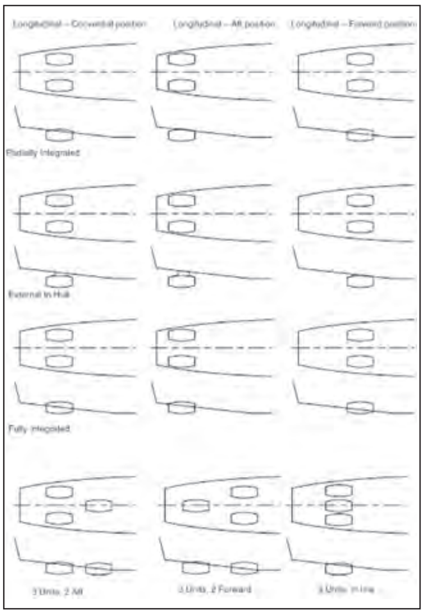

Figure 1: Propulsor Integration Options.

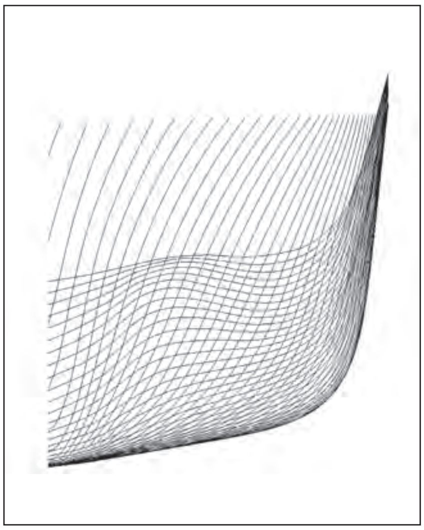

Figure 2: AWJ Naked Hullform Lines Plan.

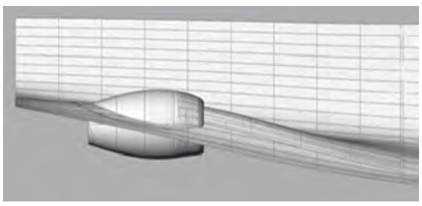

Figure 3: Side View of AWJ Second Iteration.

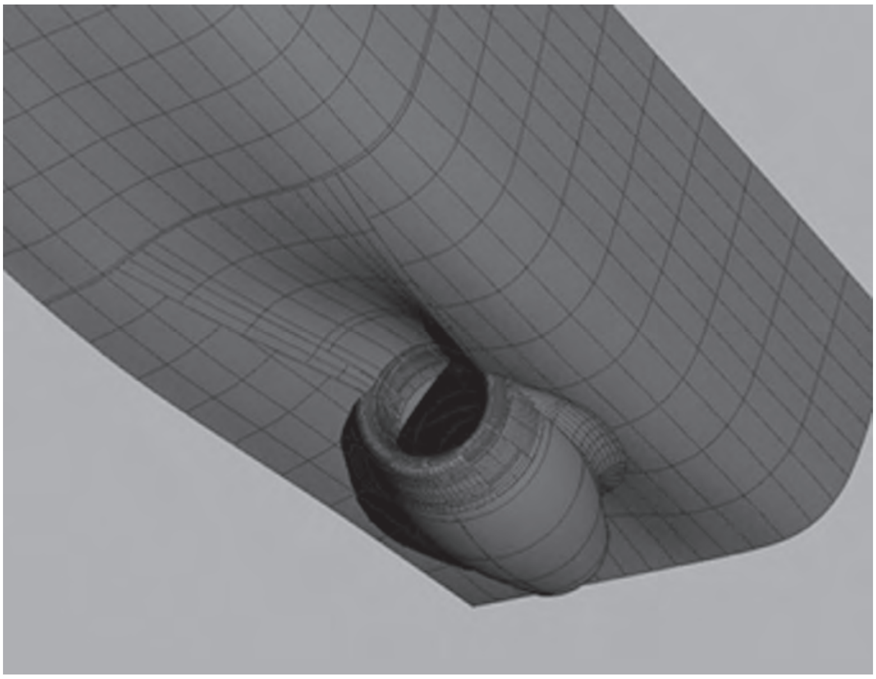

Figure 4: Oblique View of AWJ Second Iteration.

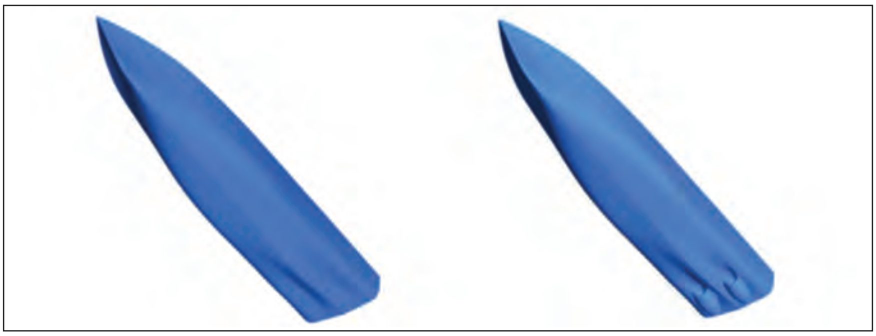

Figure 5: General View of Naked and Propelled Hull.

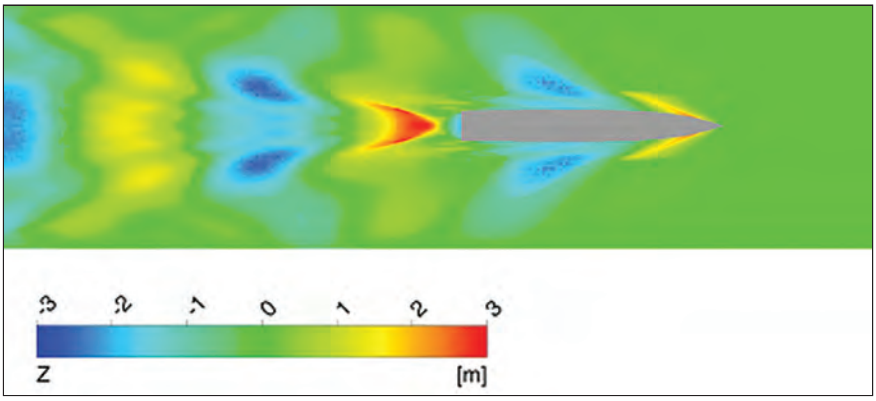

Figure 6: Predicted wave Pattern at 30knots.

more risk of ventilation and emergence/ slamming in a seaway. The forward position was discounted as this was believed to be less efficient due to the higher inflow speed and implications for vessel draught and location of the propulsive machinery. This left the conventional position.

The AWJ hullform was developed based on the conventional hullform. Modifications included the slight tunnelling of the stern aft and widening of the hull to provide a suitable location for the waterjet to be fitted. Part of the object in placing a 'soft' tunnel on the naked hull form prior to fitting the actual intake duct was to provide a beneficial environment for the waterjet to operate in, the object being to focus some of the boundary layer towards the waterjet intake and to provide a local static pressure rise. The naked AWJ hull form body plan is given in Figure 2 (see page 33).

Based on an initial assessment of the requirements for the waterjet installation a design of waterjet and inlet was produced as shown in Figure 3 (see page 33) and Figure 4. The waterjet was mounted horizontally with the front part of the waterjet ahead of the impeller housing shaped to match and ease the intake duct ahead of the waterjet. The waterjet was partially faired into the hull to reduce nacelle drag.

CFD calculations where undertaken for both the resistance and the self propelled case. The resistance results were used to give some indication of what the actual resistance for this vessel would be and the propulsion to give some insight into the propeller hull interaction factors. The high degree of integration of the waterjet and the hull coupled with the fact that the waterjet also protrudes into the flow means that a resistance calculation with the non-driving waterjet unit fitted is not so useful. The drag of the waterjet installation would be very high when it is not in operation. For this reason it was decided to regard the waterjet and the recessed intake duct as part of the propulsion arrangement and to run a separate CFD model without these items fitted in order to get a resistance estimate for the 'naked' hull. The 'naked' and the 'propelled' models are shown in Figure 5.

BMT Fluid Mechanics were contracted to carry out the CFD computer runs with the detailed interpretation conducted by BMT Defence Services. The calculations were performed using the multi-purpose CFD software, CFX. Free surface effects have been incorporated. The computational mesh used for the simulations comprised approximately 4.5 million tetrahedral and prismatic cells. The model was allowed to sink and trim so that buoyancy equilibrium was maintained using a method described in Reference 2).

An example of the wave pattern results is shown in Figure 6 (see page 34) which gives

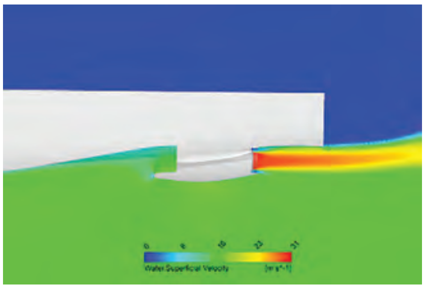

Figure 7: Predicted flow velocities through jet at 30knots.

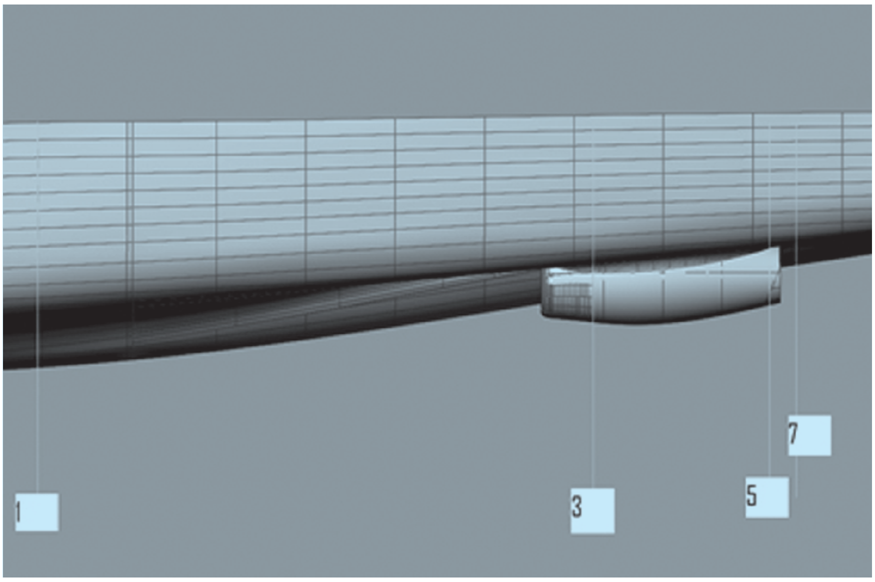

Figure 8: Definition of Control Planes.

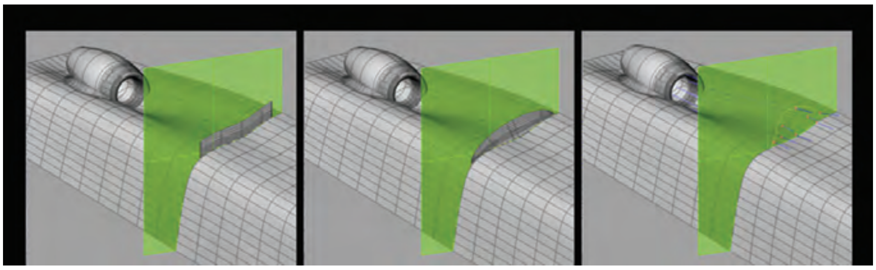

Figure 9: Possible Definition of Intake zone on Plane 7, Rectangular (left), Elliptical (Middle), From CFD (Right).

Plane	Location	Purpose
0	Upstream of vessel clear of any effects due to hull or waterjet	Provides reference values of static pressure, velocity and flow energy
1	Just upstream of the waterjet intake	To provide information on the flow as effected by the hull prior to entering the waterjet system
3	Just ahead of the pump	Gives information on flow as it enters the intake. Differences between 1 and 2 quantify the inlet losses
5	Just after the pump	Info for nozzle losses
7	On waterjets which exit to air, this should be at the Vena Contracta position, but here the jet is flooded and mixing is occurring, so position is not well defined.	Comparing with 5 gives nozzle losses.

Table 1: Definition of Control Planes.

Intake Zone Assumption	Rectangular	Elliptical	CFD Capture Zone
Wake Fraction	0.053	0.044	0.041
Intake Loss	0.2%	1.0%	2.5%
Propulsive Efficiency	0.549	0.542	0.533
Propulsion Efficiency % Difference from CFD	3.04%	1.70%	

Table 2: Effect of Different Intake Zone Assumptions.

the predicted wave pattern for 30 knots.

The CFD model for the propelled case is also shown in Figure 6. The internal details of the waterjet were not modelled. Instead the action of the waterjet was represented by placing sink and source planes inside the waterjet ahead and astern of where the stator and rotor would be located. The strength of the sink and source where set to give the correct inflow and outflow velocities at these two planes. A cross section of the waterjet model in operation at 30knots giving a diagram of the flow velocities through the jet is shown in Figure 7.

The method used to analyse the CFD results is based on the recommendations of the ITTC (References 3 and 4). This method involves the analysis of the flow through a number of control planes. These are shown in Figure 8 and described in Table 1.

The determination of the portion of the flow field to be analysed for control Plane 1 is less clear cut. For normal model test work where the boundary layer profile is measured at on location only or if not measured then is calculated using a simple boundary layer model, the ITTC recommends that it is assumed that the flow ingested by the waterjet comes from an area a certain amount wider than the intake duct and is of either rectangular or elliptical shape. The height of the intake zone is adjusted so that the correct volume flow rate is captured. In cases where CFD calculations are available, a third option of determining the actual intake zone by consideration of the ingested streamlines exists. Figure 9 shows diagrams of these three options.

In work summarised in Reference 3 it is reported that there is little difference between using these three methods. In view of the fact that in this case the hull has considerably more shape in the region of the intake than is the case for most waterjet type hulls it is interesting to compare the results from these three methods.

Table 2 gives the calculated results for wake, inlet loss and estimated propulsion efficiency for a speed of 30knots for the three different assumed intake zone shapes. It will be seen that there is up to a 3% difference between the calculated efficiencies and it is concluded for a hull such as this it is more important to use the correct capture area than for a more conventional waterjet hull form.

Based on the preliminary CFD results, with a non-optimised, first iteration design, it was found that the AWJ-design starts to be more efficient than propellers around 30knots. However, there is room for optimisation by for instance incorporating better fairing of the waterjet/hull integration and the AWJ intake geometry. Since in the speed range from 25-30knots the difference between the propeller design and the first iteration AWJ design is only small, it is believed that with such further optimisation the crossover point may shift down to 25knots, which may make the AWJ a viable alternative propulsor. Further CFD studies are required to study the benefits of AWJ propulsion in more detail. *NA*

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Simulation for tomorrow's world

UK-based design consultancy Frazer-Nash looks to push design studies further using the latest developments in computational fluid dynamics (CFD) and hydrodynamics calculations, which Henry Gordon-Wright, engineer, Frazer-Nash Consultancy explains further.

Marine manufacturers are being driven to provide cost effective, timely solutions to the engineering challenges posed by ever increasing customer demands and expectations in a competitive industry. In addressing these mounting pressures, designers are finding that computer aided simulation techniques, and notably CFD, are invaluable in enabling them to rapidly prototype and evaluate engineering solutions.

Computational Fluid Dynamics began life in simple panel codes developed by the aerospace industry as far back as the 1960s. Today, CFD is being applied across a broad spectrum of disciplines, ranging from medicine and chemistry, to sports and renewable power. CFD has become an established tool in the marine industry, and recent technological and process developments are allowing CFD to be applied to an increasingly wide range of problems.

CFD in the marine industry has moved beyond hydrodynamic simulation and is being used by Frazer-Nash to evaluate and improve external aerodynamics, airwake and thermal signatures, internal ventilation flows, cooling and gas dispersion, and in the prediction of flow-induced noise.

Hydrodynamics

Hydrodynamic simulation using CFD has become standard practice across a diverse range of marine applications from hard chine planing craft to displacement hulls and more sophisticated multi-hulled or unmanned configurations, and the evaluation of vessel seakeeping performance is as much a part of new build as refit or conversion projects. With rising operating costs, any performance gains, however small, that can be found through optimisation of vessel geometry, propulsion, and operation are relentlessly pursued.

However, CFD is still as much an art as a science, requiring experienced users and not inconsiderable effort to produce useful and reliable results. As a result, designers must consider a hierarchy of methods to evaluate hydrodynamic performance. Selection of an appropriate method depends on the required fidelity of the solution as well as time and cost constraints. It is for this reason that hand calculations and design codes are still in many cases the solution of choice early in the design process. As the design matures and develops the required solution fidelity increases so that designers can make informed decisions regarding relatively small scale changes to hull design, and generate more accurate predictions of vessel performance. It is at this stage that more complex methods such as linear and non-linear strip theory, panel methods and ultimately full CFD come into their own.

For example, Frazer-Nash has used its in house solver, HydroDyna, to demonstrate that reducing the length of a large naval platform by 8% would result in only a minimal reduction in crew availability due to motion sickness, but would dramatically reduce cost and allow the vessel to be constructed in a much wider selection of shipyards.

Recent developments in CFD software codes have focussed on attempting to bridge the gap in the solver cascade (the contrast between simplistic, but computationally efficient low fidelity solutions and complex, high fidelity, computationally intensive solutions) by improving usability, increasing automation, and through integration with design software. This has produced a step change in the throughput of CFD simulations giving designers a unique and detailed perspective on vessel performance and seakeeping at an early stage in the design process. The effects of changes to vessel topology on seakeeping performance can now be evaluated in hours or days rather than weeks or months as previously.

Hydrodynamic simulation in itself is an extremely useful tool, but it is only when fully integrated into the design process and coupled with other computer aided engineering (CAE) techniques such as structural analysis and control system design that the full potential can be realised.

The CFMS initiative, part funded by the Technology Strategy Board, has led the way in developing these techniques. A pan-industry cooperative programme involving Airbus, BAE Systems, MBDA, Rolls-Royce and Williams F1 among others, the programme aims to deliver a paradigm shift in the capability of fluid mechanics simulation systems. As lead marine contributor to the programme, Frazer-Nash has focussed on coupling established geometry, optimisation, and simulation packages to allow fully constrained, multi-objective optimisation to be performed on high-speed planing craft. Frazer-Nash said that it has demonstrated the ability to optimise hull forms for minimum slamming loads, vertical accelerations and resistance through a variety of rough sea conditions in a single automated optimisation operation taking less than one day.

The logical next step for this tool is to combine the hydrodynamic simulation with finite element analysis of the structural response and to evaluate the seakeeping response of the vessel under helm inputs. In this way it is possible to automatically produce a hull design that is optimised for hydrodynamic, structural and manoeuvring performance for a specific range of likely operating scenarios. With today's high powered computing clusters, and sophisticated optimisation and automation systems, such a simulation is no longer a pipe dream and has become a reality.

Beyond hydrodynamics

Automated optimisation can theoretically be applied to any problem where the inputs can be parametrically defined, and the output mathematically quantified; as such, the possibilities for optimisation in the future are seemingly endless. Similarly the use of CFD itself in the marine industry is not limited to hydrodynamics. To the CFD user, water is merely another continuum material which can be discretized and simulated using a computer, and CFD is increasingly being used to simulate both external and internal aerodynamic, rather than hydrodynamic, effects.

External and internal aerodynamics

Engineers at Frazer-Nash have brought the full range of CFD tools to bear on the external aerodynamics of aircraft carriers. The airwake over the carrier deck has been simulated using CFD in order to characterise the turbulent structures over the flight deck. This information has been used to inform take-off and landing procedures and allow pilots to train more effectively for future carrier operations.

Airwake assessment is more commonly used in helideck operations, across defence, superyacht and container platforms. The maturity of CFD techniques has been recognised to such a degree that CFD simulations are now considered reliable and accurate enough to provide sufficient evidence for helideck certification. Frazer-Nash has been actively involved in the MCA committee developing the LY2 regulations and has successfully assessed helicopter operations across a number of platforms.

The external aerodynamics of superyachts are of particular concern for designers since passenger comfort is a primary design driver. CFD can be used to predict the dispersion of engine and ventilation exhaust gases over the vessel in order to gain an understanding of likely passenger exposure. The CFD models can then be used to drive design changes in order to reduce and mitigate this exposure.

Whilst the external aero and hydrodynamics are of key importance to the design of many vessels, Frazer-Nash has frequently found that the HVAC system can be a high risk in a vessel's design, both in terms of performance and safety, and can be easily overlooked. Insufficient or arduous intake or extract flows to main propulsion or secondary systems will clearly lead to sub optimal system performance. However in many cases it is insufficient engine cooling, both in terms of fluid and air conditioning systems that will lead to downtime. Frazer-Nash have used CFD simulations to evaluate losses in pipework systems where performance does not meet design expectations and have redesigned engine room ventilation systems across a variety of platforms in order to provide more effective, targeted cooling. The scale of these simulations has ranged from luxury superyachts to large naval vessels.

Simulation: the future

As discussed previously, the future of CFD technology lies in simplifying and speeding up the transition from geometric model to useful simulation result. This allows for automated optimisation runs to be completed in a timely manner, and increases the feasibility of one-off simulations to evaluate design changes on an ad-hoc basis. Designers can then use CFD to understand and predict performance prior to manufacture rather than only to understand the root causes of problems which have been designed and built into the finished vessel, as has been the case in the past.

The potential for increased throughput is dependent on development in four key areas, specifically: computational power, automated meshing, automated simulation, and automated post processing. The final two areas are now well established, and it is in computational power and automated meshing that real gains are being seen.

The majority of readers will be familiar with the concept of parallel processing and multi-processor clusters. Machines of this class can now be found on home desktops, and high-performance computer clusters consisting of 64 or more processing cores are now commonplace in the CFD industry. However, an interesting recent development has been in the application of Graphics Processing Units (GPUs), originating in the computer games industry, to CFD simulations. Cambridge University has recently been able to demonstrate a speed up in the simulation of flow through a gas turbine from 12 hours on a single processor to nine minutes using a GPU.

Another interesting development has been in the use of mesh-free methods for fluids simulation. This side-steps the need for automated meshing in the optimisation process by using advance modelling techniques such as smoothed particle hydrodynamics (SPH). These methods are increasingly finding their way out of academia and into real world applications in the marine industry as they are particularly suited to modelling the flow of water under gravity.

Exploiting the combined potential of these exciting software and hardware developments will allow the full potential of these methods to be unleashed to the benefit of designers, manufacturers and operators alike. *NA*

AI-*FreSCo*+ airs complex RANS code

To face the ever increasing challenges in hydrodynamic analysis, Hamburgische Schiffbau Versuchsanstalt GmbH (HSVA) and the Technical University in Hamburg-Harburg have joined forces to develop a dedicated RANS code for maritime applications. Marco Schneider, Dieke Hafermann and Jochen Marzi explain the developments of FreSCo+.

Originating from an earlier cooperation of the two, the "Free Surface Code" FreSCo+ was further developed during the European VIRTUE project. Having matured over the last year, the code is now the main backbone of HSVA's computational fluid dynamics (CFD) services. Based on a modern computational approach, the code's versatility will allow users to address a broad span of typical maritime applications covering resistance, wake field, propeller and cavitation predictions, as well as dynamic simulations for manoeuvring or seakeeping analysis. The following examples highlight some typical design – analysis problems encountered in the routine of a ship model basin which have been solved using FreSCo+.

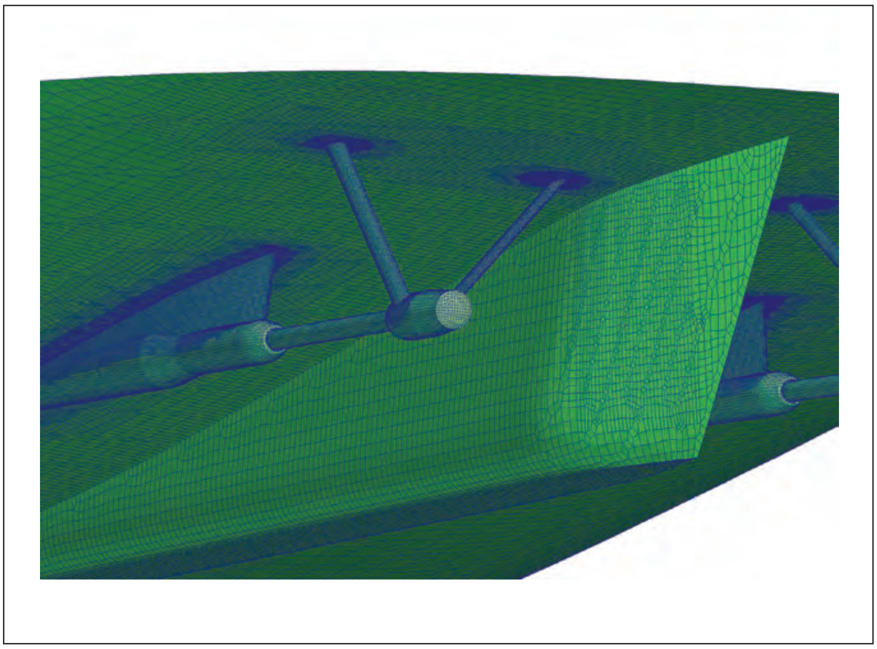


Figure. 1: Surface grid for twin screw vessel.

Numerical model

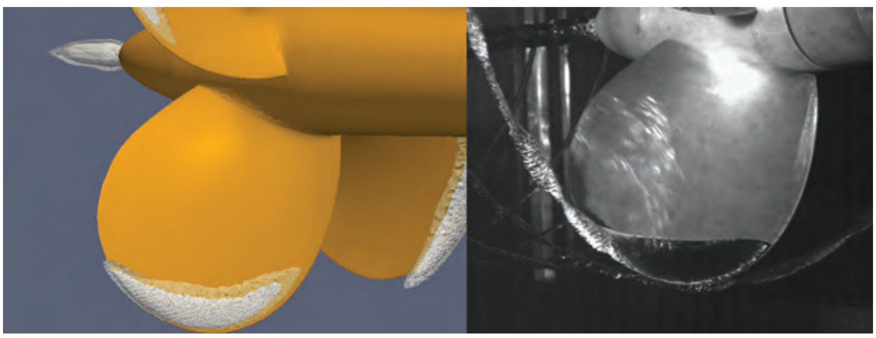
The FreSCo+ code solves the incompressible, unsteady Navier-Stokes-equations (RANS). The transport equations are discretised with the cell-centred finite volume method. Using a face-based approach, the method is then applied to fully unstructured grids using arbitrary polyhedral cells. Therefore, the code can use grids from different grid generators like the fully unstructured, automatic grid generator HEXPRESS.

This reduces the time needed for generating typical grids from several days to hours. The code is efficiently parallelised in space using the message passing interface (MPI). A wide range of different 1- and 2-equations turbulence models have been implemented to account for turbulent flows.

Propeller study

Cavitation is an imminent problem of marine propulsion, often caused by inappropriate propeller designs especially for high speed vessels. The accurate prediction of these phenomena in the early design process can help the shipyards, propeller manufacturers and ship operators to adopt design solutions avoiding or at least reducing the associated risks of erosion and vibration excitations. In the context of the VIRTUE project, a common test case based on a four bladed fixed pitch propeller from INSEAN has been selected to test and further enhance cavitation prediction capabilities of RANS codes. Available Model scale experiments from towing tank and cavitation tunnel for this propeller were compared with numerical results. The FreSCo+ results shown in figure (left) indicate a realistic prediction of cavitation extension and

Figure 2: Vapour volume fraction iso-surface for $\sigma_V = 0.5$, Computations, Experiments (1).



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Changes in regulations have also had a large impact on design, probabilistic rules for damaged stability and new rules for the structural use of composites open up new possibilities but also bring new challenges for all involved in design and manufacture. The introduction of the Energy Efficiency Design Index also places greater restrictions on the design of new vessels.

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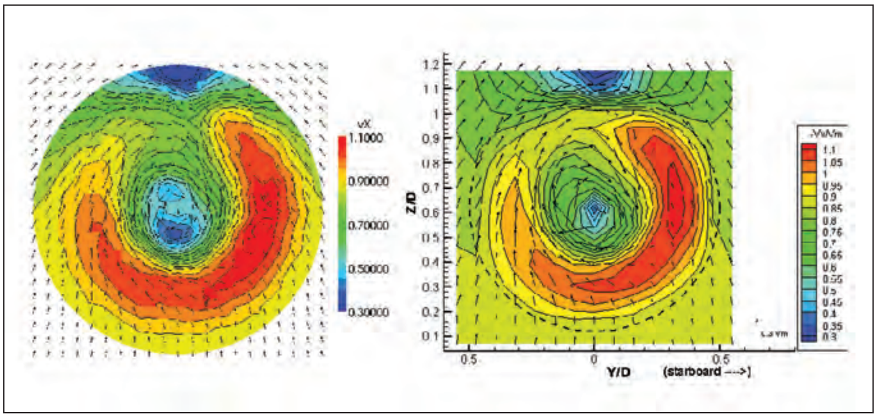


Figure 3: Hamburg Test Case: Axial Velocity behind propeller (computations (left) / measurements).

intensity when compared with the experiment (right).

Numerical propulsion test

Propulsive efficiency is a key element in ship and propeller design as it largely determines fuel consumption and hence cost as well as the amount of emissions caused by a ship. Although the resistance of the hull is the largest overall contribution to the forces acting on a ship's hull during operation and hence the accurate prediction of the resistance is of great importance, a final assessment of the quality of a new hull design can only be made once the propulsion performance is known.

FreSCo+ offers an advanced concept to perform a numerical propulsion test in that the RANS code is coupled with HSVA's in-house vortex lattice code QCM [2] (Quasi Continuous Method) for propellers in an iterative fashion [3, 4]. At the start of the predictions, the (nominal) wake field is predicted and fed into the vortex lattice code where propeller thrust and torque are computed. The turning rate is adjusted until a propeller thrust to overcome the ship resistance is obtained. The hydrodynamic forces of the propeller are converted in the form of body forces, which are assigned to cells within the swept volume resulting from rotation of the propeller blades and fed back into the a new RANS calculation. This procedure runs iteratively until and equilibrium between the resistance of the ship under self-propulsion condition and the propeller thrust is reached.

The method has been validated using several test cases, the first one being the self propelled "Hamburg Test Case" (HTC), a widely investigated small container ship. Figure 3 shows the comparison between computed and measured velocity distributions at (x-xp)/D=-0.201 behind the propeller and indicates a very good agreement. Today, the numerical propulsion test is applied to customer projects on a regular basis.

Free surface – wave resistance predictions

Determining the wave resistance of a new hullform is – still – among the most important tasks of a model basin. Although early CFD developments based on potential flow theory, e.g. HSVA's panel code ν-SHALLO have shown very good computational results already, the methods often fail to predict accurate results for blunt ships or hullforms sporting a wetted transom. FreSCo+ has been applied to such cases.

In a comprehensive computational exercise, FreSCo+ results have been validated against experimental data obtained from both, the VIRTUE and the ABSS project where detailed wave measurements beside the ship and behind the transom have been performed, the latter using a novel laser cut technology. One of the vessels investigated in this project has been the so called VIRTUE container ship, a contemporary design for a 3000TEU vessel.

The results obtained from these predictions demonstrate that the new code allows the user to accurately predict the wave pattern around a ship hull, capturing

Figure 4.1: FreSCo+ has been used to compute the wave pattern around the ship, wave elevation on the hull and behind the transom stern as well as the total resistance force.

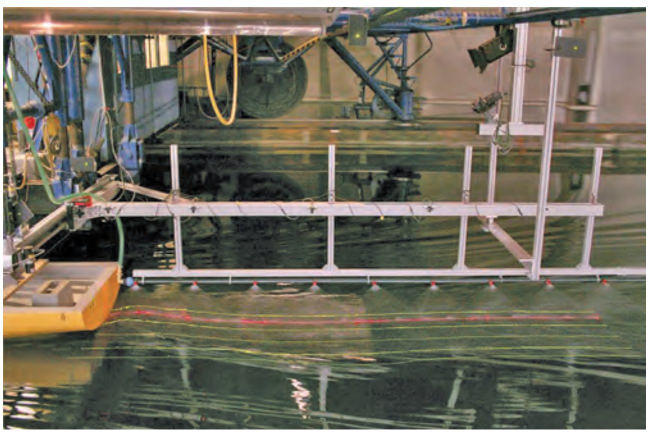
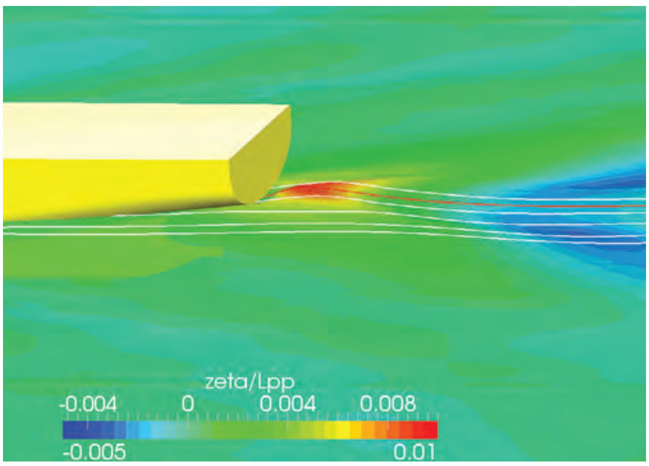


Figure 4.2: Predicted wave pattern for the VIRTUE container ship at FN = 0.25.



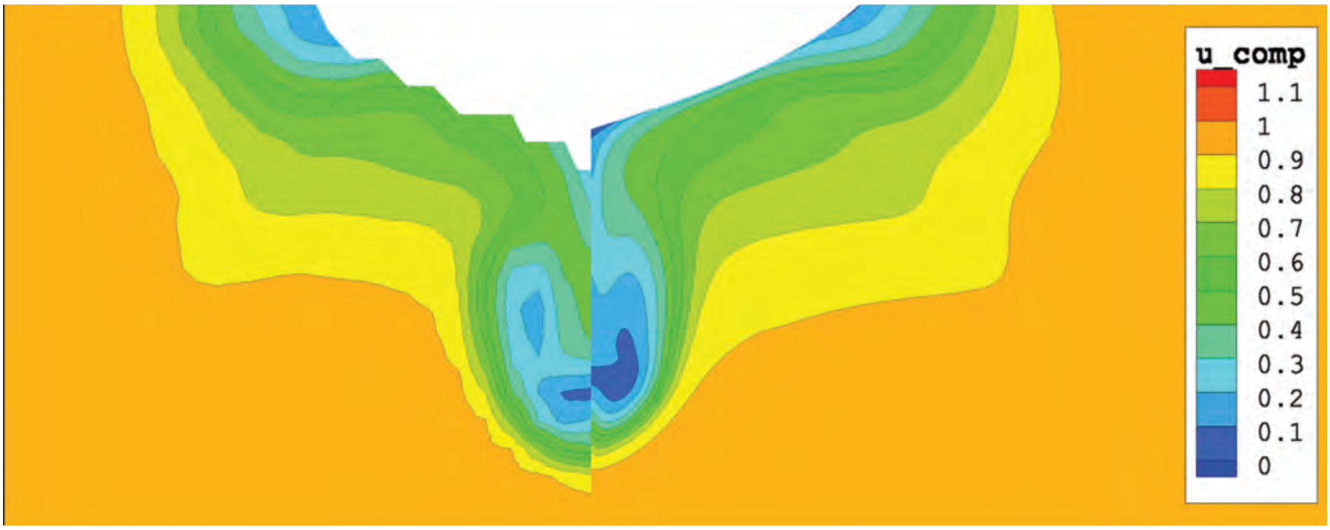


Figure 6: Validation: Tanker Hull: FreSCo+ Results (right) vs. experimental data (left).

more detail for example in the region of the forward shoulder and especially behind the transom stern.

Wake field predictions

Wake analysis and propulsion optimisation are among the most important elements during ship design as propulsive efficiency largely determines the commercial viability of any new design. It is hence of great importance for all RANS solvers applied in wake predictions to validate results on approved experimental data. FreSCo+ underwent a series of validation exercises on standard cases such as the KVLCC2 tanker and other hulls before being finally released.

Having gained confidence in the numerical results obtained from FreSCo+ predictions, the more challenging tasks of optimising a hullform for improved wake flow was addressed in different in-house projects. The first one was aimed at the optimisation of the aft body of a tanker hull where first comparisons of the wake alone were performed. In a more thorough exercise performed in a second project a full optimisation of the hullform of a bulk carrier was performed, accounting for wake quality and all relevant resistance components. This was based on a parametric CAD model allowing for quick modifications of the hull form and subsequent analysis. This was the first example for an integrated process chain in which FreSCo+ could be used within a complete design environment comprising CAD, RANS analysis and optimisation.

Another big issue in this context is the application of Propulsion Improvement Devices (PID) to increase propulsive performance and efficiency of existing ships. Retrofitting such devices to today's cargo vessels is expected to give a substantial contribution to reduced emissions from maritime transportation. FreSCo+ has been applied in a number of projects already to analyse the effects of different types of PIDs, flow alignment fins or ducts. The detailed flow results obtained from the computations, typically combined with a numerical propulsion test described above, allow for dedicated design optimisation and customised PIDs to be selected for a given case.

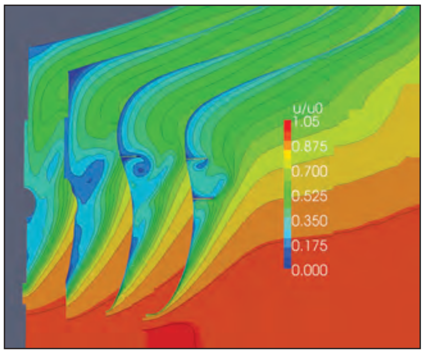
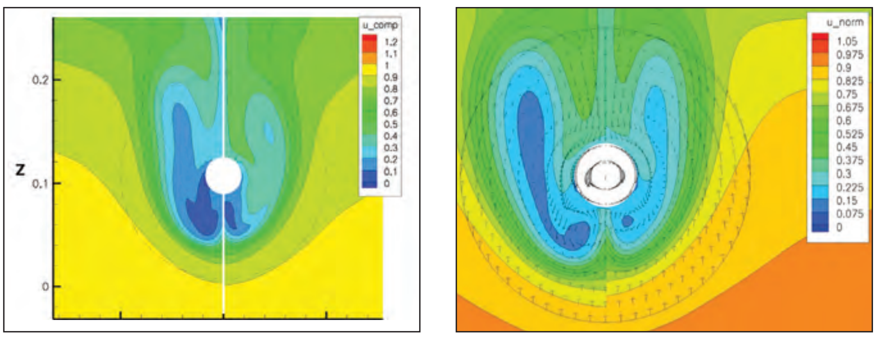


Figure 8: Wake development under the influence of fins mounted ahead of the propeller.

Figure 7.1 & 7.2: Wake optimisation: tanker hull (left), bulk carrier (right), each showing the baseline design on the left and the optimised hull on the right.



Manoeuvring simulations

Forecasting manoeuvring performance is another important area of hydrodynamic ship design. Again in the context of the VIRTUE project, FreSCo+ has been applied to the prediction of manoeuvring coefficients for a large range of standard manoeuvres which could be validated with experimental data obtained from model tests in HSVA's large towing tank.

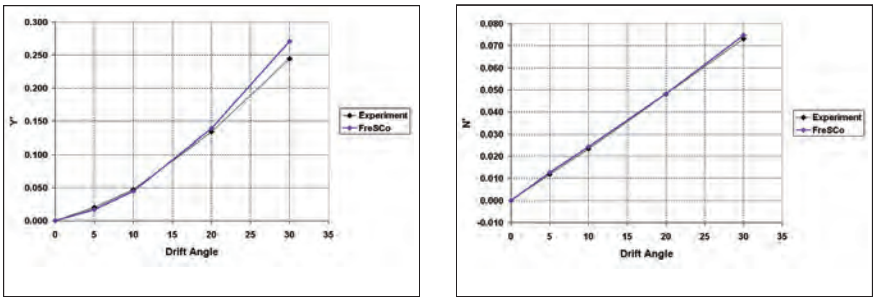


Figure 9: Comparison of predicted normalised side forces and yaw moments (VIRTUE – WP 3).

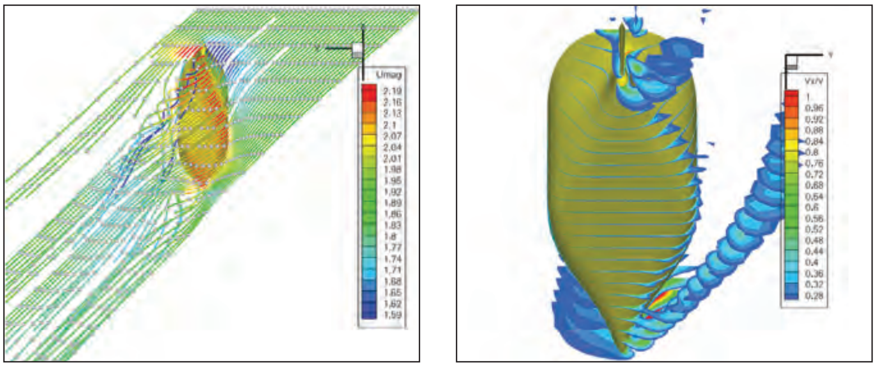


Figure 10: Predicted streamlines and hull pressure distribution (left) and axial flow field velocity (right) for a drift angle of 30degs.

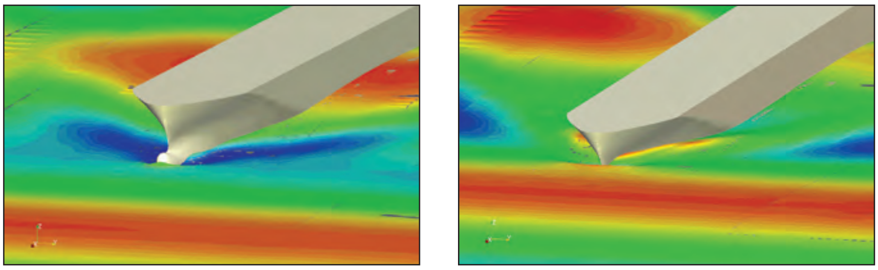


Figure 11: Ship motion simulation - Container vessel in head seas.

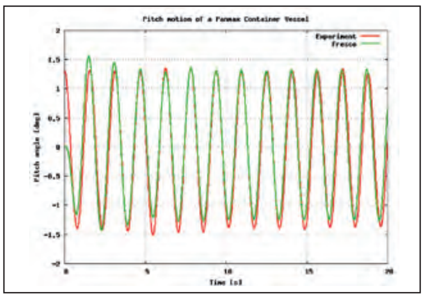


Figure 12: Comparison of pitch motion simulation – FreSCo⁺ (green) and experiment (red). Present research aims at the prediction of vessel behaviour in extreme conditions including rogue waves.

In a workshop with six participants using different flow codes, HSVA's FreSCo⁺ predictions again are among the best submitted results. The code proved to be accurate, fast and versatile and showed that it is a valuable means for the prediction of manoeuvring performance at the design stage of a new ship. Besides, the overall amount of flow field information yielded (see the predicted streamlines and hull pressure distribution for a yaw angle of 30degs) provide deeper insight into the mechanisms and will help to suggest improvements for critical cases.

Seakeeping predictions and ship stability

Safety is now acknowledged to be a design driver and key to sustaining the leadership with technologically advanced ships. Ship stability in a seaway is a prime element of an integral safety assessment of new and more unconventional vessels, which stretch the limits of traditional evaluation methods. Where former panel code or strip method based numerical tools yielded satisfactory results for standard vessels in the past; today's focus lies on the simulation of extreme situations and extreme ship designs. FreSCo⁺ is now applied to the analysis of ship motion behaviour using a 6 DoF approach. The following example shows results from the simulation of a container vessel in head seas with good balance between the experiment and numerical results.

Summary

Today, FreSCo⁺ has been successfully applied to a wide range of typical shipbuilding and maritime applications during the routine work at HSVA. Accurate free surface predictions as well as the numerical propulsion test, make FreSCo⁺ the tool of choice for ambitious ship design applications and further challenging analysis tasks. Recent research of the joint development group at TUHH and HSVA will further enhance capabilities and functionality of the code to meet new requirements arising from offshore applications and stability / safety considerations. At HSVA a full range of FreSCo⁺ based services is offered in routine projects for the benefit of our customers. *NA*

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Shipyard fabrication and quality control

Following is part one of a three part paper written by Lloyd's Register's David J Howarth and John Durkin (parts two and three will appear in the September and October issues of *The Naval Architect*). The paper demonstrates the need for the maritime industry to learn the lessons, not only to improve quality and ultimately safety, but also to reduce costs and improve efficiency.

Introduction

Class requirements are intended to ensure that the vessel operates safely and successfully during its design life by ensuring the integrity of the hull envelope. Construction of a new vessel involves the control of materials, shot blasting and priming, fabrication of hull panels, fabrication and erection of blocks within a dry dock. Several of the above activities involve the use of a variety of welding processes which have been selected for a specific reasons – usually high productivity, low cost and fitness for purpose or application.

If the fabrication inspection methods are not suitable for the detection of fabrication flaws, it is possible that structurally unsound welds will be installed in the vessel. Welds in the above condition may be considered critical in the context of fatigue during service.

This paper looks at the basis for quality control in a shipyard and the effects of fabrication processes on the mechanical properties of the materials.

Consumable grade		Suitable for steel grades		CVN test temp. °C
1N	A	AH32	AH36	+20
2N	B, D	DH32	DH36	0
3N	E	EH32	EH36	-20
1Y	A	AH 32	AH36	+20
2Y	B, D	DH32	DH36	0
3Y	E	EH32	EH36	-20
4Y	-	FH32	FH36	-40
2Y40	AH32	AH36	AH40	+20
2Y40	DH32	DH36	DH40	0
3Y40	EH32	EH36	EH40	-20
4Y40	FH32	FH36	FH40	-40

Table 1: Consumable grades appropriate to structural steel grade.

Principles of welding qualtiy control

Steel grades intended for the vessel's hull are specified by the classification society's rules.

The chemical composition and mechanical properties for all grades and strength levels are today unified by the International Association of Classification Societies [1], [2].

Plates and sections are shot blasted and primed before profile cutting to a variety of shapes for a particular part of the hull structure. The forming of plates is either carried out cold by roll forming or pressing, or warm by line heating. Issues with both cold and warm techniques are discussed later with respect to their possible effects on mechanical properties.

Welding processes

Today the welding processes used in the fabricating of the hull structure involve the following welding processes:

- Shield Metal Arc welding (SMAW)
- Gas Metal Arc Welding (GMAW)
- Flux Cored Arc Welding (FCAW)
- Submerged Arc Welding (SAW)
- Electro Gas Welding (EGW).

Currently, the most common welding process used for hull construction is the gas shielded flux cored arc welding. This process is capable of depositing large volumes of weld metal quickly and efficiently. Electro gas and submerged arc welding are also commonly used. They are both automatic high heat input processes, but submerged arc welding is restricted to horizontal flat panels such as found in panel lines and decks, whereas electro gas welding is used in welding flat vertical joints and therefore is generally restricted to the joining of block structures. The use of ceramic tiles for semi-automatic and automatic processes for single side joints is widely used at every stage during hull construction. Hybrid laser welding is not included in the list but is used extensively in thin materials (6 – 10mm) where a low distortion process is necessary to help reduce distortion [3].

The selection of welding consumables

for hull construction is based on a classification society's list of approved consumables. Welding consumables for hull steels are classified or graded on the basis of toughness and minimum yield strength. The grade is usually indicated by a numerical character for toughness and an alphabetical character for the strength level. For higher strength steels the alphabetical character is supplemented by a number representing the yield strength, traditionally in Kg/mm^2. For example, in the description 2Y40, '2' indicates the toughness grade, 'Y' indicates the higher tensile steel, and '40' indicates yield strength; in this instance 400N/mm [2].

The selection of welding consumables is based on the weld metal Charpy impact toughness requirements matching the minimum Charpy V-notch (CVN) impact toughness levels specified for hull materials. Table 1 summarises the welding consumable grades appropriate to the steel grade.

You will note from the above table that the required test temperature is 20°C higher than that required for the parent plate. This is an historical requirement, rather than a technical one, and dates from the time of the early development of welding consumables when low temperature properties in weld metals were difficult to achieve when compared to the wrought plate. However, the consumable manufacturers did not get too much of a concession, the weld metal had to achieve a higher energy value. Today, welding consumables would have no problem in achieving the lower temperature used for the wrought product, yet the historical difference remains.

Weld procedure

The establishment and qualification of welding procedures in any fabrication is an essential function and has become standardised throughout the industry [4] and, indeed, throughout the world [5]. No matter how good the base material's mechanical and fracture properties are, the process of fusion welding will cause a reduction of these properties, and the amount of this reduction needs to be controlled. It is the welding procedure specification (WPS) that confirms that the minimum required properties can be achievable, provided of course, the welder follows the welding procedure.

The welding procedure specification is qualified by a series of destructive and non-destructive tests. A typical example of the requirements for such tests taken from Lloyd's Register's *Rules for Materials* is shown in Table 2.

Where a non-approved welding consumable is used, a longitudinal tensile test and chemical analysis of the weld metal are also required. The record of the test results, any retests and the details of the welding procedure specification are maintained and recorded in a separate document, The Welding Procedure Qualification Record (WPQR). This document also outlines a series of essential variables that include the:

- manufacturer
- welding process and technique
- welding position
- joint type
- thickness and diameter
- parent material type
- welding consumable
- shielding gas
- heat input
- current type
- preheat temperature
- interpass temperature.

The essential variables are very specific, such as the welding process, or have a specified range to which the welding procedure specification can be applied, such as with thickness. It should also be noted that a welding procedure qualification record may be used to qualify multiple welding procedure specifications.

Welder qualification

Whereas the qualified welding procedure specification is the control necessary to ensure adequate control of the metallurgy and mechanical properties of the welded joint, the testing and qualification of the welder to the welding procedure specification is essential in terms of a workmanship standard. The welder must be shown capable of using a welding procedure specification by producing a test weld of good quality in terms of freedom from deleterious imperfections.

Table 2: Examination and testing of weld procedure test assemblies.

Weld assembly	Test	Extent of testing
Butt joint with full penetrat ion	Visual Radiographic or ultrasonic Surface crack detection Transverse tensile test transverse bend test Impact test hardness test Macroscopic examinination	100% 100% 100% 2 4 Weld & HAZ 1 1
Fillet welds	Visual Surface crack detection Fracture tests Hardness test Macroscopic examination	100% 100% 2 1 1

The test is to simulate, as far as practicable, the welding techniques and practices to be encountered during production welding. The test assembly should be designed to test the skill of the welder and have the shape and dimensions appropriate to the range of approval required. Each completed test weld is to be examined and tested in accordance with the standard used. Examples of the sorts of tests specified are shown in Table 3 for butt and fillet welds.

The qualification of welders is to be documented by the manufacturer and, in the same way as both the welding procedure specification and the welding procedure qualification record, is to be documented by the shipyard. All such records are to be available for review by the surveyor.

The welder qualification test, if successfully carried out, will qualify the welder to a number of essential variables arising from test weld carried out. These include:

- welding process
- parent material type
- thickness and diameter
- joint type
- back gouging
- welding position
- welding consumable type
- shielding gas.

The welder is considered to be approved for an initial period of two years. The welder may retain this qualification for a further two years provided that the shipyard confirms that the welder has used the welding process with acceptable performance in the preceding six months. Where there is any reason to question the welder's ability, or there is a lack of continuity in the use of the welding process, or insufficient recorded evidence of acceptable weld performance, the welder is required to perform a new qualification test.

Weld inspection during construction

Inspection of the welded fabrication is carried out by non-destructive examination techniques (NDE). These include:

- visual examination
- surface magnetic particle (MT) or dye penetrant (PT) examination
- volumetric radiographic (RT) or ultrasonic (UT) examination.

In the same way that welding procedures and individual welders need qualifications, the use of procedures and the qualification of NDE operators are probably even more important. For each inspection method, operators should be qualified according to a nationally recognised scheme with a grade equivalent to Level II qualification of ISO 9712, SNT-TC-1A, EN 473 or ASNT Central Certification Program (ACCP). Operators qualified to Level I may be engaged in the tests under the supervision of personnel qualified to level II or III.

In the same way, personnel responsible for the preparation and approval of NDT procedures should be qualified according to a nationally recognised scheme with a grade equivalent to Level III qualification of ISO 9712, SNT-TC-1A, EN 473 or ASNT Central Certification Program (ACCP).

All personnel qualifications should be verified by certification to prove they are up-to-date and appropriate to the test methods being carried out.

The extent of NDE should be in accordance with the appropriate classification society rules; these identify a minimum number of inspection points dependent on vessel type and size. A typical capesize bulk carrier would require over 3000 checkpoints. In all cases, the extent of applied NDE may be increased at the request of the surveyor where there is reason to question the quality of workmanship of the shipyard.

Classification society rules are a minimum requirement and shipyard quality control departments normally have their own inspection procedures that far exceed the requirements of the classification society.

Non-destructive testing should be conducted after welds have cooled to an ambient temperature and after post-weld heat treatment where applicable. For steels with specified minimum yield stress of 420 N/mm^2 and above, non-destructive testing should not be carried out before 48 hours after completion of welding. Where post-weld heat treatment (PWHT) is carried out, the requirement for testing after 48 hours may be relaxed. *NA*

Test	Butt welds	Fillet welds
Visual	100%	100%
Surface crack	-	100%
detection	100%	N/R
Radiography	4	N/R
Bend tests	N/R	1
Fracture tests	N/R	1
Macro-section		

Table 3: Welder qualification test requirements.

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IMO sets tanker and bulk standards

For the first time in its history, the International Maritime Organization (IMO) will be setting standards for ship construction, following an agreement reached at the Maritime Safety Committee (MSC), meeting in May, writes Sandra Speares.

The IMO's MSC adopted goal based standards (GBS) for construction of tankers and bulk carriers, which means that those classes of ship will have to comply with structural standards drawn up by the committee.

The MSC also adopted rules that give the IMO a role in verifying compliance with the safety of life at sea convention, SOLAS. This included amendments to Chapter II- 1 of the convention. The changes are set to enter into force on 1 July 2012.

The verification process comes in two stages. Firstly there will be a self assessment by the body submitting the rules to the IMO for checking, then an audit of procedures by experts appointed by the organisation.

According to the IMO: "The new SOLAS regulation II-1/3-10 will apply to oil tankers and bulk carriers of 150m in length and above. It will require new ships to be designed and constructed for a specified design life and to be safe and environmentally friendly, in intact and specified damage conditions, throughout their life.

"Under the regulation, ships should have adequate strength, integrity and stability to minimise the risk of loss of the ship or pollution to the marine environment due to structural failure, including collapse [of the hull], resulting in flooding or loss of watertight integrity."

The goal based standards adopted last month relate to three tiers including overall objectives, functional requirements and verification of conformity. Two further tiers cover rules and regulations for ship design and construction and industry practices and standards.

IMO Secretary-General Efthimios Mitropoulos has described the adoption of GBS as "a significant and important breakthrough for the organisation, not only in terms of how future regulations will be developed, but also with respect to the role that IMO will play in verifying compliance, in this particular case, with SOLAS requirements."

"The concept that IMO should state what has to be achieved, leaving classification societies, ship designers and naval architects, marine engineers and ship builders the freedom to decide on how best to employ their professional skills to meet the required standards is a sound one and I congratulate the Committee on the painstaking and hard work carried out to turn the concept into reality."

The agreement has been welcomed by many industry bodies including the International Chamber of Shipping (ICS).

> "a significant and important breakthrough for the organisation, not only in terms of how future regulations will be developed, but also with respect to the role that IMO will play in verifying compliance, in this particular case, with SOLAS requirements."

"This is the culmination of several years of negotiations in which ICS has been closely involved and continues to be active," said ICS Marine Director Peter Hinchliffe.

"It is likely that we will increasingly see regulatory developments at IMO being based on a more explicit goal-based assessment of hazards and their mitigation measures. In particular this may apply to requirements for the specification and carriage of shipboard equipment."

Derek Hodgson, permanent secretary of the International Association of Classification Societies (IACS) commented: "IACS welcomed the adoption of the new regulatory framework for newbuilding oil tankers and bulk carriers at the meeting of MSC. In particular, IACS was pleased that the committee agreed a deadline by which rules will need to be submitted for verification that takes account of the work IACS has already commenced to develop harmonised common structural rules (HSR).

"In June's IACS Council meeting progress on the HSR project was discussed. IACS recognises that the timely delivery of technically robust outputs from this work will be needed so they can be taken account of in the rules that will be submitted for verification."

Under the new procedures class societies will submit their structural rules to the IMO and the expert group will verify that the rules are adequate to meet the criteria set down in goal–based standards.

The idea of goal-based standards was first put to the IMO Council in November 2002 by the Bahamas and Greece with a view to getting more member state control over the rules being applied to the construction of tankers and bulk carriers. "They have really got what they asked for," commented Mr Hinchliffe.

"The proof of the pudding will be when the IMO has verified the rules, what difference will that make to the rules that have been submitted? Will they verify them or will they make some changes?"

In welcoming goal-based standards, he says there is a synergy with the common structural rules under development by class societies. The process is designed to ensure that the structural rules meet the necessary requirements. This presents an opportunity on a continuous basis to "move forward construction standards"; although he stresses that there is no suggestion that current construction standards are sub-standard.

There was a good deal of debate at IMO about the timetable for implementation. IACS indicated it could not submit the common structural rules without continuing the harmonisation process between tankers and bulk carriers.

"We said there are differences in requirements between the tanker rules and the bulk carrier rules", Mr Hinchliffe explained. ICS wanted to see those differences removed to the extent that that was possible and IACS was in agreement with this approach which enabled work already underway to continue.

Mr Hinchliffe said IACS put two proposals on the table, firstly to continue the harmonisation process, in which case the association would not be able to submit the rules until 2013. Alternatively it would not continue with the harmonisation. ICS did not agree with the second option, Mr Hinchliffe said.

The last date by which the IMO Secretariat will be able to process verification requests from classification societies in time to meet the GBS implementation date is 31 December 2013. Verification in this context means verification that the class society rules for ship construction are in conformity with goal based standards.

Although some people were not pleased with the delay to 2013, Mr Hinchliffe said: "We would take the view that it is important that the IMO has adopted the goal-based standards and it is better to do a proper job rather than to rush things through in order to be seen to be doing so".

The timescale as it stands is "workable and achievable" he said. In January 2016 the IMO will prepare documentation for audits. In May 2016, the MSC will take final decision on conformity with GBS for all rules submitted. That means GBS will be up and running from 1 July 2016.

According to Roberto Cazzulo, deputy director of the marine division of Italian class society RINa, the fact that the IMO reached the decision to fix the verification date at the end of 2013 was a good one as it enabled submission to IMO of harmonised structural rules for tankers and bulkers which are under development within IACS.

"The proof of the pudding will be when the IMO has verified the rules, what difference will that make to the rules that have been submitted? Will they verify them or will they make some changes?"

The importance of the decision was that the audit committee within IMO would be able to audit each class society on the most up to date technology and rules that the societies can produce.

At present details like fatigue analysis or ultimate strength are slightly different in the common structural rules for tankers as opposed to bulk carriers and this issue can be addressed.

The philosophy behind the harmonisation work is to take the highest standard when comparing the different methodologies to ensure that the standard to be judged to conform to goal-based standards is the best achievable. There will inevitably be sensitivities as to how this issue is addressed.

In the work within IACS, it is a "delicate matter" as to how to benchmark the various methods being proposed, Mr Cazzulo said and most importantly "how to benchmark the results that come from the application of the different methods."

How the rules are tuned will affect such vital issues as scantlings research will cover a "large population of vessels" he said.

All work on the project from smaller specialist groups will be fed into IACS' Hull Panel including contributions from non-IACS members should they wish to make them.

Although there may be doubts about whether the necessary deadlines will be met, the decision made at MSC exerts a "positive pressure to allow IACS to complete the job in time". It also gives individual classification societies the time to incorporate changes into their own rules.

The work has to be completed in IACS six months before the deadline of 31 December 2013 otherwise there would be no time for individual societies to get the approval of their technical committees before submission to the IMO. Information will be shared with other class societies outside IACS, to ensure there are no anti-trust issues.

The European Union (EU) has been supportive of the goal based standards project according to Mr Cazzulo, as it is in line with EU directives adopting a similar approach in other industries and is considered as a means of developing new technology.

The EU has had its own role to play in discussions at IMO over the development of GBS.

RINa itself has been an "active partner" in the structural rules harmonisation project. The classification society has developed its own software tool Leonardo, which allows speedy checking of rule results. It is suited for ship structure, allowing a "very easy, very quick definition of the hull".

RINa has also developed the Green Plus notation which is a goal-based notation for impact on the environment. When a designer has an innovative solution on board ship, Green Plus will reward that solution more than a traditional solution if as a result performance is better. "We believe it is important to balance all the pieces of equipment onboard the vessel to have the best environmental performance, including air, water and other issues. Green Plus is intended to reward solutions that show the best balance." *NA*

Wake-adapted design and propeller analysis for naval architects

The hydrodynamic design and analysis of marine propellers occurs along a broad spectrum of detail and complexity. Most naval architects use some sort of "system-level" software for propeller analysis, essential for the proper matching of hull, engine, transmission, and propeller, writes Donald MacPherson, VP Technical Director HydroComp, Inc.

Custom and semi-custom propellers – now commonplace for new vessel designs – offer a different set of technical challenges to the naval architect. They differ from stock "off-the-shelf" propellers in two principal ways – they are designed using contemporary foil geometries, and they are optimised and fitted to the individual vessel (or vessel type). To fully take advantage of the benefits that custom or semi-custom propellers make available, or to evaluate them in service, naval architects must look to a different kind of propeller calculation.

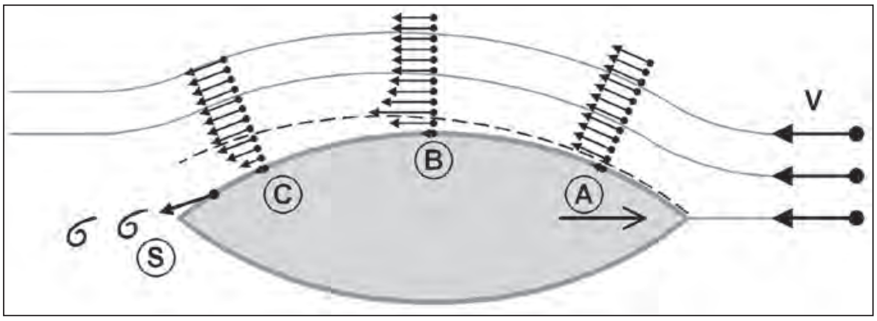


Figure 1: Water flow and boundary layer.

Wake fields of velocity

The term "wake" is used in a number of different ways in maritime operation, but for our purpose, we use wake to refer to the measure of local velocity at the stern of a ship. It is how we quantify differences in the environment around the propeller from vessel to vessel.

Consider the following graphic (Figure 1). This is a stylised schematic of a hull showing the creation of its boundary layer and flow vortices at the stern. You will note at point C that the free-stream velocity V gradually reduces and becomes very small at the hull itself. This is the region where the propeller lives, so the propeller will be seeing water that is typically somewhat slower than the ship's velocity. When conducting propeller analyses, we need some measure of this reduction of speed into the propeller, and we use the "wake fraction" coefficient to provide a figure for the overall reduction (reflecting the "speed of advance" at the propeller).

The critical velocities for propeller evaluation are those found in the plane of the propeller disk area. For a given vessel, these velocities can be measured in a model test, or predicted using computational fluid dynamics (CFD) or statistical algorithms. The following graphic (Figure 3) is an example of a wake field plot of axial velocities for a twin-screw vessel with a single strut (P-bracket). The iso-lines on the plot represent velocity as a ratio of the open free-stream velocity. You can easily see the reduction in water velocity nearest the hull's boundary layer, around the propeller hub and shafting, and particularly behind the strut.

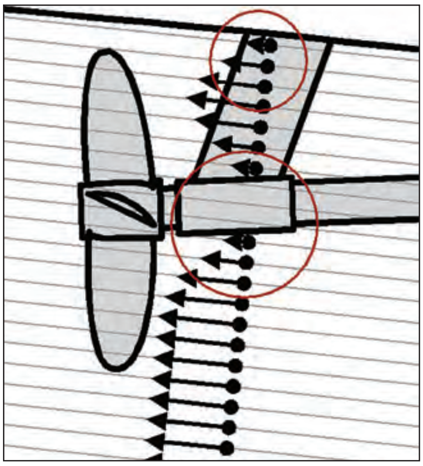


Figure 2: Velocity reduction due to appendages.

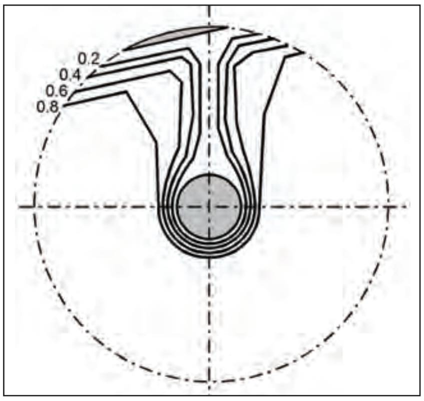
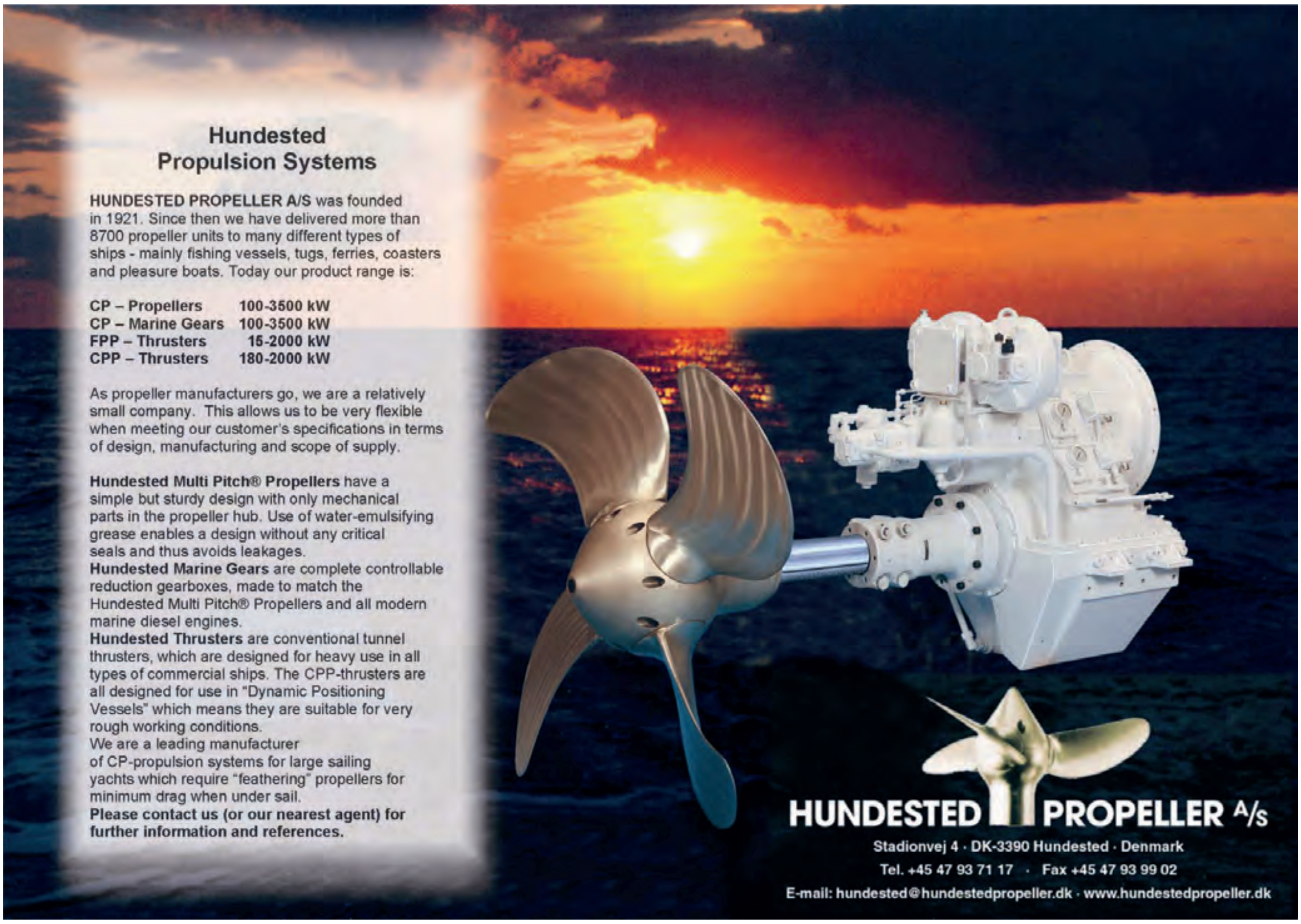


Figure 3: Example axial velocity wake field.

Not only are axial velocities considered, but tangential (or rotational) contributions due to upward and transverse flow vectors are also taken into account. These would have a similar plot or be represented by vector arrows on the axial wake field plot.

The wake field data is further developed to determine averaged velocities for each radial position (along the propeller blade from root to tip). This data is presented as a radial distribution of velocity, shown below (Figure 4).

Identifying the vessel's specific wake field properties or radial distributions by empirical testing or detail calculation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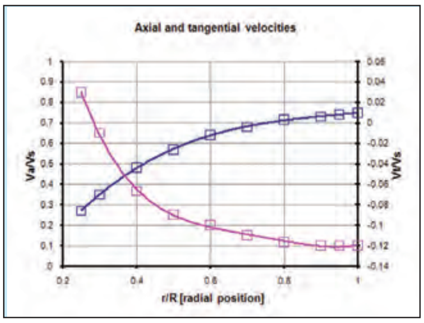


Figure 4: Average axial and tangential velocities.

is not always necessary. Particularly for "semi-custom" designs, representative wake distributions for vessel "types" can be effectively applied to propeller calculations. Representative wake field data can be found in various hydrodynamic technical papers, reports, and texts.

Wake-adapted calculations

Using specialised software, a custom propeller can then be optimally designed to match the unique inflow properties of the vessel (or a semi-custom propeller designed for a vessel "type"). This offers a propeller that is "custom tailored" to fit, or "wake-adapted". Such software is able to consider axial and tangential inflow properties, and ascertain optimised distributions of pitch and camber for prescribed foil characteristics. Of course, the propeller design process would also take into account blade strength, tip and hub loading, and cavitation.

HydroComp PropElements is an example of wake-adapted propeller detail design and analysis software. Unlike general-purpose CFD or more complex codes, PropElements was designed to be readily employed by practicing naval architects, as well as propeller designers and builders. Its analytical core is a unique implementation of a vortex lattice lifting-line calculation, with empirical connections that allow analyses to be viscous and fully-scalable. PropElements calculation modules include Geometry, Performance (Figure 5), Strength, and KT-KQ (curves).

Contemporary propeller geometries – pressure-equalised designs, for example, with variable pitch distribution and camber established for "shockless entry" – are substantially different from series geometries (B-series, AU, Segmental). In system-level propeller sizing and analysis, this is managed using correlation strategies (such as "aligned prediction" to model tests). These propeller geometries can be explicitly evaluated in PropElements, with additional considerations such as skew and nozzles.

Performance versus stock propellers

So how much "green" might be achieved with an optimised wake-adapted propeller? The following example is for the propeller design of a twin-screw vessel using the axial and tangential distributions shown in Figure 4 above. The original propeller was a popular stock model, with a prescribed camber (of flat-faced segmental design) and constant pitch. The newly optimised propeller (with the same basic foil section) was designed with variable camber and pitch to better match the wake, as shown in the plot below (Figure 6).

A comparative summary between the original and an optimised propeller designed by HydroComp PropElements (Table 1) indicates a power reduction and efficiency gain of more than 6%, just by better matching the propeller to a representative wake field.

Other potential design benefits that could be attained with a wake-adapted propeller design tool include unloading the tip (i.e., reducing the pitch into the tip) to mitigate potential noise and vibration problems, and evaluating changes in the outline (chord distribution) or thickness for even better performance.

Detailed analysis of propeller performance

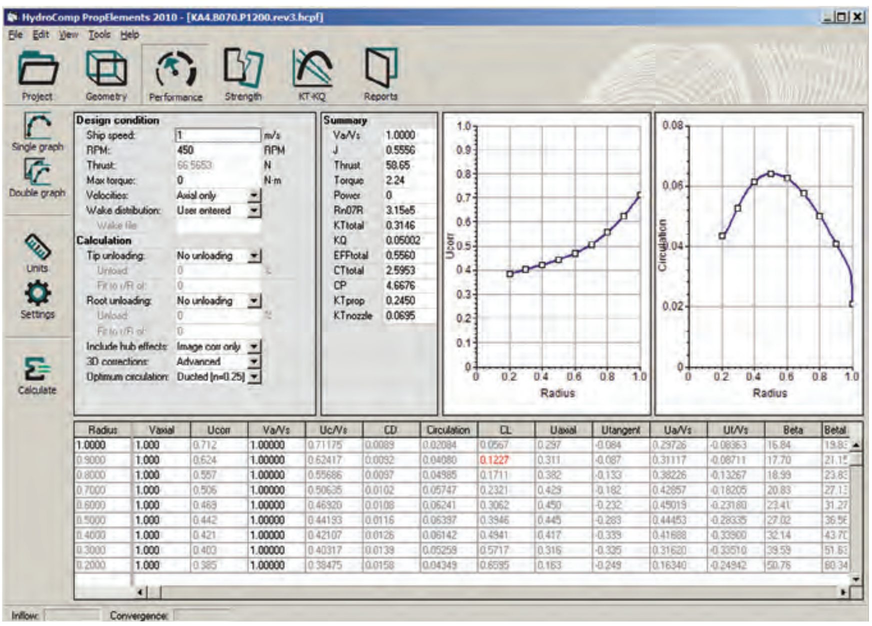
Wake-adapted calculation software such as PropElements can also be applied to analysis, as well as design. The ability to investigate radial values of foil lift and cavitation number, for example, can help identify potential sources of root cavitation or blade impulse excitation. It can help evaluate tip loading (for hydro-acoustics), and also be employed in forensic investigations of blade strength or failure.

Calculation of KT-KQ curves can be applied to system level calculations in replacement of direct propeller series predictions. For example, KT-KQ curves from PropElements can be exported in a form that can be used with HydroComp's NavCad speed-power software for propulsion analysis. The following plot (Figure 7) shows the results of a validation study for PropElements, which clearly demonstrates the quantitative accuracy of these calculations.

Summary

As custom-tailored suits offer greater comfort and better fit, a wake-adapted propeller can provide a variety of performance benefits over stock propellers.

Figure 5: HydroComp PropElements wake-adapted propeller design (Performance page).



Improvements in efficiency of 5% or more are common, with reduction in noise and vibration a typical side benefit.

It is to be expected that engine power densities will grow; fuel costs will increase; and emission reduction become more urgent. With more propeller builders now capable of manufacturing propellers made to order – many fully CNC milled – custom and semi-custom propellers of wake-adapted design should be considered for new construction and repowers.

The widespread installation of these propellers also suggests that naval architects need the ability to analyse their performance in greater detail that has typically been available. Whether for confirmation of propeller designs for newbuild projects or the post-delivery evaluation of trial performance, wake-adapted propeller design and analysis tools will be a commonplace fixture in the naval architect's toolbox.

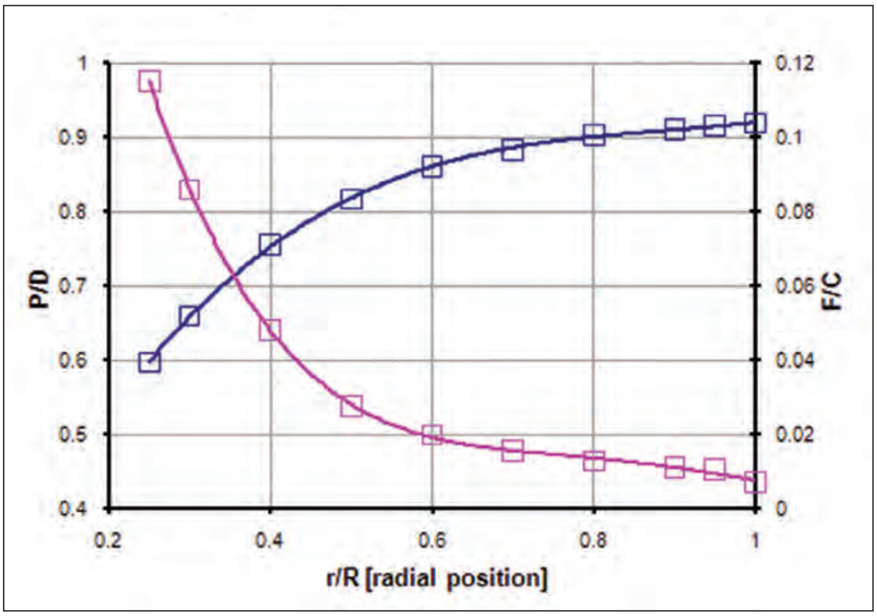


Figure 6: Optimised pitch and camber distributions.

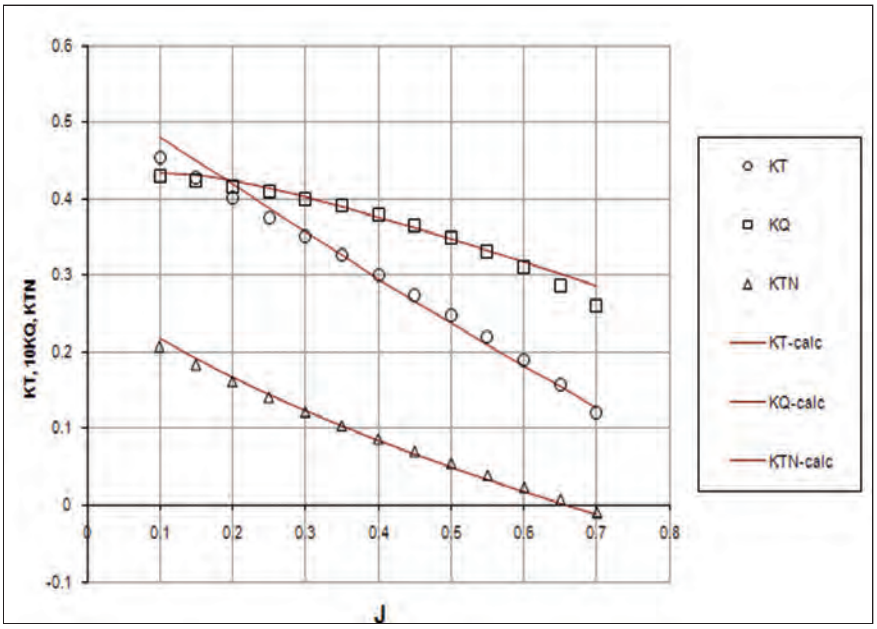


Figure 7: KT-KQ calculation for Ka 4.55 propeller in 19A nozzle.

About the author

In its 26th year of operation, HydroComp, Inc. of Durham, New Hampshire, USA provides software and services for the performance analysis and design of marine vehicles to industry, research, academic, and government clients. Donald MacPherson has been HydroComp's Technical Director since its inception. He is the author of numerous technical papers and presentations on applied hydrodynamics, is Instructor of Naval Architecture at the University of New Hampshire, and is a member of SNAME's H8 Propellers panel. HydroComp's web site is www.hydrocompinc.com. *NA*

	Va/Vs [nominal]	J	KT	KQ	CT	CP	EFFY
Original	0.6475	0.6327	0.1247	0.02260	0.3325	0.3876	0.5555
Optimized	0.6475	0.6327	0.1247	0.02217	0.3325	0.3647	0.5904

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TRUST in MARIN for a dynamic solution

MARIN has a long history in research into the performance of thrusters during Dynamic Positioning (DP) operations. Today MARIN is carrying out research on ducted propellers thruster interaction effects in the application of DP systems.

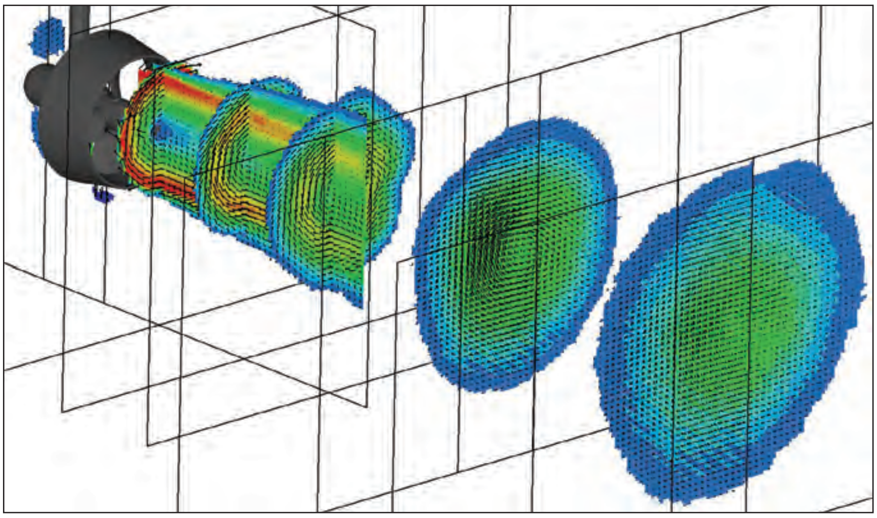
As a result of the application of DP systems on many different vessels, there is continued interest in this subject. Today, newly developed tools enable more detailed measurements and computer simulations of the thrusters on DP vessels. This has lead to new research initiatives to improve the understanding of thruster interaction effects. During DP operations the effective force generated by thrusters can be significantly smaller than would be expected based on the thrusters' open water characteristics.

This is a result of thruster interaction with the hull, current and the wake of neighbouring thrusters. The understanding and quantification of thruster interaction (or thrust degradation) effects is essential for an accurate evaluation of the station-keeping capabilities of DP vessels. At present, thrust degradation effects can be quantified using data available from literature, or by carrying out dedicated model tests. Published data can give valuable insights but often it is too general, or not applicable to the specific design. Model tests, on the other hand, do provide detailed results but they are relatively expensive.

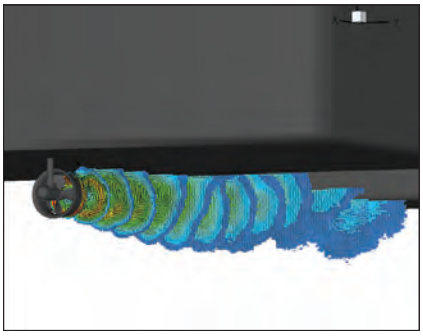
In addition, model test results often only become available relatively late in the design process, making it difficult to incorporate the results in the design. Computational fluid dynamics (CFD) calculations could be an alternative method but there is little experience in the application of CFD as an engineering tool for thrust degradation effects. With the rapidly increasing capabilities of CFD models and computer hardware, the time is right for the development of new tools to analyse thruster interaction.

New measuring techniques

In the summer of 2009, MARIN received its new stereo-PIV measurement system, which has a powerful Class 4 laser with two digital cameras built into a single underwater housing. MARIN carried out a research project to evaluate the possibilities of using the PIV system for measuring the flow velocities in the wake of an azimuthing thruster. Model tests were carried out in MARIN's Deepwater Towing Tank. An example of the measured wake velocities in open water conditions, showing both cross sections and velocities in the longitudinal plane, is shown above. Results show that the new PIV system is capable of recording the velocity field in the propeller wake, with a level of detail that was not possible before. This data is extremely valuable for the validation of CFD calculations. The model test programme also included measurements with the thruster built into a barge model. Here, the deflection of the thruster wake, due to the presence of the hull and its rounded bilge (Coanda effect), could be captured (see example alongside). These first PIV measurements will be used as validation material for CFD calculations. A key issue in these calculations is the correct representation of the shape of the thruster wake.



PIV measurements of a thruster wake in open water conditions.



PIV measurements of the wake of an azimuthing thruster under a barge.

Research efforts

In the coming years, CFD calculations will increasingly be used as an engineering tool for application in offshore hydrodynamics. Examples are the calculation of current and wind loads, viscous effects in wave loads, VIM and the analysis of thruster interaction. MARIN's research aims are for its CFD studies to be documented into a "roadmap", in a bid to streamline research and development. Currently, MARIN is starting a Joint Industry Project on the hydrodynamics of thruster interaction, called the Thrust Hydrodynamics JIP (TRUST JIP). The TRUST JIP aims to gain insight into physical phenomena, quantifying thruster interaction effects and investigating possibilities for improvement. In the TRUST JIP model test data, CFD calculations and full-scale measurements will be combined to provide the methods and tools for the hydrodynamic optimisation of a DP vessel's thruster configuration during the design.

The project deliverables will include a calculation tool for DP capability calculations. This combines traditional DP capability plots with the evaluation of other operational criteria, such as motions and accelerations. Thruster interaction data obtained will be included in this tool. Guidelines will also be developed on how to use model tests and CFD calculations in the analysis of thruster interaction effects and for the optimisation of thruster configurations on DP vessels. More information can be found at http:// www.marin.nl/web/ JIPs-Networks/Public/ TRUST.htm.

Calculation possibilities

The application of CFD calculations for the analysis of thruster interaction is still largely unexplored. At this moment CFD calculations of a vessel hull, complete with all its thrusters, may seem too complex but suitable modeling methods will be investigated and developed in the near future. A thorough validation of CFD models against measurement results, both at model-scale and at full-scale, is required. An example of some initial calculations on a single thruster under a schematical barge is shown. Results show the same trends found in the measurements by Nienhuis, but further developments are necessary to achieve more accuracy. Research into CFD calculations for thruster interaction will first focus on the calculation of the velocities in the wake of a thruster in open water. The accurate calculation of the velocities, especially at larger distances from the thruster, is crucial for an accurate prediction of thruster interaction effects later on. Different modelling options will be investigated. Subsequently, increasingly complex configurations are considered, introducing step-by-step additional physics, such as friction forces on the hull, deflection of the thruster wake (Coanda effect), the effects of current and loads on appendages.

Another example is the calculation of the loads caused by the thruster wake on the opposite pontoon of a semi-submersible. In this manner, the performance of thrusters in various different configurations can be investigated. The latest developments in CFD calculations and PIV measuring techniques offer new possibilities to increase the understanding of the physics of thruster interaction effects. The TRUST JIP will investigate the applicability, accuracy and limitations of CFD for thruster interaction by comparing the results from model tests, CFD calculations and full-scale measurements. *NA*

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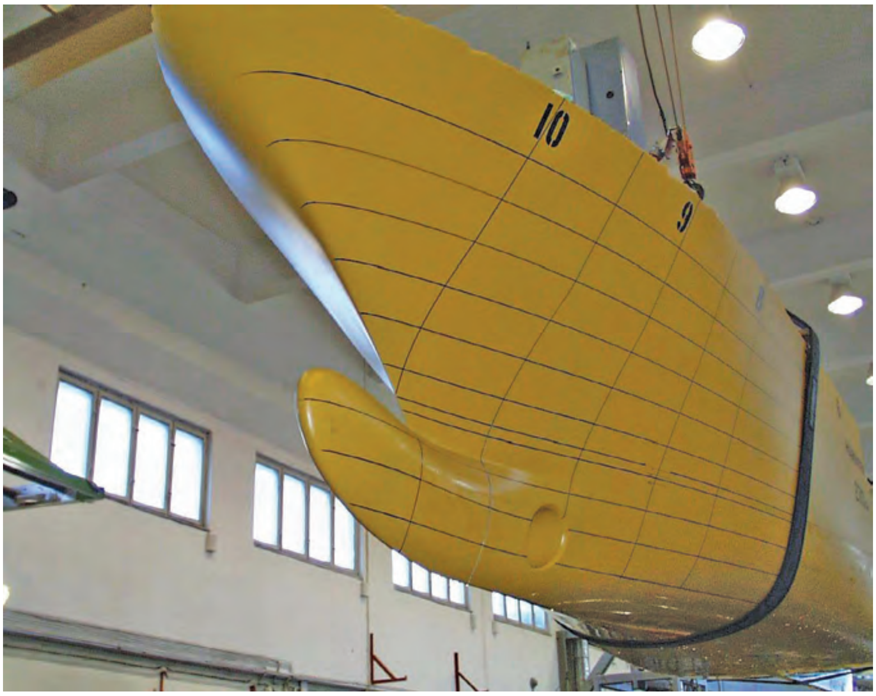
Optimisation of Superyacht Hulls

James Roy, yacht design director at BMT Nigel Gee and naval architect Rob Sime, draw on their combined superyacht design and commercial vessel experience to explore the practical limitations of optimising superyacht hulls.


An optimised 85m yacht about to undergo physical testing.

Operating costs and fuel costs in particular are the biggest driver in the commercial vessel market. The desire to reduce these costs has always provided a focus for the optimisation of the vessel's hull to develop efficient ships with minimal powering requirements; even a significant investment in hull form optimisation at the design stage can quickly achieve a payback.

Large yachts, however, spend far less time at sea than commercial vessels and consequently, for an average yacht, fuel costs represent a far smaller proportion of annual operating costs. Additionally for those who own and operate these yachts the adage that: "If you have to worry about filling her up then you probably can't afford it" holds true and cost is in general not an issue. However, with rapidly increasing fuel prices, ever more stringent environmental legislation and the desire to be seen to be green, there is an increasing focus in the superyacht industry to improve efficiency.

Large yachts tend to have relatively high hotel loads and, given the relatively low hours at sea, much of today's focus within the industry is on reducing generator fuel burn through energy efficient technologies. Hull efficiency still remains a very significant part of the overall through life efficiency, and whilst optimisation of a yacht hull is often undertaken, it is typically compromised by other factors relating to the functional aspects of the design. It is these factors that present different challenges to the optimisation of a commercial vessel.

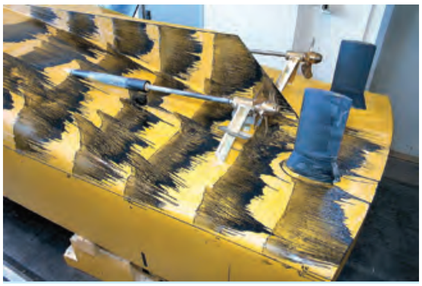
BMT Nigel Gee undertakes optimisation across both the yacht and commercial vessel industries. Critically the work is not limited to the pure naval architecture of the optimisation process but also to complete vessel design and engineering (from concept through to delivery) allowing valuable insight into how the processes differ between yachts and commercial vessels.

This makes use of optimisation techniques predominantly based on experience, married with an appropriate level of computational analysis. With modern computer techniques it is very easy to launch into the generation of 3D lines too early in the process without sufficient focus on a formal optimisation methodology. Additionally the use of computational fluid dynamics (CFD), whilst of significant potential value, has its limitations. Where utilised, such techniques must in our experience be tempered with optimisation variable limitations specific to large yachts gained from practical experience, some of which will be cited as specific examples in this article.

The hull design process begins with three critical parameters; displacement, length and speed. The latter two variables define the Froude number which gives an indication of the basic hull type, where to set our goals and how challenging they will be to achieve. With a commercial vessel there will be a well defined operating profile with target speeds often derived from analysis of required transit times or freight rates against optimum voyage speed analysis. This is not so for yachts where the cruising speed and maximum speed are often decided upon by the captain or the owner. Additionally there is no defined, or even typical, operating profile to apply so deciding the optimisation point in an analytical manner can be very difficult. It is also often the case that the maximum speed desired may be subject to one-upmanship resulting in a large difference between the cruising speed and the maximum speed, further complicating the optimisation process.

With a well executed project, part of the job of the naval architect is to try and influence the owner's decisions to bring the target speeds and optimisation point to sensible parameters.

The third variable in our initial assessment is the displacement in relation to length and the next step is to undertake an assessment of the yachts overall design concept. Is the vessel a slender, low volume design or a



Flow visualisation tests.

beamy, high displacement motor yacht? These factors have a critical influence on the direction that we follow, as displacement in relation to length is the most influential parameter on resistance.

With a commercial vessel the naval architect will be in control of the design intent behind the concept. This is rarely the case with large yachts where the stylist (aka the yacht designer) will have defined the design intent and many of the defining features of the yacht. These will have already been laid down and "sold" to the owner. It then becomes the job of the naval architect to work with the stylist to try and maintain as much of that design intent whilst quantifying the compromises that may have to be made in order to improve the hydrodynamic efficiency of the overall design.

Additionally at this stage the naval architect will undertake a preliminary stability assessment in order to confirm that the beam, often already decided by the stylist, will be acceptable. In conjunction with this, preliminary powering estimates will also be made to verify the space reserved for the main machinery space.

Following the initial assessment the designer sets the target values for the optimisation of key form coefficients and parameters including block, prismatic and maximum sectional area coefficients, longitudinal centre of buoyancy and floatation, wetted surface area and immersed transom area. If a bulbous bow is to be used the basic parameters are set down; bulb type, centreline profile shape, sectional area and immersion. Additionally the effects of appendage and propulsion system integration are considered including propeller diameter, tip clearance and rudder configuration amongst others.

It is normally at this point that many of the aforementioned features of the stylist's design intent start to present barriers to effective optimisation. Two examples spring to mind. The first is a 100m motor yacht where the arrangement of the design had been centred around a central vertical 'feature' staircase running from the tank deck right to the sky lounge of the yacht. The longitudinal location within the yacht was fixed by the stylist and considered immovable. The end result of this was that the engine room had to be pushed relatively far aft in the design, resulting in a less than optimum longitudinal centre of buoyancy (LCB), form coefficients and steep buttock angles, all contributing to an increase in resistance. The second example was an 85m motor yacht where the design featured a large swimming pool in the aft lazarette (commonly called the 'beach club' on large yachts). In order to accommodate this, and integrate the shaftline, the hull had to be deepened aft resulting in increased transom area and non optimal LCB: The consequence of which was a significant increase in vessel resistance and reduced propulsion coefficients.

"With a well executed project, part of the job of the naval architect is to try and influence the owner's decisions to bring the target speeds and optimisation point to sensible parameters."

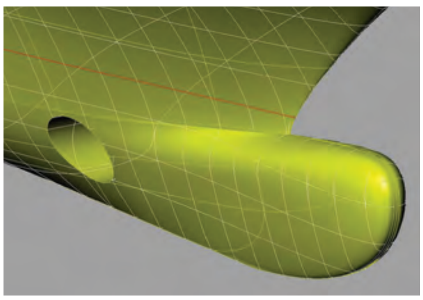
The next step in the process involves optimisation of the sectional area curve. This is an exercise which is often forgotten, but achieving the correct area profile is critical in achieving a set of hull lines which combine the desired characteristics with efficient hydrodynamic performance. It is generally started with the sectional area curve for a basis yacht such that the designer has a known and quantified baseline. Once the sectional area curve has been satisfactorily developed the next step is to modify the parent lines to obtain the optimum midship section shape and area distribution.

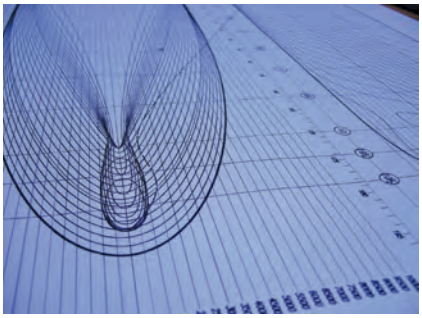
At this stage, BMT takes into consideration for further practical constraints which limit our ability to achieve the desired sectional area shape. Many of these are common to both commercial vessels and yachts alike, such as integration of the selected propulsion system. However some are in general limited to yachts only, for example roll fins on yachts are designed for operation at zero speed. In the absence of hydrodynamic lift they generate the required righting moments by being over sized (typically 30-40% greater area than conventional roll fins) and operating in a paddle fashion. These large fins are often constrained in their longitudinal position by internal arrangements and frequently present a serious challenge to integrate within the beam-keel envelope whilst maintaining an optimised sectional area curve and undistorted waterlines.

Bow thrusters are another common challenge on yachts. Typically, in an attempt to maximise internal volume for accommodation, they are pushed very far forward in the general arrangement. This can lead to fuller forebody waterlines and sections with the resulting half angle of entrance being increased significantly to achieve the minimum required tunnel length.

Having developed a set of lines optimised to the principal parameters, as far as possible, within any accepted compromises, the next step in the process involves more refined consideration of section shapes, waterline shapes and buttocks. Generally by this stage there will

A properly optimised bow can offer significant savings.



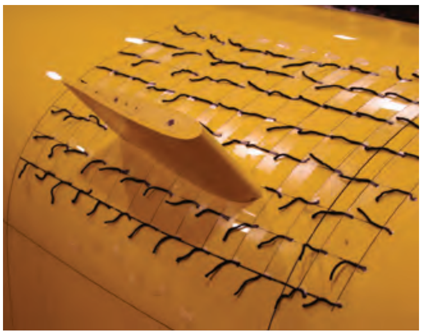


Generic image - hull lines plan.

be a clear idea of the mix of characteristics that are needed to be incorporated; partial propeller tunnels, required return in stern buttocks and forward waterline curvature are all parameters which we optimise at this time. The use of CFD can be useful at this stage to compare the impact of subtle refinements and to assist in positioning appendages such as bilge keels or to study theoretical flow patterns in areas of special consideration.

An excellent example of a design where efficiency has not been overly compromised by function is the 73m motor yacht *Silver* (2008). In this case the GRT of the design (internal volume, and therefore function) has been restricted in order to save weight resulting in an internal volume of only 60% of a typical 73m vessel. The result is that a high length beam ratio can be adopted together with a high length displacement ratio. This resulted in the vessel achieving a 27knot maximum speed with only modest levels of propulsive power. It is evident in this design that the owner has accepted fewer functional luxuries in order to achieve a fundamentally efficient design; less accommodation space, no helicopter pad, no large swimming pool etc.

Optimisation of appendage alignment (Roll Fins).



The optimisation of a yacht hull is beset with challenges, many beyond the control of the naval architect. In the interest of ensuring efficient hydrodynamics, BMT Nigel Gee attempts to manipulate the yacht's layout such that the impact of these constraints are minimised allowing the highest level of optimisation to be achieved. However the dynamics of the particular project, relationships and parties involved often means that on many large yacht projects significantly higher levels of compromise are required than would be expected for a commercial vessel. Educating the client and stylist in a quantified manner as to the impact of compromise is as much part of the design process as the naval architecture. Ultimately it is up to the client to decide how much compromise they are willing to accept but involvement of a naval architect at the very early design stage of a project will ensure that the hydrodynamics and design intent of the stylist can be harmoniously integrated with minimal compromise. *NA*

Architecture meets ship design

Ashish Gupta, an Indian-based architect more used to designing buildings, recently stirred up the mega yacht market with his latest 150m yacht design *Maharaja* that draws on his architectural background.

Maharaja is the latest concept from Ashish Gupta, who started moving into yacht design in 2003. Mr Gupta won an award in 2000 for one of his latest architectural designs and in 2003 saw him starting on his first yacht project.

"The owner approached me after he had seen my architectural designs and offered me a project. I wanted to take a week away to research ideas before I agreed, as this type of project was new to me," comments Mr Gupta. "The owner wanted the yacht to be "made in India", with Indian design and built in India," he adds.

This first project bore Mr Gupta's first yacht design, *Ashena*. In 2003 at the same time of taking on his first vessel Mr Gupta also launched his company Beyond Design. After *Ashena*, Mr Gupta was commissioned for another yacht design in 2008, *Indian Empress*, that pushed Mr Gupta's designs further as the vessel was larger than first one, he said. Ashena is 45m in length overall (LOA), where as the *Indian Empress* is 95m LOA.

Maharaja the latest design of yacht, which is still at concept stage, has pushed Mr Gupta further. The planning of the 150m yacht has allowed for Mr Gupta to incorporate design features from the previous two projects, but has also allowed him to capture the architectural design aspect of his work.

Mr Gupta also highlights that one of the key features of the vessel is that it has been designed "inside-out". The idea is to create more open spaces and allow more light to come on to the decks. The yacht also features a large open breakfast area that was inspired from previous meetings with the owner of his other designs.

Mr Gupta said: "I had visited many yacht shows and been on yachts before designing *Maharaja* and I found that all were similar with some detail being different here or there and then there was Wally yachts. I wanted to design something that I had never seen before and also thought that the industry deserves better in big yacht design as well.

I designed the yacht "inside-out" with all areas connected to the sea every-time. Form followed function and when I envisioned *Maharaja* 150 I was sitting on the aft deck of *Indian Empress*.

Maharaja incorporates architectural design with modern day mega yacht design.

All the new upcoming concepts around had few balconies folding out and the superstructure colour being different, but no genuine future yacht concept which will appeal to the young tycoons as well as reigning tycoons. *Maharaja* has the ability to attract all generations of industrialists which was my goal"

Mr Gupta enlisted the help of Dutch-based naval architecture firm Stolk Marimecs to turn his designs into reality. Willem Stolk, naval architect, Stolk Marimecs has said that he believes that *Maharaja* is a plausible concept. He also highlighted that at the moment this vessel is very early in its design stage, and with a closer look there are features that will need to be changed to make it apply with class rules.

"As the boat design stands the design of it is a cross between a conventional boat and a wave piercer, which is not possible. What will need to be looked at is turning the recess in the hull into a more conventional shape," he comments.

Mr Stolk adds that *Maharaja* is an exceptional design and that with Mr Gupta's architectural background and not being tied to technical restrictions it allowed him to push the boundaries of ship design and the traditional look of a vessel. However, he adds when making the design into a real vessel the rules and regulations with which it will have to comply will have to be taken into consideration.

The 150m *Maharaja* will incorporate green technology into the final design.

"We have already addressed the design and know that we will review the hull shape, outer bows, the low freeboard and weight [as there is a lot of glass in the design], which will impact the stability of the vessel," adds Mr Stolk.

The vessel will also feature the latest 'green technologies' onboard and will be powered by diesel-electric engines.

At the moment Mr Gupta and Stolk Marimecs are talking with brokers and yards about the yacht concept, though the recession has impacted the yacht market drastically, Mr Gupta said: "A 150m boat isn't easy to sell in this current market. We are expecting to get back on track with this design shortly though and expect to be working on it properly by the end of the year."

Mr Stolk said that at the moment there is a lot of interest in *Maharaja*, but no one is buying. He also expects that a client may come through from either China or Korea, as the shipbuilding in these countries remains strong. He added that for the yacht market to start to improve it will need owners and builders to take a chance on innovation. *NA*

SUV mega yacht takes Blohm + Voss to greater depths

Slower greener Blohm + Voss has taken its foot of the accelerator pedal and launched a mega yacht design that is aimed at a more adventurous owner with the time to appreciate his surroundings.

Breaking from its usual high speed yacht designs, Blohm + Voss shipyard has created what it has described as its "sports utility vehicle (SUV)" yacht the B+V 120 MY/X. This is the second yacht to be presented to the yacht market after the B+V 110m/fast yacht that is capable of achieving 40knots.

Even though the yacht has a slower maximum cruising speed of 18.5knots, what the B+V 120 MY/X lacks in speed it makes up for in "toys" onboard. The B+V 120 MY/X has been laid out to combine the capability of worldwide cruising at a maximum possible comfort for the owner and guests and still include space for further sea exploration equipment, such as diving equipment, said Blohm + Voss.

In keeping with green regulations the yacht will be powered by three 4500kW pod drives and eight 2080kW generators with soot filtration. The propulsion plant has been designed to achieve lowest noise and vibrations levels, highest manoeuvrability performance and maximum environmental friendliness by means of a diesel-electric propulsion system.

Blohm + Voss has launched its "SUV" onto the yacht market.

The B+V 120 MY/X offers a different type of yachting to the market.

TECHNICAL PARTICULARS	
B+V 120 MY/X	
Length, o.a	124.2m
Beam waterline	25.7m
Draught	5.6m
Max. Speed	18.5knots
Cruising Speed	16knots
Range	5000nm@16knots
Propulsion	3 x 4500kW pod drives
	8 x 2080kW generators with
	soot particle filtration
Manoeuvring system	2 x bow thrusters
Passengers	2 owners
	16 guests
	50 crew

The interior of the yacht has also been designed for a more leisurely pace. Starting in the main entrance lobby, which is located in the "eye-shaped" feature on the main deck, a grand staircase and a lift lead up to the bridge deck. Going up to the very top and located half in the aft part of the bridge deck is the lounge with seating areas that has impressive 180deg views.

The yacht also features an owner's deck that has its own private staircase from the guest deck. The owner's suite also has a jacuzzi in the bow area and space for an office and a meeting area.

There are eight cabins onboard the yacht, with six guests cabins on the main deck and two VIP duplex suites (two levels) each with a bedroom on the guests' deck, with a dressing room and bathroom one deck above. Also, located on the guest deck are dining and lounge areas, as well as balconies on each side and ample exterior spaces around the swimming pool.

The yacht has large storage capacities, which has space for tenders that range from 5.5m to 16m in length, a seaplane, an amphibian car and there is even space for an 8.05m submarine.

Adding to the cost of the yacht it has also been designed with two separate helipads. The primary helicopter landing area is located to the aft part of the owner's deck and is strong enough to support a five tonne load. Located just below the touch down area a fully enclosed hangar provides shelter for one helicopter. The second helicopter landing area is located forward part of the guest deck with direct access to guest areas. *NA*

Bigger is better

The financial downturn has taken the veneer off the yacht building market over the past year with figures dropping by 60% in some cases, highlights Italy-based classification society RINa.

The yacht industry has been viewed by many in the past as a "recession-proof" industry, linked with moneyed people and profits that keep growing. But, as Paolo Moretti, business manager yachting, RINa Services SpA has pointed out that has not been the case for the last year and the yacht industry in Italy has been hit the hardest, with the smaller yacht market the worst affected by the recession.

Due to the impact of the recession a lot of Italian boat builders are now over stocked, comments Mr Moretti, where yards where effectively stock piling designs in 2008 due to the strong financial growth at the time, there are now almost new vessels on offer in an attempt to sell off the surplus stock.

Although, the recession has affected Northern Europe and the mega yacht industry, it has been less affected by the recession than the smaller yacht market, but it will still take a long time to recover, said Mr Moretti. The size of yachts has grown substantially over the last few years, to vessels that now have to be classed under passenger vessel regulations. He added that the size of vessels will keep growing, but it will be the number of units that will be a problem. He also highlights factors such as port/marina size, shipyards capable of handling vessels of this size, and the practicality of a steady income for this vessel type due to the infrequency of orders.

Currently, RINa has set its sights on working on a code for large yachts that carry over 12 passengers and will have to meet with the latest regulations for damage stability and SOLAS 2009. The aim of the code is to clarify the latest regulations coming through from the International Maritime Organization (IMO) for both yacht owners and designers, say RINa. Mr Moretti commented that: "The big problem is how to regulate a 3000gt yacht and vessels that can carry 13-36 passengers. Lifesaving equipment [SOLAS 2009] will be a big feature of this and boats that are built of this size will need to conform to the rules."

Paolo Moretti, business manager yachting, RINa services SpA.

He continued: "The damage stability rules are a problem for designers as they have to balance what the yacht owner wants from the design with the latest IMO regulations. Yacht owners do not tend to like seeing the orange life boats attached to the side of their vessels, so alternative marine evacuation systems (MES) are being looked into."

Further research and experimentation into green technology for yachts is also being carried out. Research into fuel cells and battery powered vessels are a possibility for smaller vessels and other fuel saving measures such as cold-ironing is also being considered, to keep yachts as environmentally friendly as possible.

Technologies such as diesel-electric engines that are being employed on commercial vessels look to be a likely solution for larger yachts that will allow them to conform to green regulations.

This year Fincantieri will be launching its first 134m yacht with a second on the building blocks that was ordered in 2008 that will be 140m. Along with this Blohm + Voss has launched its latest 120m yacht design, which comes equipped with an 8.5m submarine and two helipads. Although, so far this year T.Mariotti yachts has been the only Italian-yard to see an order for one of its yachts.

Mr Moretti points out that there are three main shipyards that can handle mega yachts of around 100m in size in Europe. Adding that at the same time Turkey's has seen an increase in the size of the yachts that it is building.

Looking forward Mr Moretti has said that countries such as China, the Middle East and Russia will be the ones to watch, as China has started to build yachts and a potential market is starting to emerge due to it opening up areas of its territorial waters.

The yacht market will take a long time to recover, Mr Moretti has said that the spring 2010 was "terrible" for the yacht market as it didn't see the orders that it was hoping for.

The market has now swung in favour of the owner and the waiting game has begun. "In 2007/8 it was a case of buy now or queue for five years for owners wanting to get a yacht, but now that has changed. The owners are now waiting for prices to drop and yards are waiting for the orders," comments Mr Moretti. "It will be hard for the market to regain the numbers that it saw in 2007 as the numbers were faked due to designs that were not bought by owners but yards that added to the numbers and gave an inflated idea of the market."

Already this year Italy has seen two to three yards close due to the economic impact, but Mr Moretti was optimistic that March and May's figures will be better. Further, he has predicted that the market will be clear of the recession in 2012, but highlights that the current crisis in Greece will need to stop. He believes that 2012 will be the year that will see significant improvement in the market as he hopes that orders will start to come through in 2011. *NA*

Double acting tanker set for Pechora Sea debut

The first of two new Arctic double acting shuttle tankers for the Prirazlomnoye project has entered service.

The result of a unique collaboration involving an overseas designer and a Russian shipbuilder, the 70,000dwt *Mikhail Ulyanov* (IMO Number: 9333670) was delivered to Sovcomflot by Admiralty Shipyard at the end of February.

The state of the art vessel, designed by Aker Arctic Technology, is currently undertaking general duties in the spot market, but her destiny lies in plying one of the harshest of trades, shuttling oil from the Prirazlomnoye oil field development in the Pechora Sea to a Floating Storage and Offloading (FSO) unit moored off Murmansk.

Sister ship *Kiril Lavrov* is also soon to be delivered to service an area which is covered in ice during the entire winter navigation season, with ice first forming in November and lasting until June. During hard winter seasons ice can of over 1.2m in thickness can form.

Operations will continue year around in an area where the average number of ice period days is 213, and the minimum air temperature is -46°C. Oil Production is expected to last for 22 years.

Originally envisaged as an Aframax design, the eventual selection of smaller ships came about due to concern with the draught and the stern loading effects in the shallow platform location, where there was a risk of flushing of the supporting beam for the ice resistant platform. Consequently the concept ship was reduced to feature a draught of less than 14m and with a bow loading system adopted.

At 257.33m long and 34.04m wide, *Mikhail Ulyanov* features a draft of 14.0m and a depth of 21.6m. The ship features a total cargo tank capacity of 87,029m^3 and separated ballast tanks of 35,200m^3. She is fitted with 10 Marflex electrically driven deepwell type pumps for cargo tanks and two electrically driven deepwell type pumps for slop tanks.

The ship features a tailor made Bow loading system for the Prirazlomnoy

Mikhail Ulyanov **under construction at the Admiralty Yard.**

MAIN DIMENSIONS

Mikhail Ulyanov

Length over all, abt.	257.33m
Length betw. perp.	235.94m
Breadth mld.	34.04m
Depth mld.	21.59m
Draught summer load line	14.00m

Main Particulars

Deadweight	69,830tonnes
Trial Speed	16knots
Cargo tank capacity, incl. slop tanks	87,029m^3
Ballast tank capacity	36,361m^3
Bunker capacity	2,332m^3
DO capacity	122m^3
Fresh water capacity	514m^3
Ice breaking, DAS mode	3knot speed in level ice of 1.2m thick and 20cm snow layer on top of the ice
Ice breaking, bow ahead	3knot speed in level ice of 0.5m
Classification	The Vessel, including its machinery, equipment and outfitting constructed in accordance with rules of dual classification by Russian Maritime Register of Shipping (RS) and Lloyd's Register of Shipping (LR)

The relevant class notations of Russian register and Lloyd's Register are described below:

The vessel(s) have the following RS class notation:

Class: .... KM + Arc6 (2) AUT1 EPP Oil Tanker (ESP)

The vessel(s) have the following LR class notations:

+ 100A1 Double-Hull Oil Tanker, ESP, ShipRight (SDA, FDA, CM), LI, +LMC, UMS, IGS, NAV1, IBS, ICC, SPM, BLS, Helicopter Landing Area, EP(P), DP(AA)1), Winterization D(-40)2) and LR descriptive class notations

Pechora Sea (Prirazlomnoye) to Murmansk Service, part higher tensile steel, Ice Class (RMRS LU6), Centralized Operation Station for Liquid Cargoes, ShipRight (PCWBT), ETA.

In action, *Mikhail Ulyanov* dispays its ice breaking capability.

platform Direct Oil Offloading Complex (DOOC). The 10,000m^3/h capacity Maritime Pusnes AS system is fully compatible with all other offshore loading facilities requiring "North Sea Type" bow loading.

To meet their exacting tasks, the hull form for the Prirazlomnoye tankers was developed by Aker Arctic Technology Inc. (AARC), based on the double acting operation principle, for year round independent navigation in seasonal "*average*" ice conditions.

Pioneered by Aker Arctic Technology, the double acting concept found first form in the shape of the tankers *Mastera* and *Tempera*, delivered by Sumitomo Heavy Industries to Neste Shipping. Sovcomflot, meanwhile, already has three Aker Arctic-designed double acting tankers in service delivered by Samsung Heavy Industries, while Norilsk Nickel is operating the first five double acting containerships ever to be built, and is in the process of taking on a sixth double acting ship, this time a product tanker from Nordic yards of Germany.

Mikko Niini, president of Aker Arctic Technology Inc., said: "For the Prirazlomnoye shuttle tankers, the hull form has been optimised for two modes of operation in first-year ice conditions. Those are astern operation in medium and thick first-year ice and ahead operation in thin and young ice conditions and open water.

"A double acting ship draws on operating experience and knowledge of the improved ice going performance of existing icebreakers arranged with bow propellers. The two basic hull-ice interaction mechanisms for improved ice going performance are decreased hull ice resistance, due to '*washing*', or '*lubrication*', of the hull by the wake of the bow propeller, and improved hull icebreaking performance, due to the slight pressure drop that occurs just ahead of the icebreaker due to water flow into the bow propeller."

Dimensioning of hull structures for ice strengthening for the ships is in accordance with Russian Maritime Register of Shipping ice category LU6 (Arc 6) , with the stern of the vessel strengthened for bow design ice loads for double acting operation. The shuttle tankers are dual classed by RMRS and Lloyd's Register, with a class notation of KM * Arc6 [2] AUT1 EPP Oil Tanker (ESP).

Here, the shell in the forward region of hull ice strengthening is transversely framed throughout; with built section main and intermediate ice frames at 400mm spacing. A 60mm thickness stem bar is arranged with a 45mm radius stem plate.

The bottom shell in the forward intermediate region of ice strengthening is longitudinally framed. At the edge of each of the vertical regions on the ship side there is a 4mm step down in shell plating thickness.

The side shell in the midship region ice belt between the ice load waterline and ballast waterline is strengthened with bulb sections for the main and intermediate ice frames at 400mm spacing. Within the double side skin space there are platforms decks arranged vertically every 3.4m with intermediate ice stringers.

The underwater hull form incorporates an icebreaking bow for operation ahead in young ice and thin first year ice conditions. However, as the tanker has also been designed for international trade, the bow shape is derived from a compromise between performance in ice and open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Azipods waiting to be fitted to the *Mikhail Ulyanov*.

water sea-keeping and performance in the Barents Sea and North Atlantic (for possible shuttle voyages from Murmansk in open water to European refineries).

Mikhail Ulyanov is driven by four nine cylinder (380mm bore) Wärtsilä 9L 38 main engines, with maximum continuous ratings of 6525kW apiece. For harbour use, the ship is equipped with one Wärtsilä 4 L 20 auxiliary engine, while the emergency engine is an MTU 12V 2000 P82 unit.

The ship is equipped with two equal 'pulling' Azipod propulsion units from ABB Marine with solid fixed pitch propellers of 5.6m diameter. Classed to LU 6 and with a maximum output of 8.5MW, each system consists of a azimuthing rudder propeller and an electric propulsion motor installed inside the propeller's submerged pod.

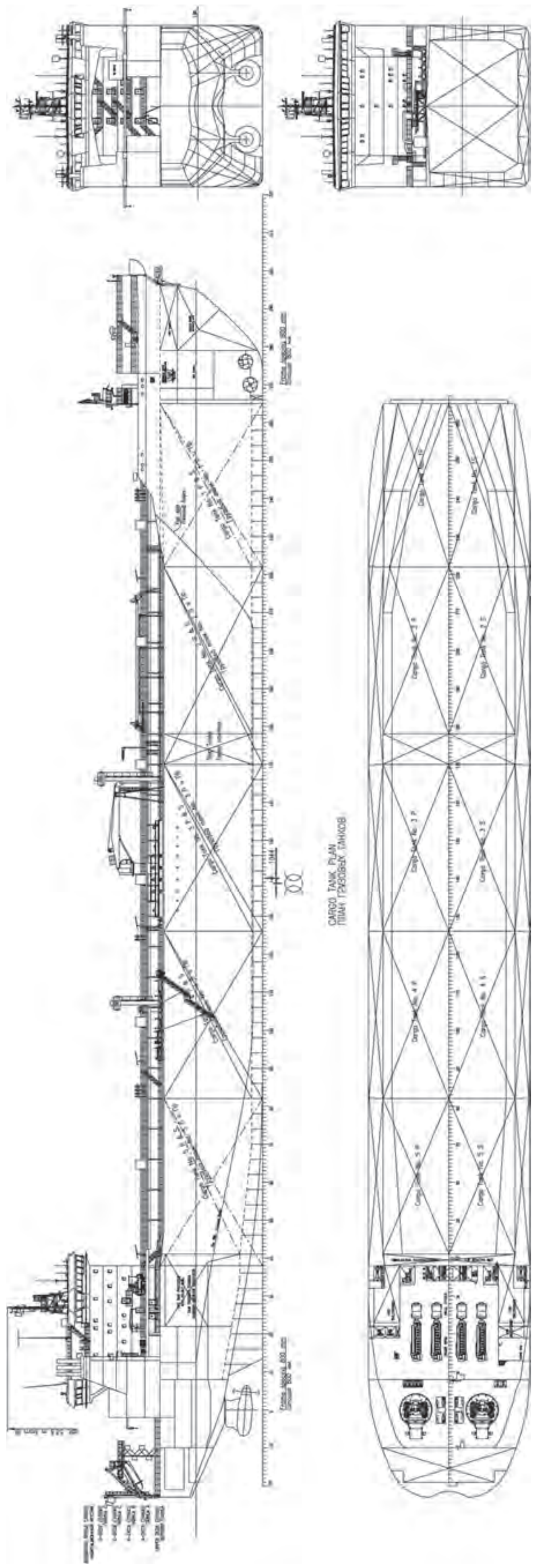
Azipods enable a ship to penetrate cross ridged ice when running astern with a continuous slow speed, where conventional ships ram when running ahead. The basic hull-ice interaction mechanisms, for ridge penetration and crossing ridges in astern operation with Azipods, is the flushing and milling of the submerged surface of the ice ridge by side to side turning of the Azipod units.

ABB Azipod units were selected for *Mastera* and *Tempera*. Equipped with one 16MW Azipod unit apiece, these vessels operate in Baltic ice conditions. However, the higher power twin Azipod solution was preferred for *Mikhail Ulyanov* and *Kiril Lavrov* because these ships will need to be able to achieve 3knots speed astern in first year level ice, of 1.2m thickness with 0.2m of snow layer and 3knots speed ahead in first year level ice of 0.5m thickness.

The ship is also equipped with two electrically-driven bow thrusters with controllable pitch propellers, while its 10,750m^3/h capacity inert gas system has been supplied by Hamworthy Moss. She is equipped with a Sotznia Ustka Free Fall type lifeboat for 39 persons, while her helicopter deck for MI-8 type helicopter has been built in line with the latest International Chamber of Shipping (ICS) recommendations.

As with every other aspect of the design of the ship, the bridge has been outfitted with state-of-the-art equipment, in this case supplied by Transas. The electronics will include communication equipment for GMDSS area (A4), two radars for extreme temperatures, two ECDIS 3000-I systems, six information displays with Navi-Conning, Automatic Identification System, Voyage Data Recorder, log, and echo-sounder. Meanwhile, a fully redundant Kongsberg Maritime dynamic positioning system based on two control computers (1 on-line and 1 standby) is also installed. *NA*

GA plan fro *Mikhail Ulyanov*.



The Royal Institution of Naval Architects

INTERNATIONAL CONFERENCE ON INNOVATION IN HIGH SPEED MARINE VESSELS

2-3 March 2011, Fremantle, Australia.

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First Announcement & Call for Papers

Few sectors of the maritime industry have embraced innovation as readily and successfully as the high speed marine vessels sector, in seeking to extend operating envelopes, reduce downtime and increase reliability, safety and comfort, and reduce costs. Advanced design, the use of new materials and more efficient production methods and other means have and are all being explored to achieve these aims for commercial, military and recreational vessels.

Building on the success of the 2009 conference, the 2011 International Conference on Innovation in High Speed Marine Vessels will again provide an opportunity for all those involved with this sector of the maritime industry to present and discuss recent and future developments in all these aspects of commercial, military and recreational high speed vessels.

Technical papers are invited containing new and original ideas, innovative applications and practical achievements in various aspects of high speed marine vessels, including but not limited to the following topics:

- Design & Construction: including monohulls, multihulls, and special craft such as, SWATH and hydrofoils.
- Coatings, materials and manufacturing processes, including nanotechnology.
- Research & Development: Including model testing, hydrodynamics and structural response.
- Operations: including wake and wash implications, propulsion machinery, motion control, seakeeping and human factors.
- Safety, Regulation and Classification
- Equipment

http://www.rina.org.uk/highspeedmarinevessels2011

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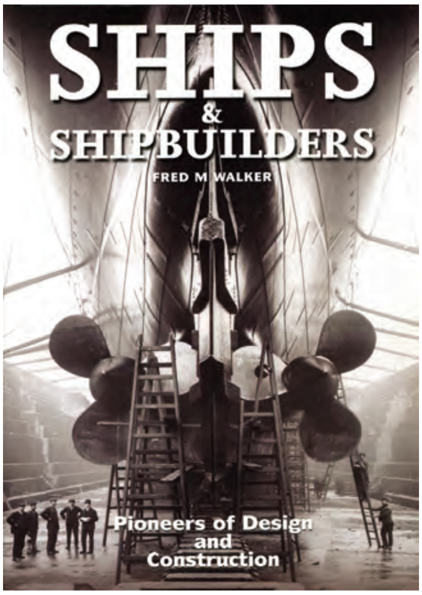
Ships and Shipbuilders.

Reviewed by Ian Buxton

Ships and Shipbuilders
Written by Fred M Walker.
Published in 2010 by Seaforth publishing as a hardback, 256pp,
ISBN 9781848320727
£25



Many members will have enjoyed reading Fred Walker's pen portraits of pioneer naval architects in RINA Affairs. This was, however, just the hors d'oeuvre, what we are now treated to is a full banquet, adding many more names to make a compendium of 135 illustrious men and one woman who have contributed to the evolution of ships and shipbuilding up to 2000.

Not all are those we would class as naval architects – there are also mathematicians, scientists, shipowners, industrialists, naval officers and marine engineers – even a head of state (Peter the Great, Tsar of Russia). Some names will be familiar like James Watt and William Froude and nearer our day, Hyman Rickover, others less so.

The book is divided into five periods, Pre-1800, and then four 50-year blocks. Each starts with a useful summary of developments during the period, with a somewhat idiosyncratic chronology of key dates. Appropriately the first biography is Archimedes of Syracuse. The remaining 23 pre-1800 names divide half and half British and continental pioneers.

This period laid the practical and theoretical foundations which enabled the next half century to develop both iron hulls and steam propulsion. Robert Napier, a shipbuilder and marine engineer, trained many notable engineers who reached the top of their profession. To a wider public, Isambard Kingdom Brunel will be the best known.

Part 3 is sub-titled Naval Architecture comes of Age 1850-1900. Here are those who refined the art and science into practical engineering – William Froude (builder of the first modern towing tank), William Rankine (whose textbook "Shipbuilding Theoretical and Practical" publicised the basics of ship structures and much else).

This period also saw the rise of the industrialists who capitalised on their technical and business acumen to develop large companies. William Armstrong (hydraulic machinery to guns to ships), Charles Palmer (pioneer of steam colliers, forerunners of today's bulk carriers, at whose works at Jarrow on the Tyne the iron ore entered at one end and the finished ship came out at the other), Edward Harland (whose name is perpetuated to this day coupled with Wolff in Belfast).

Pioneer founders of the Institution get a place, John Scott Russell, Rev Joseph Woolley, Edward Reed and Nathaniel Barnaby, who together with son Sydney and grandson Kenneth formed a notable dynasty – the latter writing the review of the Institution's first hundred years. This period saw the growth of the classification societies, featuring Benjamin Martell and Bernard Waymouth, both of Lloyds Register who celebrate their 250th anniversary this year.

Part 4 is entitled The World Wars 1900-1950, so perhaps not surprisingly features several associated with warships – Directors of Naval Construction William White and Philip Watts, and America's David Taylor, he of the eponymous model basin. With the continuing growth in ship size and speed, propulsion machinery needed to develop much higher powers. So we read of Charles Parsons and Carl de Laval of steam turbine fame, and Rudolf Diesel. Supporting technologies are not neglected – Oscar Kjellberg (welding), Robert Macgregor (steel hatch covers) plus one civil engineering contractor turned shipbuilder, Henry Kaiser who used his skills for the mass production of ships during WW2 in the USA.

Part 5 A Global Profession 1950-2000 is the shortest with but 12 worthies, now all deceased. So perhaps there will be room for others to be added later to this era. Well known authors include the prolific Edmund Telfer and Cuthbert Pounder, whose book Diesel Engines has gone through many editions. As well as 'big ship' folk, those associated with yachts or lifeboats or high speed craft are not forgotten.

It is noticeable that many subjects rose to eminence at quite young ages, in an era when one talented individual really could make a difference. Maybe this accounts for the large proportion of Scotsmen who are featured, reflecting that the Clyde was the pre-eminent shipbuilding region of the world for the best part of a century. With today's huge corporations and amorphous technical teams, a similar brilliant technical innovator has less opportunity of achieving worldwide recognition.

Well researched by a knowledgeable author who has drawn on many sources to create a readable and well produced compendium. Associated with each biography is a short list of the subject's publications or papers related to his work or a published obituary – a source that will be increasingly denied to future writers, as most technical publications have ceased printing such. In some cases a design associated with the individual is illustrated, and in other cases a portrait, but overall there are disappointingly few of the latter.

This is a book you can dip into in no particular order and always find something of interest. Here are well known names you might wish to learn more about – Guglielmo Marconi, Samuel Plimsoll, or Clement Mackrow (he of the *Naval Architects Pocket Book* – no such compendium being available to today's young naval architects). Overall a worthy tribute and an inspiration to naval architects everywhere. *NA*

Bulk loading lore earns stern rebuke

Dear Sir,

Recently in Athens I presented to the 2009 RINA conference on the Design and Operation of Bulk Carriers a paper entitled '*Naval Architects - are they out of touch with bulk carrier operations?*'

I did so to bring attention to what I believed were the failures of classification societies, ship designers and builders to provide mariners with some of the information and tools required to operate bulk carriers safely and efficiently.

Some years ago, when it was first noticed that many bulk carriers had been provided, in their stability booklets, with unworkable 'Typical Loading Sequences', the International Association of Classification Societies (IACS) was persuaded to issue Recommendation 83 'Guidance for Loading/Unloading Sequences for Bulk Carriers', but, despite this, some stability booklets still include cases with loading sequences that put the ship 3m by the head, (ie with the bows 3m deeper in the water than the stern), that only require deballasting to start when half the cargo has been loaded or which leaves one of two loaders sitting idle for hours. I realise that most experienced bulk carrier officers never need to use the typical loading sequences, but for those that do this dodgy guidance is a disaster.

The carrying of cargoes of steel coils is, from the accounts I have received from various parts of the world, riddled with confusion for many bulk carriers, particularly those built before 2006, as to the tonnage they can carry, with P&I clubs, classification societies and Arthur Sparks, in 'Steel Carriage by Sea', all giving different advice. The industry seems very reluctant to grasp this nettle; meanwhile those who know, and play by, the rules continue to be penalised.

My presentation questioned the effectiveness of ventilators set in the hatch covers of bulk carriers for ventilating the ends of holds and deplored that ships were given no information about the acceptability of 50tonne loaded fork lift trucks working on the tanktop. Also proposed was a clearer rendering of the contents of the IMO Circular, which provides guidelines to the master for avoiding dangerous situations in adverse weather and sea conditions.

Finally I drew attention to the way in which the Australians, Americans and Canadians, for valid safety reasons, require grain stability calculations which differ from those required by the International Grain Code and accepted by most other countries, thus creating confusion for mariners whose calculations must meet different requirements in different places.

My reason for raising these matters in *The Naval Architect* is that I believe that naval architects - both those in positions of authority and young entrants to the profession - should be aware of a possible problem for which at least two remedies are available. More consultation with users of the ships designed and approved by naval architects is possible, and more time spent aboard ships in service to observe problems can surely be arranged with shipowners.

A copy of my presentation to RINA can be obtained by applying to me at JackIsbester@aol.com and I would welcome any interest shown by naval architects in what seems to me to be an important issue.

Captain Jack Isbester, ExC, FNI
Tiptree, Essex, England

Dear Sir,

In his letter entitled "Overstating the green's case for emission control?", published in the June 2010 issue of *The Naval Architect*, Capt Amos Cohen queries if ship emissions can be compared with a state's emissions.

He goes on to suggest that this comparison can be likened to that of comparing a tomato with a potato, inferring difference. However, as any gardener will confirm, these two are members of the same family and consequently should not be grown in close proximity, lest blight be transferred from one to the other.

In order to maintain the lack of comparability of emissions, perhaps "chalk and cheese" might have been a better comparator,

Yours sincerely,

Brian J. Russell,
MRINA and erstwhile gardener.

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